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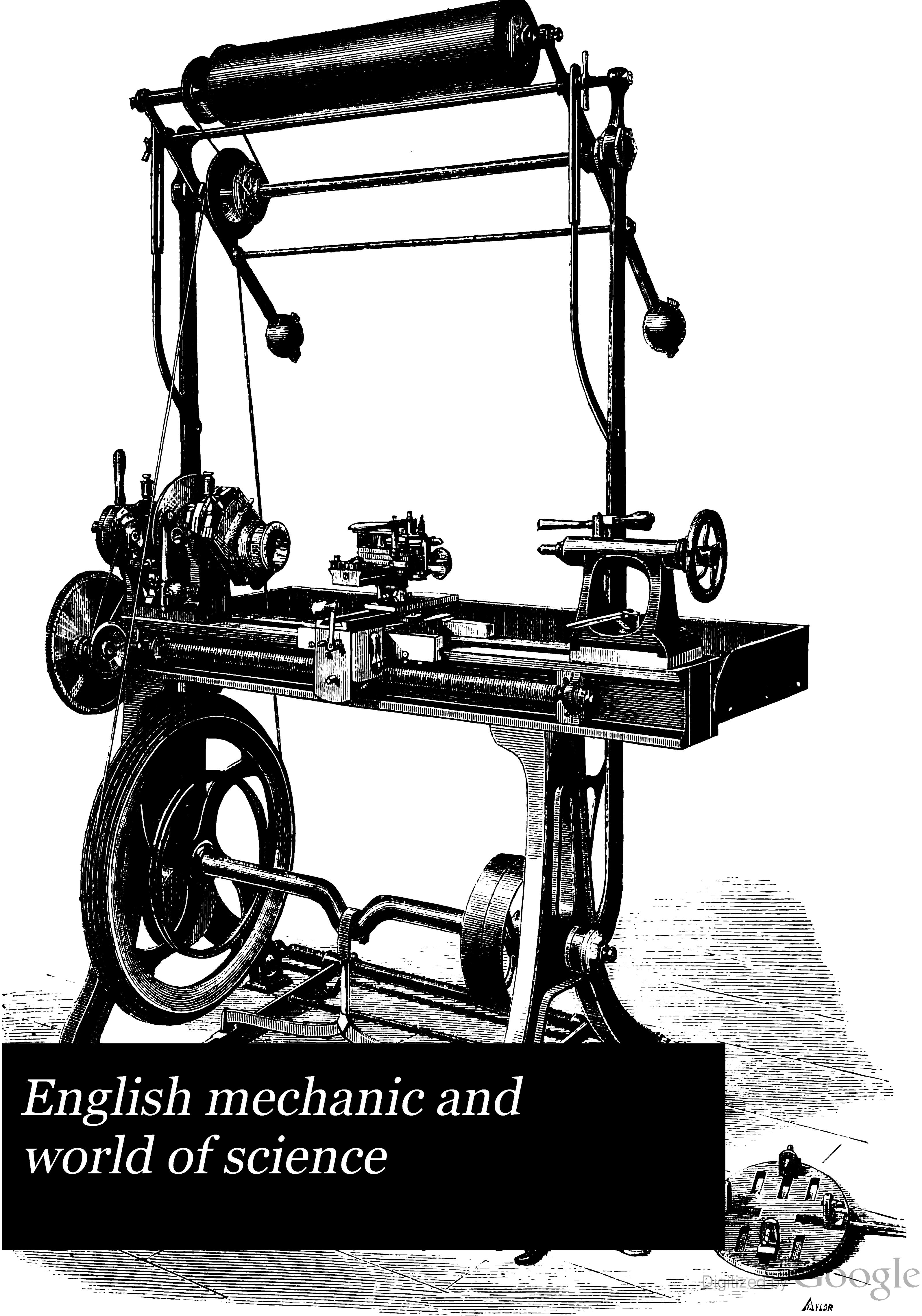

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THE

ENGLISH MECHANIC

AND MIRROR OF SCIENCE AND ART.

OURSELVES AND OUR SUBSCRIBERS.

AS promised last week, the English Mechanic and Mirror of Science appears *this* week in an enlarged size and an *altered form*. In putting the advertisement pages outside, we have acted in obedience to a generally expressed wish on the part of our subscribers. No doubt the publication will be subject to some disadvantages from this change, as it will be less exhibited in shop windows, and will therefore be less under the eye of the passing public. On the other hand, our subscribers, as we intimated last week, will derive decided advantages from the alteration, and they may easily make up for any disadvantage we may suffer by introducing the work to an enlarged circle of readers.

We have increased the size of the paper because we desire to satisfy the largest number of subscribers. Some may say, Why not increase the *number* of pages, instead of increasing the *size* of the pages? Our answer is, Because increasing the number of pages involves the necessity of double machine labour, and consequently double expense. When we have from time to time given a Supplement of Eight Pages, it has cost us nearly as much for machine work—that is, for working off the sheets from the type, as we have paid for machining the ordinary impression of thirty-two pages; or, in other words, it costs as much to work off a small sheet as a large one. As it became necessary to give additional space, it was also necessary that the size of the page should be increased.

During the past fortnight we have received, in response to our invitation, many suggestions for the improvement of Our Journal, with some of which we shall comply. More than one has suggested that the contents of each number be placed on the outside page. This we have done. As it may be expected, different readers and correspondents are desirous that their favourite subjects should receive more especial treatment. If we complied with such requests we should favour some at the expense of others, and so to some extent prevent the primary object we have in view —that of providing the largest amount of useful information for the largest number of readers. It should, however, be borne in mind that the English Mechanic is to a large extent what its correspondents make it. Its subscribers may be considered as members of a vast mutual improvement society, who consider it a duty or a privilege to instruct each other. One person asks for information on some particular subject, and another person, several hundred miles away, it may be, sends it, not only without fee or hope of reward, but at his own expense. He, however, has the satisfaction of knowing that his letter, suggestion, or recipe may be of benefit to thousands besides the one who specially asks for the information. The English Mechanic is therefore a reflex of the intelligence and the generosity of thousands of subscribers. Its contributors are numbered not by units, as in most publications, but actually by thousands. Each one contributes according to the wealth of his intelligence, or his desire to impart it to others. Any one who has listened to debates in mutual improvement societies, at an educational or scientific conference, or in Parliament, knows the standard of eloquence varies with the speaker. Some speak well, and to the point, and others occupy time to very little purpose; say what others have said before them, and in a less effective way, or say things that are erroneous. It is pretty much the same in our English Mechanic's national improvement society. Some correspondents write about what they thoroughly understand in appropriate language; others are less fortunate. They either ask questions which others have asked before, or go over ground which others have trodden with more effect. But woe betide them if they make mistakes. Then a half a dozen are ready with pen and ink, not, as they say in the House of Commons, to catch the Speaker's eye, but to seize the Editor's attention, in order to correct the mistake, and rebuke, not always in the most parliamentary language, the offender. Sometimes a comparatively puerile question evokes an elaborate reply, or an incorrect answer leads to an interesting controversy. This picturesque variety constitutes the chief charm of the English Mechanic. In the House of Commons, any member has the right to ventilate his own opinions on any special subject, and we have frequently been surprised to see a poor speaker on his legs "in that oldest temple of freedom in the world" speaking in a prosy manner to almost empty benches. Take away his right to do so, and you immediately vitally impair the value of the house as a consultative and representative assembly. As in the House of Commons so in the English Mechanic. Sometimes, it may be, a somewhat illiterate man asks what may be supposed by many readers an unimportant question. But it is not unimportant to the asker, and possibly to thousands of others similarly situated. If, then, the well-informed will be tolerant of the ignorance of their brother readers, sympathise with them, and do their best to enlighten them, the fundamental purpose of this journal, under, its present management, will be answered. Every correspondent may contribute something to the common stock for the common good, and by so doing he will in no way impoverish himself, but do something towards enriching all.

Several years since, when passing through the streets of Liverpool, we were accosted by a pretty little girl. We shall never forget her bright blue eyes, and her hair, which fell like woven sunbeams over her shoulders. This pretty little creature asked us, of all things in the world, *to buy a brick*, showing us at the same time a small engraving of a brick on a card. We asked her what she meant, and she said they were about to build in some part of the north of England a temperance hall, and that it was computed that each brick in the building, and the labour of putting it there, would cost about a penny, and she wanted us to assist to build the hall to the extent of a single brick. Did she possess fewer charms, and speak less musically, we should have bought a brick. As it was, though pennies were of some importance to us then, we bought more than one, and have the satisfaction at this moment of remembering that we assisted in a very small way in raising a temperance hall. So it is with the contributors to the English Mechanic. Each one, by replying to a single query asked by a brother reader, contributes his brick to the Temple of Knowledge.

Our readers will be glad to know that for some time past the English Mechanic has been increasing its circulation and its influence week by week. It circulates at the present time not only more than any scientific publication in this country, but more than all of them put together. This is authoritatively stated. It is right that our correspondents should know to what a large number of readers they speak, and that our advertisers should also know to what a large constituency they appeal.

TIME.

By a Fellow of the Royal Astronomical Society.

(*Concluded from page* 649, *Vol.* X.)

WE must, however, return to the Transit itself, the use of which, as the reader will be by this time prepared to learn, is to observe the passage of Celestial objects over the Meridian, either for obtaining the time or determining what is called Right Ascension. The way in which observations are actually made is this. Just before the expected time of transit of any given star, the telescope is elevated, by means of its altitude circle and level, to the height proper for its perception. Now what the observer has to do is to note with all imaginable accuracy the instant of the star's passage over each of the wires, and this he does by listening to the beats of the clock while regarding the star, and we now see the importance of the clock having a clear sharp tick. As it will very rarely happen that the star exactly *on* a wire at the exact instant of the clock's beat, we have to estimate the fraction of a second. This is done by comparing its distance from the wire at the beat before it crosses it, with the distance at the beat after it crosses it. Reference to Fig. 6 will explain this.

Remembering that as the telescope inverts, stars seem to come into the field at the right-hand side, and to leave it on the left, if we imagine that, in the figure, a having entered at the righthand side is at *a* at the 17th second of any given minute, and at *b* at the 18th, then we should estimate that it was on the wire itself at 17·8s. Or, again, if it were at *c* at 52, and at *d* at 53, we should put down its time of crossing the wire as 52·5s., and evidently the higher the power employed, the more rapid will be the apparent motion of the star, and the more accurate these subdivisions. The object of observing stars between the two horizontal wires is that all transits should be taken over the *same parts* of the vertical ones. Supposing, then, that the hour, minutes, seconds, and fraction of a second at which one star was upon each of the five wires is noted, all we shall have to do is to add the five observations together and divide the result by 5 to obtain the instant of the star's passage over the central wire, which, if the instrument be in adjustment, will coincide with the meridian. In the case of the Sun, Moon, and Planets, which present sensible discs, as of course it is the passage of their *centres* over the Meridian which is the phenomenon to be observed, the mode adopted being to take the time of passage of the west or preceding limb over all the wires, and then to do the same with the east or following limb, the mean of these two sets of observations being evidently the instant of the transit of the centre or the body we are observing. The "Nautical Almanac" gives the Right Ascension (or distance in sidereal time *eastwards* of the Vernal Equinox or first point of Aries) of 148 standard stars, as well as that of all the members of the Solar System; so that, as our Sidereal Clock marks, or should mark, Sidereal Noon, or 0h. 0m. 0s. when this first point of Aries is on the Meridian, we have only to compare the observed time of passage of any given Star, &c., with its Right Ascension, as given in the "Nautical Almanac," to find out the Error of the Clock. It will further be instantly seen that a comparison of the Clock Errors day after day will give us the Clock Rate. An actual example of a transit, taken at random from our Transit book, under the date of the 9th of October, 1869, will exemplify a good deal that we have been saying:—

a Cygni	H.	M.	S.
1st wire	—	36	44·3
2nd	—	87	10·2
Centre	20	37	86·1
4th	—	38	2·0
5th	—	38	27·9
			120·5
			·2
Apparent Transit of *a* Cygni	20	87	36·10
True Right Ascension	20	36	59·72
Clock Error	+		36·38

It will be noticed that instead of adding up the whole of the five observations, and dividing the result by 5, we have merely added the seconds together and multiplied the result by ·2; $\frac{2}{10}$ of anything being obviously $\frac{1}{5}$ of it. The only precaution necessary is to add or subtract as many fifths of a minute, or 12 seconds, as shall make the result correspond with the number of seconds shown at the middle wire; because in reducing a really good observation, the decimals of a second are all that we need take account of.

It may however, have occurred to any one who has carefully followed us so far, suppose that we do get the exact error and rate of a Clock, as far as *Sidereal* time is concerned, what use can we make of this when we have got it? Well, Mean Solar time can, by an easy process, be derived immediately from Sidereal; but perhaps the simplest way for a beginner is to compute the *mean* time of Southing of the object he proposes to observe; and he can then compare its transit directly with an ordinary Clock. This is most simply effected by the following rule. From the Right Ascension of the star or planet, as the case may be (adding, if necessary, 24 hours), subtract the Right Ascension of the Sun at the previous Mean Noon, given in the "Nautical Almanac" at p. II. of every month under the head of "Sidereal Time at Mean Noon." The remainder will be the Sidereal hours, minutes, and seconds after Mean Noon at which the body in question will cross the Meridian. Turning this into Solar time by the aid of the table on pp. 506 and 507 of the "Nautical Almanac," we shall have the instant which a good clock, regulated by Mean Solar time, should indicate when our star is on the middle wire of the Transit. Supposing that our reader has the "Nautical Almanac" for this year before him, we will illustrate this rule by a couple of examples—and, first, At what hour will η Ursæ Majoris South on the night of the 12th of March at Greenwich? We find on p. II. of the month of March, that on the day we have selected the Sidereal time at Mean Noon is 23h. 19m. 43·28s. Turning, now, to p. 364, we see that the Right Ascension of η Ursæ Majoris at the same date is 13h. 42m. 26·04s. Adding, according to the precept, 24 hours to this, we get 37h. 42m. 26·04s. Then subtracting from this the Sidereal time at Mean Noon—thus:

	H.	M.	S.
	37	42	26·04
	23	19	93·28
we get	14	22	42·76

as the number of Sidereal hours, minutes, and seconds after the Noon of the 12th of March, when this star will cross the Meridian. Converting this into Mean time by the aid of the table on pp. 506 and 507 of the "Nautical Almanac," in this way:—

Sidereal time. H.	M.	S.		Mean Solar time. H.	M.	S.
14	—	—	=	13	57	42.3862
—	22	—	=	—	21	56 3958
—	—	42	=	—	—	41·8853
—	—	0·76	=	—	—	0 7579

we finally obtain 14h. 20m. 21·4252s. as the mean time of transit of the Star referred to, or the instant which a good ordinary clock ought to indicate as η Ursæ crosses the middle wire. This will be seen to be 2h. 20m. 21·4s. after midnight on the 12th of March. Or, again, What will be the mean time of transit of Sirius on the 11th of April? From the Right Ascension of Sirius, 6h. 39m. 24·82s., we take the Sidereal time at Mean Noon, 1h. 17m. 59·85s.; we get 5h. 21m. 24·97s. Converting this as before into Mean time we obtain 5h. 20m. 32·31s. as the instant by a good ordinary clock or watch that Sirius will be on the Meridian. We may obtain the clock rate without any reduction of the observation, if we bear in mind that any given star ought to return to the Meridian after an interval of 23h. 56m. 4·09s., as shown by a clock or watch indicating ordinary or Mean time. We believe there is a little book just published called "How to keep the Clock Right," the author of which we fancy must proceed upon this principle of observing this interval of 23h. 56m. 4·09s. between the successive returns of any particular star to some fixed point in the Heavens; but we have never seen it.

Into the adjustment of the Transit and the corrections to be applied to its indications, we shall not here enter. Should the want of information on these points be felt, and the desire for it be expressed, we might at some future time perhaps, enter fully into detail on this subject. As it is, we feel that in giving directions for making these adjustments and corrections, we should be addressing a very limited public indeed, and occupying precious space, which we have already considerably trenched upon. Our present, and we would fain hope not wholly unsuccessful, endeavour has been to present in a simple form an exposition of the mode in which the succession of natural phenomena is made subservient to the purpose of the equable subdivision of Time; and so, more by the method of illustration than in a merely didactic way, to remove some of the vagueness which attaches to popular conceptions on this subject.

ON THE PHENOMENA OF COMBUSTION.

SPECIAL REPORT.

ON Monday evening, March 6, in the Lecture Theatre of the Society of Arts, the first of a series of four Cantor Lectures on Combustion was delivered by Dr. Benjamin Paul, F.C.S. He first showed that combustion was generally a chemical action involving the union and material alteration of two substances with which we were familiar in the use of fuel and in the production of light; was a cause of oxidation, the one material being yielded by fuel and oil of tallow, and the other being furnished by the atmosphere. The second point to which he called attention was that combustion took place in several different forms; that there were several conditions essential for active combustion or burning; that two of the most prominent effects of combustion were the evolution of heat and light, and then there was between all the phenomena attending combustion, a quantitative relation which was constant and uniform—that is, the relations between the quantities of two materials uniting in such a way as to constitute combustion, and the quantity between the materials uniting and effects produced, either the amount of heat generated by their union or between the quantities uniting, and some effect due to the heat produced by them. Lastly, he pointed out that there was a difference between the temperature and the quantity of heat contained in matter.

The precise title of the second lecture, delivered on Monday, the 13th inst., is as follows:—"Use of fuel for domestic purposes, as a source of motive power, for industrial operations not requiring intense heat, distillation, evaporation, &c., and for producing cold; varieties of fuel." The time at the disposal of the lecturer did not allow of his dwelling upon all these topics in detail, but after some general remarks, he proceeded to observe that temperature could only, in a certain limited sense, be taken as measure of heat. The use of coal for domestic purposes had only become general during the last hundred or hundred and fifty years; and although the means of using it were considerably improved, yet many of the fire-places now in use were very defective, inasmuch as the greater part of the heat produced from the fuel was wasted. In a mass of fuel in a state of bright glow, the quantity of heat that was radiated in the same manner that light was diffused, varied from about a quarter to one-half of the whole. In many fire-places, a great deal of heat, instead of being radiated into the room, was radiated up the chimney. Great economy, as far as fuel was concerned, was effected by the use of close stoves, which, on the Continent, especially in Germany and France, was almost universal. By the use of these stoves, a small amount of fuel sufficed to keep apartments warm. Similar stoves had been introduced into this country by Dr. Arnott, but had never found much favour with the English. Although chimneys were universal here, they were by no means so in all parts of Europe. In certain parts of Italy and Greece but few of the houses had chimneys, the only means of warming rooms being by open braziers, like those used by the ancient Greeks and Romans. This mode of burning fuel was open to the serious objection that the air became vitiated, owing to no mode of escape being allowed to the carbonic acid gas. After describing some of the more recent improvements made in fire-places, the lecturer offered a few remarks upon the use of gas for domestic purposes. The recommendations in favour of gas were convenience, cleanliness, readiness for use as well as for being dispensed with. Yet, notwithstanding these recommendations, it must be always regarded as a very dear kind of fuel when compared with coal or any fuel of that nature. Speaking next of fuel as a source of motive power, the lecturer remarked that this was undoubtedly one of the most important of all the uses to which fuel could be put. Its use in this respect was based upon the principle that heat being itself a condition of energy was capable of being converted into mechanical force. It was chiefly through the medium of water transformed into vapour that this motive power was produced. In this case, the heat generated by combustion was expended in vapourising the water, and in such cases there was a definite relationship between the quantities of heat expended and of water vapourised. Every pound of boiling water required 966 units of heat for converting it into steam, or just five and a third times as much heat as was requisite to raise the temperature of a pound of water from the freezing to the boiling point. The lecturer then alluded to the relationship between heat and mechanical energy, and in doing so briefly traced the history of the mechanical development of heat from the production of

FIG. 20

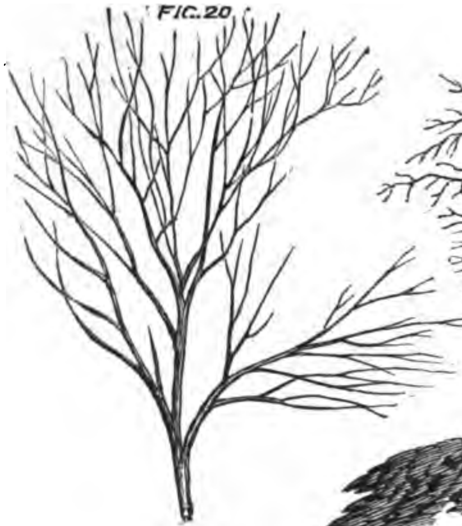


FIG. 21

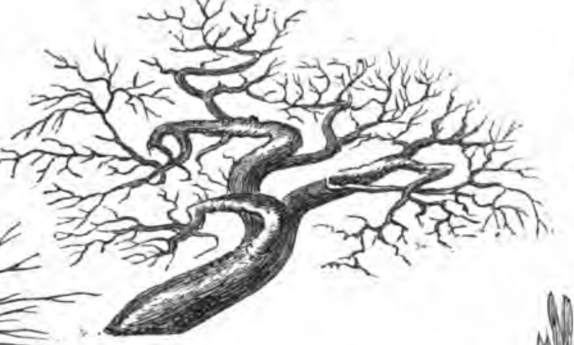
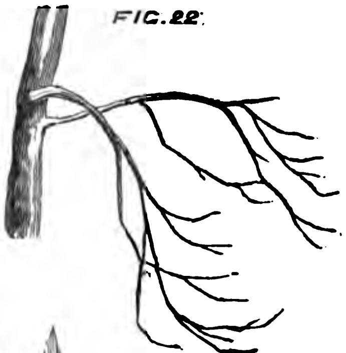


FIG. 22



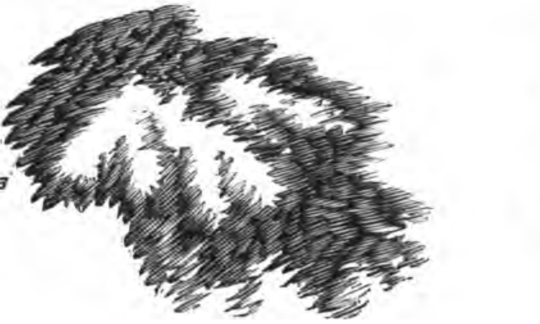


FIG. 23

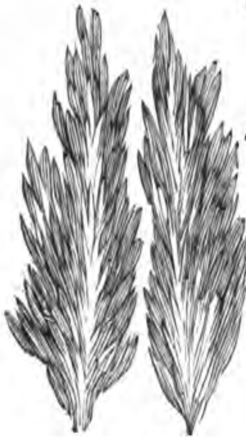


FIG. 24

deep shadows between, the upper masses shutting out the light of the sun from below them. Still further off a tree is a mass of gradated, grey shadow, yet even then the general form suggests the kind of tree. In buildings, again, details become more and more indistinct as we go further from them. Doors and windows fade into oblong patches of shade (unless the sun shine brightly upon the glass), yet still there will be always a suggestion, so to speak, of detail. It is a mistake to make the distance always paler than the foreground. Very generally the middle distance is the darkest part of the picture. It is delicacy of treatment, not paleness, that gives distance, and the contrast of a vigorously expressed foreground. Our allotted space is now filled, but it is hoped that even this slight sketch may assist those who intend to devote their spare time in the ensuing summer to the most delightful study possible—a study that always repays our labour a thousand-fold. The writer strongly recommends the brush and sepia as a substitute for pencil or pen and ink, as being, after a little practice, much more manageable, and affording the most rapid method of work. For passing effects of light and shade, such as we specially see on cloudy, threatening days, when momentary gleams of sunlight flash across the scene, this medium is perfect. But whether by pen, pencil, or brush, let nature teach, and don't try to teach nature. J. L.

MILBURN AND CO.'S APPARATUS FOR DESICCATING GRAINS.

(*Illustrated on page* 13.)

THE fact that the spent grains from our breweries and distilleries, when properly dried, become a valuable food for horses and all kinds of cattle has been recognised for some time past, although we believe it is only within the last few years that systematic attempts have been made to turn this knowledge to profitable account. The question of desiccating grains has received very careful attention at the hands of Messrs. Milburn and Co., of 76, Church-lane, Whitechapel, and they claim to have perfected an apparatus which successfully solves the problem they set themselves to work out. A perspective view of the machine is shown at Fig. 1 of our engraving; Fig. 2 being a vertical section through the feeding apparatus. The dimensions of the machines are about 19ft. in length and 4ft. in diameter. A is a fixed cylinder, which consists of two boiler plate shells, the 2in. annular space between them forming a steam chamber I. B B are revolving shelves, and C is a self-acting screw for feeding the grains from the hopper D into the machine. A connection is made with the steam boiler by means of the pipe E, through which the jacket I is supplied with steam. The condensed steam escapes at F. G is the exit for the dried grains, whilst H is a ventilating flue for carrying off the vapour arising from the grains or other substances being operated upon. The action of the machine is very simple:—The wet grains are fed in through the hopper, and are gradually carried to the other end of the machine by the revolving shelves, where they are delivered dry. The rate at which delivery takes place is of course governed by the degree of dryness required, and is regulated by the working speed of the engine which drives the machine. The degree of heat imparted is also under perfect control. The machines at Messrs. Milburn's works are driven by a 10-horse power engine, steam to which—and to the dessicating machines—is supplied from a 40-horse Cornish double-flued boiler, of which there are three at these works. Each of the machines dries about 100 quarters of grains per week, and from 22 to 23 quarters of wet, produce 1 ton of dry grains.

Another form of this apparatus has just been completed by Messrs. Milburn, who have combined the drying machine with a portable steam engine. This arrangement is seen in perspective at Fig. 3 of our engraving, Fig. 4 being a part cross section and front end view. Here A is the steam space in connection with the water space below; in other words, this is the boiler of the engine. The revolving shelves are seen at B; C is the flue leading from the furnace to the funnel, and D is the exit for the dried material. The operation of drying is the same as in the machine we have previously described, the difference being only in the construction of the apparatus, the one being fixed and driven by an independent engine, the other being portable and having its driving power attached to it and transported with it. This machine will be found very valuable to agriculturists and others for drying corn, seed, pulse, roots, &c., also for coffee planters and others, and, being mounted on wheels, it can be readily removed from place to place.

MECHANICAL MOVEMENTS.

"THE MECHANIC," a penny publication, which is to-day incorporated with the ENGLISH MECHANIC, gave from week to week a series of "Mechanical Movements," from a useful little work of that name, compiled by Mr. Henry J. Brown, the editor of *The American Artisan*. We shall so far follow in the footsteps of the absorbed penny journal as to take weekly from the same source a few specimens of its illustrations and descriptions.

1. A mode of obtaining an egg-shaped elliptical movement.

2. A movement used in silk machinery to guide the silk on to spools or bobbins. On the back of a disc or bevel-gear is secured a screw with a tappet-wheel at one extremity. On each revolution of the disc the tappet-wheel comes in contact with a pin or tappet, and thus receives an intermittent rotary movement. A wrist secured to a nut on the screw enters and works in a slotted bar at the end of the rod which guides the silk on the bobbins. Each revolution of the disc varies the length of stroke of the guide-rod, as the tappet wheel on the end of the screw turns the screw with it, and the position of the nut on the screw is therefore changed.

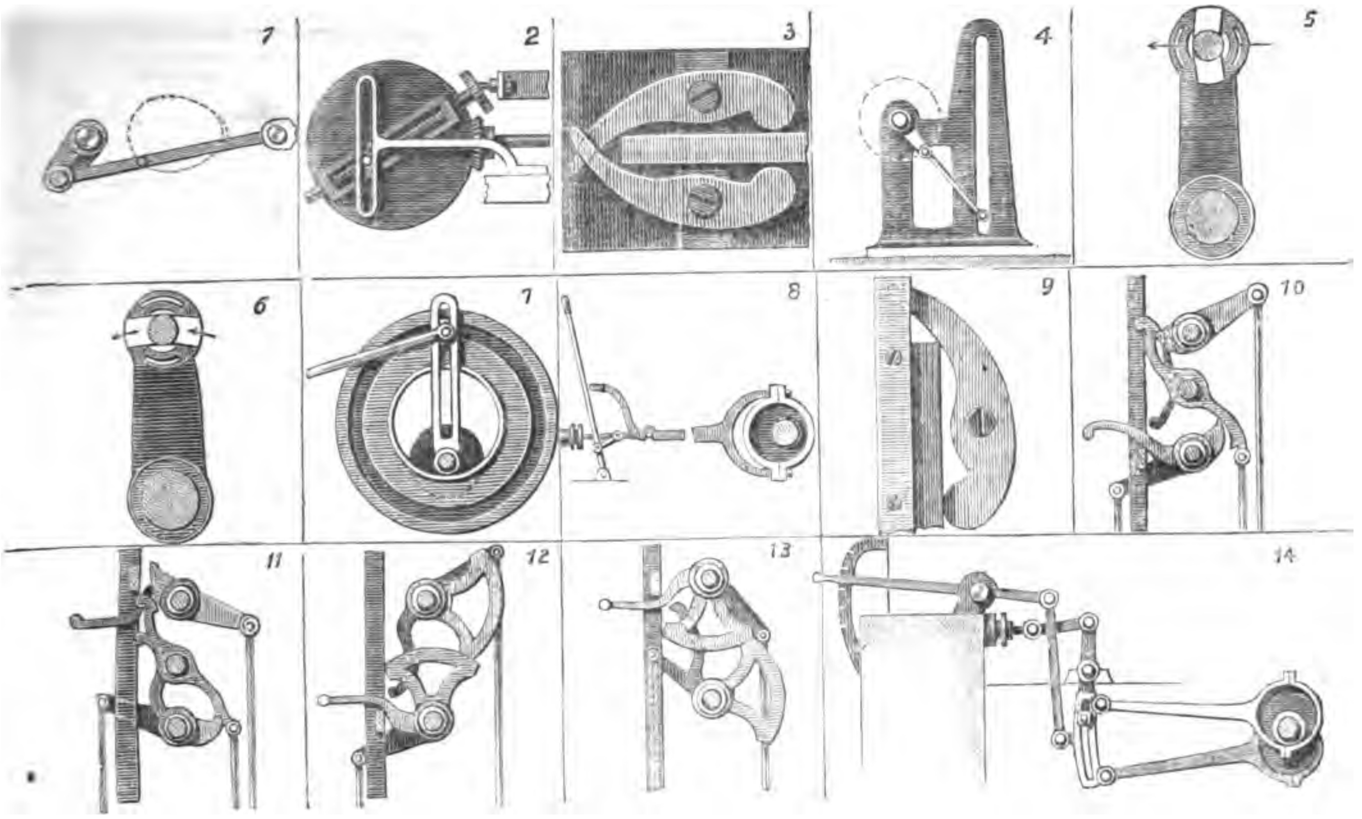
3. Carpenters' bench-clamp. By pushing the clamp between the jaws they are made to turn on the screws and clamp the sides.

4. A means of giving one complete revolution to the crank of an engine to each stroke of the piston.

5 and 6. Contrivance for uncoupling engines. The wrist which is fixed on one arm of the crank (not shown) will communicate motion to the arm of the crank which is represented, when the ring on the latter has its slot in the position shown in 5. But when the ring is turned to bring the slot in the position shown in 6, the wrist passes through the slot without turning the crank to which the said ring is attached.

7. Contrivance for varying the speed of the slide carrying the cutting tool in slotting and shaping machines, &c. The driving-shaft works through an opening in a fixed disc, in which is a circular slot. At the end of the said shaft is a slotted crank. A slide fits in the slot of the crank and in the circular slot; and to the outward extremity of this slide is attached the connecting-rod which works the slide carrying the cutting tool. When the driving-shaft rotates the crank is carried round, and the slide carrying the end of the connecting-rod is guided by the circular slot, which is placed eccentrically to the shaft; therefore, as the slide approaches the bottom, the length of the crank is shortened, and the speed of the connecting-rod is diminished.

8. Reversing-gear for a single engine. On raising the eccentric-rod the valve-spindle is released. The engine can then be reversed by working the upright lever, after which the eccentric-rod is let down again. The eccentric in this



case is loose upon the shaft and driven by a projection on the shaft acting upon a nearly semicircular projection on the side of the eccentric, which permits the eccentric to turn half-way round on the shaft on reversing the valves.

9. This only differs from 3 in being composed of a single pivoted clamp operating in connection with a fixed side-piece.

10 and 11. Diagonal catch or hand-gear used in large blowing and pumping engines. In 181, *the lower steam-valve* and upper eduction-valve *are open, while the upper steam-valve* and lower *eduction-valve* are shut; consequently the piston *will be ascending.* In the ascent of the piston-rod the lower handle will be struck by the projecting tappet, and, being raised, will become engaged by the catch and shut the upper eduction and lower steam valves; at the same time, the upper handle being disengaged from the catch, the back weight will pull the handle up and open the upper steam and lower eduction-valves, when the piston will consequently descend. 11 represents the position of the catchers and handles when the piston is at the top of the cylinder. In going down, the tappet of the piston-rod strikes the upper handle and throws the catches and handles to the position shown in 10.

12 and 13 represent a modification of 10 and 11, the diagonal catches being superseded by two quadrants.

14. Link-motion valve-gear of a locomotive. *Two* eccentrics are used for one valve, one for the *forward* and the other for the backward movement of the engine. The extremities of the eccentric-rods are joined to a curved slotted bar, *or*, as *it* is termed, a *link*, which can be raised or lowered by an arrangement of levers terminating in a handle, as shown. In the slot of the link is a slide and pin connected with an arrangement of levers terminating at the valve-stem. The link, in moving with the action of the eccentrics, carries with it the slide, and thence motion is communicated to the valve. Suppose the link raised so that the slide is in the middle, then the link will oscillate on the pin of the slide, and consequently the valve will be at rest. If the link is moved so that the slide is at *one* of its extremities, the whole throw of the *eccentric* connected with that extremity will be *given to* it, and the valve and steam-ports will be *opened to* the full, and it will only be toward the *end of the* stroke that they will be totally shut, consequently the steam will have been admitted *to* the cylinder during almost the entire length of each stroke. But if the slide is between the middle and the extremity of the slot, as shown in the figure, it receives only a part of the throw of the eccentric, and the steam-ports will only be partially opened, and are quickly closed again, so that the admission of steam ceases some time before the termination of the stroke, and the steam is worked expansively. The nearer the slide is to the middle of the slot the greater will be the expansion, and *vice versa.*

(*To be continued.*)

THE EAR.—ITS USES AND ABUSES.

By Dr. Ussher.

If I were asked to point out the most complex part of the body in the smallest space, I would indicate the human ear. It is the solitary instance of bones, joints, and muscles not concerned in locomotion or prehension, and apparently beyond our control. Our senses are correlated—each helps the other as a valuable handmaid, recognised only too vividly as such when the loss is experienced. We see people happy enough under the privation of one sense, but when the gap becomes larger, then it is an existence so blotted and blurred that comfort only comes with the certain hope that in another world all these groanings of creation will be set at rest in the perfect liberty of the children of God. The blind man, who, from his birth, has been deprived of the sense of the beautiful, who sees "men as trees walking;" the deaf mute who can never take in the beauty of song, are lightly smitten compared with those who are suddenly bereft of these luxuries of life; they will hardly adopt Pope's saying, that "whatever is, is best." Can we read the history of Beethoven's crushing calamity of deafness, stealthy in its approaches as the heavily-laden thunder-cloud, without feeling the deepest sympathy for that will-impassioned nature, weird-like in its grandeur, fierce, uncouth, rendered all the more taciturn by the master malady of his life, denied the full enjoyment of the very wonders he created, poor, independent, high-souled, he seemed at last to wrap himself within himself, preferring gloom and solitude, to such friendships as were worth his acceptance?

Forgotten at Vienna, where he is now adored, he died without the worldly consolations, Coleridge has so happily touched, and quaintly expressed, in the following lines:—

Tho' friendships differ, endless in degree,
The sorts, methinks, may be reduced to three:
*Ac*quaintance many, and *con*quaintance few,
But for *In*quaintance I know only two,
The friend I've mourned with and the maid I woo.

These were written on the occasion of seeing his little daughter in company with another child. "Who may your friend be?" asked the father. "She is an *in*quaintance of mine." Poor Beethoven! You might have flooded the world with the fruits of your unrivalled genius if woman's tender suasion had drawn you out of yourself and left you untrammelled by your galling kindred. Deafness to the musician, or blindness to the painter, who can say which is the more dire calamity? Signposts on the way to decrepitude; slackenings of speed that tell of sands nigh run out; warning chimes of a fast-fleeting three score years and ten—perhaps, a long way on this side the mark. We hear with the keenness of childhood, we feast in olfaction the glories of the summer flower-garden freshened by a passing shower, but as we advance in life we find things are not what they were, pleasures are grasped and gone—the flowers are the same, the brightness of the glowing sun is none the less, the lovely quiet of a summer's eve, with its schoolboy reminiscences—a far back vista—is brought from memory's treasure-house; friends gone from our very embrace are present in imagination, and change impresses its finger on all things. Why should it not? There is nothing perfect here. Some of us are born with decay ready imprinted, a tiny spark it may be, but soon fanned into giant dimensions, the unexpanded bud is nipped, and on all is inscribed *decay*. How often comes the expression, with a sigh, "I cannot do what I used"! No, my friends, we once could go hand-over-hand the five-barred gate; that no longer suits us; solid thews and sinews are useful but not lithesome; we now feel that we have organs that we must use with deference if they are to be lasting, although time was, I daresay, when you and I considered "a stomach" a myth, or, at best, the semblance of a reality capable of accommodating anything short of paving-stones—but pain is a reminder, physic is a reminder—notably that horrid chief remembrancer, 'Gregory's Powder," which chemists call a "Rhabarbarate of Magnesia"—barbarous enough in any sense, looking like a compound of crabs' claws prepared by loving hands, and from which escape was impossible, for if your sense caused you to eject the unsavoury morsel through your nose into the cup or giver's face, a double portion in the morning was "your shepherd's warning." This was a reminder that your future journey through life was to be crossed by ups and downs—troubles as plentiful as the sparks that fly upwards. What has all this to do with our senses and privileges? Much, I opine, considering that the better you use them the longer you will enjoy them. My labours, I trust, have not been in vain in my endeavour to lighten *your eyes*, and it will not be my fault if I fail to enlist your attentive ears. I trust Wisdom's proclamation will not be lost on you when she says, "This is the way; walk ye in it, *when* ye turn to the right hand or to the left."

The sensation is most pleasurable when a ship is in full sail, and one pair of hands can control the wheel. The compass before you, the course there indicated, and your eye ever and anon turned to the well-filled canvas, tells you all is right. The tall masts bend, and you feel her give as she flies through the water; but throw her out of her course, and as the bellying canvas flaps against the mast, you are conscious of loss of progress. Again you return to your missed point, and the breezes favour you. So I must take my course right ahead, and try and avoid a long tack.

Man being the highest of creation, has everything for his wants fashioned in the highest perfection, "a place for everything, and everything in its proper place," saves his ideas, and these tenements of his brain he occasionally lets out to queer lodgers. We will follow the same division here as in the former paper on "The Eye," considering first the external, then the inner or true ear; but first look at the temporal bone of the skull, called so because "Old Time," or Tempus, left his grey hairs thereon as a set-off against the bald vertex. In that triangular-looking portion which is the hardest in the body, was once the perfect hearing ear, there are some odd holes or so in it that used to puzzle us students when we had nothing better to do than load our brains with hard names, and devious courses of nerves, what they were related to, and what not, and what, I am rejoiced to say, I have long since forgotten, names invented to frighten one, as I thought when I came across the "mylohyoidean branch of the inferior dental of the fifth pair." Pity they didn't add some more! Now, this ear-bone contains an anatomical nut, one of the wonders of the body, seldom broken into unless a terrible fracture of the skull shatters it. The eye was placed in the front of the body, the van, as it were, the ear, as sentinel, does duty in the rear, unhapplily no protection against those who talk behind your back distilling malice. We can afford, however, to pass on, as did He "who wrote on the ground as though he heard them not." Would that our grievances were always thus recorded, to be effaced by the next passer by!

A pretty ear is one of the special ornaments—may I say vanities?—of the ladies, highly prized. To be deprived of it was a mark of infamy. To be nailed by the ear to the pump was not a pleasant process, and a durance vile with a vengeance. Earrings are nowadays as common as earwigs, an amiable weakness with women (affected sometimes by male Yankees, and others, under the delusion that they cure sore eyes, which they don't), but a graceful appendage, I must say, to the more graceful ear, common to all nations, and in this country to all classes. You see light and heavy weights, false and real gems, adorning the ear, but the beauty is in the soft, cushiony lobe, that feels elastic to the fingers—a privilege reserved for you when you are "over head and ears in love," unless you are one of those who elongate the ears of youngsters as a corrective to evil manners, a custom, let us hope, falling into desuetude, a process that did convert the "silk purse into the sow's ear," and in the days of our grown bullies at school I have known boys to be thus elevated by the monster dunces that infested our Dotheboys Halls. Some jewellers, sensible of the beauty of the lobe, do not pierce it, but encircle it with a gold wire, a mere trifling addition to the pleasure of supplying the pendants. The piercing of the ears may lead to troublesome inflammation or eruptions, as I have many times seen. Some think that the allusion of the Psalmist, "Mine ears hast thou opened," *or bored*, refers to the practice of boring an awl into the lobe (Deut. xx., verse 17), the master by that proceeding making "a servant for ever." It is a practice in the West Indies ("Wilde on the Ear") for a negro, when he wishes to attach a dog to him, to nail his ear to a door-post for the period of one day—rather a novel mode of proceeding, to say the least of it.

The ear stands out a little from the head to catch the sounds, and the hollow cup, or concha (shell), acts as an ear-trumpet; the outer rims are called respectively the helix (ελιξ) or fold, and the antihelix, peaked portion in front, is denominated the tragos (τραγος), the hairs on which are supposed to resemble a goat's beard. These, with the antitragos, opposite the tragos, complete the auricle, or external ear, so far as you might slice it off. The passage to the ear, or auditory passage, is partly formed of cartilage, as is the ear proper, and this is attached to a bony canal pretty firmly. Blood is not sent in very extravagant supply to the ear, save in the very amiable and tell-tale process of blushing (a nervous act), and by no means the tell-tale process it is supposed to be—although sometimes a charming thermometer of the thoughts—albeit a gentle suffusion, but acceptable to some eyes as the roseate blush of morn to the expectant shepherd.

It used to be said when your left ear was red somebody spoke well of you—that I can't be certain of; but when both ears suddenly redden you may set it down, on my authority, that the parties have not *paid their doctor's bill*. Why one ear should be hot to tingling and the other quiescent, is one of those things we have yet to learn, unless it be that one carotid artery is larger than the other, and this may account for the common fact that one whisker is smaller than the other. Special muscles are attached to the ear which cause it to raise itself when any special message is telegraphed—not under post-office surveillance. Some people can move the ear upwards and downwards. I am favoured with that addition to my accomplishments. When the ear is outstretched, increased hearing is the result. Look at the sharp terrier, how movable his auricles are; how he fixes them forward when he smells a rat, and, with forepaws outstretched, is ready for a spring. Watch the activity of the ear in the graceful greyhound; or observe the cavalry charger with outstretched ear patient for the call to arms, eyes intent, nostrils dilated, muscles in impatient quiver, as if horse and rider were all one. When I had the misfortune to be a parish doctor, drawing the munificent stipend of £60 per annum, more or less, and obliged to keep a horse to do the work, I used to talk to my horse as I went along, and watch his ears moving as if he understood me, and the poor beast evinced his gratitude for kindly care far more so than some of the patients. He, as a goodly Houyhnhym, appreciated my kindly qualities, except when I passed a ball down his throat, and patted him into an appreciation of the bolus. If the power of speech had not been denied to him, he would surely have exclaimed, "Save me from my friends!" Would that we were always as ready to the call of duty as those dumb creatures, and ever grateful! The elephant has a lazy, comfortable-looking ear, tapering in its point, as if nature intended it as a whip for adventuresome flies; and we must not overlook the dear, old patient donkey, patient even to the burthen of the fat Brightonese ladies, done up in hats and feathers, chignons and panniers. No wonder the poet should exclaim:—

> Poor little foal of an oppressed race,
> I love the quiet patience of thy face.

The animal begets its kind care and thanks to the society for its protection. We seldom see the beast of burthen bludgeoned as in days gone by, or assailed with the savagery of a Balaam.

Fish moving quickly through the water, or birds with the speed of an arrow flying through the air, would be only encumbered with an external auricle, and with them it is dispensed with. Both fish and bird hear acutely enough, remarkably so the former.

Not to go back to the story of Amphion and the Dolphin, or to the music-loving propensities of the seals, described by Sir Walter Scot ("Lib. Ent. Know.") as—

> Rude Heiskar's seals, through surges dark,
> Will long pursue the minstrel's bark.

"In Germany they take the shad by means of nets, to which bows of wood, hung with a number of little bells, are attached in such a manner as to chime in harmony when the bells are moved. The shad, when once attracted within the sound, will not attempt to escape while the bells continue to ring. Aelian says the shad are allured by castanets, and so delicate is the ear of the fish reported to be, that the sound of thunder terrifies them to death, and numbers are annually found thus killed on the Rhine and the Moselle." But to cite other cases of acute hearing in birds, &c.:—"An officer confined in the Bastile of Paris begged the governor to permit him the use of his lute to soften his confinement by the harmonies of his instrument. At the end of a few days this modern Orpheus, playing on his lute, was greatly astonished to see frisking out of their holes great numbers of mice, and descending from their woven habitations crowds of spiders, which formed a circle about him while he continued playing on his instrument. At first he was petrified with astonishment, when, having ceased to play, the assembly of animals immediately broke up. Having a great dislike to vermin, it was two days before he ventured to touch the instrument, but having mustered courage to conquer his dislike, he recommenced his concert, when the assembly was far more numerous than at first, and in the course of time he found himself surrounded by a hundred of these musical amateurs. M. Marville observed, while a man was playing on a conch shell, that a cat was not in the least affected, and he even judged by her air that she would have given all the musical instruments in the world for a mouse, for she slept all the while unmoved in the sun; the horse stopped for a short while before the window, raising his head up now and then as he was feeding on the grass; the dog continued for above an hour seated on his hind legs looking steadfastly at the player; and the ass did not discover the least indication of his being touched, eating his thistles very peacefully; the hind lifted up her large white ears and seemed very attentive; the cows slept a little, and after gazing awhile went forward; some little birds who were in an aviary almost tore their little throats with singing; but the cook minding his hens, and the hens solely employed in scraping a neighbouring dunghill, did not show in any manner that they took the least pleasure in hearing the music."

(*To be continued.*)

THE EARTH—ITS FIGURE AND MOTIONS.

By Richard A. Proctor, B.A., F.R.A.S.,
Author of "Saturn and its System," "Sun-views of the Earth," &c., &c.

CHAPTER VI.—(*Continued.*)

The Earth's Revolution.

BRADLEY'S discovery of the aberration of the fixed stars forms one of the most interesting narratives in the whole range of the history of astronomy. Yet, here I must perforce leave it untouched, and deal only with the phenomenon itself, since properly to relate the steps by which he was guided to that most important discovery, would occupy all the rest of the space now available to me.

The great and general law, then, to which the apparent annual motions of the stars are subjected—a law which must be accounted for by any theory which pretends to exhibit the real relations of the celestial bodies—is this: Every star in the heavens, whether obvious to the naked eye or visible only by the aid of powerful telescopes, whether shining in solitary splendour or lost, so to speak, in the profundities of some rich star-cluster, travels once a year in a minute ellipse, whose major axis is somewhat more than two-thirds of an arc-minute in length, while its minor axis depends on the position of the star with reference to that great circle on the heavens in which the sun seems annually to travel. A star close by the pole of this circle—the ecliptic—has an almost circular aberration-ellipse; one near the ecliptic itself has an aberration-ellipse so eccentric as to be almost a straight line. But every star has an aberration-ellipse of the same major axis. And that major axis, though, as I have said, minute, belongs to the order of magnitudes which are obvious to the telescopist—palpable, unmistakable, clear as the sun at noon to the worker in a well-appointed observatory.*

Now let us inquire what the particular law is according to which these remarkable ellipses are described by the stars, for much depends on this point. If merely a vague notion is given of the character of this instructive phenomenon, then some vague and general explanations will immediately suggest themselves to the supporters of paradox. When the exact nature of aberration is described, the proof of the earth's revolution

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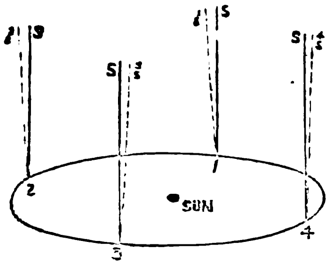
*The mere fact that Bradley, when telescopic appliances were so imperfect, at once recognised the aberrations of the first fixed star he watched with care, though he had no reason to look for or expect such a motion, is enough to show how very palpable the phenomenon is. But it may be well to add that astronomers can now recognise and feel certain about stellar displacements which are only about *one-hundredth* of the aberration motion.

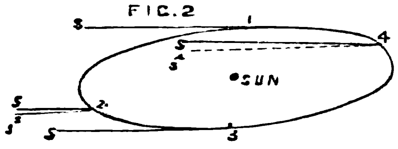
will be found (by all who have sufficient intelligence to understand the matter, or honesty enough not to pretend blindness), absolutely irrefragible.

FIG. 1



The best way of describing the nature of aberration is by a reference to the accepted theory of the earth's motion. Let 1, 2, 3, 4, Fig. 1, represent the earth's path (perspectively presented) around the sun, and suppose a star so placed on the heavens as to occupy the pole of the ecliptic; then the star being at a distance practically infinite, we should expect the lines of sight from all the points in 1, 2, 3, 4, to the star, to be directed towards *this point*—the ecliptic pole. In other words, *the lines* 1S, 2S, 3S, 4S, would all be at right *angles* to the plane 1, 2, 3, 4. Instead of this, *when* the earth is at 1, the star is seen towards S_1, the plane S1 s^1 passing through the tangent line to 1, 2, 3, 4, at 1. So when the earth is at 2, the star is seen towards s^2, the plane S2 s^2 passing through the tangent to the circle 1, 2, 3, 4, at 2. And similarly when the earth is at 3 or 4, the star is apparently displaced as shown, the displacement being always an angle of one-third of a minute (approximately), and always in the direction of the earth's motion. Next suppose the star placed on the ecliptic. Then the earth's path being again represented by 1, 2, 3, 4, and the lines 1S, 2S, 3S, 4S, being drawn

FIG. 2



in that plane parallel *to each other to* indicate the direction in which one would expect to see the star, it is found that, whereas when the earth is at 1 and 3, where she is moving in a line towards *or* from the star, there is no displacement; when she is at 2 and 4, where she is moving at right angles to the line of sight to the star, there is the same displacement as in the former case. Also, in this second case, the star seems more and more displaced as the earth travels from 1 to 2, then less and less till the earth is at 3, when there is no displacement; then more and more, but on the contrary side, till the earth is at 4, and so finally less and less till the earth is again at 1.

It will be easily seen that in the first case the star appears to describe a circle 1, 2, 3, 4, Fig. 3, about *its* mean position S, while in the latter it describes a straight line 1, 2, 3, 4, Fig. 4, through *its mean* position S; 2, 4 in Fig. 4 being equal to the diameter *of* the circle 1, 2, 3, 4, in Fig. 3.

FIG. 3

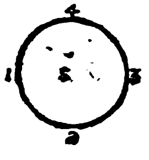


FIG. 4

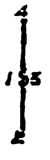
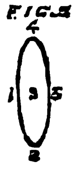


FIG. 5



When the star is somewhere between either pole of the ecliptic and the ecliptic itself, it describes an ellipse, as 1, 2, 3, 4, Fig. 5, always reaching its greatest excursion as at 2 and 4, when the earth is travelling in a direction at right angles to the line of sight to the star (which necessarily happens twice a year), and its least excursion at 1 and 3, when the earth is travelling as nearly as it can towards or from the star (which also necessarily happens twice a year).

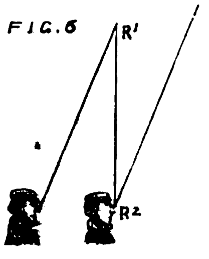
Now it is to be noticed here that though I have made use of the accepted theory to describe the observed motions, this by no means involves the assumption that the accepted theory is correct. It *is* the fact, and a striking fact it is, that we cannot even *describe* stellar aberration conveniently without a reference to the accepted theory, so that even though that theory were false, it would still be convenient to speak of the aberrations of the stars, as being such as would correspond to such and such assumptions respecting terrestrial motion.

But here we have a phenomenon to explain. We have every star on the heavens announcing some great fact to us, or rather writing down year by year on the celestial concave a lesson for our instruction. To reject the lesson as meaningless, would be to abandon one of the highest and noblest faculties given to man, his desire to search out and investigate the problems set by nature for his interpretation. What, then, is the meaning of this million-on-million-fold repeated lesson? Can astronomers explain the matter? Perhaps astronomers have some far-fetched explanation, which they would force on the world by crafty argument.

The case is otherwise. Astronomy can not only interpret the aberration motions of all the millions of stars revealed by the telescope, but the accepted theory of astronomy would have to be abandoned if those motions did not take place. Stellar aberration was discovered as by an accident, was long looked on as a great source of doubt and perplexity, was honestly submitted by astronomers to the inquiry of the world—and then suddenly it was seen that the aberration motions could not but take place, if the earth moves as the accepted theory asserts. Let us inquire how this is.

It had been independently discovered, by observations made on the eclipses of Jupiter's satellites, that light travels with finite, though inconceivable velocity. Always when Jupiter and his family were farthest from the earth, the satellites seemed tardiest to announce by appearance or by disappearance, their motion through the shadow of their primary. And so it was seen that the light messages sweeping to us from these bodies come at a definite speed to the earth. A consequence of this peculiarity had been wholly overlooked by astronomers. The light travelling in appreciably parallel lines from a star towards the solar system, may be compared to a shower falling in parallel lines on moving bodies. Now we know that in moving through a vertical shower of rain, the rain seems to fall somewhat towards the face. The reason is obvious; thus, suppose a traveller's face at 1, Fig. 6, when a a rain drop is at R^1, and that by the time he reaches 2, the rain drop is at R^2, it is clear that the drop will seem to have fallen from a position in front of him, and in the direction indicated by the dotted lines; and if we conceive of the motion of a small body travelling in a circle under a vertical shower, we shall see at once that this property may be made to illustrate every case of stellar aberration, by assuming different positions, as 1, 2, 3, in Fig. 7, for the circle in which the body moves under the shower.

FIG. 6



It will be seen, though, that in order that this explanation may hold, it is necessary that the rate of motion of the earth should bear an appreciable relation to the enormous velocity of light. If rain fell a thousand times as fast as it actually does, the fastest runner would not find that a vertical rain-shower would seem to fall appreciably towards his face. Now, apart from all considerations of the real size of the earth's orbit, or of the rates of motion either of light or of the earth in her orbit, we can at once test this explanation of aberration. It had been independently shown by Römer that light takes about eight minutes in crossing the radius of the earth's orbit; the earth occupies a year in travelling round the circumference of the circle; all we want to know is, whether the displacement of a star over an arc of about one-third of a minute, corresponds to these relations. What we require is, that supposing S. E^2 to be the distance traversed by light in any time, $E^1 E^2$ the distance traversed by the earth in the same time, $S^1 E^2 E^1$ being a right angle, the angle $E^1 S E^2$ should be about one-third of a minute of arc. Let it be remembered that this was the problem as presented in Bradley's time by mere observation, and

FIG. 7

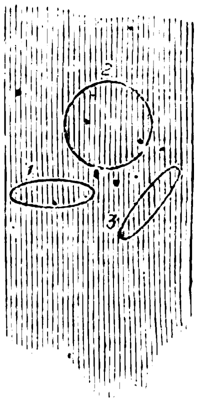
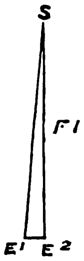


FIG. 8



before it had been guessed what a noble proof of the true theory of astronomy was to be adduced from it.

Now for the test of figures.

Since the earth completes a circuit of her orbi in one year, she would traverse a length equal to the radius in the period

$$\frac{365 \times 24 \times 60}{2\pi} \text{ minutes (roughly),}$$

where π represents the number 3·14159... or the ratio of a circle's circumference to its diameter. Hence the velocity of light is to that of the earth as $\frac{365 \times 24 \times 60}{2\pi} : 8$; or as $32850 : \pi$. Now the proportion of E_2, S to $E_1 E_2$ where $E_1 S E_2$ is an angle of about one-third of a minute of arc is $1 : \frac{\pi}{360 \times 60 \times 3}$ or $32400 : \pi$. It is seen then, at once, that we have a satisfactory explanation even with these rough assumptions, since the difference between 32400 and 32850 is but $\frac{1}{72}$nd part of 32400. But if I had taken the mean of the estimates of the velocity of light from observations made on Jupiter's eclipses, as determined before Bradley's observation, and Bradley's estimate of the aberration of the star γ Draconis as made before he knew what theory required, the coincidence would have been found very much closer.

Here, then, we have a perfect proof of the earth's revolution. No question can remain that the lesson really taught us by the stars as they annually traverse their aberration ellipses is this, that the earth annually traverses a nearly circular path round the sun. This interpretation accounts for all the peculiarities of the stellar aberration motions; nay, the theory of the earth's motion requires every one of those peculiarities. No other theory has ever been put forward in explanation of stellar aberration,* and it may be alleged, with more than confidence, with the fullest certainty of conviction, that no other theory can explain the phenomenon.

CHAPTER VII.

THE EARTH'S MOTION AS AN ATTENDANT ON THE SUN IN HIS JOURNEY THROUGH SPACE.

Since the stars are observed to be slowly shifting their positions on the celestial vault, and therefore presumably in space, it is obviously suggested that the sun, which is but a member of the sidereal family, has also his proper motion through space. It is a difficult problem to determine what that motion is, because all we have to judge by is the movement observable among the stars, and, as the stars are themselves in motion, it is not easy to separate the effects of their own motions from those due to the sun's.

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* I need take no further notice of a so-called explanation in a work purporting to be written by a Cambridge wrangler (name not given), than to remark that it does not even pretend to explain details, and that what it does pretend to do suffices to exhibit the utter ignorance of the writer as to the real nature of the problem. I do not say that the writer is not a Cambridge wrangler, because I know from my own experience that a man may become a wrangler without knowing even the definitions of astronomy. But I do say that the writer, being a wrangler, should have had sense enough to know that before pretending to write on astronomy, he ought to have acquired a better knowledge of the subject than he shows himself to have.

Still, this problem has been attacked and fairly vanquished by astronomy. It is true we cannot here get certainty, because we no longer have absolutely certain relations to deal with. But, as it is certain that, supposing the sun to be moving in a definite direction, there would result a balance of stellar motions in the contrary direction; we can obviously deduce the direction of the sun's motion, by noticing the direction towards which the stars show the most noteworthy balance of motion. This has been done, and in many ways. The result is that astronomers point confidently to the constellation Hercules and its neighbourhood, as including the point towards which the sun is speeding. His rate of motion has been estimated at about 150,000,000 miles per annum, or, between four and five miles per second.

I am only concerned here with the sun's proper motion, in so far as it relates to the earth's motions. The conception that the sun may be speeding through space with this enormous velocity seems, at first sight, so contrary to the fundamental hypotheses of modern astronomy, that many persons have been led to believe there is a real contradiction. They see that the earth's real path in space can no longer be looked upon as a closed curve, yet Kepler speaks of it as an ellipse; that, again, the earth, according to this new idea, is not travelling in a conic section, yet Newton says, all bodies under the influence of a central attracting force, such as gravity, must move in some conic section or other.

In reality, however, there is no difficulty. Modern astronomy only requires the earth and planets to move in ellipses *with respect to the sun*, not in space. Supposing the sun at rest, and the planets moving in their present ellipses around him, and that then under the action of far distant suns, our sun began to travel through space, the planets would not (as Mr. Reddie fears), be left behind. They would be under the influence of those attractions as well as the sun. They would obey them then, precisely as he does, obeying all his influences as before. Thus their motions, with respect to him, would not be changed even by a hair's breadth.

CONCLUSION.

And here I draw these papers to an end. They have occupied much more space than I contemplated when I began, and yet each part of my subject has been dealt with far less completely than I could have desired. The fact is, a book, and no small one, is wanted to present at due length all the arguments which enforce upon astronomers the assurance that the Newtonian system is correct.

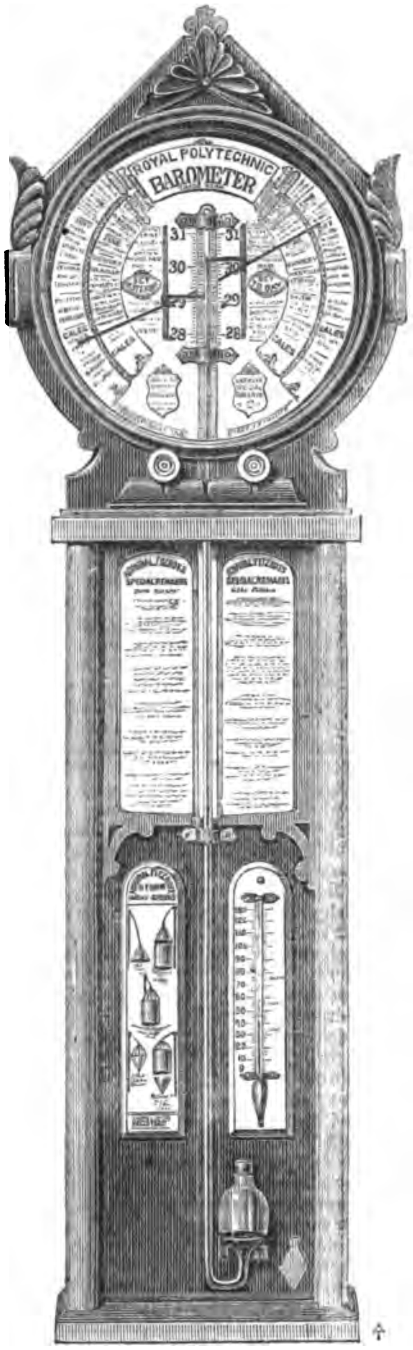
Would such a book be a desirable addition to modern astronomical literature?

I think not.

I believe that all sensible persons, even if, not capable of fully mastering the evidence in favour of modern astronomy, feel yet no doubts as to its truth. For them, then, such a book would be of little service. For the paradoxists—dividing them into two well-marked parties, the knaves and the fools—what can be done? One cannot make the blind see, let one talk ever so fluently about light; and those who, having sight, refuse to see, are blinder than the blind, according to the true old proverb. Towards the paradoxists, then, of either order, one should act as Sir John Herschel is said to have done, when a rampant one told him he had squared the circle. "Indeed," said the greatest living astronomer, raising his hat, "then, sir, I must wish you good morning."

But while a set treatise, in defence of modern astronomy, would be a waste of labour, I believe, and hope, the matter I have just completed may have been of use to many readers of this journal. The greater proportion of them, those in fact for whom the ENGLISH MECHANIC is specially intended, have not time for a thorough investigation of the subject, yet possess the power of appreciating to its fullest extent the arguments by which modern astronomy has been established. Knowing for whom I have written, I have not feared to be dry where my subject needed close and consecutive attention.

THE ROYAL POLYTECHNIC BAROMETER.



THE name of Admiral Fitzroy will ever be remembered in connection with some of the most important improvements in the science of meteorology generally, and in the barometer particularly. The instrument which bears his name is perfect as a weather indicator, and as such has had a prize medal awarded to it, and is known as Admiral Fitzroy's prize medal barometer. But although perfect in itself as an indicator, and although clearly comprehended by those who are accustomed to the reading of such instruments, experience shows that to make it universally useful, its readings must be rendered in clear and definite language. Its price is within reach of all, and it only wants to be made intelligible to the most ordinary observer. To meet this requirement, Messrs. Davis & Co. have improved the apparatus in the manner shown in our engraving. Their Fitzroy barometer forms the base of the new instrument; this consists of the mercury tube with the cistern in one piece, which is enclosed in an oak case. On the lower part of the case is a thermometer, and opposite to this are diagrams of Admiral Fitzroy's storm warning signals. These are surmounted by tables explaining their meaning. The novelty is in the upper portion of the barometer, which will be seen to terminate in a circular dial about 10 inches in diameter. In the centre of this dial is the ordinary standard barometer scale, with its two verniers for taking the readings. These verniers are set to the rise or fall of the mercury by means of a rack and pinion arrangement, worked by the two keys seen just below the dial. So far, we have the ordinary arrangement for taking the readings; but as this is not always clearly understood, Messrs. Davis have supplemented it by placing on the right side of the dial two columns of remarks which refer to changes in the weather, one column showing the winter, and the other column, the summer changes. On the left hand of the dial these two columns are repeated, and are intended to record the weather of the previous day. The indications are effected by a simple and ingenious arrangement in connection with the verniers. On looking at the engraving, it will be seen that there are two hands or pointers radiating from the centre of the dial. These pointers are centred loosely on a pin fixed behind the tube, and each passes through a slot cut in the verniers, which thus hold them up. Now when the verniers are raised or depressed, the hands must follow the same direction; and according as the verniers are placed at the height of the mercury, so the pointers stop opposite to a statement of the weather that height indicates. The right-hand pointer is set to show the weather expected to-day, whilst the left-hand is set to record the state of the weather yesterday. The mechanism of the instrument is exceedingly simple, and is not liable to get out of order.

PROCEEDINGS OF THE ROYAL ASTRONOMICAL SOCIETY.—MAR. 11, 1870.

W. LASSELL, ESQ., F.R.S. IN THE CHAIR.

(SPECIAL REPORT.)

AFTER the minutes of the preceding meeting had been read and confirmed, the first paper communicated was from W. Marth, Esq., containing observations of position angles, and apparent distances of the Satellites of Uranus from the primary, which was ordered to be printed forthwith. Lieutenant Herschel communicated, through his brother, a paper remarking on a curious appearance, as seen on the Sun's disc. The author remarked that in October last, while preparing to observe the prominences of the Sun with a spectroscope, an unusual phenomenon presented itself, consisting, apparently, of a train of dark shadows and light streaks on the solar disc, which were at first thought to be sparks in the tube of the telescope, but the permanence of the phenomena did not permit of this explanation. The possibility of this extraordinary appearance being occasioned by the transit of a system of meteors, next occurred to the observer, and preparations were made to observe the circumstances of the transit with all the care possible. The image of the disc of the Sun was thrown on a screen, and the equatoreal telescope set in motion. The apparent size of the shadows was shown on the screen, and they were observed all that day. On looking at the Sun the next day, the same phenomenon was observed; the objects were still seen passing in a continuous stream. The direction was 150° E. by N., or perhaps two streams not very far distant. The dark objects were out of focus when the Sun was in focus, and were still seen when the Sun was partly obscured by cloud, and notwithstanding the Sun's light they were seen after they left the disc; and the smaller they were, the less was their velocity. The direction of motion of one only was retrograde; and one entered slowly, and then changed its direction. Every care was taken to notice every peculiarity presented, till the observer convinced himself that he was watching the motion of a number of locusts, passing in continuous succession between the instrument and the Sun, and however curious the phenomenon might be in natural history, it was clearly not of an astronomical character. The author endeavoured to account for some of the peculiarities seen in America at the time of the Eclipse last year, by referring them to the same cause.

Mr. **STONE** remarked on the necessity of a change of focus, in attempting to explain any peculiarity of this nature, which was the best means of effectually settling the question.

Captain **NOBLE** remarked that in a previous number of the "Notices," would be found the remarks of Mr. Reed, on a similar question, whose suggestions led Mr. Dawes to focus for the well-known "thistle seed."

Captain **NOBLE** communicated three short papers to the Society. One on occultations of Stars by the Moon; an observation of Venus, near her inferior conjunction; and an observation of the Zodiacal Light. In the second paper Capt. Noble said that the state of the sky prevented him seeing the planet till about two hours after her conjunction, when he saw a very narrow thread of light, not quite semi-circular, and saw the body of the planet projected on the sky beyond, *sensibly* darker than the surrounding sky. On the 3rd March, 7h. 40m., the author saw the most brilliant exhibition of the Zodiacal Light that he ever witnessed in this country. Besides its brilliancy, two peculiarities were noticed, namely. that it was very nearly perpendicular to the horizon, and the axis inclined to the ecliptic at an angle of 20°.

Mr. **BROWNING** exhibited some drawings of Jupiter, and remarked upon the many changes of form and colour of the belts of Jupiter, the principal of which seems to have been a sensible widening of the Equatoreal belt to nearly double its former dimensions. Mr. Browning invited the attention of observers to a consideration of the Planet, which the peculiarities it presented rendered interesting at this moment.

The **PRESIDENT** seemed to suspect some slight exaggeration of the colour and outline of the Equatoreal belt, but Mr. Browning defended his drawings, which appear to have been carefully made.

The last paper was from Mr. Proctor, having reference to the Corona seen in total eclipses of the Sun. Mr. Proctor said that at the next eclipse of the Sun, which occurs next December, in Spain, the attention of astronomers would be drawn to the Corona with a view of explaining the difficulties that it now presents. The author of the paper contended that the phenomenon witnessed could not be owing to terrestrial causes, for in cases of total eclipse the Moon is seen projected on the corona, which could not be if the light was occasioned by the Earth's atmosphere. He added that in an annular eclipse, the centre of the Moon has been seen darker than the edge; and that in partial eclipses the edge of the disc has been seen *projected (dark)* on the *background of the sky, as often* as the observer *has looked for this* particular, which would *seem to disprove the existence* of an atmospheric glare. Mr. Proctor argued from Captain Noble's *remark* concerning the visibility of the dark part of Venus when in the neighbourhood of the Sun, the existence of a continual brilliancy which *might* be owing to the richer part of the Zodiacal Light, which increases in brilliancy as it approaches the Sun, and in the close neighbourhood of the Sun itself doubtless merges into the Corona. In concluding his remarks, the author conjectured that the Zodiacal Light itself was the collection of the richer portion of the meteoric streams, perhaps incandescent, where near to the Sun. He remarked that numerous meteor streams must exist, since the Earth meets with *56* of these systems, and that if the Great Comet of *1863* was followed by a train of meteors similar to *that* that accompanies Tempel's, the near approach of these to the Sun must produce an effect which can easily be supposed to resemble that witnessed where the Corona is brightest. Mr. Proctor hopes that the Society will form a committee to consider the best means of setting at rest the vexed question of the Corona, and made some suggestions which he thinks likely to produce that end.

It was asked at the meeting if the Government were proposing to render any assistance to astronomers that intended to go to Spain to view the Eclipse of the Sun next December?

The **PRESIDENT** replied that the Government certainly had *not proposed* any such measure, and were not likely to, but that the Council were now *discussing* the mode of application to Government, and the best way to derive results that were *likely to* follow from the observation.

Mr. **STONE** observed that he hoped that *three* observers might make observations on the polarised *light,* as two would probably differ in their results, and *the* observations of the third would be needed to settle the question. If anything had appeared to be *settled* by the Indian Eclipse, it was the question of the polarised light, which the observers agreed to have been polarised in a plane passing through the centre of the Sun, but the American observations had again opened the question. Mr. Stone hoped that the observers would not confine their observations to any particular locality in the Corona, but examine all positions of it.

MODERN CHEMICAL NOTATION.

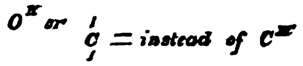
By Dr. Ferd. Hurter.

(Concluded.)

When the atomicity or basicity of the element should be expressed by the symbol, then the letter is provided with another figure at the top, but this figure must be a Latin one. The sign O^{II} means accordingly that one atom of oxygen possesses two equivalents, or better, that one atom of oxygen can combine with two atoms of a monogenous element. This latter way of expression is the more general one. When a number of atoms of the same element form one group, then the Latin number at the top is the expression for the capacity of saturation of that group, or, as it is also termed, for the atomicity of the group, or still otherwise, for the quantivalence of that group of atoms. In this way we write $O_5{}^{II}$ or $Mn_2{}^{VI}$, and understand by it, that 5 atoms of oxygen can combine with only 2 atoms of a monogenous element, that 2 atoms of manganium can combine with 6 atoms of a monogenous element.

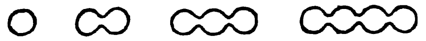
The same rules apply to groups of atoms of different elements—for example, CO^{II} indicates that one atom of carbon is combined with one atom of oxygen, and that this group is able to combine with two atoms of a monogeneous element.

When, however, a formula should be quite a rational one and express the function of each equivalent of the various elements forming the compound, then the letters and figures are not always sufficient, and we have to enrich the chemical alphabet with a few more signs. Instead of using a Roman figure at the head of the letter to indicate how many atoms of a monogenous element the element represented may combine with, horizontal or radiating strokes are used, as many in number as the Latin figure indicates. Thus one often finds $O=$ instead of O^{II}, or



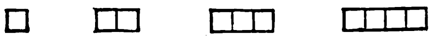
$$O^{II} \text{ or } \overset{|}{\underset{|}{C}}= \text{ instead of } C^{IV}$$

Some chemists use still more symbols. They represent all the monogenous atoms by a circle, and all the other elements by combination of as many circles as the element's quantivalence requires. Such signs are represented by the following:



Monovalent. Divalent. Trivalent. Tetravalent.

Or

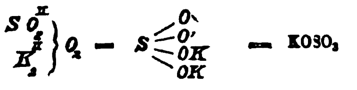


However, the letters, and, if necessary, the horizontal strokes, are quite sufficient to make the rational formula of a substance perfectly clear. It is, as a chemist of high standing said, perfectly useless to attempt to give any other representative to the atom than its letter. Any drawing cannot but lead to too mechanical a view of the constitution, and we see in the present periodicals plenty of proof of the nonsense which such mechanical views, when used to too great an extent, will bring forth.

As the whole system of notation will become clearer by citing a few examples and discussing them, we append here an assortment of modern formulas and some explanatory notes as the conclusion of this paper.

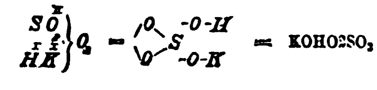
	Modern formula.	Elder formula.
(1.) Water	$\begin{matrix}H-\\H-\end{matrix}O = \left.\begin{matrix}H\\H\end{matrix}\right\}O = H_2O$	HO
(2.) Potassic hydrate.	$\left.\begin{matrix}K\\H\end{matrix}\right\}O = \begin{matrix}K-\\H-\end{matrix}O = KHO$	= KOHO
(3.) Potassic chloride.	$\left.\begin{matrix}K\\Cl\end{matrix}\right\} = KCl$	= KCl

(4.) Potassic sulphate.



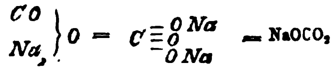
$$\left.\begin{matrix}\overset{II}{SO_2}\\ \overset{I}{K_2}\end{matrix}\right\}O_2 = S\begin{matrix}=O\\=O\\-OK\\-OK\end{matrix} = KOSO_3$$

(5.) Hydro-potassic sulphate.



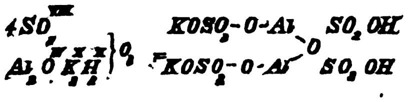
$$\left.\begin{matrix}\overset{II}{SO_2}\\ \overset{I}{H}\overset{I}{K}\end{matrix}\right\}O_2 = \begin{matrix}O\\O\end{matrix}{>}S\begin{matrix}-O-H\\-O-K\end{matrix} = KOHO2SO_3$$

(6.) Sodic carbonate.



$$\left.\begin{matrix}CO\\Na_2\end{matrix}\right\}O = C\begin{matrix}-ONa\\=O\\-ONa\end{matrix} = NaOCO_2$$

(7.) Alum—Modern formula



$$\left.\begin{matrix}4\overset{II}{SO_2}\\ Al_2\overset{VI}{O}\overset{I}{K_2}\overset{I}{H_2}\end{matrix}\right\}O_8 = \begin{matrix}KOSO_2-O-Al\\KOSO_2-O-Al\end{matrix}{>}O\quad\begin{matrix}SO_2OH\\SO_2OH\end{matrix}$$

Elder formula—

$$Al_2O_3 3SO_3 + KO_1SO_3$$

The above formulæ are sufficient to show us the use of the chemical alphabet.

The first of these formulæ as well as the second and third need no comment. Potassic sulphate is represented by a symbol which is intended to convey an idea of the manner in which the single atoms are connected. The sulphur being tetravalent is connected with two atoms of oxygen, which are (if the compound must be saturated) again combined among themselves. Thus the group SO_2 has still two equivalents of sulphur left free to attract other atoms, which we find to be oxygen atoms, each combined with an atom of potassium. The same formula would apply to hydro-potassic sulphate in one atom of potassium is replaced by one atom of sodium. The group SO_2 we find in formula (7) representing alum to occur 4 times. Alum is a sulphate like hydropotassic sulphate. Each SO_2 is connected by 2 atoms of oxygen on the one side to the aluminium, on the other to either hydrogen or potassium. The metal aluminium has, like all metals of the same group, the property of occurring as a group of two atoms, which by their combination saturates 2 of the 8 equivalents of which they naturally consist. The two aluminium atoms are directly united with one atom of oxygen, saturating two more equivalents of aluminium, so that at last we have the group Al_2O being tetravalent. This group replaces four atoms of hydrogen in four molecules of sulphuric acid, forming the compound

$$\left.\begin{matrix}Al_2OH_4\\4\,SO_2\end{matrix}\right\}O_8$$

In which finally two atoms of potassium become substituted for two of the hydrogen atoms.

The sign $\}$ is a remainder of the theory of types; it now is used to indicate that the two parts which it connects are held together by the elements it points to. $\left.\begin{matrix}H\\H\end{matrix}\right\}O$ mean that the two atoms of hydrogen are held together by one atom of oxygen. In organic chemistry this modern notation is invaluable. Inorganic chemistry, however, can be taught just as well by means of the old notation. Still the former has its peculiar advantages, and will no doubt help to further the knowledge in that department as it has done in organic chemistry, where the constitution of bodies is so well studied that we can deduct almost every property from the formula. We can, with a certain degree of accuracy, predict the properties of a substance from its formula in inorganic chemistry, but not to the same extent as it is possible in organic chemistry. Here we derive from the formula the specific gravity of a liquor at boiling point, the boiling point itself. A well written formula tells us how many hydrogen atoms can be exchanged for a metallic atom, or for acid radicals. It tells us at once whether the substance has more the properties of an alcohol, or of an acid, or of a base. It tells us, as we have discussed in our last paper, the specific gravity of the gaseous state and the quantity of heat necessary to raise the substance's temperature one degree.

It is evident that the chemical formula will not be perfect until it represents all the properties of matter as it does now a few. And when chemistry will make as rapid progress in the next twenty years as it has done in the last twenty we shall soon arrive at that perfection of our knowledge which Berthollet thought to have arrived at some 70 years ago when he published his "Essai de Statique Chimique."

Hoping that I may have helped some of the readers of the ENGLISH MECHANIC to an understanding of the leading principles of the modern theory, I conclude my paper, asking the reader's indulgence for my want of style. I feel that I have not the English language sufficiently at command to expose my ideas always so clear as I should like to have done.

EMIGRATION.—Professor Goldwin Smith writes to a friend in England a letter on emigration as a means of escaping the economical difficulties and perils which he fears are gathering round England. The professor commends the Southern States of America, especially Virginia, as better worth the attention of emigrating Englishmen than either Canada or the Northern States. He says, the Southern States are more English than any other portion of America, and that Englishmen in those States would find both a generous welcome and an ample field for their enterprise, neither of which are to be so readily found in the Northern States, where Englishmen do not and cannot fraternise with the Irish, German, or native American population. "In the Northern States" says Mr. Smith, "the English emigrant now finds himself, I am sorry to say, not only in a foreign but a hostile country." And as a practical and likely means of securing a solid home in Virginia, he mentions that there is a Virginian Land Company in New York, presided over by General Imboden, one of the Confederate Commanders—that he has had communication with the company and seen its papers, and that we are likely to hear of its movements in England. It should be added that he intimates that English predelections for Canada are a mistake, both on the grounds of climate and other natural and agricultural difficulties in comparison with Virginia and other Southern States.

ROYAL NATIONAL LIFEBOAT INSTITUTION.—The annual meeting was held on March 15. The report stated that there were 220 lifeboats on the coasts, and that during the past year 871 lives had been saved through the Institution's agency. The sums voted as rewards had amounted to £2705, and 38 silver medals had been granted. The income, during the twelve months, had exceeded £40,000, and there was a balance in the society's favour of upwards of £6000.

LETTERS TO THE EDITOR.

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[We do not hold ourselves responsible for the opinions of our correspondents. The EDITOR respectfully requests that all communications should be drawn up as briefly as possible.]

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*** All communications should be addressed to the EDITOR of the ENGLISH MECHANIC, 31, Tavistock-street, Covent Garden, W.C.

All cheques and Post Office Orders to be made payable to J. PASSMORE EDWARDS.

I would have every one write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that, as to other things, knows no more than what everybody does, and yet to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks: a vice from whence great inconveniences derive their original.—*Montaigne's Essays.*

CONES FLOUR.—BARIUM CHLORATE—TEST FOR ARSENIC.—SODA CRYSTALS, &c.

SIR,—On page 633 of your valuable journal a correspondent, signing himself "One of the Old School," has expressed an opinion that my statement relative to the adulteration of cones flour with rice is incorrect. Now, we are aware that revet wheat is the proper wheat to use for the manufacture of cones flour; but I say that rice flour is wholly and partially substituted for that article, according as the price is intended to be high or low. Some bakers at Eton pay 36s. to 41s. per sack for good flour, and for cones from 20s. to 25s. I do not mean to say that 20s. is the regular price, because of course that varies; this flour, cones for dusting, as supplied at the present time here from 23s. to 25s., consists of nothing else but *rice flour*; and on applying to various bakers in the neighbourhood for a sample of cones, I invariably obtained pure rice flour. On one occasion I inquired minutely into the sale of this cones, and I found (a rice flour variety) that it was labelled "cones," invoiced "cones," and inserted in the account as cones. The bakers about here, as I have said before, pay 36s. to 41s.; and if they pay (now) 23s. to 25s. for cones, it is hardly likely that it can be pure wheat flour. Once, and once only, I obtained information to the effect that nearly the same price was paid for cones as for flour; and when it was found that there existed a cheaper variety, 26s., it was obtained directly.

After having expressed my opinion on the master from direct observation, I will take "One of the Old School" to a work called "Adulteration Detected in Food and Medicine," by Dr. Hassall, page 277.

Dr. Hassall says: "Dr. Paley, of Peterborough, brought a sample of flour seized on suspicion, and which the baker called '*cones flour.*' On subjecting this to microscopical examination, it was found that it consisted *entirely* of *rice flour.*"

Page 279: "It appears therefore that *cones flour is rarely to be obtained genuine, but is subject to an enormous amount of adulteration*; further, that some of the samples *do not contain a particle of wheat flour*, of which alone they should consist."

Twenty-two samples of "cones flour" were procured chiefly in the metropolis: the following is the result (this is also taken from Hassall's work). At the same time, I think it is a mistake to say that *bean flour* is found in *cones*. The samples below, in which that article was found, were in all probability inferior, adulterated varieties of wheat flour:—

1. Contains rye and *rice* flours. 2. *Entirely rice flour.* 3. Contains *rice* flour. 4. Contains *rice* flour. 5. Consists in great part of *rice* flour. 6. Genuine. 7. *Almost entirely rice flour.* 8. *The same.* 9. Chiefly *rice* and bean flours. 10. Contains much *rice* flour. 11. Not cones at all, but consists of *rice*, Indian corn, and bean flours. 12. Bean and *rice* flours. 13. Contains much *rice* flour. 14. Contains barley flour and alum. 15. Genuine. 16. Barley and *rice* flour. 17. Consisting in great part *rice* flour. 18, 19, and 20 were genuine. 21. Not cones at all, consisting entirely of *rice* and Indian corn flours. 22. Consisting chiefly of *rice*, with some Indian corn flour and much salt.

Now, the preface to the above work is dated 1857, and "One of the Old School" will perceive he is decidedly behind time when he finds that Dr. Hassall found in cones flour that which I stated I found, in my letter on starch. I am glad to find he can "conscientiously affirm that no rice, beans, or any other intermixture ever entered a sack of his." He says that some of the "new school" add *dry bean* or *white pea flour* to wheat flour, *to give it strength*, but that "cones should consist principally of *rice*, and yet sold and accepted as *cones flour* is a novelty." We (all of us, I may say) read the ENGLISH MECHANIC for two purposes—first, diversion, the principal motive, and instruction the second. "One of the Old School" then must own that he has not subscribed for naught; he has gained a wrinkle, and that is, that rice flour is sold as cones, labelled and sent by rail as cones, paid for, aye, and the purchaser satisfied by paying rice flour price for CONES. Hassall says that "there are several kinds of cones in the market, the best being nearly twice the price of the worst, the adulteration being usually in proportion to the price." I can tell, directly I see a loaf, which kind of cones the baker uses, real cones or rice flour.

BARIUM CHLORATE.—As there seems some difficulty in "Pyro" getting an answer to his query relative to the manufacture of barium chlorate, I will furnish him with the various minutiæ:—Take 918 parts of barium oxide (baryta), finely levigated, and suspend it, in water, keeping it in a state of suspension—*i.e.* not letting it sink to the bottom of the vessel; place the vessel containing the above in a sand bath, and submit it to a temperature of about 90° C. (194° F.). Then take a retort furnished with a leading tube, which dips into the vessel in the sand-bath; place in the retort 540 parts of manganese dioxide ($Mn.O_2$), cover with hydrochloric acid, and apply heat. Chlorine will be liberated, and pass over into the solution containing the baryta, which latter will be decomposed. Barium chlorate and barium chloride will be formed, and will co-exist in the solution together. The chlorine must be passed in until the milkiness has disappeared. More manganese dioxide may be required than is stated if the sample be very impure; but if 600 parts are taken, that will generally be found sufficient. The reaction which takes place may be thus represented:—

$$(BaH_2O_2)_6 + Cl_{12} = (BaCl_2)_5 + Ba\,(ClO_3)_2 + (H_2O)_6$$

The action of the chlorine being continued for a short time after the milkiness has disappeared, the clear liquid (if necessary) may be filtered, and the filtrate evaporated to dryness. 2000 parts of water are then added to the residue, the whole raised to the temperature of 100° C., and set aside to cool; the barium chloride will remain in solution, and the chlorate crystallising out. 316 parts of this latter salt would be formed by taking the above quantities.

HYDROFLUOSILICIC ACID.—"Taffy," although professing to correct me in the barium chlorate preparation, has fallen into an error himself with regard to the above acid. "Pyro" can prepare it thus:—Take one part each of finely-powdered fluor spar and powdered glass, or fine sand, and mix with 6 parts of concentrated sulphuric acid (H_2SO_4). On applying heat to the mixture, gaseous, silicon tetra-fluoride is formed:

$$(H_2SO_4)_2 + (CaF_2)_2 + SiO_2 = (CaSO_4)_2 + SiF_4 + (H_2O)_2$$

A precipitating glass is then taken and partly filled with distilled water. Some mercury is then placed in the bottom, and the tube delivering the silicon tetrafluoride is made to dip into the mercury; the gas as it passes out of the mercury is decomposed by the water, forming gelatinous silica and hydrofluosilic acid. This latter is not "a gelatinous mass," as "Taffy" states; the silica may be separated by filtration through a cloth, while the clear liquid is hydrofluosilicic acid (H_2SiF_6). This acid, when concentrated, fumes strongly in the air; when added to potassium chlorate, an insoluble potassilicon tetrafluoride is formed, liberating chloric acid. This chloric acid solution may be poured off the insoluble precipitate and neutralised with barium carbonate, and followed out as "Taffy" states. The following reaction takes place on passing SiF_4 into water:—

$$(SiF_4)_3 + (H_2O)_2 = SiO_2 + (H_2SiF_6)_2$$

PURIFICATION OF CHLORIDE OF SILVER.—"W. H." will find that heat is the proper method for separating paper from his silver chloride. If he dissolves the chloride by means of ammonia, he must recover it by spontaneous evaporation. If he attempts to drive off the water by the application of heat, he will find that fulminating silver will be deposited. I merely mention this because I find "Ernest" and "Beta" had both forgotten to mention it, and "W. H." instead of recovering his chloride, might lose his head. The excess of ammonia might be neutralised by the addition of an acid before evaporation.

TEST FOR ARSENIC.—Let "Claudius" proceed thus:—Procure some pure zinc, *free from arsenic*, and place it in Marsh's apparatus with the substance to be tested. Add sulphuric acid, and when the gas is being given off freely light it, and hold a crucible lid in the flame; if arsenic or *antimony* are present, there will be a metallic deposit upon the lid. To discriminate between antimony and arsenic, the metallic deposit must be submitted to the action of a drop or two of *yellow sulphide of ammonium*; antimony dissolves, and arsenic remains unaltered. To test the cleanliness of the apparatus, use the zinc and sulphuric acid alone. If clean (free from arsenic) and the materials pure, there ought to be no deposit upon the lid. Arsenic may also be detected when in solution by giving a green precipitate with cuprammonium sulphate. The precipitate consists of arsenite of copper.

POWDERING PHOSPHORUS.—"M. P. S." can reduce phosphorus to an impalpable powder by dissolving it in bisulphide of carbon, and letting the latter spontaneously evaporate. By-the-bye, I may as well add that the latter operation is best performed in the open air, if the operator is blessed with the sense of smelling.

SODA CRYSTALS.—In the manufacture of soda crystals, the first step is to form a sulphate of soda. This is done by placing a quantity of common salt in a decomposing pan, and running in an equal quantity of oil of vitriol. When heat is applied, hydrochloric acid is given off, and may be condensed in towers or scrubbers. The mass is then raked out upon the hearth or roaster adjoining the decomposing pans, and submitted to a somewhat higher temperature. The *salt-cake* thus produced is mixed with an equal quantity of limestone and two-thirds its weight of coal. A charge of this mixture is introduced into a reverberating furnace, heat applied, and when completely fused it is raked out into moulds. This product is called *black ash*. This product is digested with warm water, the clear solution evaporated to dryness and heated with sawdust, to convert any caustic soda into the carbonate. The residue is then dissolved in hot water, decanted off from any insoluble matter, and run while hot into crystallizing pans. After the first crop of crystals have separated, the mother liquor is drained off, and evaporated for a second crop. Does "Soda Crystals" infer that his decomposing pans hold 120 gallons, or that that is the capacity of his crystallizing pans? If the latter, they would hold 16cwt. of soda crystals, deposited from solution. By a little calculation he will be able to arrange quantities in the proportions given above that will suit his plant.

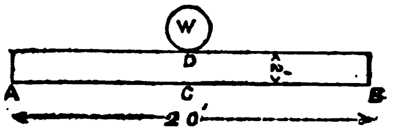
"Practical Chemist" (Query 2054) is easily answered. There exists no acid termed "hypochloric" acid. Hypochlorous acid is known, having the following molecular formula, HClO.

GEORGE E. DAVIS.

STRAINS ON GIRDERS.

SIR,—Will you kindly allow me to make a few remarks in connexion with J. W. Bedford's notes on "Strains on Girders" which appeared in your last impression? The action of a load placed at the centre of a girder is as follows:—Let A B represent a girder 20ft. span, 2ft. deep and W = 10 tons. $\frac{W}{2}$ is supported at A, and the reaction at A caused by the bent lever A C D is increased 5 times in compressing D. Therefore, strain at centre $= 5\,\frac{W}{2} = 5\,\frac{10}{2} = 25$ tons.

The general formula for finding the strain upon wrought iron or other girders at centre is as follows:



W = load, equally distributed. l, length in terms of depth, s, strain of compression at top flange, or tension at bottom flange. $S = \frac{W \times l}{8}$. Now, 10 tons placed upon the centre of the girder in question will be equivalent to 20 tons equally distributed. Hence, the formula becomes $\frac{20 \times 10}{8} = 25$ tons strain at centre.

The breaking weight of this girder may be found by the following method:—Let a = sectional area of bottom flange in inches, d = depth in inches, and s = span in inches. 74·4 tons a constant for wrought iron girder or tube. $\frac{a \times d \times 74{\cdot}4}{s}$ = breaking weight in tons at centre. Let the girder in question have a bottom flange area of 6in., then $= \frac{6 \times 24 \times 74{\cdot}4}{240} = 44{\cdot}64$ tons.

ROBERT PICKWELL.

QUESTION FOR MILLERS.

SIR,—In answer to "C. J.'s" personal question, I beg to say I have only in one instance had the trouble he complains of with the neck of the stone spindle, which happened some time since in a mill I was carrying on off-hand, when I had to take the stones in hand myself, and flayed two high sides of the bed-stone, and when I had dressed them two or three times myself the neck went all right, and has been no further trouble the last two or three years. I will also add that I rectified the running balance at the same time.

To the second question, I never yet saw a thick top heavy stone running satisfactorily on a short spindle, and I have always kept the greater part of the weight of the stone below the bearing in my own mills, and shall continue to do so. Some years since one pair were fitted with universal iron, like the ship's compass, with the bearing near the face of the stone; but they had to be removed and replaced by cross bar and driver.

R. R. SMITH.

REFLECTORS AND REFRACTORS.

SIR,—It is nearly eight months since I last wrote to you on the above subject, and I then promised your readers, should they so desire it, to supply them at some future time, with a further description of the 8½in. mirror and its performance. From the kind allusions which some of your correspondents have made to this promise of mine, and to the matter contained in my former letter, and from the increasing interest with which, I am glad to say, the subject of practical astronomy is every week being invested in your columns, I feel I cannot do better, during a period of enforced rest from professional labour, than state what I have found that performance to be, and drop some further hints to amateurs, who, like myself, are anxious to render their home-made telescopes as perfect and useful as possible. I had thought of giving a brief *résume* (with the Editor's kind permission) of the work done during the past half-year, but found it would occupy far too much space and trespass too much on your indulgence, to think of such a thing, so I shall simply state the work done on one or two favourable nights last summer, and leave the reader to form his own opinion of what the telescope has since accomplished on similar nights.

A short time after I had written the former letter, describing the mounting of the 8½in. mirror, which I had obtained from Mr. Browning, of the Minories, in the end of June or beginning of July, we, in this neighbourhood, were favoured with four nights in succession of most exquisite definition, a boon indeed to those who possessed really good instruments, which they wished to test. On the first of those occasions, in the early evening, just as the sun was setting, I brought out the large telescope, and having inserted a large field eye-piece, giving a power of 35, and a field of 3¼ degrees, directed the telescope to the position in the sky where the planet Saturn would probably be found. After some little searching, I successfully picked him up, shining with a pale silvery light, in a sky which appeared, with that power, of a deep violet hue. Viewed under such circumstances with a large telescope, and with the evening light still bright, the planets present a most beautiful appearance, one which often tempts the observer to neglect for a time the use of higher powers, but of course, if the physical details of celestial objects are to be investigated, they must be used.

The definition I knew to be most excellent, for, with a little experience, one look at the circle of light which is formed in the eye-piece, when a bright object is slightly out of focus, will tell this, if the illuminated circle is steady and calm, without any bubbling or waving motion, after the telescope has been for some time in the air, the observer may prepare for good work. This steadiness, too, is not in the least affected by the beautiful pulsations of coloured light which came from the larger stars, but refers equally to them.

It was peculiarly so on this occasion, for having inserted, first a power of 100, and then, as the evening darkened, 187, I was enchanted and completely chained to the spot with the exquisite appearance of the planet Saturn, without one trace of haziness or of indistinctness of outline; it seemed chiselled out in colours of purest silver and pale sky blue, and golden yellow. The dark division in the ring was sharply marked all round, without a break in its continuity, spreading out into a dark band at the "ansæ," and narrowing at the minor chord of the ellipse into an infinitely fine black line. The transparent ring too was so evidently and beautifully seen, of a dusky grey colour, and clearly less bright on the side next to the rings, than on that next the planet. This I took particular note of, and examined it most carefully on the two following evenings, when it was verified beyond all doubt. It is not noted in the engraving of this planet in the interesting little work by Mr. Lockyer, copied from Mr. De La Rue's sketch, but is very well marked in the lithograph on the frontispiece of Mr. Browning's pamphlet. On the occasion above mentioned, it was plainly seen, not by myself alone, but by two other gentlemen, who were examining the planet with me. We also directed our attention to the outer ring, and searched with the greatest care for some trace of a division, but could not detect any line which might be rightly so called; there was a shading sometimes visible, more guessed however than clearly seen, which might possibly suggest the idea, but did not satisfy me. During the time I was observing the shading on the transparent ring, and searching for a division on the outer one, five of the satellites had come into view. On the second evening I saw the sixth, and had glimpses of the seventh (if it was not a very minute star, for not having any ephemerides of the satellites, I could not absolutely identify it), with the six satellites however, so clearly seen, and the body and rings of the planets so beautifully defined, your reader will believe me when I say, I never saw a more wonderful or more fascinating object.

There was one thing about this strange planet which delighted me, even more than all I have yet described. I refer to the colours on the ball and on the rings—it is only on such nights as these I am speaking of, that this phenomenon can be seen to any advantage, and to see it well a large aperture is absolutely necessary. I do not know how most astronomers account for these colours, whether they think them intrinsically inherent in the planet or its atmosphere, or to some extent caused by the vapours in our own atmosphere, through which the light of the planet has to penetrate, certain it is that they are much better seen and brighter, when the planet is near the horizon, provided only high powers can be used, than when it is more overhead. I believe, too, the larger the aperture the more clearly are they marked, so that the possessors of large telescopes have a very great advantage in this respect, over those who are not so fortunate. On the night in question, I found that a power of 350 showed them most admirably in my reflector of 8¼in. I could well imagine, however, the much greater brightness and beauty they would have in a 12in. or 15in. speculum. The contrast between the delicate sky blue of the poles of the planet, the golden yellow, alternating with silver and grey on the belts, and the blending of all these hues on the rings, was indeed a lovely sight, but should be looked for and seen to be at all appreciated. The beautiful appearance which Saturn presented on that occasion, lingers in my mind still, and although I have seen the globe of Jupiter under equally favourable circumstances, with far more marked and darker hues on his belts and brighter tints altogether, the soft delicate beauty of the planet Saturn surpasses in perfection and loveliness all else I have ever seen in the infinite amplitude of space. I have dwelt thus minutely on these observations of Saturn, because they have made a lasting impression on my mind, and showed me what a perfect speculum will accomplish under favourable circumstances. But to continue my description from my note of these evenings.

The planet Saturn is setting, and at last drops behind the roof of a neighbouring house, so I am reluctantly compelled to turn the telescope to other objects, and surely here are a great variety of most interesting double stars, some of them excellent tests, and all very favourably situated for observation. Here is π Aquilæ, λ Ophiuchi, τ Ophiuchi, η Cor. Bor., δ Cygni, μ² Boötis, all just as well placed as they could be. Here are also two remarkable nebulæ, M 57, the annular nebula in Lyra δ, M 13, the magnificent globular cluster in Hercules. Let us take them in the above order and give you our impression of them as we saw them on those admirable nights.

π Aquilæ. I have divided this star more beautifully with a 2·8in. achromatic, by Wray, so of course do not mention it as a test for an 8¼in. speculum, but certainly the smallness of the discs and the large space between them, does surprise one who has been accustomed to telescopes of much smaller aperture; a power of 100 separated this star well.

λ Ophiuchi, τ Ophiuchi. The former a beautiful object, both easily divided; components with exquisitely small discs.

δ Cygni. A much more difficult object for a reflector than any of the previous stars, as it is of the third magnitude; however, on three of the evenings referred to, it was beautifully and completely divided, and frequently since that time, whenever the air was fine and steady, a power of 187 just split it, but 300 completely divided it. The division of this star gave me very great pleasure, especially as it was accomplished so easily and so neatly.

η Cor. Bor. Very easy. 187 completely divided it; discs beautifully defined and exceedingly minute, with 300, black division was equal to 2, if not 3, diameters of one of the discs.

μ² Boötis. Here was indeed the crowning test, as the components of this star are only 0″·55 apart, and it was with fear and trembling I approached it on the first night, but what was my joy and delight, when I had applied a power of 300, to see the discs clearly separated by a black division, yet looking square! When, however, I had applied a power of 350, the division was perfect. Again and again I looked at this beautiful object, two 8 magnitude stars, like most minute circles of light, lying so exquisitely close to one another yet perfectly distinct. I thought I detected a slight difference of colour in the components, and hope, when the calm summer weather comes again, to make many more observations on this star, for a most wonderful and interesting object it certainly is.

While speaking of this star I may mention, that it seems somewhat more easy to divide than γ² Andromedæ, which I have nicely separated on some favourable occasions since; perhaps this may arise from the greater magnitude of the latter. I will finish what I have to say on the subject next week.

H.

RECENT QUERIES AND REPLIES FROM MILLERS.

SIR,—Mr. J. Sharpe, in answer to several correspondents, denying that I am the inventor of the universal joint, described on page 526, No. 255, says that he has had the same working in his mill since 1856, while the description he gives of it seems to represent quite another thing. Perhaps Mr. Sharpe will be kind enough to send a drawing to your excellent engraver of what he means by the following sentence:—"The oval ring of mine has the journals at the foci of the transverse dia., which admits of the inner ring, or driver, being shorter, and therefore stronger, and leaves more room between them"—without which the following sentence seems quite incomprehensible—viz., that the centres of all his journals are in the same circle, which could not be so in mine. I maintain that the centres of my invention *are* in a circle; therefore, if his joint is anything different to this, as he says, all his centres cannot be within one and the same circle. My object in forming the oval ring was to bring all the centres within a circle, so as to cause the stone to oscillate alike on all the four bearings. The centres are also in the same plane or level. It is therefore a perfect universal joint in every respect, and as it stands as purely and simply my own invention. I also repeat my former assertion that it is superior (until convinced to the contrary) to anything at present in use. May I invite Mr. Sharpe to send to the MECHANIC the *first new* thing, as he deplores so much the *antiquity* of *all* hitherto sent respecting milling?

THOS. EVANS, Stockport.

GALVANIC BANDS.

SIR,—Without any wish to find fault with other suggestions, I send you a description of a band of simple and cheap construction, and of the efficiency of the action of which I have had several practical proofs. A strip of copper and one of zinc, of any desirable length, are to be joined (by rivet or any other preferable mode), at the ends, the joint whipped together by thread, and varnished with shellac in alcohol; the extreme ends having a hole punched in each, for fastening with a silk ribbon, or other non-conductor. To apply and bring the same into action, wind a piece of list spirally round the united strips of metal, wet the list with vinegar, reduced in strength by water if slight action only is wanted, cover the wetted list with oilskin, and fasten it with the ribbon in desired part. About an inch of each extremity of the strip of metal, must be left uncovered at each end, and be in contact with the skin. The cost of the contrivance must evidently be reckoned in pence.

SUFFOLK AMATEUR.

SELF-CENTERING LATHE CHUCK.

SIR,—I think that "A. B." must have made a mistake in his drawing of the self-centering lathe chuck that appeared in your last issue. I see that the thread is left-handed in the chuck, where it screws on to the lathe mandrel. Now, I have seen a great number of chucks, and have used them myself, but I never before either heard of or saw one with a left-handed thread; directly the tool in the rest commences to cut the piece of work fastened between the dogs, the chuck, instead of tightening up on the mandrel, will screw off, unless the cut be a very small one; but if it was a right-handed screw, the larger the cut, the tighter the chuck would get. One with a left-handed screw might answer for a face-lathe, or more commonly called a chuck lathe, where by twisting the belt, the lathe can be reversed, and using the slide-rest at the opposite side to where it is usually used. I think the chuck, on the whole, is a very useful one, it saving a great deal of trouble in setting small work.

MARINE.

SHODDY MANUFACTURE.

SIR,—Seeing "Scrutator's" remarks in No. 258, page 610, on the way in which I endeavoured to help one of your correspondents with regard to the *shoddy manufacture*, I was at once induced to look further into the matter, and have since consulted one of our best encyclopædias on the subject. In this work, I find that I am perfectly correct as to the machine used for tearing up old woollen rags, &c.—"Scrutator" goes further, and says, that allowing the machine mentioned to be correct as I take it, I have only "mentioned one of them, and therefore 1395 is still unanswered." As far as the *shoddy* is concerned the *willey* is the only machine used to reduce it to a state fit for spinning. To go further into the matter would be to give an account of the machines used in spinning and weaving, &c. "W. M.," the correspondent who asked for the information, is apparently satisfied; therefore, what business is it "of Scrutator's" to criticise that which is meant for others?

The *willey*, which, he says, is used for opening *raw cotton*, is quite different from the one used in the *shoddy manufacture*. That used for opening raw cotton is called the *willow*, which name he makes use of, but that used in the *shoddy manufacture* is called the *willey*. Now, the *willowing* or *scutching* machine, is composed of a feeding apron and two sets of rollers and beaters. The first set of rollers, turning in opposite directions, drag the *raw cotton* through, and transfer it to the first pair of beaters, which, revolving with great rapidity, thrash out nearly all the sand and other impurities which the wool contains; the second pair of rollers and beaters complete the process.

It will thus be seen that "Scrutator" has jumbled together the two machines, owing to the similiarity of the names; "rushed headlong into print," to use his own expression, without taking taking the trouble to investigate and thoroughly "master" the subject; has drawn hasty conclusions, and tried to criticise what he apparently knows nothing about.

GITCHE MANITO.

METEOROLOGICAL.

SIR,—Would you, or some one of your readers, give information how to observe the daily changes going on in the horizontal and vertical motion of the needle, as well as the intensity of the magnetic force?

Is there not some more simple way of observing and recording these variations and earth-storms, than the complex apparatus in use at some observatories?

J. W. A.

THE ILLUMINATED PORTION OF THE MOON.

SIR,—When I called your attention to an apparently anomalous appearance in the illuminated part of the moon, it was with the view of affording or eliciting information for the more observant of your readers, on a subject which probably has puzzled many of them, but I had no idea of its being so followed up or for so long a time. When the letter of "Sigma" appeared, I thought his satisfactory explanation would have been generally accepted, and though I think his diagrams might have been improved, I forbore to trespass more on your space, or to tax your engraver further. But as Mr. Beardsley cannot accept the explanation of "Sigma" and has sent you a diagram, I cannot help writing a few words on the subject, especially as his diagram is pretty nearly what I would have sent myself, and helps to prove "Sigma's" views instead of his own. If any of your readers will place a pin to represent the position of an observer on the earth's surface where Mr. Beardsley supposes him to be, another 1in. above it to represent the centre of the moon, and a third at a distance of 33ft. in the direction of Mr. Beardsley's retiring suns, and to do duty for one of them, the relative positions of the three bodies will be nearly obtained; a thread then passed round all will show how very nearly parallel the rays of light from the sun to the earth and moon are, and thus prove the contrary to what Mr. Beardsley puts forth as his argument against "Sigma's" explanation. The enlightened part of the moon is directly opposite the sun, although the latter appears on the tangent to the earth's surface shown by Mr. Beardsley.

I do not know whether Sir John Herschel will be considered an authority with that gentlemen; he probably will be by most of your readers, and I therefore beg to quote from his "Outlines of Astronomy" in conclusion:—"The sun's distance being 23984· radii of the earth, and the moon's only 60—the former is nearly 400 times the latter—lines, therefore, drawn from the sun to every part of the moon's orbit may be regarded as very nearly parallel."

R. L. J.

DR. TYNDALL'S EXPERIMENTS ON LIGHT.

SIR,—On trying the experiments on atmospheric dust particles, of which an account appeared in your journal, it occurred to me to try the effect of inorganic particles, and for this purpose a piece of brown paper was ignited, and allowed to smoulder for a short time in the darkened room. A very small quantity of smoke (carbon particles) heightened the effects to a remarkable and unexpected degree, and on a spirit lamp being held four or five inches below a beam of sunlight, the apparent cloud of smoke, before faintly seen, was now strikingly manifest. An iron bar, raised to a red heat, showed the same effects.

S. T. PRESTON.

ARTIFICIAL ICE.

SIR,—In a late number of the ENGLISH MECHANIC inquiry was made where ammonia apparatus for the production of ice could be obtained. I have one procured from Mignon and Rouart, 149, Rue Oberkampf, Paris, and have used it with perfect success several times. Some friends have had one in constant use for four years, and it never required repair or renewal of any sort. There are two sizes for domestic use, one costing 282f. or £11 6s., makes one kilogramme of ice in about two hours with the expenditure of about a double handful of charcoal, and ¼ pint of methylated spirit or less. The other makes 2 kilogrammes in 3 hours, and costs 406f., or £16 5s. There are larger for manufacturing purposes.

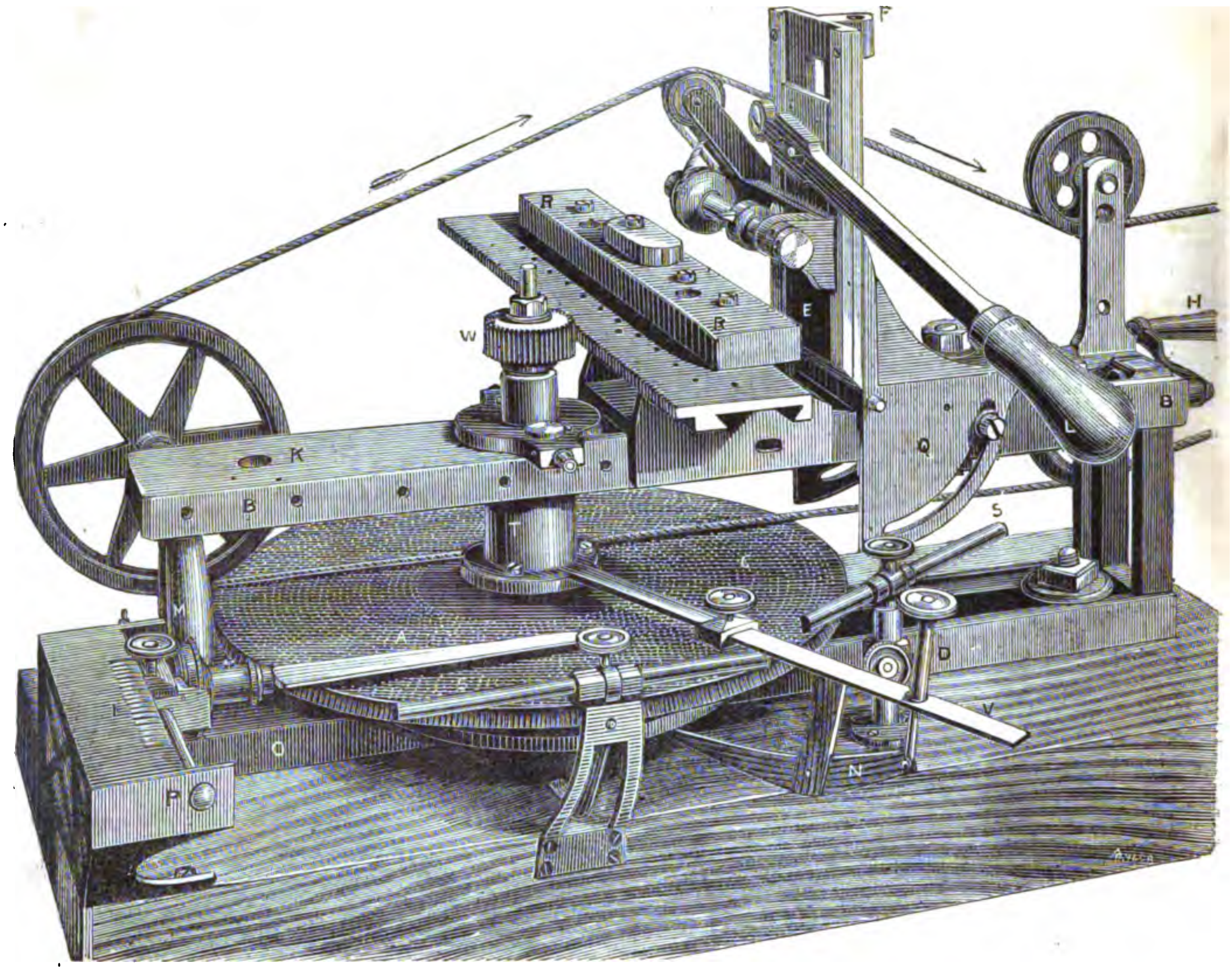
J. B. YONGE, Mebourne, Winchester.

COLLIERY VENTILATION.

SIR,—As a well-wisher of the ENGLISH MECHANIC, and as I desire to see its usefulness extended, I beg to suggest that colliery ventilation would be a good subject for discussion in its pages. You would thereby give some of our most intelligent working men an opportunity of recording their experience and giving their opinions.

To begin, would any brother reader oblige me with an honest reply to the following query:—Query: If the intake of a colliery should be 50ft. area, what should be the size of the return—with the mode or rule by which it is found?

T. H. THOMAS.



WHEEL-CUTTING ENGINE.

SIR,—Through the kindness of a gentleman at Halifax, I am enabled to forward a very good photograph of a wheel-cutting machine for small work. B B is the bed, which is solid towards the left-hand end, and open to the right, to form a slide for carrying the upright part Q E F, which is drawn along by a screw, of which the handle appears at H, to adjust for different diameters of wheels to be cut. Supposing the slide R R to be taken away, and W the wheel to be cut, the upright slide would first be brought to its place by turning the handle H, next the set screw C loosened, and the peg under it slid down to the circle of holes containing the division to be cut, and the peg of the alidade A brought to the same circle by sliding along the pin P till the index at I shows the right number. The stops S S are then adjusted, so that the lever T V, which works on a loose socket at T, may be able to swing sideways to the amount of the angle subtended by each tooth of W; and the machine being set going, the first cut is taken downwards by depressing the handle L, which may be made to rise again by hanging a weight to it over a pulley fastened to the ceiling. To move the division plate the required quantity for the next cut, the peg under C is first lifted by raising the end V of the spring lever T V against the pressure of the spiral spring D, and T V is then moved towards the right till it is stopped by S; and on letting go the lever the spiral spring D forces the peg at C into the proper hole in the plate. Next, by pressing on the head of D, the lever N presses against another lever (O) under the plate, lifts A up out of the way, and allows the plate to be moved round till T V comes in contact with the other stop S; and so on for each tooth in succession. M is a micrometer for adding a tooth when the division plate does not contain the precise number wanted—as, for example, in cutting 101 teeth with a division plate of 100 holes.

For bevel wheels the quadrant Q allows the upright slide to fall forward to any required angle, and for cutting teeth askew, as in the case of a worm-wheel, there is a centre at E on which the vertical slide can be swivelled over sideways. K is a hole in which a crane may be fixed to come over to steady the top of the arbor on which the work is held.

The picture shows the arrangement for rack-cutting, the whole length of the slide R R being itself a rack, into which the wheel W works. The lever L is found to work more agreeably than the screw which used to be at the top of F for moving the upright slide.

J. K. P.

HOPKINSON'S VALVE.

SIR,—In reply to the inquiry of your Leamside correspondent of last week, I beg to inform him that the two valves act quite independently of each other; and the small one being regulated by a *dead weight inside* the boiler, which cannot be tampered with whilst the latter is working, continues to blow off steam, no matter how heavily the lever of the large one may be weighted.

GEORGE BATES, Agent for Messrs. Hopkinson and Co., for Durham and Northumberland.

FOTHERGILL'S SELF-FEATHERING SCREW PROPELLER.

SIR,—The above screw is designed to supersede the necessity of hoisting up the screw in auxiliary screw vessels, when under canvas. It is entirely self-acting, requiring no hollow shaft or inside gearing, as in the case of the Bevis feathering screw; all its parts are concealed, so that no wreckage or floating material can jamb its action, its external appearance exhibiting no more peculiarity of form than an ordinary propeller. (Fig. 2.) The principle is equally applicable to any kind of screw, whether two, three, or four blades. The boss is divided into three parts (Fig. 1), the forward part carries the blades for going a-head, the after for going astern, immediately upon the engines stopping or upon the vessel over-running or outsailing her screw, the blades feather themselves into a line with the keel, and become useless. In regard to stowage of spare screw, and repairs of damaged screw, it has many advantages over the solid propeller, as its parts can be stowed separately, and a broken blade or other part re-supplied at once from the spare screw. All seamen know the difficulty of steering a screw-vessel under canvas, with her *propeller* down, especially if it be a three bladed one. This is entirely obviated by the self-feathering screw, as the blades, when feathered, offer no twist to the passing water.

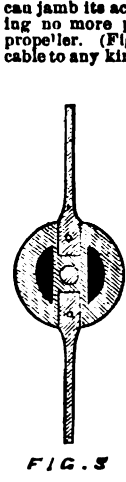


FIG. 3

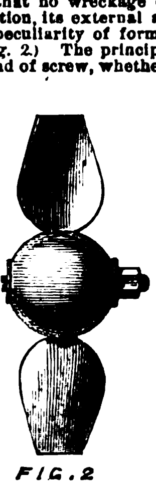


FIG. 2

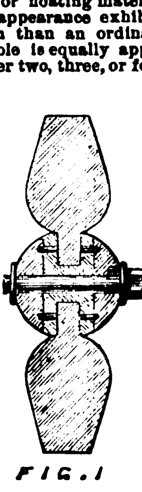


FIG. 1

It is anticipated that, now that the opening of the Suez Canal will render auxilliary steam power of more necessity than ever, that a screw on the above principle will be found a useful invention, especially in short-handed ships; and in all, when the expense and room of the screw-well may advantageously be avoided.

The inventor has a 10in. in dia. model in gun-metal, which can be seen on application, by letter or otherwise, to Watford, Crick Station, near Rugby. F.

HEATING GREENHOUSE BY GAS.

SIR,—In reply to D. Bothroyd (Qy. No. 2067), I beg to state that the consumption of gas for heating the water-pipes in the greenhouse alluded to in No. 1708 has again been accurately tested by a dry meter (Glover, maker), and found to be 25 to 30 cubic feet per hour, according to pressure, which varies a good deal, and which is a very great disadvantage in the use of the most economical burner—the atmospheric—as so much depends on the proper proportions of air and gas previous to ignition so as to ensure as complete combustion as possible, and so prevent smoke or deposit of carbon. At 3s. per 1000 cubic feet, the cost of gas in Bath, this is under 1d. per hour; and this winter, with the thermometer at 19° out of doors, the temperature inside the greenhouse was 46, at least 6° higher than required to keep the frost out. With the apparatus of Hertsman, of Bath, it could probably have been kept steady at 40, when the expense would not have averaged ½d. per hour. This very much coincides with the result of what "Professional," of Brighton, gives as his experience (see ENGLISH MECHANIC, page 637); only had he used 4in. instead of 3in. pipes, his quantity of heated water being larger, probably his result would have been in proportion.

Where there is no regular gardener or male domestic on the premises to attend to the fire of a flue late and early—for it is hardly work suitable for a female to feed either with coal or ashes—the gas (with an atmospheric burner properly fitted, and supplied with suitable mixture) will not only be found in every way more suitable, but cheaper. A man up at 12 and 4 a.m. is not long fit for his usual day's work. If the common gas-burner is used, the expense will be very much greater, and the result less.

Can "Professional" give the address where a simple good gas pressure gauge, to be attached to the meter, can be obtained? This would be of much value to consumers generally.

A very simple and cheap method of keeping frost out of a moderate-sized greenhouse is by an Arnott stove of the right sort, with an upright pipe of 6in., by

MILBURN AND CO.'S APPARATUS FOR DESICCATING GRAINS.—(Described on page 4.)

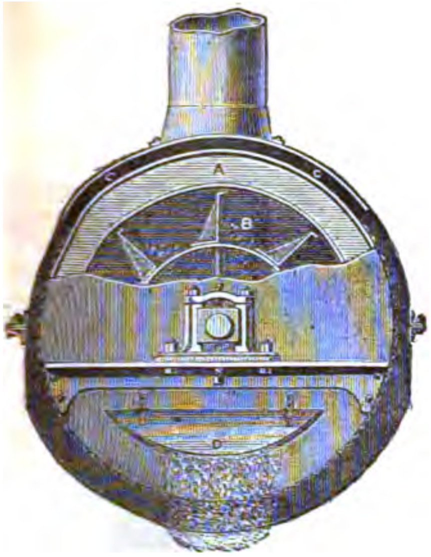


FIG. 4.

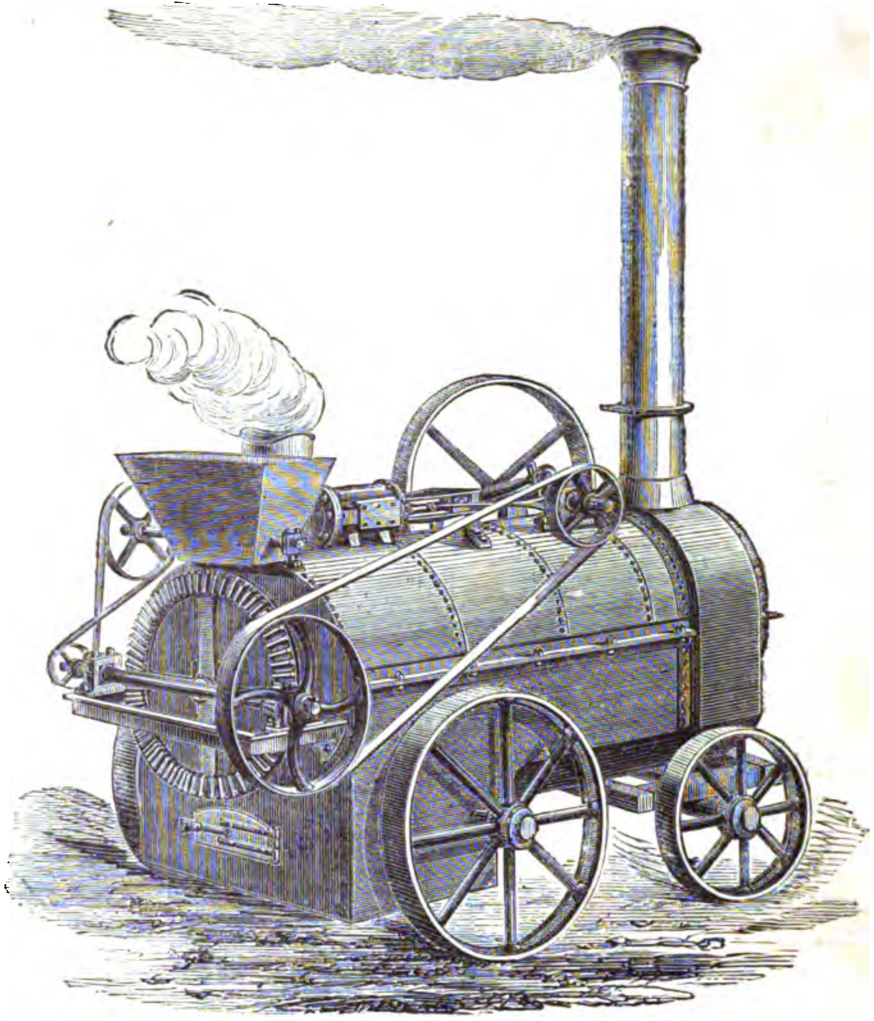


FIG. 3.

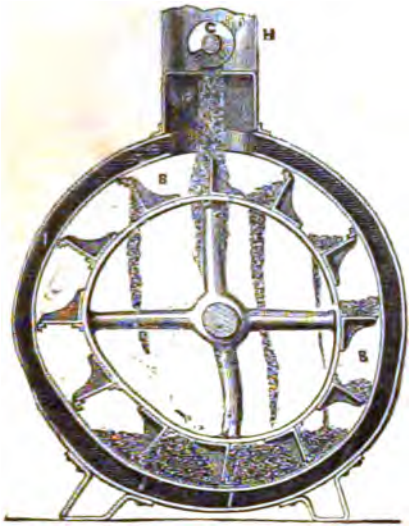


FIG. 2

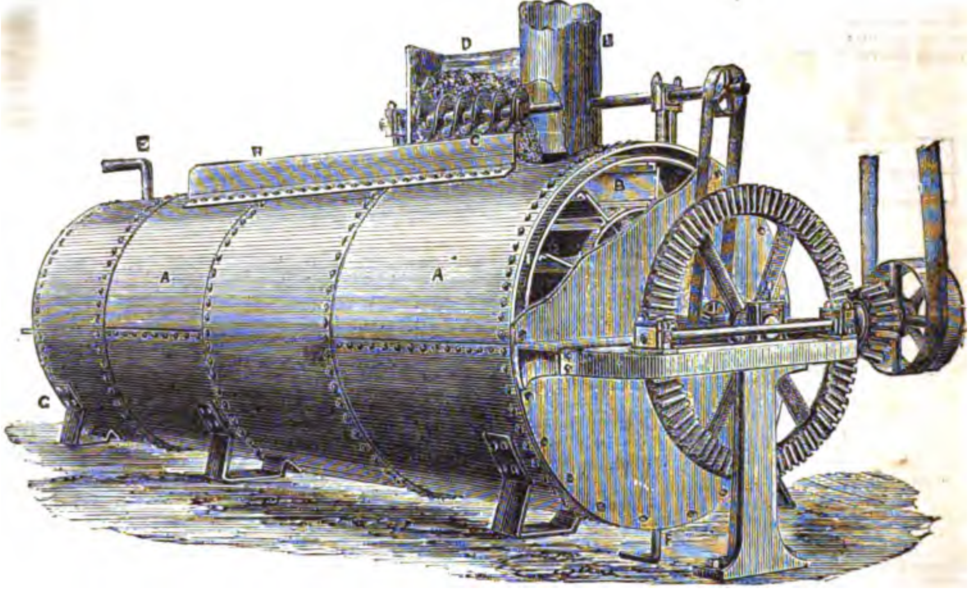


FIG. 1.

6ft. perpendicular height, with a horizontal pipe of 3in. going off near the top with a descent of 3ft. or so, to serve as a heat-trap. But this should be into a kitchen chimney finally, to ensure the continuous carrying off of all vapour, otherwise this would injure the plants. It is requisite also to have an earthenware vessel on the top of the house, with water always in it, to ensure requisite moisture, or this heat will be found too dry for plants. Great care must also be taken of dust, or the leaves of the plants soon become covered from the [illegible] out of the stove.

There is also an item of expense in repair. Though the interior of the stove, lined with *fire-brick*, will last for years, the sheet-iron *piping*, the cheapest and easiest heated, will require renewing every three years, at a cost of about *30s. to £2.*

Anthracite, or malting coal, should be used, with care not to supply too much air at any one time, or overheating will be the result. This system was used for three years with No. [illegible] house, as gas could not be had moderate. Should anyone be desirous *personally* to inspect and test these particulars of heating by gas, he has only to apply at 21, Park-street, Bath.

J. B.

TELESCOPIC.—ANSWERS TO QUERIES.

[illegible]—In accordance with "Leo's" request (page [illegible]) I give him my method of roughly estimating the [illegible] of specula:—Procure an open wooden frame, [illegible] to that of a schoolboy's slate, across which [illegible] stretched parallel cords of smooth whipcord, or what is better, violin strings, or catgut, in a similar manner to a harp. About 6 of these strings will be enough. They should not be more than ¼in. apart, and must be exactly equidistant from each other. Next stand the mirror, which is to be inspected on any convenient support, with its face opposite a window, and at a distance from it rather more than its radius of curvature, or twice its focal length. Then incline the mirror slightly, until it reflects the image of the observer's head when standing close to the window. In this position then, with the face looking towards the mirror, hold up the test frame between the eye and the mirror, and parallel to it, until the [illegible] image of the cords is seen reflected on its surface. If now the mirror be spherical, the cords will appear to *converge* towards each other as they approach the edge of its disc; but when the mirror is truly parabolic, the cords appear as they really are, perfectly straight, and equidistant from each other.

The simplicity of this test speaks for itself; and should the operator have a venetian blind to his window, that alone would be sufficient, without a test frame, to enable him to form a tolerably correct idea of the figure, providing the room is large enough to permit the mirror being placed at a sufficient distance.

I should say that to give this test its best trial, the eye should be brought as near to the mirror as distinct vision will permit. Any distortion of the parallel cords will then be exaggerated just in proportion as the lines are magnified; and if preferable, the cords may be only ⅛in. apart to bear this amplification.

Next in order, I must attend to my "Pupil" (page 590), or else he will think me by this time a forgetful teacher. "Pupil" seems to think "the band suspension the best for such as himself, with blanket to rest on." I should think so too. He will no doubt find it very comfortable, and will do far better to rest on the blanket himself than trust his mirror there. Blankets are very nice things in their place, but I, for one, have no faith in them as supports for specula (unless, perhaps, when they are small). He should try the method explained on page 604; it will answer perfectly for a 10in. glass, or even larger. The plane for a 10in should not be less than 1¼in.; 2in. is still better. As to the ordinary plate, I have used a flat cut out of this material for solar observation, and it has shown the rice grain stippling very plainly; but I have not yet tried it on the stars, but believe it would work well. I may add that the cone of rays in a Newtonian, although bent or *diverted* to an angle of 45°, suffers no other alteration beyond a slight diminution of light; the object seen is in the same position, and moves across the field in the same direction, with respect to the observer, as in a refractor.

The foregoing replies will no doubt satisfy "G. C." on the same page. My mirrors are made of 1in. glass.

I do not consider myself accomplished in the art of silvering glass, although I have produced some very decent films. No doubt scrupulous attention is required to the directions given by Browning, who, I may say, has kindly informed me that the temperature of the room has much to do with the success of it. It should be not less than 70°, and great care must be taken to get the glass *perfectly* clean. I have found that after cleaning the glass with nitric acid, an *alkaline* solution is useful before the final washing with water.

As to the question asked by "Novice," page 606, I am sorry to say I am at a loss to know what he means. I am afraid he is running his head against some imaginary post. Let him read the directions again more carefully. W. PURKISS.

ELECTRIC MACHINES.

SIR,—"Derf Errac," page 657, reminds me of a promise of information as to Carré's improvements in electrical machines on the inductive principle. I have not happened to meet with further particulars than those he gave or referred to, and they are by no means clear and comprehensible; and I have had too much on my hands to make experiments, especially as I feel very doubtful if the matter is of much value. If "D. E." has not the number, he should obtain No. 226, which contains a description of Holtz's machine, on similar principles. I have tried vainly to get a sight of one, but none of the instrument makers appear to think them worth troubling themselves about. In reference to the brown paper machine, I do not think my remark was calculated to raise the querist's hopes unduly, and I quite agree with "D E." in what he says, it would be a very poor investment of time and labour. I expect a great drawback would be the hygroscopic nature of the paper, which is not a very good non-conductor in consequence. As to the ebonite disc, I hope "D. E." will get off better than I did. I ordered a 15in. one, and was charged 17s. 6d. for it, though weighing barely 2lb., the seller declaring he had to get it from Germany. Flat sheet ebonite, say ¼in. thick, can be got and cut to size without difficulty, and the price is about 8s. 6d. per lb., while the cuttings from the square would be valuable for making up other instruments. For an induction machine a much smaller plate would do; and as there is no strain on it, only sufficient thickness is needed for maintaining its form. SIGMA.

HORIZONTAL WINDMILL.

SIR,—Seeing that the subject of windmills is being ventilated in your paper, I send you drawings of a horizontal windmill which I have designed, and which may perhaps be useful to some of your readers. Fig. 1 is a horizontal view, and Fig. 2 a view of it as seen from above. The letters are the same in both figures. The sails as shown at A, Fig. 1, are fixed loosely on to the levers, so as to permit the upper half to fall forward until horizontal, as shown at A¹, when the lever itself keeps it from further depression; neither can it go farther back than a perpendicular position. The sails are not fixed on the levers exactly in the middle, but, as shown at A, Fig. 1, the upper half is larger than the lower. B is a pulley fixed on near the end of each of the levers, round which a cord runs which is fastened to the top of the larger halves of each of the opposite sails. Fig. 2 shows the position and working of the sails when in operation, the wind blowing in the direction indicated by the arrows. At A¹ the wind has the greatest power, the sail being in a vertical position. Soon after passing A² the last pressure of wind on the sail will cause the upper half to fall backward at the same time by means of the cord fetching up the sail at A⁴ to a vertical position, the wind itself forcing it up immediately it is raised above a level; the opposite sail or the wind indicated as A² being then in the position shown at A³, the wind has no power at all. The levers can be shortened to suit the power of the wind, as the inner part, being hollow, permits the outer to be pushed into them and fastened with a pin at C. I have made one similar to this on a small scale, which works admirably. I think great power could be obtained by this machine. Next week, with your permission, I will send you drawings of another windmill, by which I think still greater power could be obtained, and which would be admirably adapted for working ship's pumps, as on board ship there is generally plenty of wind at man's disposal, but which is seldom made to perform those duties besides propulsion, which would be the saving of trouble and expense to the owner.

A RUSTIC FROM BERKSHIRE DOWNS.

FIG. 1

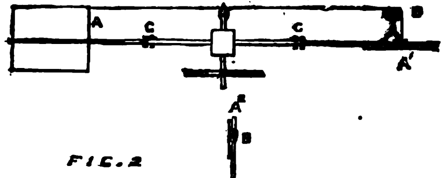
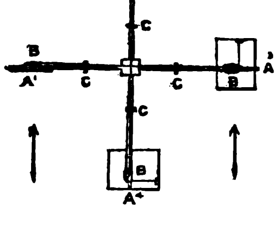


FIG. 2



HORIZONTAL WINDMILL.

SIR,—In reply to "P. P." and Mr. J. Thrower, I beg to state that I should regulate the machine in the following manner:—In the first place, I should weight the cord A (Fig. 1), which would run over the pulley-wheel C—with the weight B, the latter being light enough to allow of the sail swinging out in a high wind, as in A, Fig. 2, and thus permitting the excess of wind force to pass by.

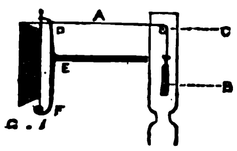
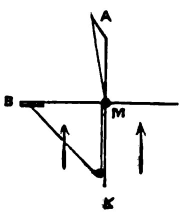


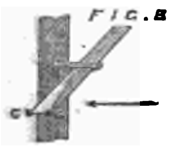
FIG. 1

Secondly, I should cause the rod D F, Fig. 1, to pivot at E, E being above the middle point of D F, and E F consequently longer than D E. The effect of this would be, that when the sail was at or about B (Fig. 2), E F would swing back and D E forward, and the whole sail lie more or less edgeways to the wind, as in Fig. 3. To prevent this occurring, however, in any but heavy gales or strong gusts of wind, I should weight it at G G, and also perhaps have a cord running from G to K and M (Fig. 2), with a weight attached to it as before.

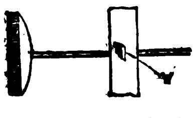
FIG. 2



A better, but more expensive plan for regulating the sails at B (Fig. 2) would of course be to have them made with movable weighted fans, as in the ordinary "patent sails" of vertical mills. They would then open in a high wind at B, close at A on the reverse side of the sail being presented to the wind, and thus cause the cord and weight, Fig. 1, to come into play.



The sails might slip up and down the arms, as this would admit of the leverage being lessened or increased at pleasure. In such a case they must pivot on a tube. If the arms were not very heavy, they might be shortened, if required, by being drawn through the shaft, thus:

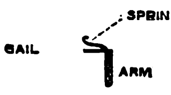


Head of Screw or Peg to fasten the Arm to the Shaft.

I cannot answer Mr. Thrower's question as to the power required for his lathe. If Mr. T. makes any experiments, and would state the results in your paper, I should be much obliged.

I have never tested the above plan, nor indeed any other. My model has no regulator. H. ALGAR.

P.S.—Instead of cords and weights, steel springs might be used to catch the sails. The springs should of course be strong enough to resist an ordinary wind, and weak enough to yield to a gale. The sails should be much larger than I have represented them either in this or my former letter. If there were four sails, one cord only would be in tension at or about A, Fig. 2, at any one time. If there were eight sails, two weights would be needed, and cords 1, 3, 5, 7 must be tied to weight No. 1, the others to weight No. 2.



SIR,—My reply to Mr. Thrower and "P. P." was forwarded to your address before the number of the ENGLISH MECHANIC containing Mr. Vallance's letter reached me.

I must apologise if I have at all infringed Mr. Vallance's patent, but at present do not understand very exactly how far our plans agree. Would Mr. V. kindly send a side view of his mill, with sails and spring ready for action?

I have never made any use of mine except as a motive power to a small model raft fitted with paddle wheels. I thought it possibly might be employed to force a vessel against the wind. Clumsiness of workmanship, however, and disproportion between sails and paddle-wheels prevented my arriving at any decided opinion on the subject.

I have known my mill revolve with only one sail up, but fancy it would do so only in a high wind, my model being too small and ill-made to admit of much momentum. H. ALGAR.

"F.R.A.S." AND THE NAUTICAL ALMANAC.

SIR,—In answer to a query from "Equatoreal," concerning the tables of Jupiter's satellites, that appear in the "Nautical Almanac," "F.R.A.S." has employed language which, I think, is susceptible of misconstruction, as it may be thought to censure the authorities that publish the "National Ephemeris."

The business of the computers of the "Nautical Almanac," is to accurately deduce certain results from certain tables, and the predictions concerning the phenomena of Jupiter's satellites, are in this respect as accurate as any other part of the work. I will remind "F.R.A.S.," that the use of an ephemeris is not only to enable astronomers to observe certain phenomena, but to enable them to make comparisons between the assumed theory and the observed fact, and so to derive the amount of correction that must be applied to the elements, to bring the theory in accordance with the observations; and when the elements of Jupiter's satellites come to be re-discussed, the discordances between the predictions and the observations, will be of the greatest use, and the accuracy with which the predictions have been made, from an assumed theory, so far from being the approbrium of the "Nautical Almanac," may be its pride.

"F.R.A.S." says, that the use of Damoiseau's tables ought long since to have been discontinued, but he knows that there are none to replace them, and surely cannot be an insinuation that the "Nautical Almanac" office ought to have computed others that should better represent the observed phenomena. It is the duty of computers attached to that establishment to use, and not to form tables. W. E. P.

THE RELATION OF POWER TO APERTURES IN TELESCOPES.—TO "HUGO."

SIR,—With reference to this subject, I do not think the explanation of "F.R.A.S." satisfactory. It is evident, that if the magnifying power of a telescope, cæteris paribus, be doubled, the image of the object on the retina will then occupy an area four times as great, and consequently the intensity of the light must be reduced to one-fourth; therefore an object glass of four times the area would be required, *i.e.*, of twice the diameter. From this it will be understood, that the power to be used must vary directly as the aperture, and not as the area of object-glass, as "Hugo" supposes. S. T. PRESTON.

VIOLIN VARNISH.

SIR,—A week or two ago a letter appeared in the ENGLISH MECHANIC, signed "B.," inviting discussion on the subject of violin varnish; but although it appears to me a subject eminently worthy of attention, and of interest to a considerable number of your readers, "B.'s" letter has not at present elicited any reply. I venture to write this letter in the hope that the subject may be re-opened by attracting the attention of some of your chemical subscribers or others, although they may not themselves be directly interested in the construction of the violin.

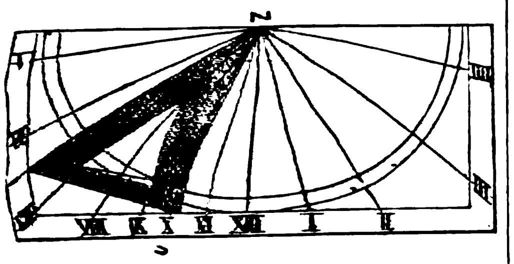
The requirements of a good violin varnish are, that it should afford protection to the wood, but at the same time it must not interfere with the vibration of the instrument. All the ordinary varnishes made from gums and resins are quite unsuitable for violins, since they do not allow the wood to vibrate freely. M. Grivel, who professes to have re-discovered the old Cremona varnish, says that not one of the substances used in ordinary varnish is used in compounding it, and that it is a spirit varnish. If this latter assertion is true, it upsets the generally received opinion that the Cremona makers varnished in oil.

There are many who insist that the sole cause of the superiority of the Cremona instruments is the varnish with which they are covered; but although no one who has studied the subject properly will hold this idea, no one will deny that the varnish is of very great importance; and any hints in the MECHANIC would be highly interesting to many.

In conclusion, I may suggest a method by which the fitness of a varnish for musical purposes could be tested. Two thin slips of the same wood, and of the same dimensions, if made to vibrate in the same manner—that is, made to produce the same nodal division—will render the same sound. Now, if one of two such rods be covered with the varnish under examination, and then both rods be caused to vibrate again, the effect of the varnish will be at once apparent. If the varnish be bad, the covered rod will give a lower sound than before; but if a varnish could be found that could be applied to the wood without lowering the sound, or, in other words, without interfering with free vibration, the desired result would be obtained. J. T.

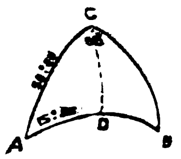
HOW TO MAKE AN ERECT DECLINING SUNDIAL.

SIR,—I am not about to repeat in this letter what has been offered in a former one, and for those who wish to know what an erect declining sundial is, I will refer them to No. 252 of the ENGLISH MECHANIC, page 460. My object now is to state the method of constructing such a dial by the terrestrial globe, which may be of service to those who prefer doing it this way to working it out by trigonometry and logarithms. All sundials, whatever be the declination of the place, may be made upon the principle of a horizontal dial, if we only know the latitude and longitude of the place to which the declination of the plane answers, for all are constructed for the meridian of some particular country; and in declining dials, the reason of the substiler line being at a certain distance from our 12 o'clock line is, because the country where it would be a horizontal dial has the time earlier or later, according to the declination of the plane. Thus, for instance, we all know that the time in Africa is later than in London; that when it is 1hr. 16min. at the Cape of Good Hope it is 12 o'clock at London; consequently the sun will come to the meridian of any place in that country sooner than here. Suppose the plane on which we construct our dial decline from the N. towards the E. 63°, we shall find by the globe that such a place corresponds to a place near the S. coast of Africa. We must first count 90° from that point on the wooden horizon, which will be 27° from the S. towards the E., and having made a mark on the globe where it touches this point on the wooden horizon, we must bring it to the brazen meridian, and then we shall find its latitude and longitude. We must remember, however, to have the pole elevated to the latitude 51° 30′, and the meridian of Greenwich under the brazen meridian. We shall then find the latitude to be 33° 40′ S., and the longitude 33° E. The difference of time, therefore, is 2hr. 12min.; but as it would be very inconvenient to subtract this amount from our dial, we can arrange the hours for the latitude of London in the following way: Keeping the globe elevated, we may pass a thin strip of brass across it graduated to 180°, or a thin tape would answer the purpose—one end of it must be placed on the wooden horizon exactly at the degree of the wall's declination. Thus, we must bring one end of it to 63° from the N. towards the E.; we must then pass it under the brazen meridian across the zenith, which, as the globe is elevated, will be 38½° from the Pole, the other and we must place at 63° from the S. towards the W.; then there will be a hemisphere formed, and the meridians passing through 15° (not 10°, as on some globes), which the tape cuts will be the hour-arcs. It will be seen by inspection that they are all oblique angles, and their width may be ascertained by measuring with the quadrant. They will be found to be the following:—XI o'clock, 9° 43′; X, 19°; IX, [illegible]; VIII, 35° 10′; VII, 48° 56′; VI, 65° 15′; V, [illegible] 45′; these will be the morning hours; the afternoon hours, being farther away from the meridian, will be wider, namely—I, 11° 20′; II, 26° 47′; III, 49° 20′; IV, [illegible]: when the sun will leave the plane. The elevation of the style, and its distance from the 12 o'clock line may also be found by the globe, and in order to make the style parallel to the axis of the world, and point to the N. and S. Poles, we must form a right-angled spherical triangle, and this may be done by any meridian passing through a plane just 90° distant from the point of declination; and as it is impracticable to mark every meridian on a terrestrial globe, we may, for convenience, take that of Greenwich, and turn the globe until it touches 63° from the E. point towards the S., then it will be 90° distant from the point of declination, and so a right angle will be formed; then in the point where it cuts the tape, or thin strip of brass we shall find both the things required. The number of degrees on this meridian (which may be measured by the quadrant) reckoning from the N. Pole to the part where it cuts the tape, is the elevation of the style, which will be found equal to the latitude 53° 40′, and the number of degrees on the tape or strip of brass, reckoning from the zenith to the part where it cuts the meridian, will be the distance of the substiler line from the 12 o'clock line, namely, 19° 45′, over which the style must be erected perpendicularly.



A sun-dial of this kind I made some time ago on the wall of a house, working it out first by the globe, and then verifying the results by the formula in trigonometry, and it answered the purpose admirably. It is a most useful kind of dial, and is often to be met with. The hour-arcs may also be found by the following formula:—*R : cos A C : : tan. A : cot. A C D. ∴ B C D is known; then again, cos B C D : cos A C D : : tan. A C : tan. B C*, which will give the morning hours; but for the afternoon hours we must make the angle *A C B, 30° + 90°*, which, worked out by logarithms, will give the distances required. I hope, Sir, to finish these remarks on dialling in one more letter.

T. S. H.



TURNING BUNGS WITH A FOOT LATHE

SIR,—I bought a small foot lathe about a month ago for the sole purpose of turning bungs. The size of it is 2½″ centre, with a 2′ 2″ fly wheel. I have spent a considerable amount of time in trying to find out a plan by which I could them (the bungs) speedily, and tried three or four different ways without, I may say, any success. I have no doubt there is a proper method, if I only knew of it, by which I could turn them with great speed, and fear I am only exposing my want of mechanical skill in asking a question which I have no doubt is simple enough to the *initiated*. I shall be very thankful if you or any of the readers of your valuable journal can tell me of a good plan or instrument by which I can accomplish my object.

P. KENNY.

TURRET CLOCK.

SIR,—Will you kindly allow me to ask Sidney Maddison if he will explain the manner in which the hour and quarter trains of his clock are discharged, and also to explain the winding more fully, and how the motion work is worked. Can the clock be seen in action; if so, where and at what time?

COMPENSATION.

POISONOUS POSTAGE STAMPS.

SIR,—I went to see a friend of mine one night last week, and, much to my surprise, found him suffering from severe vomiting, as he seemed quite well when I saw him at noon of the same day. I asked the cause of his illness, and he informed me that he had been despatching a quantity of circulars by post that evening, and that the gum—or, better, the "glutinous concoction"—on the back of the penny stamps had made him very sick. Now is not this too bad? It almost makes one shudder to think what this stuff is composed of; and we know for certain that some of it must pass down the throats of stamp users. There are many "pretty, *patent*" little devices for wetting postage stamps, but how many use them? We can safely say that 99 out of every 100 stamps consumed in the kingdom are wetted with the mouth. The higher priced labels are free from this concoction; so also are the stamps of the Inland Revenue Department. What excuse has the Postmaster-General for this?—surely not expense, seeing how small the proportionate cost of better gum would be, and how large his profits are! One million and a half is the average amount netted by the Postmaster-General annually! One would think that out of this a trifle might be found to pay for a better quality of gum. I hope that a change for the better will soon be effected.

TERSET DENROY, Liverpool.

[No doubt a letter or two addressed to the Postmaster-General would be the means of putting the matter right.—ED. E. M.]

THE "MACCLESFIELD" VELOCIPEDE.

SIR,—This machine was made from my own design by a coachbuilder of the same name. It cost me £7.

Its trial trip was an utter failure. The machine went beautifully up the street, but the driving wheel refused to bite on the road. When that difficulty was overcome, I found it hard work to get up hill—another alteration was suggested. The machine is beautifully balanced, and velocipede riding becomes a pleasure (without toil). This is the only machine where a large driving-wheel can be used with any degree of comfort. A 36in. driving-wheel gives 586 pulls of the lever to the mile; 48in. takes 440 pulls; and a 60in. 354 pulls; weight about 85lb., which would be no material consideration when one-third the movements are saved betwixt using a 36in. driving-wheel and a 60in. Price ought not to be more than 8 guineas to have a durable machine. This machine works by the hand as well as the feet. It needs no springs, and the maker will not let out any on hire.

J. STANWAY, King-street, Macclesfield.

A GOOD INSTRUMENT.

SIR,—"G. C." mentions my name in the ENGLISH MECHANIC, as the possessor of a 4¼in. Alvan Clark, and which he very justly, I think, describes as a fine instrument. I have only had the instrument some two or three months, but have used and tested it a good deal in the time. It seems very perfect in both stellar and planetary definitions. It will clearly divide ε Arietis. η Orionis it appears to separate, but the smaller and dull coloured star is a little flattened. γ Andromedæ is elongated, and also ζ Cancri, slightly I think; but in this case I am speaking from only one observation. The following minute stars I have seen with this glass:—The 5th and 6th stars in trapezium; the 6th about three or four times in the last two months; the faint companion to λ Orionis, as a steady object, and with all powers; the 15th magnitude comes to 62 Arietis on three occasions, steadily, with 130 power; T. Orionis, with nearly all powers; 15 Monocerotis quadruple. The small stars in Sigma, Arionis, and the 11th magnitude star, companion to A Lyra, are not "put out" with a power of 400, although are of course not so well seen as with a much lower power. I have seen six specks, or craters, on the floor of Plato. Jupiter and Venus I have seen beautifully defined. I have an achromatic eye-piece, giving a power of about 500, and I have seen with this power Venus defined really wonderfully well. Jupiter wants more light, and I have generally found 220 high enough. The outline of the disc is sharp, with any power, but with a high power there is not sufficient illumination to show the fainter belts. There is a peculiarity about this O.G. which I never met with before, and that is, that the two surfaces of the crown lens, are worked to the same curve, and either surface seems exactly to fit the concave flint. On trying the telescope I found the O.G. would perform wonderfully well with crown lens, turned either way, and it took me some little time before I became satisfied which was the best position for the crown lens. I find with crown lens, placed in one position, the O. G. will not bear a ring aperture so well as in the other position, but with the full aperture, definition is very good, and this is the position in which the lenses were placed when I received the O. G. (second hand). My experience leaves me to prefer the reversed position of the crown lens. I had an opportunity of looking through "G. C.'s," telescope, 2¾in., mentioned in the MECHANIC, and I find it gives very small star discs. I am an unbeliever in size of star discs, varying with aperture alone, irrespective of the focal length and figure of speculum, or curves of object glass.

W. MATTHEWS, Hill House, Gorleston, Yarmouth.

BREAD MAKING.

SIR,—I should feel obliged if any of your readers could give me a good recipe for the making of yeast or barm. It is sometimes difficult to get it from the brewers, even in the country—I mean in remote places, and in London you can't get it all, and if you wish to bake your own bread, you must put up with baking powders. For my own part, I don't believe they are wholesome, and am afraid they leave an injurious deposit on the system, if long used. Besides, the bread made in this way is not light, neither is it heavy and (no matter what pains you may take in mixing) it is anything but satisfactory. I have tried Liebig's method, Borwick's method, hydrochloric acid, carb. amm., carb. soda, &c.: but they are really failures, and not equal to bread made with brewers' yeast. Liebig's mode is the best, but still the bread is not sufficiently light. Borwick's powders any one can try, as they are sold at many places, and are panegyrised from day to day. I have found them ineffectual, but for those who are not particular the following form is perhaps as good as any, and any person can make it for next to nothing, the cost being very trifling; Ground rice, 1lb.; carbonate of soda, ½lb.; tartaric acid (crushed very finely), 6oz. To be kept in a dry place, in a stoppered bottle, or well secured from the air. Use it like other baking powders. A good sort of yeast is made in Hungary from bran, and I believe the Persians use pease (which are windy) for the same purpose, but I am ignorant of the process. Teetotal barm is made of potatoes, flour, hops, and brown sugar, quickened, I think, with brewers' yeast. Cobbett recommends a kind of cake, made in summer time, of rye flour, but the process, although satisfactory, is inconvenient.

What is wanted is a simple yeast that will act on flour like brewers' barm, and that can be easily made by ordinary person, good bread from powders or German yeast being an impossibility to those who know what bread really is.

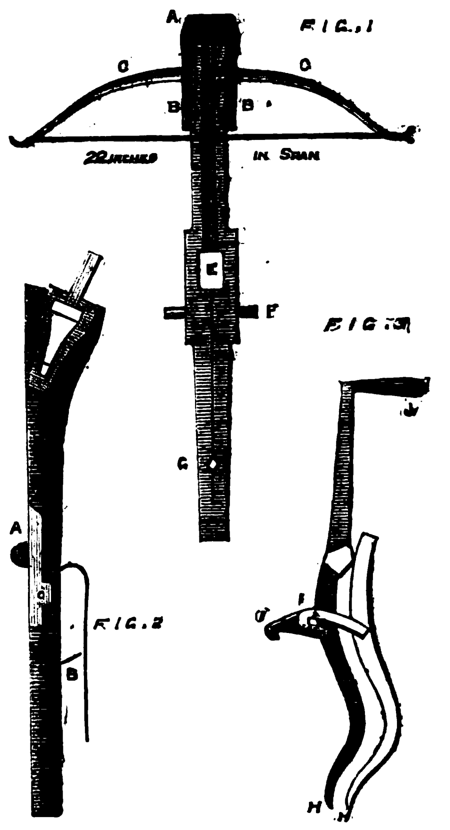
T. ESTEE.

CROSS-BOW.

SIR,—A correspondent in your paper has, through your kindness, asked instructions and dimensions to help him in constructing a cross-bow. I enclose a drawing of one I some years back obtained of an old family in the New Forest, where they were used to shoot deer and rooks until a late period.

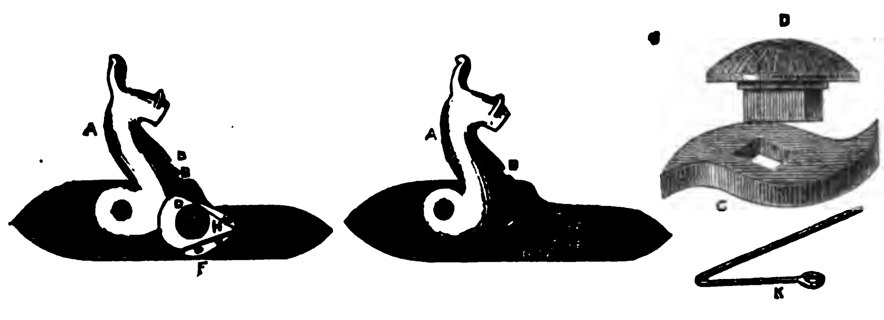
A is a piece of iron in which to place the toe of the foot whilst stringing. B B, two iron braces, connecting this toe-rest, the steel bow and stock, as shown in No. 2. C C, the steel bow, 1⅝in. in width at top, graduating, from the bend to each extreme, to ⅝in., having a fork to receive the bowstring. D is a groove of smooth horn to facilitate the slide of arrow. E is a bone sunk in the stock of the bow, on which the trigger sets, to keep it strung. It is of circular form, projecting above the stock of the bow, and is grooved. When the trigger is loosed, this bone turns and propels the arrow, shown at A No. 2. F are strips of iron to strengthen the stock and keep the bone to place, having a transverse pin on which to rest the instrument, to claw the string back over the bone E. G, an iron lozenge pin, with two bone pins for sighting. No. 3, the instrument to claw back string H H, pass each side of stock behind the F transverse pin in drawing of crossbow. I I, two claws put to the string of bow, when the handle J is drawn back, and brings the string to shooting position. B No. 2 is a piece of iron similar to the guard of a carving fork, and keeps the trigger to place. When this is pushed forward, the bone A passes round, and the string released, propels the arrow. The bow steel is ⅜in. thick. The string must be a very strong tendon of an animal, or bullock twistle. The stock is 2ft. 2½in. in length.

F. B. ARGYLE, Christchurch, Hants.



GUN ACCIDENTS.

SIR,—As a humane man, you will, I am sure, insert the following description and drawings of an invention of mine for preventing those deplorable accidents resulting from the unintentional discharge of firearms. Such accidents are almost invariably caused by the cocks becoming caught in hedges, bushes, etc., or by the gun being carelessly or ignorantly carried at full cock, when, of course, any accidental touch on the trigger fires the piece, and the result is frequently wounds or death. My invention is simple, strong, and inexpensive; can be attached to any gun-locks, makes guns much safer, prevents wear of locks, and removes the necessity of always bringing the gun to "half cock" before crossing hedges, walls, etc. I merely add that having no pecuniary interest whatever in the invention, and not having patented it, all persons are at liberty to use it. A the cock, with the notches B B B cut or filed on its front edge. C is a steel catch, with a square hole through it, into which the boss or button D fits. D, a *milled* boss or button, countersunk at the top to receive a small screw and washer. It has a hole drilled through it to admit a stout steel pin, upon which it turns, and which is rivetted to the lock plate. E is a small, short steel peg, also rivetted to the lock plate, to prevent the catch C from going below the lowest notch B in cocking, and to support the cock if the trigger should be

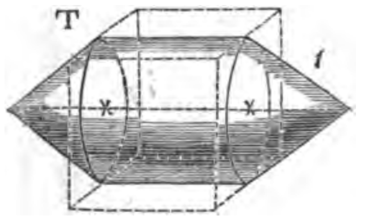


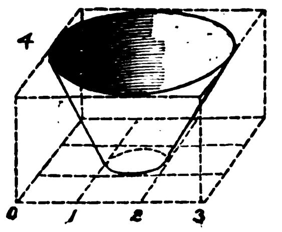
accidentally pulled. F F F are screws to fasten the cover or cap H to the lock plate. K is an ordinary V spring. The notches on the edge of the cock need not be cut quite across the edge of the cock, but the face of the cock can be left unaltered, so that the notches may be unseen. Of course C and D may be made in one piece, if preferred. H is a cap or cover made of stout sheet-iron, case-hardened, or of thin steel. In some locks it will be necessary to place the guard in the *rear* instead of the front of the cock. In that case it will only be necessary to invert the guard and cut the notches in the rear of the cock. To set the guard, turn the boss D towards the cock, and to throw it out of gear, turn it from it. I have severely tested my invention, and find it never fails. One of the notches B is for full cock, another for half cock, and the upper one is for securing the cock in case it should be accidentally lifted. I sincerely hope that the Baines safety guard may be of service to my countrymen, and that it may be the means of saving human life.

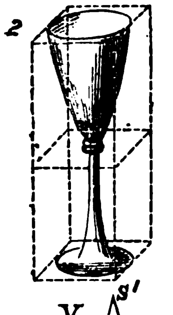
Henry D. Baines.

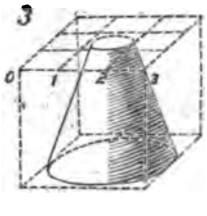
DRAWING FOR THE MILLION—No. IV.

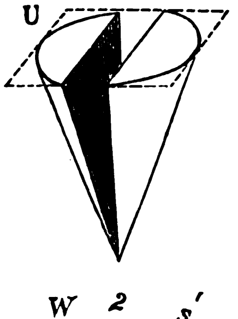
Sir,—T. 1 to 4.—Continuation of cylinders and cones. Many figures are combinations of cylinders and cones. Draw always first the enveloping prism, the great outlines. Generalise your exercise, put the solid in other positions: p. ex., horizontally instead of vertically, &c.

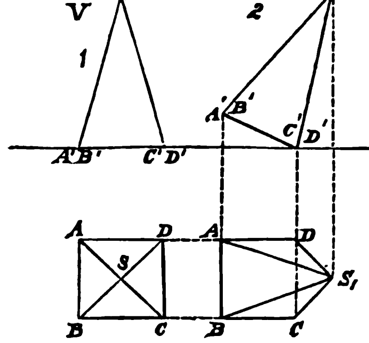


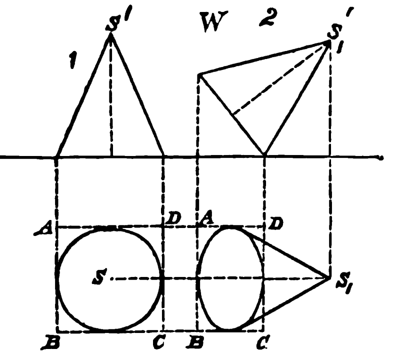












U.—Cone cut by two planes passing through the vertex.

V. 1.—*Plan* and *elevation* of a square pyramid having two sides of the basis: A D and B C parallel to the vertical plane of projection. V. 2.—The same inclined Draw first the elevation; from S^1 a perpendicular and from S an horizontal line will give the point S_1 now horizontal projection of the vertex.

W. 1 and 2.—The same exercise for a cone; the ellipse projection of the basis is limited by the rectangle A B C D.

G. Quilosa.

GAS AS A FUEL.

Sir,—I see that the question of gas as a fuel has been more than once inquired about, and written on in your pages of late. To threw some light on the controversy, I beg to send an extract from an American paper, which has recently been sent to me by a friend on the other side of the water.

An Old Subscriber.

"During the last few years heating with gas in different ways has been introduced, and doubtless this mode of heating would enjoy a far more extensive application on account of its cleanliness and simplicity, were it not for the high price of illuminating gas on the one hand, and the impracticability of generating gas on the principle of Sieman's gas generator, on a small scale, on the other hand. The supply of a cheap article, seems, therefore, very desirable; and this object, we learn, is about to be realised by the gas works now building at Fürstenwald, near Berlin. The gas is to be generated from lignites at Fürstenwald, about 22 miles from Berlin, and carried to the latter city by means of pipes. For this purpose there will be erected at Fürstenwald 12 buildings, each 105 by 62ft., with an aggregate of 70 furnaces, each containing 10 retorts. The furnaces will be provided with Sieman's regenerator. The gas, after having been freed from tar, water, &c., by passing through condensers, is brought to Berlin through a series of pipes, 4ft. in diameter, into which it is forced by 4 cylinder-blasts of 7ft. 7½in diameter and 6ft. stroke. The blasts are propelled by 4 steam engines of 6ft. stroke, and 360 horse power each, capable, however, of working up to 500 horse power. The pressure of the gas in the pipes is intended at 16ft. water, equal to about 7lb. to the square inch, since this comparatively high pressure allows of a smaller diameter of the pipes, and seems to offer a lower one in many other respects. The pipes are to be made of ¼in. boiler plates, and not buried, but laid above ground, to render them at any time easily accessible, and supported in an appropriate manner by stone pillars. Under a pressure of 16ft. water, the pipes will deliver 407 cubic feet per second.

At Berlin the gas will be stored in 12 gasometers, each 154ft. in diameter and 40ft. high, having, therefore, a capacity of about 750,000 cubic feet. From these gasometers the city is to be supplied. From experiments made by Dr. Zuirck, of Berlin, it seems that a gas of good heating quality can be made from the Fülstenwald lignites. The components of the gas at a specific gravity of 0·5451, is said to be as follows:

Hydrogen	42·36	per cent.	
Carbonic oxide	40·00	,,	,,
Heavy carburretted hydrogen	11·37	,,	,,
Nitrogen	3·17	,,	,,
Carbonic Acid	2·01	,,	,,
Carburrëtted hydrogen (condensible)	1·09	,,	,,
	100·00		

If this composition of the gas can be regularly maintained throughout, it will answer it purpose perfectly. The experiment shows that 3000 cubic feet of the gas are equal in heating power to one ton of lignite, or one-third ton of hard coal. The price at Berlin is rated at 12½ cents gold per 1000 cubic feet, and the equivalent of one ton of hard coal will cost in Berlin 1 dol. 12½ cents gold. The capacity of the works are calculated at 9,500,000 cubic feet per annum, or about 10½ millions per day, which it is said will cover the demand of about half the city."

THE WORKING OF GRANITE IN ANCIENT TIMES.

Sir,—Granite is now commonly planed, turned in the lathe, and polished by machinery, but it is very questionable if it is wrought more beautifully than it was by hand in ancient times. Egypt shows examples of what patient labour can effect, but India, from whence it is probable Egyptian civilisation was derived, yet possesses monuments of early human skill, which are hardly equalled by any extant examples of Egyptian art.

The famous temple of Chillambrum, in Southern India (probably at least as old as the Egyptian pyramids), originally consisted of seven lofty walls, six of them within the external one and each within the other, surrounding the central quadrangle. These walls had seven gateways and twenty-eight pyramids, forming a huge cross, probably by no means the earliest example of that most universally distributed figure, for the crosses discovered in Central India by Mr. Mutheran, appear to be far more ancient. The walls of this temple extended over a mile in one direction, and have never, that I know, been equalled in magnitude by any modern Christian structure.

The interior of this temple is decorated by festoons of chains, depending from pilasters; each of these chains was wrought out of a single piece of granite, sixty feet long, the links, twenty in number, having been carved, intersecting each other, and highly polished; indeed they retain their polish to this day. Each link is thirty-two inches diameter, and I am told, only one is broken; and much as I dislike the desecration of ancient monuments, I should like to see a few links of the broken chain in the British Museum, for an example to English mechanics. I cannot help thinking it rather doubtful, if our automatic granite working machinery could do much better than these people of the same Aryan race as ourselves did by hand, it is said, without steel tools—but this I beg leave to doubt—notwithstanding Sir J. Whitworth does deservedly esteem its powers so highly.

The Harmonious Blacksmith.

VERY REMARKABLE ANCIENT MUSICAL INSTRUMENT.

Sir,—In an ancient Peruvian huaca, or catacomb, a syrinx, or Pandean pipe, was found, which was carved out of a solid mass of lapis ollaris. This interesting relict of an ancient and extinct civilisation (which may be as old as the representations of harps found by Bruce in the tombs of the kings of Egypt, an engraving of which is in Burney's "History of Music"), is profusely ornamented with representations of what are termed Maltese crosses, a thing not very surprising when it is considered that the cross is perhaps without exception, the most ancient and widely diffused of existing symbols, both in the Old and New worlds, for it is found throughout Europe, Asia, Africa, America, and even the islands of the Pacific, Tonga, Viti, and Easter Island for instance. This instrument is also ornamented by other symbols, very similar to those found on Egyptian obelisks, and on some of the monoliths met with in Western Europe. An engraving of this remarkable specimen of Pan's pipe, is in the "Trans. Roy. Soc. Edinburgh," Vol. 20, page 121. Query, does not its ornamentation indicate (in common with the almost identity of ancient architectural remains in India, Java, the Pacific Islands, and South America), the intercommunication of the ancient races of mankind, which inhabited the Old and New Worlds, perhaps before the Pacific Ocean was formed, or at least before a large extent of land between Asia and America was submerged?

The Harmonious Blacksmith.

LOCK NUT.

Sir,—In our valuable paper for February 25, page 575, there is an account and drawings of a patent lock nut for the joints of railway rails. I think it would be too expensive for railway work, and propose a lock nut for joints of rails in this form; the head of the bolt made to fit in an oval hole, so that it will not turn, and on the inner plate a small square groove, cut across the centre of the hole, and a cut similar in the squares of the nut, but at the back, so that when the nut is screwed home, any of the squares put opposite the groove in the plate, there remains a square hole for a key to drop in, but not to be made to fit too tight, and long enough to get hold of it to take it out at any time, so that when the plates wear, take out the key and you can either give it a quarter or half turn, whichever it requires to tighten it, so that the nut is level, then put in the small iron key, and it will remain firm until wear takes place. If too expensive for main roads, it would prove valuable for points and crossings in yards, especially for junctions. Let some of our brother correspondents give me their opinion of it.

Platelayer.

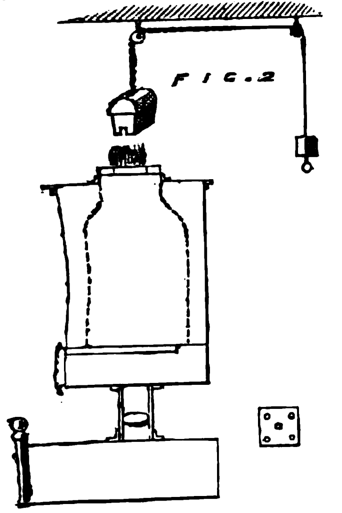


FIG. 2

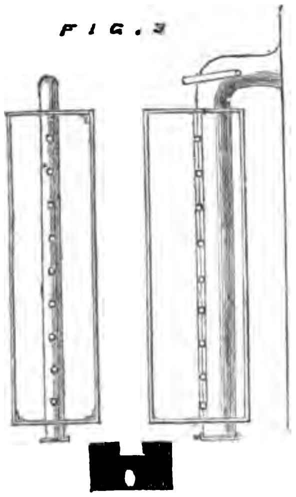
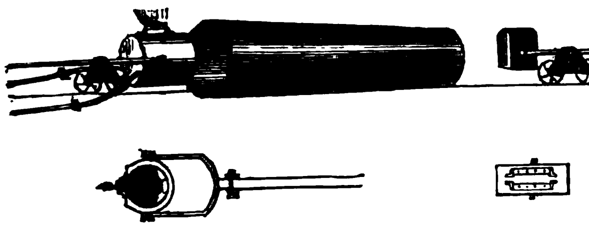


FIG. 3

FIG. 1


KAPPER'S IMPROVED FIRES.

SIR,—I send you above a rough sketch of Mr. Kapper's improved fires, which he has introduced into Chatham Dockyard, with a saving of 50 per cent. Fig. 1 is for welding tubes. The sketch shows the working of it. When it welded the shaft tubes for the *Glatton* the tubes were 13ft long, 4ft. one end, 2ft. 6in. the other. This fire is well adapted for boiler-makers, for welding the inner tubes. Fig. 2 is more for beams, plates, or angle iron. It is a very valuable fire. It is easily lighted or easily cleaned out; there is no turning the work on edge. Fig. 3 is for heating the arms of beams for bending. We are able to bend an arm in one heat. I think the sketch needs no explanation; but if any of the readers wish it, I will be most happy to give it.

GEO. HUART, Franklin-road, New Brompton.

EXTRACTS FROM CORRESPONDENCE.

STARCH.—H. E. Godfrey observes:—"I was delighted with the interest taken in the subject 'starch.' Long live our journal of mutual instruction! Much good might be done among pharmaceutical students by short notes on Materia Medica, Botany, and Pharmacy, &c."

WATCH CLEANING.—"Ab-oth-Yate" writes:—"To 'Veritas,' 'Stopt,' and others. The olive oil purified with lead shavings is very good, but if they will purchase the best almond oil, they will find it much better, as it does not gum nor freeze like the best purified olive oil does. Tried and found good."

THE USES OF OLD HORSE.—H. E. Godfrey, referring to a letter under this head in our last number says:—"It may be interesting to some of the readers of the ENGLISH MECHANIC who have a passion for ketchup, to be informed that there are establishments, in and about London, devoted especially to the preparation of *genuine mushroom* ketchup from old horses' livers, which are allowed to decompose for the purpose."

ALGEBRAICAL PROBLEMS.—"Pneuma" says:—"I enclose a reply to a question in last MECHANIC for insertion in your next number, if you think it worth while. At the same time, are you not almost too liberal in the space you afford for solutions to algebraic problems, which are frequently of little *general* interest? Could you not suggest to your readers that almost every young algebraist can surely find in his own neighbourhood some educated person who would be glad to help him out of an occasional difficulty."

ON SKETCHING FROM NATURE.—"Mus" says:—"May I make a remark or two on the above papers? At line 7 from the bottom the writer says, 'Hence it is always,' *&c.*, &c. He should have explained that if an appearance of *height* is to be given to a building, in the foreground especially, the *perspective* must be attended to. For instance, in *Fig.* 1, *standing* at the foot of a house, the perspective causes *the* line of the roof to slope as in diagram, and, as the writer *himself* states and shows, not only the proportionate height of the house, but also its position. In the same Fig. we have, on the opposite side a smaller house; hence the difference in perspective. The only method we have of showing the stupendous height of such towers as St. Peter's at Rome, and Strasbourg Cathedral is by the perspective. Proof of this may be seen in a lithograph of the latter church, *by* T. M. Richardson, jun."

HINTS TO CORRESPONDENTS.—"Scrutator" says:—"G. Forrest (p. 636) recommends 'Scrutator' to sign himself 'Screw Loose,' or 'screw tighter his ideas before he rushes into print.' The force and real application of these remarks will be seen by reading further on, where he says—'"Gitche Manito" is quite right in saying that the machine used for shoddy manufacture is called a "willey," or vulgarly a "devil."' Now it so happens that 'Gitche Manito' did not say anything of the kind. The expression *vulgarly a devil* was my own! From this I infer that G. Forrest did not quite understand what he was writing about; I beg, therefore, to include him with those to whom, Hints to Correspondents' are intended to apply. 'Gitche Manito,' whose letters are most fully appreciated by me, will, I am sure, see the folly of G. Forrest 'rushing into print.' With regard to G. Quilosa's more respectful letter, I beg to remark that if, after 25 years' experience in teaching, he will inform me through the pages of our MECHANIC that he is not sufficiently 'up' in the subject of Projection to detect the erroneous teaching in the book he so strongly recommends ('Projection,' by Ellis A. Davidson), I will, through the same medium, endeavour to enlighten him, although I have no intention of reviewing the work in question."

CONSUMPTION.—"Hanley" states:—"I am glad to see you take so much interest in that terrible complaint consumption. Some years ago, a relation of mine travelled amongst the Portuguese, and the country-people used the following plan for all lung diseases, in the first stage.—New milk one quart, then take a flat bar of clean iron about 1¼in. thick, make it a bright red colour in the fire, then stir the milk with the iron till you have reduced the quantity by a half a pint; this is taken every morning till the patient gets better; they very seldom give drugs of any kind. Perhaps some of your medical correspondent can enlighten us what is the chemical action of iron and milk on a diseased lung."

MEDICAL OPINION.—"F.R.C.S." writes "to beg to add a further remark on the question of improvement of your journal, and I venture to do so solely on public grounds, it is to caution correspondents, both those who make and those who answer medical questions at various times. I have noticed inquiries and replies calculated to lead to great mischief; I might particularly indicate some relating to the sight and diseases of the eye. I am myself the chief surgeon to one of the large eye hospitals, giving advice to upwards of 10,000 patients annually, but I would not venture to reply to some of the questions as propounded in your columns."

MANGANESE BATTERY.—Mr. W. H. Stone deprecates the imperfect information which has been given since we inserted his detailed account a short time since. He says:—"The 'strong saline solution,' spoken of in the last number, is best formed of saturated solution of sal-ammoniac. No 'perforated shelf to hold a supply of salts' is needed; at least mine has been working untouched for seven months without. A 'cylinder of amalgamated zinc open at top and bottom' is equally needless, as a small flat strip 2in. broad answers any purpose, and costs much less. Lastly, there is no need to give 7s. or even 5s. for each cell. A quart jar costs 6d, a 6in. porous pot 7d., a carbon to match about 1s., zinc about 2d., sal-ammoniac ¼lb 3d, manganese about 1lb. 2d; total 2s. 8d. Of course binding screws and platinum connections are expensive, but there are simple means of dispensing with both.

PARAFFIN OILS.—The United States' Government has recognized the danger of the so-called paraffin oils. A general order promulgated by the United States War Department provides that hereafter no volatile oils will be issued or used for illuminating purposes at military posts, and all varieties of coal oil will be regarded as volatile. In general, lard oil will be supplied for issues of oil authorised for the necessary illumination of military posts.

A RARE LENS.—The largest photographic portrait lens ever made in this country is one of 10¼in. diameter, recently completed by Ross, and now in the possession of Mr. Mayall, of Regent-street. It is an achromatic lens of great power, and will take portraits of any size, from the smallest miniature up to very nearly life size. It is made of glass of the whitest description, and its size admits so large a volume of light that photographs covering a space of 10in. by 12in. may be done in eight seconds. The lens renders in the photograph all that is seen in the optical image, and this so truthfully that the coarseness and exaggeration belonging to large photographs taken with inferior lenses are altogether absent. In the open air groups of 15 to 20 persons (each face about the size of a sovereign, and the whole picture 24in. by 24in.) can be taken with the short exposure of 10 seconds. The cost of manufacturing the lens was upwards of £200.

REPLIES TO QUERIES.

◆

[1507.]—**SEA VOYAGE.**—Seeing that no answer appeared to this query, I extract the following from the "Annuaire de la Maison de Melle-lez-Sand," circumnavigation in 1870. The establishing of the steam boat lines between Australia and San Francisco (1866), and between San Francisco and Hong Kong (1867), has completed the circumnavigation by steam. Those two lines present but a little difference as well as to the price of passage as to the duration of the voyage. Prices are the following in first-class (I reduce approximatively in English currency), from Paris to Marseilles £4, from Marseilles to Alexandria £20 12s., from Alexandria to Suez £2, from Suez to Aden £40, from Aden to Pointe de Galle (Ceylon), £30. At Pointe de Galle the two lines separate. On the northern one we pay from Ceylon to Hong Kong £30, from Hong Kong to San Francisco £60, from San Francisco to Saint Nazaire, (France), £70, on the Panama Railway £5, and from St. Nazaire to Paris £2. On the southern line from Point de Galle to Sidney £50, from Sydney to Panama £60, for Panama Railway £5, from Colon or Aspinwall to St. Nazaire £44, and from St. Nazaire to Paris £2. The whole voyage costs:—

By Hong Kong, 1st class, £263 12s.
By Australia, „ £257 12s.

The duration in time is the same.

	Days.		Days.
Paris to P. de Galle ...	25	Paris to P. de Galle ..	25
P. de Galle to Sydney	24	P. de G. to Hong Kong	15
Sydney to St. Nazaire	55	HongKong to S. Nazaire	64
Total	104	Total	104

By the opening of the Pacific railroad, the Australian line comes in the second rank. The shortest route round the world is that of San Francisco; by this line one can go in 39 days from Liverpool to Hong Kong, and the whole tour requires only 80 days.—CAMILLE, D. P.

[1651.]—**LOCKS.**—There is a book on this subject, "Construction of Door Locks," to be had of Virtue Brothers and Co., 26, Ivy-lane, Paternoster-row.—MATY.

[1729.]—**RINGS OF STEAM.**—Any force acting suddenly upon the air from a centre imparts to it a rotary motion, which is not only confined to loco's and baccy pipes. If a big gun, on a still day be fired, without shot, with a well greased muzzle, an enormous and regular smoke ring will be the result.—MATY.

[1798.]—**VARNISH.**—Mr. B. Nicoll's address is Regent-circus, Piccadilly; and his works, No. 11 Arch, Lachmere-grove, Battersea.—A. M.

[1799.]—**REVERSING ECCENTRIC.**—I cannot do better in this instance than quote Rankine:—"To reverse the direction of rotation of the shaft of a steam engine, the piston must be made to come to rest and then to move the reverse way, before completing a stroke, and the eccentric must assume that position relatively to the crank which is proper for working the slide valve when the rotation of the shaft is reversed. That position (or the position of backward gear) is somewhat less than half a circumference from the position of forward gear, measured round the shaft in the direction of forward rotation. To bring the eccentric, therefore, into backward gear, it is sufficient to cause it first to stand still while the shaft nearly finishes the first half turn backwards, and then to accompany the shaft in its rotation. In most stationary engines, and many marine engines, those objects are effected by having the eccentric loose on the shaft, and so counterpoised, that its centre of gravity shall be in the axis of the shaft, but prevented from turning completely round by means of two shoulders, one of which holds it in the position of forward gear, and the other in that of backward gear, care being taken that the motion of the loose eccentric round the shaft shall be forwards to go from forward into backward gear, and backwards to go from backward into forward gear. To reverse an engine with a loose eccentric, the gab is to be disengaged from its pin and the slide valve moved by hand if necessary. When the shaft has made part of a turn backwards, a stop on the shaft comes against a shoulder of the eccentric causing it to assume its motion, re-engaging the gab and working the valve as before.—MATY.

[1809.]—**FEATHERS IN WOOD.**—The following which recently appeared in the *Builder*, will answer "E. R. S.:—"In the structure of all woods used in building, there is, firstly, a series of vessels of woody tissue surrounding the heart of the tree, having a *vertical* growth, and arranged in *annual concentric circles*; secondly, there are certain hard woody growths, called the "medullary rays," *radiating* from the heart, and consequently more or less *horizontal*: these vertical and horizontal growths are intimately but *regularly plaited and intertwined together*, to give strength to the trunk, and thus far all is regularity. Now where the branches burst through the stem this regular arrangement is upset, and the above-mentioned woody vessels are disarranged, and pushed at different angles. When the tree is cut down and sawn horizontally across amongst these branches, these disrupted horizontal and vertical vessels (of different colours, be it remembered) are seen cut at every conceivable angle, and an ornamental 'feather,' more or less extensive, is the consequence. These feathers do not exist at the *base* of the tree, because there are no branches there to disturb the annual growths of the wood (minute feathers do indeed exist at the *very heart*, and these were caused by the growth of leaves and twigs when the tree was a seedling or little cutting). 'Feathers' are not seen in *deal*, because the fir is a straight-growing tree, without branches in the portion of the trunk used in commerce. 'Feathers' are seen most abundantly in 'pollards,' for the simple reason that after the top of the tree has been sawn off, an immense growth of branches is always induced, disturbing the tissues in every imaginable way: the action of the *light* on the 'feathers' adds greatly to their beauty after the wood is polished."—GIPSY.

[1831.]—MOTION OF WATER.—The amount of water passing through a 9" pipe 12ft. long, 1ft. head, is 105,877 gallons per hour.—MATY.

[1831.]—MOTION OF WATER.—I think that "A Subscriber from the First," will find the following table useful to him, which shows the velocity per second, due to different heights or heads:—

Height—Feet.	Velocity—Feet.
1	8.
2	11·314
3	13·856
4	16·
5	17·889
6	19·596
7	21·166
8	22·627
9	24·
10	25·298

The height being 1ft., the velocity through his pipe will be 8ft. per second; therefore when the pipe is 9in. in diameter, area being 63·6in., the discharge per second will be 6107·25 cubic inches.—STREBOR.

[1859.]—MATCH MAKING.—Mr. Ch. Mertens, at Lessines (Belgium), patented three months ago in that country, his lately invented dipping machine for match making.—RAIMOND STAES.

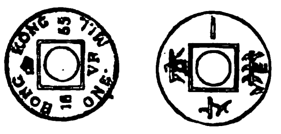
[1865.]—WHITE METAL BEARINGS.—When the chair is cast, have it hollowed so that it will hold the metal, fasten the chair in its place, put in the spindle packed up, put some clay round the spindle to keep the metal from running out, pour to the centre of spindle, cut off any projecting metal, lay some strips of cardboard on each side of the spindle, put on the top part of chair clay round the spindle as before, and pour through oil hole. This mode requires neither fitting nor boring. I have seen lead used alone, and wear very well.—MILLY.

[1887.]—PUTTY.—Let "Hortus" get about 20lb. of whiting, and pound it up fine, then add enough raw linseed oil to make it into a stiff uniform dough. I found it took three pints, and that was not quite enough. Then hammer it well out, as thin as it will go, and work it well till it comes soft enough. I was told that one pint of oil was sufficient for 15lb. whiting, but found three pints hardly enough. This is the best and cheapest putty. He had better add the oil as he wants it—not all at once, and warm the putty before a fire.—AUGUSTUS.

[1889.]—BELGIAN AND FRENCH PERIODICALS.—No journal similar to our ENGLISH MECHANIC is published in Belgium or France. In no one, such variety of instructive matter is to be found, as they respectively and for the most relate to some special branch of science. If my fellow correspondent "Argente" will communicate with me through our MECHANIC what subject he more especially prefers, or what branch of science, mechanics, or technology, he wishes to be informed on, I shall be glad if I can to answer his demand.—RAIMOND STAES.

[1894.]—CHINA GRASS DIVISA.—I have also been puzzled by that name, and never could get any conclusive information about the plant; the following article appeared in several French reviews:—"Dr. Grothe, director of the manufacture of Rammelsberg, near Berlin, employs with great success, for making figured stuffs, much in demand for England, yarn of China grass, white or dyed in different colours. He produces the *China grass divisa* (*sic*) in a plantation he planted, and which yields 50 per cent. dry fibre, and 30 per cent. long and very fine filaments. In the mountainous regions where the soil and the severe temperature form a serious obstacle to cultivation of flax, the Urticaceæ in general, and the China grass in particular, resist perfectly. (?) The Prussian Mining Office has taken into serious consideration a culture which seems to furnish an accessory and very precious resource to the miners of the Harz and of Hanover." I made several inquiries, but always failed. I even wrote to Dr. Grothe, but did not receive any answer. If later I learn anything, I will communicate it to our ENGLISH MECHANIC. I supposed also that *divisa* might be a fault of impression for *dioica*, or for *diversa*, different kind.—BERNARDIN.

[1895.]—COWRIE COINS.—The following letter from Lord Alfred Churchill, to the Secretary of State for the Colonies, which I extract from the "*Technologist*, of July, 1865, deals with this subject:—"The Council of the African Aid Society have had under their consideration the necessity and advantage of finding some metallic substitute for the cowries, hitherto in use among the natives. A currency ought to be adapted to all the wants and habits of the people for whose use it is intended. Cowries, as a circulating medium, have been for a long time in use in the countries of the Bight of Benin and the Niger territories. Since the annexation of Lagos to the British crown, all the English coins have been introduced there. They are coming into use among the natives, but do not suffice for the general wants of that portion of the community. The lowest English coin in circulation is the farthing. The value of this is 30 cowries, but a great many articles of daily consumption are purchased much below that price. Unless, therefore, some smaller coin be introduced, cowries cannot be abolished or replaced as a circulating medium. In the interests of progress and civilization, of which Lagos is an outpost, it is desirable that the currency should be solely metallic. The Council of the African Aid Society have had an opportunity of seeing the small coins—one mil each—now being struck at Her Majesty's mint in London, for Hong Kong. Those coins being each one-twentieth of a penny, or one-fifth of a farthing, would be the value of six cowries. As nothing worthy of mention can be bought for a lower sum than six cowries, those coins would respond to all the minor wants of the native Africans, while their being perforated, so as to enable them to be strung as cowries are now strung, would render them equally safe and convenient as cowries, while they would not be more than one-seventh of the average weight of the smallest cowries used in the interior trade. The Council of the African Aid Society beg leave, therefore, to suggest to Her Majesty's Government that it would be advisable, and of general advantage, to introduce perforated coins of a similar size and value, in the currency of Lagos, Cape Coast, &c. The Council also beg leave to suggest that the perforation, in a similar manner, of other coins intended for circulation in native Western Africa, would tend greatly to facilitate their use and favour among the people." I send a sketch of the "mil" above mentioned; this may, perhaps, interest some reader. White cowries (cypræa moneta), are extensively imported in Western Africa from India; Hamburg firms, established at Zanzibar, send away blue cowries, which seem to yield a great profit. A hole is made in the shells, and they are strung on threads of palm fibre; 40 shells = 1 string. Many merchants in Lagos occupy eight or ten girls stringing cowries. 2000 blue African cowries weigh 80 or 90lb., the white Indian ones 35 to 40lb.; 2000 = about a dollar.—BERNARDIN.



[1896.]—EQUATION.—In the last number of your paper, page 640, C. H. W. Biggs announces his intention "in a short time to commence" his "Notes on Algebra." Permit me to express a hope that "C. H. W. Biggs will first master the question before undertaking to teach others, otherwise those readers of the ENGLISH MECHANIC who put their trust in his "Notes," will be in danger of falling into errors, as, for example, that the square of $-\sqrt{5x+10}$ is $-5x - 10$; or that

$$-\sqrt{\frac{175}{4}} = -\frac{\sqrt{175}}{2}:$$

See reply by C. H. W. Biggs to [1896] Equation, page 615. The reply by "Hugo" to same Equation, same page is quite correct.—SENIOR OP.

[1896.]—EQUATION.—If Mr. Biggs will consult Wood's Algebra, he will find in the chapter upon Quadratic Equation, page 118, the equation fully discussed in its *unaltered* form: $x + \sqrt{5x + 10} = 8$.—H. C. C.

[1910.]—TURKEY STONE.—I cut a lump of turkey stone into twelve oil stones when I was an apprentice, partly with a sheet of copper, and partly with a sheet of lead, of course fitted to wood frame for convenience, in both cases with sand and water, but I cannot remember which cut it quickest.—JACK PLANE.

[1913.]—GAS BURNERS to burn common coal gas are not of much use to illuminate dissolving view apparatus. I have tried several, including a 50-hole argand, but always found camphorated colza oil more effective. My experience led me to adopt the improved oxyhydrogen burner when I want more light than oil will give; the apparatus is very simple and quite safe.—C. WARD.

[1929.]—LACQUERING.—In answer to "Inquirer," I beg to send him the following method for lacquering brass-work. If he is going to proceed on old work he must first boil the articles in strong soda and water, so as to get off the dirt and old lacquer; then scrub them with sand and rinse them. The next process is the dipping, for which he will require an earthenware pan capable of holding the articles, which he must fill with aqua fortis, which he can obtain at any chemist's; 2 pails of clean water and a box of sawdust. If he has any means of keeping the sawdust hot all the better, and a nice clean brush. Now he will have to proceed as follows:—Tie the articles on copper wire, dip them in the acid, then rinse in the water and well rub them in the sawdust till thoroughly dry, and then brush the sawdust off. If there are any parts that want relieving this must be done with a bright steel burnisher and a drop of stale beer, then the articles are ready for lacquering; but if the articles have tarnished, to restore their brightness he must dip them again, but he must dilute the acid with ten times its weight of water, rinse and dry as before. Now for lacquering them he will want something to beat them on; a plate of iron with a gas-burner under it will do; but if he has an oven that will do as well. If he wants that red gold tint on his articles, it is best to get French gold lacquer and mix a drop of red lacquer with it; he must heat the articles so that he can just bear the hand on them, and then with a soft camel-hair brush lay the lacquer lightly on, care being taken not to lay it on too thick or to get the articles too hot. If there is anything else that "Inquirer" wants to know, I shall be happy to inform him.—W. SEABROOK.

[1931.]—LINCOLNSHIRE IRON.—I beg to inform "R. W. M.," that the ironstone of this district contains in its raw state from 30 to 35 per cent. of iron of a very good quality. The average price for the ore in waggons at the mines is from 4s. 9d. to 5s. 3d. per ton, and 5s. 3d. to 5s. 9d. per ton delivered at the nearest wharf. Should "R. W. M." require further information, I shall be glad to help him.—BLAST FURNACE ENGINEER, Frodingham.

[1934.]—LOGARITHMS.—To "Y. P. W."—Chambers' "Tables of Logarithms," contains seven figure tables of logs., log. sines, cosines, &c., and natural sines and cosines, with a heap of other information; proper title "Mathematical Tables," gives a few examples at commencement to explain the tables, has no treatise. Can be had anywhere for 3s.—MATY.

[1954.]—CEMENT FOR PARAFFIN LAMP.—Let "Noodle" get twopennyworth of shellac, and melt it by the fire in a tin cup, to which he may add a small drop of water, to keep the shellac from burning. When melted he then may fill the brass socket and stick in his reservoir; he will find he has a good job.—LING FISH.

[1964.]—CARPENTERS' PRICES.—I have put up fencing of four railings and one stake post: have mortised the post and pointed the railings for 6d. per length, but they were 10ft. long, that however is immaterial. The posts and rails had to be put up, but if put up at per chain it would make a considerable difference; they were laid out on the work ready for use gratis.—UNLEARNED PLATELAYER.

[1964.]—CARPENTERS' PRICES.—Posts, 12s. per 100 for mortising; 1d. per pane of 4 rails for chopping rails; 1s. 6d. per 100 for sharpening stakes; [illegible] £6 10s. per mile for putting up.—MILLY.

[1935.]—EQUATION.—

$x + y + z = a + b + c$ .. .. [illegible]

$bx + cy + az = cx + ay + bz = a^2 + b^2 + c^2$ [illegible]

From (2) .. $(b - c)x + (c - a)y + (a - b)z = 0$ .. [illegible]

From (1) and (2) .. $(b - c)x + (a - c)z = a^2 + b^2$ [illegible] $(a + b)$ .. .. [illegible]

From (1) and (3), $(b - c)x + (b - a)y = b(a + c) -$ [illegible] $+ c^2$ .. .. [illegible]

From (4) and (5), $(a - c)y + (b - c)z = a^2 + b^2 -$ [illegible] $+ b)$ .. .. [illegible]

From (4) and (6), $(c - b)y + (a - b)z = a^2 + c^2 -$ [illegible] $+ c)$ .. .. [illegible]

From (7) and (8) by transposing and dividing,

$$\frac{a - c}{c - b} = \frac{a^2 + b^2 - c(a + b) - (b - c)z}{a^2 + c^2 - b(a + c) - (a - b)z};$$

whence, by multiplying up and reducing,

$z(a^2 + b^2 + c^2 - ab - bc - ca) = a^3 + b^3 - c^3 -$ [illegible] $c + 2ac^2 - 2b^2c + 2bc^2 - abc$

whence, dividing each side by the co-efficient of [illegible] will be found that $z = a + b - c$. I should be gl[illegible] see a neater solution from some abler pen than [illegible] —SENIOR OP.

[1966.]—MOULDING MACHINE.—If "Jona[illegible] would visit any of the undermentioned plac[illegible] would see moulding machines at work. To see [illegible] for half an hour will give him more know[illegible] than a reply to his query. Houldworth's, G[illegible] Platt's, Oldham; Howard's, Bedford; [illegible] Enfield Lock; Royal Arsenal, Woolwich. [illegible] places are inaccessible to him, I shall be ha[illegible] afford him full details in the ENGLISH MECHA[illegible] N. L.

[1970.]—VARNISH FOR IRON PATTERNS.—The following is what I have seen used with succe[illegible] in several foundries in Glasgow; it is better [illegible] beeswax:—When the pattern comes from the finis[illegible] shop smear it all over with oil rubbed on with [illegible] of waste, put it in the drying stove all night, so as th[illegible] oil will burn in; if not in a hurry for the pattern repeat the dose. I can recommend this, having see[illegible] it done and having done it myself pretty often.—N. L.

[1978.]—LIQUID GLUE.—I have made a strong liquid glue by treating Russian glue with a little strong acetic acid; add a small quantity to the powdered glue, cork tight, and let it stand for some hours; you will find it soften; by adding more acid you can make it of the consistency you require it. A common recipe for ordinary liquid glue, and which [illegible] have used, consists of 8oz. best glue, dissolve in [illegible] water, add 2½oz. nitric acid; cork up tight.—[illegible] CHERRY.

[1981.]—ENAMEL.—If Mr. Walker will try the following, I think he will find one or both answer his purpose:—No. 1. Oxide of tin 6, flint 3, borax [illegible]. No. 2. Oxide of zinc 2, Cornish stone 8, whiting 1.—IOTA.

[1985.]—SIDE LEVER ENGINE.—I beg to inform "Suffold Amateur" that the side lever engine was that which used to be almost entirely used for marine purposes. I think it was invented by James Watt, but I do not know if he patented it. The principle of this engine is similar to a beam engine, only the beams are down at the sides (of the engine,) and they are connected with the piston by means of a cross head and connecting rods. The other end of the beams or side levers is connected with the crank. The advantage of this kind of engine is that all the moving parts are balanced by each other. The connecting rod from the beam to the crank is very long, therefore motion is transmitted to the crank very equally and with very little strain. The heaviest parts of the engine are brought very low down in the boat. The disadvantages are that it occupies a very large space, it is very heavy, very costly, and not applicable to screw [illegible] —H. CHAPMAN.

[1987.]—WHAT IS IT?—It is a pedomet[illegible] counting the number of steps in walking, not m[illegible] use now. Time tells the distance travelled o[illegible] the walking rate is nearly uniform for each indi[illegible] and is soon ascertained by counting a few mile[illegible] once or twice.—H. W. REVELEY, Reading.

[1987.]—WHAT IS IT?—I believe the instr[illegible] "Querist" has got hold of is a pedometer, wh[illegible] worn in the waistcoat or other pocket, and mea[illegible] the distance walked. Each step taken causing a v[illegible] tion of the weight, which acts in one of the toot[illegible] wheels.—IOTA.

[1989.]—NUMBERING BOOKS.—A bookb[illegible] would stamp the books in gold for a very small ch[illegible] or the numbers might be painted on the backs [illegible] colours, black figures on a white ground.—IOTA.

[1989.]—NUMBERING BOOKS.—Gum the b[illegible] your paper, write your title numbers, &c., in go[illegible] but blot immediately with blotting paper; a few [illegible] after size with common size or glue water, le[illegible] thoroughly dry, and then varnish with pale cop[illegible] up, and stick on in the ordinary manner. Of [illegible] we suppose a sheet or a few sheets to be done [illegible] same time to be worth this amount of troubl[illegible] when done this may be termed everlasting.—S. T.

[1990.]—METALLURGY.—The most recent [illegible] complete work on this subject is that by Dr. Per[illegible] is published by J. Murray, price 21s.—BETA.

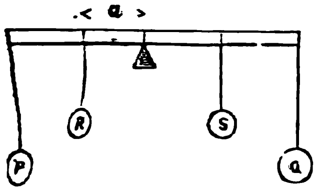
[1991.]—CANVAS CANOE.—I would per[illegible] our friend against making his canoe of can[illegible] ribs; it is impossible to obtain good lines, or[illegible] technical words, no curve can be obtained; the [illegible] boat would consist of straight lines as near[illegible] proaching the curves necessary as is posi[illegible] lessening the distance of the point of attachm[illegible] the frame, but the result is in the highest degree satisfactory.—S. T.

[1991.]—CANVAS CANOE.—After laying down keel and fixing stem and stern-post, let "S. F." [illegible]

[illegible] templets to be placed across the keel at [illegible]. These templets represent transverse sections [illegible] their several positions, and to them are [illegible] only the slips forming the skin or outer [illegible]. These run longitudinally from stem to [illegible] be ¾" wide and 1½" apart. "S. F." will [illegible] best plan, as without the slips the canvas [illegible] between the ribs. The ribs or timbers [illegible] to make them pliable by placing them in [illegible] box connected by a tube with a common [illegible] with a close lid, or they may be boiled in [illegible]. They must be put in hot, and nailed in [illegible] at once, or they will stiffen. They can be [illegible] with common copper nails, which I should advise in preference to iron. There should be a [illegible] round the boat, as it strengthens her considerably. I have used canvas myself for a covering, but find it retards the boat by its friction, and believe good strong duck would be preferable. After [illegible], give it three or four coats of white lead. [illegible] too short for a canoe; 10 or 12ft. is little [illegible], with about 2ft. 6in. beam.—STEERSMAN.

[illegible]—DEFECTIVE PIANOFORTE.—Let a good [illegible] let in a piece of hard wood a suitable width [illegible] the crack exists, screwing some good screws with a sharp deep worm in the joint itself, the worm or thread of which will hold sufficiently tight to prevent the piece inserted from drawing up by the tension of the wires.—S. T.

[illegible]—PROBLEM.—The accompanying sketch gives the solution of the problem. Let R and S be



the weights of the arms, which weights we may consider as applied at their middle point: we have for the equation of equilibrium—

$$P \times 2a + R \times a = Q \times 2a + S \times a$$

Hence—

$$(P - Q) \times 2a = (S - R) \times a$$

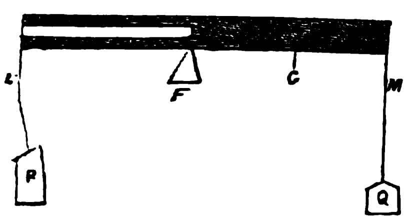
And—

$$P - Q = \tfrac{1}{2}(S - R)$$

The querist says $(S - R) = \tfrac{1}{2}(P - Q)$, but I believe this is an error of copy.—FRANCK.

[illegible]—PROBLEM.—"Y. R. W." should state that the difference is double, not half of the difference between P and Q.—J. K. P.

[illegible]—PROBLEM.—Is there not some mistake in the statement of the problem given by "Y. R. W." in the ENGLISH MECHANIC, March 11? I find that the difference between the *weights of the arms* equals twice the *difference between P and Q*, and not (as we are asked to show) *half the difference between P and Q*. I find an *expression for the difference between the weights of the arms in terms of P + Q in the following manner:—Let L F and F M be the 2 arms of a lever*



L M, [illegible] to be heavier by reason of extra matter uniformly distributed over its whole length F M. The weight of this matter will evidently act at G, its centre of gravity, and the distance F G will be equal to ½ F M. Denoting the difference between the weights of the arms by β, we have, by the equality of moments:

$$FM.Q + \frac{FM.\beta}{2} = FL.P = FM.P,$$

since by hypothesis $FL = FM$

$$2\,FM.Q + FM.\beta = 2\,FM.P$$
$$FM.\beta = 2\,FM.P - 2\,FM.Q$$

[illegible] each side by FM, we have $\beta = 2\,(P - Q)$ [illegible] difference between the weights of the arms equals [illegible] the difference between P + Q. "Y. R. W." [illegible] to this solution, and I hope he will find it [illegible]. I wish for the ENGLISH MECHANIC [illegible] volume may meet with the success which [illegible] its predecessor.—W. B., Leeds.

[illegible] PROBLEM.—Let length of each equal arm = a [illegible] weight of each arm (being uniform) may be [illegible] acting wholly at the centre of gravity, [illegible] the fulcrum. Call weight of P's arm y, and [illegible] Q's arm x. Then

$$Pa + \tfrac{1}{2}ay = Qa + \tfrac{1}{2}ax$$
$$(P - Q)\,a = \tfrac{1}{2}a\,(x - y)$$
$$P - Q = \tfrac{1}{2}(x - y).$$

PNEUMA.

[illegible]—RAZOR PASTE.—No. 1. Prepared putty [illegible], powdered oxalic acid ¼oz., powdered gum [illegible], mix with water. No. 2. Burn some [illegible], collect the ashes, reduce to a fine powder [illegible] it in the fingers, rub on the strop, or mix [illegible] instead of the putty powder. Tried and [illegible]. The second is my own invention, and is [illegible].—AZ-OTH-TATE.

[2005.]—RAZOR PASTE.—Crocus and tallow, mixed with pestle and mortar. Obtain at a watchmaker's tool warehouse.—S. T.

[2005.]—RAZOR PASTE.—In reply to "Dundreary" I can safely recommend the following:—Reduce emery to an impalpable powder, and sift through fine gauze to catch any large particle; mix the powder with as much spermaceti ointment as will form a thick paste, and lay on the strap.—GITCHE MANITO.

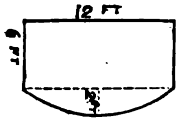
[2005.]—PASTE FOR RAZOR STROPS is thus made:—Oxide of tin, levigated 1oz., saturated solution of oxalic acid sufficient to form a paste. This composition is to be rubbed over the strop, and when dry a little water may be added. Oxalic acid having a great affinity for iron, a little friction with the above powder will give a fine edge to any razor.—TAUTAU.

[2006.]—TO CLEAN STEEL ORNAMENTS.—"Young Wife" may clean them by rubbing them over with some fine emery and oil to get off the rust, and then removing all the traces of oil and emery, rub them with a clean brush with some crocus and water; lastly, polish off with a little dry crocus—this will clean them if they are not very rusty; but if they are it will be impossible to do anything with them.—A. A. A.

[2007.]—TEMPERING DRILLS.—Heat your drill to a dull red, allow it to cool slowly, then rub the point for an inch or two up the neck clean and bright, either on a brick or wet grindstone; now lay the point of your drill on a lump of iron previously heated red hot, and the moment your drill has attained the colour you require, dip and stir it in cold water (or oil, if a small tool). The gradations of temper are—mild, blue, hard, dark straw, very hard, pale straw.—S. T.

[2007.]—TEMPERING DRILLS.—Heat the drill 1½in. up from the point until it becomes blood-red; then dip it in water about an inch, hold it to the light, and you will see a blue tint, which gradually descends, and when it is about 1-16th of the point slack it.—WILLFREW.

[2008.]—CONTENTS OF IRON PANS.—To find the cubic contents of iron pans with circular or rather spherical bottoms, you must calculate the body of the pan and the bottom distinctly. The body of the pan is a cylinder; to measure it multiply the square of the diameter by ·7854, and the product will be the area of the base; multiply the area of the base by the height, and the product will be the solidity. If the bottom is half of a sphere, multiply the cube of the diameter by ·5236 and divide by 2; the quotient will be the solidity. If the bottom is the segment of a sphere, to 3 times the square of the radius of the base of the segment add the square of its height; multiply the sum by the height and the product by ·5236 for the solidity; add the solidity of the cylinder to that of the bottom for the total contents. If the measurements are taken and calculated in inches, divide by 277·274 (cubic inches in 1 gall.); the quotient will be the contents in galls. If in feet, multiply by 6¼ (cubic galls. in 1ft. nearly), the product will be also galls. Example—



A circular pan 12ft. diameter, height of body 6ft., height of the bottom, being a segment of a sphere, 2ft.

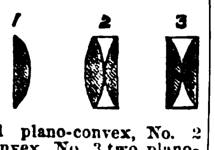
12 × 12 × ·7854 × 6 =	678·5856ft.
6 × 6 × 3 (+ 4) × 2 × ·5236 =	117·2864
Cubic contents in feet	795·8720
	6¼
Do. do. in gals	4974·2

—MILES JENNINGS.

[2008.]—WHEEL CUTTING.—In answer to "Burslem," special machinery seems indispensable for a special job, and it is absurd to rig up an apparatus for a few wheels when you can get them cut for you for a trifle. What you must have for the purpose is a division plate, containing all the numbers you want, and a cutter frame to carry the cutter, on a vertical spindle. I have seen patterns cut, or rather planed out of white metal in a lathe by means of a single point tool of proper form held horizontally.—J. K. P.

[2012.]—MULTITUBULAR BOILER.—The way in which the tubes are fixed into multitubular boilers, is as follows:—They are put loosely in first, and whilst in their place a conical plug of steel is driven into the ends so as to open them a little, and so fasten them into the tube plates. If they are not perfectly water-tight they have to be caulked a little to make them so, —H. CHAPMAN.

[2021.]—MAGIC LANTERN.—In answer to "George," I would say he will get as much practical information on the construction of magic lanterns in the back numbers of the ENGLISH MECHANIC (Vol. VI., pages 395, 424, 444, &c., &c.) as any work on the subject that I know of. As to ½-plate photograph lens being suitable for a magic lantern, I know by experience that there is no lens more so if a long range is required with a 4½in. condenser. The lantern requires to be 45ft. distant to cover an 18ft. screen, and will give a clear and distinct picture with oxy-hydrogen light. A ¼-plate lens will give the same size picture at about 28ft. distant. Condensers for magic lanterns are of various forms. No. 1 plano-convex, No. 2 plano-convex and double convex, No. 3 two plano-convex, which I think gives the best results, No. 1 being only used for the common construction of lanterns. Distance between condenser and front lens is 5½in. Condensing lenses may be had mounted almost from any optician. The price of a 4½in. is £2 2s.; 3½in., 18s.—J. E. V., Edinburgh.



[2021.]—MAGIC LANTERN.—The price of double condensers 3½in. brass cells is from 14s. to 18s. Any optician will supply them, but Cox, of 26, Ludgate-hill, or Pumphrys, of Birmingham, may be relied on for quality and price. I have seen a ½-plate portrait lens used with good effect, but "Guernsey" writes from personal experience, therefore with authority on the subject. "The Magic Lantern, and How to Use It?" by a "Mere Phantom," 1s., is a capital book on the lantern.—C. WARD.

[2016.]—COTTON WASTE.—The cotton waste is first sorted, and all hard lumps, rope ends, scrap iron, &c., thrown aside; it must then undergo the following processes:—1st, bowking with lime for 8 to 10 hours; 2nd, washing in dash wheels 15 to 20 minutes; 3rd, scouring 6 to 8 hours; 4th, sweetening; 5th, bowking with soda ash 6 to 8 hours; 6th, drying. The bowking is done in kiers of wood or iron heated by steam. The 1st requires about 4 to 6cwt. of lime made into thick cream, and freely sprinkled amongst the waste as it is thrown in the kier. The washing requires plenty of water, and is done in ordinary dash wheels. After being washed the waste is steeped in a solution of muriatic acid in water (2 to 3 per cent. of acid), then drained and sweetened by placing under a shower bath, using plenty of clean water. The 2nd bowking is done with soda ash, and takes from 3 to 5cwt. of ash per ton of waste. The drying is generally commenced in an hydro-extractor, and then finished in a stove or the open air, which is preferable. If "N_2O" desires further information I shall be happy to give it to him.—FEU FOLLET.

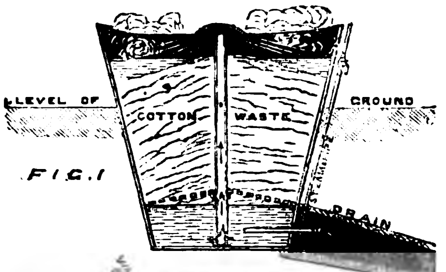


FIG. 1

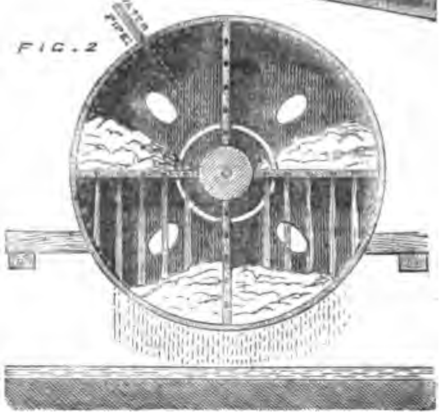


FIG. 2

[2022.]—VENEERING.—Soak your glue until it gelatinises in *cold* water, carefully boil in proper glue-pot, warm your veneer; all the rest depends on three points of detail—cleanliness, close contact of the surfaces, and the expression of all excess of the glue—*i.e.* as small a quantity really between the surfaces to be united as is practicable.—S. T.

[2023.]—AMALGAM.—Kill some mercury with *pure tin* foil; when it has lost its quickness apply with small quantity only of clean tallow.—S. T.

[2023.]—AMALGAM.—Mix your amalgam with as much lard as will make a thick paste and spread it on the cushions with a knife.—GITCHE MANITO.

[2023.]—AMALGAM.—"T. O'Connor" will find the following useful:—Melt together 2oz. of tin, 2oz. of zinc, and 6oz. of mercury; when cold, powder and mix with 4oz. of lard, and 1oz of bees-wax.—BETA.

[2024.]—MENDING GUTTA PERCHA.—Does J. Land mean an india-rubber ball?—if so, we can tell him how to repair it. A gutta percha ball seems to present no difficulty. A patch could be heated and put on, unless, indeed, the ball be very old; then the material will be found perished, and very difficult to deal with.—S. T.

[2029.]—PHYSIOGNOMY.—Lavater is the best authority. There are cheap and dear editions of his work.—BRIEFLESS BARRISTER.

[2035.]—STAMPING IN COLOURS.—Presses for this work may be bought by any one, and with practice any may do it. A prepared gummy ink is spread on a steel die in which the device is sunk; the surface is then wiped clean with the ball of the thumb, leaving the ink in the device. The paper to be stamped is placed on the die and a leather "matrix" is brought down on to it by means of the press, and is by it forced into the cuts, the ink adhering to the paper forms a coloured impression in relief. This process is called "relief" stamping.—IOTA.

[2038.]—SUN DIAL.—"T. S. H." to "Jupiter."—The hour angles for a horizontal sun-dial in latitude 51½°, beginning at the 12 o'clock line, and reckoning eastward and westward, are 12° 20′, 25° 15′, 39° 14′, 54° 45′, 71° 50′, 90°.—T. S. H.

[2042.]—CLERK OF WORKS.—A clerk of works is a man placed on the building by the architect to watch the interests of the proprietor. He must be *well acquainted* with all kinds of building materials, and thoroughly understand where and how each article ought to be used, whether wood, iron, brick, or stone, and has power to allow or reject anything he considers not according to contract.—JACK PLANE.

[2042]—DUTIES OF CLERK OF WORKS.—I think "Aspiring Mason" will find the following the duties of a clerk of works:—He will have to look after the workmen, see the work is properly finished, point out to the architect any improvements he may think fit, make up his weekly report, and send to the architect, draw most of the working drawings, and measure up all extra work; in fact, he is nothing more than the superintendent of the work in the absence of the architect.—DELTA.

[2043.]—PILLS.—"Wry Face" finds it a difficult matter to take pills in the ordinary way. Nothing is better than an oyster; it is a capital thing to carry a pill to the stomach. Use it in this way:—Slit the thick part of a native oyster and put in the pill, then swallow the whole. Children who are fond of oysters, and who cannot be made to swallow pills, may be thus effectually deceived. Another mode of taking offensive pills, or nauseous medicines, is to prepare the mouth beforehand by some aromatic substance; for instance, chew a clove or a piece of orange peel or lemon peel, or in lieu of this first put into the mouth a bit of alum.—TAUTAU.

[2043.]—PILLS.—In reply to "Wry Face," there are several plans for rendering pills tasteless. Some of these plans are patented, some not. The principle aimed at in all is to cover the pill with a film which shall resist the action of the saliva during the short time that the pill is in the mouth, but that shall be removed in the stomach. This film may be either metal, as gold or silver leaf, or a varnish composed of balsam of tolu, or some similar substance dissolved in spirit, or a coating composed of mucilage of tragacanth and sugar. I have repeatedly been told that coated pills have passed through the whole length of the intestinal tube, and have been passed unaltered through the system. Under these circumstances I leave your correspondent to judge what good they had done. A plan which I myself have found very efficacious is to screw each pill tightly up in fine tissue paper or cigarette paper, cutting off the superfluous material. A similar plan is adopted with balls for dogs and horses. The ENGLISH MECHANIC improves, and I am glad to see the quotation from "Montaigne" restored to the head of the Correspondence columns. —ARTHUR W. BLACKLOCK, Newbridge, Hardgate, Aberdeen.

[2043.]—PILLS.—First see that your pills are thoroughly dried, then stick each with a pin the head of which is bent down like a pot-hook ʃ; now dip the pills one at a time in a strong solution of gum arabic and hang on a string to dry in a warm place. This will not only render the pills tasteless, but prevent the deliquescence some kinds are subject to.—S. T.

[2043.]—PILLS.—If "Wry Face" will apply to any chemist, he will find that his grievance can be remedied without much trouble or expense.—BETA.

[2046.]—GYMNASTICS.—The following works are recommended:—"Gymnastics," by Chiosso, price 1s. 6d., Walton and Maberley; "Course of Gymnastic Exercises," by Rolland, price 3s. 6d., Oliver and Boyd; "Roth's Movements or Exercises," price 1s.; "Ling's Gymnastics," by Roth, price 2s. 6d., Groombridge.—BETA.

[2049.]—LANTERN LENS.—A single plano-convex lens would do, but the result would not satisfy you. Many cheap lanterns are nearly useless on this account; go to a little more expense to purchase a double condenser, or if you have a good flint plano-convex, get an optician to adjust another to it. Write to Cox, of Ludgate-hill, or any practical optician.—C. WARD.

[2049.]—LANTERN LENS.—If "Lime Light wishes to have good results from his magic lantern, I would recommend him to use the double combination 3½in. condenser.—J. E. V., Edinburgh.

[2053.]—BEECH.—Expose the wood to the presence of steam in a covered vessel for a few hours, then withdraw it and allow it to dry slowly. It should be under pressure of some degree, even if not more than 1 or 2lb. to the inch.—S. T.

[2054.]—HYPOCHLORIC ACID.—Such an acid has not yet been discovered. The only oxygen acids of chlorine are:—Hypochlorous acid, $HClO$; chlorous acid, $HClO_2$; chloric acid, $HClO_3$; and perchloric acid, $HClO_4$.—ERNEST.

[2055.]—COIN.—The piece, as per engraving, is a weight of the double crown of James 1st. There are others of various weights according to the denomination of the gold coin, the unit 22s., the crown 5s. 6d., the thistle crown 4s. 4½d., the half-crown 2s. 9d. I have standard weights of all the above, as also those issued in 1618. The weights were issued by Royal proclamation from the Royal mint, and the chief officers in all cities, boroughs, and town corporate of England and Wales were commanded to provide such weights and scales as provided by the master of the mint, and all persons were forbidden to have or use any other weights for the gold coins. Vide Ruding's "Annals of the Coinage," page 374.—D. T. BATTY, 9, Fennell-street, Manchester.

[2055.]—COIN OR COUNTER.—In answer to Mr. Smith, the engraving represents a card counter. I have a similar one in my possession, with Vs. VID., instead of XIs. English coins were made of tin and copper, and now are of bronze, but *brass* ones were never struck.—HENRY W. HENFREY, M.N.S., Markham-house, Brighton.

[2057.]—ZINC PLANT.—Form a feeble solution of acetate of lead, suspend in it a piece of zinc and some brass wires, the latter represent the branches of the tree.—ERNEST.

[2057.]—ZINC PLANT.—The zinc plant can be made by "A Late Subscriber, E. S." by twisting a piece of wire round a lump of zinc and inserting one end in the cork of the bottle; then attach other pieces of wire to the zinc and twist them in any form he may think proper; some put a little china doll in between, and beads of various colours, which has a curious effect; then fill the bottle up with water so as to cover the zinc, and put a little sugar of lead in, and let it stand perfectly still; the tree will begin to grow. A pennyworth of sugar of lead may be obtained at any chemist's—enough for 3 or 4; it will cause a white cloud, which clears off.—A. A. A.

[2057.]—ZINC PLANT.—This is easily prepared by suspending a piece of granulated zinc in a strong solution of acetate of lead. In a short time beautiful plates of lead will form upon the zinc, and increase till the solution becomes exhausted.—BETA.

[2057.]—ZINC PLANT.—"A Late Subscriber, E. S," is mistaken in supposing that it is merely water in the bottles in which zinc trees are made. It is a solution of acetate (sugar) of lead, in water that is used for that purpose. A piece of copper wire is attached to the cork of the bottle long enough to reach to the bottom, and if you want branches to your tree put pieces of wire across, you finally fasten a small lump of zinc on to the top part of the wire, take care that it is immersed in the solution, cork up your bottle, and in a few days your tree will be complete.—HENRY CHAPMAN.

[2059.]—AQUARIUM.—The great bugbear in aquarium manufacture consists in having a rabbet for the glass instead of a groove, the former entailing trouble and vexation without end. Take, then, a groove, and make the putty of red lead and copal varnish; in a few days all is hard, sound, and insoluble. The putty must be used as made, as it sets very quickly.—S. T.

[2059.]—CEMENT FOR AQUARIUM.—I have kept fish of many kinds in my aquarium for years: it is put together with red lead putty, common putty is useless. Red lead putty is red lead (in powder) worked up well with white lead (in oil) as stiff as it can be conveniently used; leave it a few days to harden.—JACK PLANE.

[2063.]—MEASURING TIMBER.—Numerous works have been published on "Measuring Timber," but generally speaking one work is as good as another. Of course everyone will recommend his own or the one which he has been most accustomed to use. I have been for sometime in the timber trade, and find that Aitkin's tables are as good as anybody's. Cost I think 4s. 6d.—GITCHE MANITO.

[2063.]—MEASURING TIMBER.—R. Livingstone should obtain "Hoppus's Measurer," price about 2s. It may be obtained at a second-hand book shop for considerably less.—JONATH.

[2064.]—QUESTION ON LIGHT.—The numbers of vibrations per second, of the mean rays of the several colours of the spectrum are, in millions of millions —Red 497, orange 528, yellow 529, green 601, blue 648, indigo 686, violet 728.—ERNEST.

[2066.]—ZINC PLATE FOR BATTERY.—To amalgamate zinc plates, clean thoroughly with diluted muriatic acid; pour the mercury on, and spread it over with a brush; allow them to drip, and they will be ready for use. The best sheet zinc of the requisite thickness answers the purpose as well as any other kind.—J. E. V., Edinburgh.

[2066.]—ZINC PLATE FOR BATTERY.—Had "G. Deku" put in practice the slight knowledge he seems to be in possession of in regard to his query, he would have found the practical part of it so easily acquired as hardly to need troubling the MECHANIC for information upon so simple a matter. The ordinary commercial sheet zinc will do, procurable from any metal warehouse. After scouring the plate clean in the acid solution with a piece of rag or a brush, pour upon it a little mercury, and by still continuing the rubbing "G. Deku" will find the mercury spread itself evenly over either side of the plate, making the amalgamation of the plate, if a matter of question, one of very little difficulty indeed.—H.

[2066.]—TO AMALGAMATE ZINC PLATE FOR BATTERY.—G. Deku can make the mercury flow over his plate by adding a little of the pure acid and then rubbing it over with a piece of tow or waste cotton, then well washing it in plenty of water. If he cannot get on, will he write to our ENGLISH MECHANIC?—A. A. A.

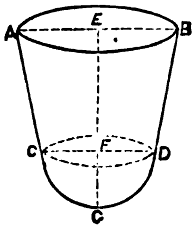
[2068.]—CONTENTS OF IRON PANS.—To find this, multiply the square of half the diameter by $\frac{356}{113}$ and by the height. For instance, the first pan contains:

$$\left(\frac{11}{2}\right)^2 \times \frac{355}{113} \times 58{\cdot}6\text{in.} = \frac{11 \times 11 \times 355 \times 11}{2 \times 2 \times 113 \times 2} =$$

522 cub. ft. 118 cub. in. To measure the cubic contents of a globe, multiply the cube of the diameter by 0 5236. —ERNEST.

[2068.]—CONTENTS OF IRON PANS.—To find the solidity of a sphere or globe multiply the cube of the diameter of the sphere by ·5236, and the product will be the solidity. To find the solidity of the segment of a sphere.—To three times the square of the radius of the base of the segment, add the square of the height, and this sum multiplied by the height and ·5236 will give the solidity.—JONATH.

[2068.]—CONTENTS OF IRON PANS.—The contents of a pan in the shape of the annexed sketch, can be found as follows:—To three times the square of the radius C F, add the square of the depth F G; and this sum multiplied by the depth F G, and the product again by ·5236, will give the solidity of the bottom; and the product of the diameters A B and C D, added to the sum of their squares; and this sum being multiplied by the depth E F and again by ·2618, will give the solidity of A B C D, which, added to the solidity of the bottom, will give the contents of the pan required. To find the cubic contents of a globe multiply the cube of the diameter by ·5236, or the cube of the circumference by ·016887.—J. LINTON.



[2069.]—PHOTOGRAPHY.—In reply to "Lex," there is no stated amount of alcohol used for the purpose he speaks of—merely a few drops or so; but I should advise him not to use it at all. With some samples of paper I have found that it tends to blister the paper, whilst with others I believe it almost prevents it. In no case, however, should I advise methylated spirit. *That* is best out of the operating room altogether, either the spirit of wine or the ether, both being impure. My method of working is to pour back the solution (after sensitising) into the bottle wherein is some kaolin, and the next time that I want to use it I shake it well, and then filter, afterwards adding a little bit of nit. silv. to replenish waste from kaolin, and filter. I have sometimes, especially after using a lot of paper, seen the bath nearly black, but the above entirely removes it.—MUS.

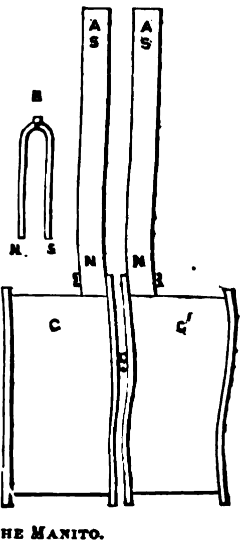
[2070.]—STENCIL PLATES.—Does our friend "The Vicar" adopt the plan of cutting his stencil plates out of thick foil (an alloy of lead and tin)? If so, great freedom may be gained even in the repetition of the same design by departing from the strict geometrical lines. In cutting a fresh stencil plate even from the old pattern, an apparently accidental deviation may be exaggerated to give greater ease. Metachromo-type has been used for the purpose named in Leipzig, but there is none of the richness of colour obtainable by stencil colouring as to decalcomanic transfers are obtainable at shops in Oxford-street on either side of the Regent-circus; but the writer has never seen any subject suitable for the purpose named.—S. T.

[2072.]—PITCH.—Shoemaker's wax is made by melting together about equal quantities of common black pitch and rosin. When thoroughly melted, a small quantity of a common oil is added, to soften the compound. The quantity of oil depends on the season of the year, more in cold and less in hot weather. To make it lighter in colour it is drawn out by the hands. An article called prepared pitch is now sold by the trade; it merely requires to be melted, and the oil added.—CRISPIN.

[2073.]—CEMENT FOR PARAFFIN LAMP.—I have one in daily use that was repaired some months ago with white lead. The white lead must be good—*i. e.*, free from baryta, its common adulterant, and the lamp must be laid aside for at least a week or two. —S. T.

[2075.]—WATER-PIPE SWEATING.—The supposed sweating is a condensation of vapour or atmospheric moisture on the surface of the pipe from the lower temperature of the water contained therein. —S. T.

[2079.]—VARLEY'S PATENT COIL.—Herewith I send you diagram of Varley's patent coils used in Post Office instruments. It is same size as the coil itself. The only difference in this coil is the needle and the two permanent bar magnets, which stop the injurious effects of lightning upon the coil. It works exceeding well, much quicker than the old system. If "H. R. H." wishes, I will send him a diagram of contact keys used in these instruments. A′A′ permanent bar magnets, B needle which has north and south poles as marked, C C′ coils, D pinion of needle.—W. GOLDING.



[2081.]—PHOSPHORUS.—If "M. P. S." will look at my recipe for phosphorus paste in No. 257, page 588 [1760], he will see that the phosphorus does not require powdering. The proof spirit will do that quite sufficiently.—GITCHE MANITO.

[2081.]—PHOSPHORUS.—If "M. P. S." introduces into a florence flask 1pt. phosphorus and 8pts. of rectified spirit, and heats in hot water until the phosphorus has melted, and then (inserting a well-fitting cork) agitates briskly till cold, he will find the phosphorus, on pouring off the S. V. R., sufficiently fine for "paste." See Beasley, p. 393, for an excellent *unfermenting* paste.—A. P. S.

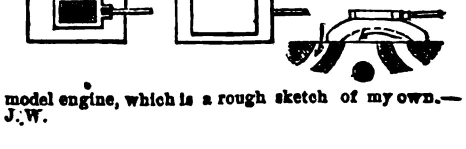
[2084.]—GRANITIC PAINT.—The menstruum employed for the granitic paint is silicate of potash, which is supposed to harden the pigment with which it is admixed, and combine them in a durable manner, neither of which points are, so far as my experience goes, successfully attained.—S. T.

[2097.]—STAINING WOOD.—F. Drop probably has not given his work coats enough of stain to overcome the blue colour he speaks of. If the stain is made properly, this is the reason of its not being black enough; he must do it several times, until the blue colour is overcome. If this does not succeed, I will give him, through our MECHANIC, a recipe that will answer on his requiring it.—GILDER.

[2097.]—STAINING WOOD.—Drop a little sulphuric acid into a small quantity of water, brush over the wood and hold to the fire; this will produce a fine black, which will receive a good polish. Or take ½pt. of vinegar, 1oz. of dry lamp-black, 6oz. of iron rust sifted; mix and let it stand for a week. Lay 3 or 4 coats of this on hot, and then rub with linseed oil, and you will have a very deep black.—MINNEHAHA.

[2097.]—STAINING WOOD.—I think if F. Drop were to give the wood a strong solution of salts of tartar before applying the copperas, it would very probably die black. This process is effective with leather, and might be so with wood. I think it is worth the trial.—AB INITIO.

[2102.]—VALVE.—I have used the annexed for a



model engine, which is a rough sketch of my own.—J. W.

[illegible].]—ALUM AND IRON TANKS.—If "Ama[illegible] Dyer" uses his iron tank to boil alum in, he will [illegible]roy the tank, waste his alum, and spoil anything [illegible] immerses in it. Alum acts strongly on iron, and [illegible] be boiled either in lead-lined vessels or in wood by means of a lead steam-pipe. Lead vessels are employed in alum works.—SIGMA.

[2134.]—BOILER TAP.—"R. A." should unscrew the screw at the bottom of the plug; take out the plug, and grind it in with emery and oil until he sees it bright in every part: then screw it up again; this may stop the leaking. To get it out, put a lever in the bib, and unscrew. Fix a new tap with lead collars. red lead, and whitelead.—GILDER.

[illegible].]—WOOL.—In reply to "J. F. F.," I can explain to him the following German names:—*Holzwolle*, woodwool, is a wood reduced into powder, and employed as velvet powder for making flock paper; *waldwolle*, forest wool, pine wool, or pine needle wool, is a fibre obtained in Prussia, Holland, &c.; by treating the leaves of the Pinus sylvestris, &c., with a solution of carbonate of soda, this fibre is used for stuffing mattresses, making blankets, &c.; an etherous oil, an extract, and a soap are also obtained from this fabrication; flannel impregnated with this essential oil is preconised against rheumatism, &c. *Kunstwolle*, artificial wool, is the well known shoddy. The name of *vegetable wool* is also given to several fibres, viz., the jute (Corchorus capsularis, textilis, &c.) of the linden order, or Tiliaceæ; the down of the lanero, corkwood (Ochroma lagopus); the down of the different kinds of Eriodendrom; these two last belonging to the Sterculia order, &c.—BERNARDIN.

[2136.]—DIVIDING PLATE.—In answer to "Bierlala," if your plate is a lathe pulley, and you have room for only, say six rows of holes, you will what I have on mine, viz., 360, 108, 190, 96, 84, 24 (the last for hard usage to save the others), as good numbers as you can have. If you want to do ornamental work by the "double counting" of Captain Ash, then you must have 192 instead of 96. If you want large strong holes, and cannot get in 360, then 240, 192, 140, 135, 100, 72, are useful numbers. That was the last I made. Before that, I made one for my own use of 300 outside, then 11, 13, 14, 17, 19, all in one row, with 216, 140, 96, 84 inside of that. If your plate is flat from outside to centre, you can get in many more in the diameter you mention, and I consider one of 13 rows, that I once made, complete enough for most practical purposes. The one of the cutting engine, figured this week, has 37 rows containing every number up to 100, and ranging as high as 366. Good gunmetal is much better than brass. I get mine at Bowen's, Dorrington-street, Coldbath-square. Ask for *best* gunmetal. I have serious thoughts of taking the gunmetal pulley off my lathe, and putting on a cast-iron one, as the holes will last better. Division pegs, or "index pegs," are, in my opinion, always made wrong. Go to Wilkinson, by all means, if you want something first-class, without being ruined. It is a chance if it did not come to him at last, if you took it anywhere else *to get it done*. Say your outside row is ¼in. from

5

edge, and distance between rows — and state number

32,

of rows you want, and direct to me at Pitcairn's, Library, King's College-road, N.W., and I will write *out a list for you*.—J. K. P.

[2137.]—*PITCH PINE WOOD*.—"Pinaster" had better get some of Stephens' wood stains. The cause of the wood looking opaque when stained is, the staining material has more body than it ought. Very good stains can be made of burnt sienna and Vandyke brown, in certain proportions, but Stephens' are more transparent. I see the "Welsh Shepherd" recommends one coat of oak varnish. Is he aware that it will not stand long out of doors, and some of it is the veriest rubbish possible. Stick to the boiled oil for the outside, two or three coats of it; never mind heating it; if heated look to your brushes, or you may get them burned up by the hot oil. "Pinaster" may depend upon this information, as I have had experience for these last 24 years as a house decorator. *All* wood stains do not get darker in course of time; *of that* I am quite positive, and do not wish to mislead.—GILDER.

[2138.]—HARDENING MILL CHISELS.—I advise *G. Doubleday* to coat his mill chisels with finely-*powdered* p u siate of potash, make them red hot, *and plung* them into urine; then brighten and *temper*.—A 3 INITIO.

NOTES AND QUERIES.

[2139.]—HARMONIUM.—Would some kind reader state how many rows of reeds I could have for an harmonium, the case of which is the size of a five-octave Alexandre's make? If some one would state how I could fit it up with two rows I should be much obliged, and, likewise, what kind of reeds, &c. would be required, as I am entirely ignorant how to proceed; but having made the case, bellows, &c., I want to finish it.—J. W.

[2140.]—POOR LAD'S QUERY.—Will some kind astronomical reader advise me? Having but very *limited* means, I thought of purchasing one of Wray's 2¼in. *object* glasses, price £2, but seeing in our last *number* that a 5in. specula would cost the same, I am *rather in a fix* which to have, and should esteem it a *favour for a good* opinion.—A POOR LAD.

[2141.]—*SPLITTING* QUILLS.—How can I split *quills in half*—*I* have tried several means without *success?* Should the quills be soaked or softened?—CROWQUILL.

[2142.]—SOFTENING CAST IRON.—Can I soften cast iron before turning? I have a face-plate to turn; being so hard, the tool will not cut it.—G. B. K.

[2143.]—GLUE TO RESIST WATER.—Could you tell me of a glue that will resist water, or of any composition for fastening wood together, so as to resist water? There is a firm in London, I think, who make blocks for carpet printers; these blocks have to be put continually in water, and I am told the water has no effect upon them.—NON-ADHESIVE.

[2144.]—FELT AND AMADOU PLASTER.—Will some one describe the *modus operandi* for covering the surface of felt and amadou with isinglass, &c.?—A. P. S.

[2145.]—REPOLISHING A VULCANITE WATCH CHAIN.—Will some kind reader inform me how to repolish a vulcanite chain which has become dead-looking with wear, so as to make it like jet again?—A COUNTRY VICAR.

[2146.—VENEERING.—Will one of your subscribers kindly inform me how to veneer a table, &c., and the tools required?—H. E. D.

[2147.]—BENNETT'S CHUCK.—I would be much obliged if "J. K. P." would explain Bennett's chuck for the benefit of myself and fellow readers of the MECHANIC. Also if he would mention a way of keeping the mandrel of the lathe still when using the division plate and index.—KENNINGTON AMATEUR.

[2148.]— TALLOW. — Will some brother reader describe the best system of refining ships' grease into tallow?—YOUNG BEGINNER.

[2149.]—SURVEYING.—Can any reader tell me what book will give the best help to make surveys and valuations of dwelling houses and land to be mortgaged to a building society?—READER.

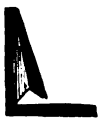
[2150.]—LIGHTING GAS LAMPS BY ELECTRICITY.—I have heard that a means has been discovered of lighting street gas-lamps in a town simultaneously with electricity. Can anyone tell me if such a system is in operation, now, where and how it is done?—CANADIAN.

[2151.]—HARDENING MILL BILLS.—Will any reader inform me how mill bills for dressing French stones are hardened, and what is used for hardening?—T. MARSH.

[2152.]—PAINT ON BICYCLES.—I wish one of your many subscribers would answer me these questions:—How is paint put on bicycles?—is it common oil paint? and what gives it the glazy look? Is it some kind of varnish?—A SUBSCRIBER.

[2153.]—VERTICAL SAW FRAME.—Would some fellow reader give me some information on saw frames? I have some large oak trees 2ft 8in. through, and I intend to put a frame to cut them. Explain the different parts and what strength to make them —it will have to cut 3ft. logs down to 1ft. 4in.—to take in any number of saws up to fourteen. Also the best way of fixing the logs while being sawn—the logs are mostly round, and will want good fixings. Give the length of stroke. The weight of foundation required. —J. T. W.

[2154.]—HARMONIUM—TO "ADEPT."—I am trying to build a small harmonium with two rows of reeds to represent four stops, and I should esteem it a great favour if our good friend "An Adept" will advise me which are the best reeds to purchase for a small instrument, also where I can purchase them, also if the feeders will act as well on the bottom board of case; if so, that will save me much room? I also should be much obliged if he will favour me with a sketch of his silent feeder valve for bellows that was named in January 14, as my valves make more noise that I like to hear.—W. D.



[2155.]—LACTARME OR MILK ALBUMEN.—How can I make this in a dry state, so that it will keep similar to the albumen of commerce, that is in flakes very like shellac?—LAC.

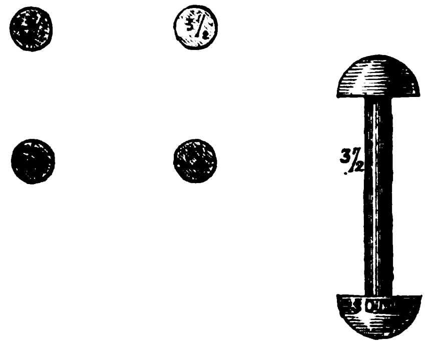
[2156.]—ZINC ASHES.—What are zinc ashes, where can I purchase them, and what is the price per ton? —ELDER KIN.

[2157.] — AN INSTRUCTOR FOR PLATE-LAYERS.—Will some of our brother correspondents inform me where I can get a book that will instruct me how to set out a radius of any dimension—say from one chain to one mile, and the proper distance from a pair of points to a crossing of say one in two upwards? What I mean is the correct radius from the points to any spread crossing for a permanent way, I think there is a book as an instructor for plate-layers?—UNLEARNED PLATELAYER.

[2158] — ARTIFICIAL LEG. — Will some kind brother give me the drawings, and inform me how to make an artificial leg below the knee, and what is the best material to make it of?—W. R. E.

[2159.]—CLAMS.—Will any reader show me how to construct a pair of clams for splicing or jointing leather—such as those used by roller coverers? A diagram will greatly oblige.—T. SIMMS.

[2160.]—PRESSURE ON COLUMNS. — Will any brother subscriber tell me how many tons' pressure four iron columns will bear standing upright as shown,



in plain figures?—W. R. E.

[2161.] — PASTE FOR CLOTHING IRON ROLLERS.—Will any reader please to tell me how to make a good paste or cement for clothing iron rollers?—T. SIMMS.

[2162.]—SEAMS OF MACINTOSH.—Can any fellow reader tell me what is used for joining the seams of a macintosh or waterproof coat?—G. W. D.

[2163.]—LEATHER BAG MAKING.—Would some one tell me how to make small leather cases—such cases being made of paper and covered with leather by gluing the leather on the paper cases—such as are now used by ladies and gentlemen?—T. H. P.

[2164.]—PHOTOZINCOGRAPHY. — Will some of your intelligent correspondents be kind enough to favour me with the titles of some of the best books on the subject of photozincography and anastatic printing?—I desire to know the "ins and outs" of the printing.—W. H.

[2165.]—WORKING MEN'S EXHIBITION.—Can any correspondent say if any employer is eligible to exhibit an article of his own invention in the forthcoming Working Men's Exhibition, and say to whom to apply for particulars?—MORELIGHT.

[2166.]—MAGNET.—Can I make a magnet by battery power? Will Smee's battery do; how many cells? My magnet is 7in. × 1¼in. × ⅜in., horseshoe-shape, tempered steel.—J. GABELL.

[2167.]—LATIN.—Can any brother reader inform me if there is a system for self-teaching Latin; where I could obtain it, and what would be the cost?—A NEW SUBSCRIBER.

[2168.] — DIMENSIONS OF MODEL STEAM ENGINE.—Will some brother reader give me the dimensions of fittings for a model steam engine—cylinder. 3in. stroke, 1¼in. bore? What size steam pipe should I require, and length of lever for safety valve?—R. R.

[2169.]—PROBLEM.—Draw a line D E parallel to the base B C of a triangle A B C, so that D E is equal to the difference of B D and C E.—P. B. McG.

[2170.]—AN UNANSWERED QUERY.—Will some correspondent tell me how to blacken old copper coins? This query was asked some time since, but has not yet received any answer.—GITCHE MANITO.

[2171.]—BORING MODEL CANNON.—I beg to return my sincere thanks for the instruction furnished on the above subject. Being unable to make the half-round boring bit referred to, will either of my kind instructors be good enough to inform me where I can obtain the same?—J. S.

[2172.]—BINDER'S CUTTING PRESS—UNANSWERED QUERY. — Will anyone oblige by giving a description of cutting press referred to by "J. J. A.," query 1467? I can bind first-rate, but cannot cut with an ordinary knife. It would no doubt confer a boon on many of our readers.—MASCHIL.

[2173.]—GAS WORKS.—Will "Rotherwood" be so kind as give a few more particulars about his economical gas works in Reply 1731, p. 613, as to construction and operation in gas manufacture; also where the E. G. works are to be had?—JOHANNES.

[2174.]—MAGIC LANTERN AND MICROSCOPE. —I have a magic lantern with 3¼in. condensing lenses, and should be glad to know what would be the cost of a good microscope to attach to it—suitable for showing animalculæ in water, &c. Would a powerful lens, to burn camphorated paraffin, give a disc of light sufficiently large and clear to show microscopic objects to an audience? Could the same instrument be so adjusted as to be used in the daytime as a solar microscope?—FRAYER.

[2175.]—LIFTING POWER.—Has the wedge or the screw jack the most power in lifting?—T. H. H.

[2176.]—BLAST FAN.—I would esteem it a favour if one or more of your readers would give me some information as to the construction and arrangement of a blast fan suitable for a smith's forge fire.—C. T.

[2177.]—PROBLEM.—With a point in the perimeter of a given circle for a centre to describe another circle, an arc of which shall divide the given circle into two equal parts.—INDAGATOR.

[2178.]—CIRCULAR DISC.—What must be the size of a circular disc to be fixed on its centre in the boundary of a circular orifice 1ft. in diameter, so that exactly one-half the area of the orifice is covered by the disc?—INDAGATOR.

[2179.]—GRINDING SPECULA.—Will steel, iron, and metal make a tool to grind and polish glass specula? For the purpose are the grooves cast or cut in the grinding tool? Can a glass speculum be ground, if firm, level and stationary? Is it possible to grind a speculum parabolic without first grinding it spherically?—ANDREW JOHNSON.

[2180.]—ENGINEERING IN GERMANY, &c.—Is there a mechanical or engineering school or college in Germany where pupils are instructed in practical as well as theoretical engineering, and where? Thanks to Mr. Biggs for his answer to query 1934, and may I ask him if he will kindly furnish me with a solution of the following, which appeared in the Science and Art Department examination papers a few years back?—"If an arc of a circle measure 50ft., while the radius is 18ft., what is the area of a sector whose base is the given arc?—Y. P. W.

[2181.]—DERBY CEMENT.—Will some one oblige me with a recipe for Derby cement for mending jet, vulcanite, china, or glass?—G. S. H.

[2182.]—CONSTRUCTING COILS.—I am about to make a coil, and intend to use about six miles of No. 36 copper wire covered with silk for the secondary. I want to know what length of No. 16 cotton-covered copper wire I should use for the primary, also about what number of sheets of tinfoil 1ft. square would go to the pound? I also want to know what length of spark I could get from the coil, also how many of the bichromate of potash bottle-batteries ought I to use? Is wire, covered with composition, better than silk or cotton-covered wire, or would wire, covered with cotton first and then with the composition, be still better? Is there any substitute for gutta percha tissue, and what kind of cotton or silk is used for covering the wire in shops where it is sold covered? These last three queries I have often seen asked, but have never seen them answered.—NEMO.

[2183.]—TAXIDERMY.—On application for the work mentioned by your correspondent, I find that it has been out of print for 20 years. Can anyone inform me if there is any other published, and who by?—SOLD.

[2184.]—SULPHATE OF LEAD BATTERY.—I will feel obliged to any of your readers who will be so good as describe how these batteries are made. I understand Moseley's patent battery consists of copper cups tinned, and fixed on a central wire. Is it actually necessary to have the cups so tinned? and is a porous cell requisite? Would a solution of sulphate of lead not do to charge Smee's cells with? "Sigma" has promised a description of all batteries now known or used, but it may be some time before his papers bring him on to that part of the subject, and in the meantime many of your readers as well as myself may be at a standstill for want of the information.—FRONTI NULLA FIDES.

[2185.]—MILDEW ON ENGRAVINGS.—I shall feel much obliged if one of your correspondents will inform me how to remove mildew from picture prints, and how to prevent it.—CONSTANT READER.

[2186.]—BAROMETER TUBES.—Thanks to "Jonath" for his information on the safety valve. I have some barometer tubes (new ones), and in laying by they have got covered with a film inside that makes the mercury look muddy when it is put in. Can anyone tell me the best way to clean them?—COMPENSATION.

[2187.]—NAPHTHA AND GAS TAR.—Would any brother subscriber give instructions for making naphtha and anything else that can be made from gas tar, with a description of vessels, &c., required for the same? About 80 gallons of tar is as much as I intend to use for that purpose weekly, which will, perhaps, give an idea of the sizes of what will be required.—J. H. M.

[2188.]—ORNAMENTAL WOOD AND METAL CUTTING MACHINE AND VELOCIPEDE.—Having for some time seen advertised in our paper Cunningham's fret-saw, drilling apparatus, and kinograph, I should like to have the opinions of a few of our subscribers who may have tried them as to whether they are useful machines, well made, of good metal, worth their price, and, in short, all they profess to be. I should also like the opinion of some of our velocipedists if in every case a driving-wheel above 36in. ceases to be an advantage. I have an ordinary 36in. and 33in. bicycle, but I want to get nearer the ground, and I think of reversing it, so bringing the small wheel to the front and making it the guiding wheel, and putting the wheels farther apart and driving it by a crank working in a bearing between the wheels, and communicating with the driving wheel (the hind wheel) by a connecting rod as outside a locomotive; or with a pedal working like the elbow joint of a bell-pull and connected as before: shall I use my old wheels, or have the driving-wheel larger—say 6ft., and, perhaps, the front wheel smaller—say 2ft., and which driving-gear shall I use?—GIMCRACK.

[2189.]—CIRCULAR RAIL.—Can any reader inform me how to make a circular rail for a model locomotive? It must be constructed on a framing of some sort, so that I can lay it on the floor of a room without injuring the carpet, &c.—F. G. C.

[2190.]—THE ORGAN.—Can any brother reader tell me the way in which an octave coupler is made? also how a composition pedal is connected to the stops? A drawing of each will oblige.—ORGANIEN.

[2191.]—TURRET CLOCK.—Would Mr. Maddison kindly inform me what advantage he gets in the use of cast iron wheels in his clock instead of brass—most generally used? I never saw one erected successfully with iron wheels. I should think that an iron wheel working it a pinion of iron or steel would work harshly together, and also be liable to stop through rust collecting between wheel and pinion.—TINTAC.

[2192.]—SULPHATE OF AMMONIA.—Would Mr. G. Davis, or some other among your talented correspondents, inform me of the most improved and simplest way for finding the degree of strength of sulphate of ammonia?—BASIN.

[2193.]—FINE CHARCOAL.—Can any subscriber inform me where I may obtain fine prepared charcoal for rubbing down silvered circles, &c.?—it is generally in short square sticks.—TERMUS.

[2194.]—INTENSITY COIL.—Can any fellow reader inform me how to make a small intensity coil powerful enough to fire gunpowder?—COIL.

[2195.]—SMOKELESS LAMPS.—Would Henry W. Reveley, Reading, who sends a sectional drawing of smokeless lamps without a chimney, in your journal of Jan. 21, 1870, kindly furnish particulars as to construction, length of cone and hollow globe, and how the wick is raised or lowered?—PRACTICAL.

[2196.]—NAMES OF PUBLISHERS.—Is there a book published entitled "Annals of the Wars of England?" and if so, please name the publisher and price? If not, I should like to know the name of the publisher and the price of the "Annals of the Wars of Europe." What would be the most simple work on bell-ringing, the publisher, and price?—H. G. REDDITCH.

[2197.]—TO GEORGE E. DAVIS.—I wish, through the medium of the ENGLISH MECHANIC, to thank G. E. Davis for the information he has so freely given, and to request him to give me further information on the following points:—1. How to estimate sulphuric acid in salt cake? 2. How to separate barium from strontium? 3. How to estimate chlorine by volumetric analysis? 4. How to analyse roughly a sample of patent manure—such as Standen's? 5. How to estimate the ammonia in a sample of manure?—DISCIPULUS.

[2198.]—BORATE OF BARYTAS.—Could any correspondent give me a simple plan how to make borate of barytas?—HANLEY.

[2199.]—TELESCOPES.—Will "A. R. T.," p. 614, or any other of your correspondents answer me any or all the following questions:—1. What is the probable reason that I cannot get a good view of the sun's spots with one of Solomon's £5 telescopes? 2. What will be the probable cost of putting a rack on the focussing slide of the above telescope? 3. What will be the best and cheapest way of mounting one of Solomon's £5 telescopes on a stand, the legs to be made shorter when not in use? Perhaps "Pollux," on p. 604, will be able to give some information about a suitable stand for a working man's telescope, as he seems to know what they have to put up with when they cannot afford the more elaborate and costly workmanship of an Equatoreal stand, viz., the primitive and uncomplicated mechanism of a brick wall, and the elevation, depression, and sideral motion of the instrument as to be performed by muscular power?—H. F.

[2200.]—ENGINE AND BOILER FOR LAUNCH.—Will any of our friends, having experience in such matters, kindly inform me what style and size of engine and boiler is best calculated for driving a launch 36ft. long by 9ft. broad, with number of blades, pitch of screw, and probable cost?—SOLICITOR.

[2201.]—STEAM ROARER.—Will some kind reader inform me how to make a cheap and simple steam roarer to act in place of a bell for a mill? I should also like to know if it is obliged to be made of brass? There was a plan of a steam whistle in the ENGLISH MECHANIC a short time back, but the drawing was very small. I failed in making one off it that would act, so I wish to have the plan and dimensions of one of those sort called a roarer, which are so much used now for works.—YOUNG ENGINEER.

[2202.]—WHEEL SKATES.—Will some brother reader kindly inform me the best plan for making wheel skates?—O. FRANCIS.

[2203.]—FLOUR DRESSING MACHINE.—I am trying to fit up a small machine so that I can run down a few sacks of seconds flour whenever my other machine is broken down, and occasionally a few grists. I have made a 12in. cylinder which will take three sheets of flour wire and one of sharp wire? What number of wire ought I to use, and how many brushes, and what fall ought the cylinder to have?—A COUNTRY MILLER.

[2204.]—PROBLEM.—The diameter of the plate of a hydrostatic bellows is 12in., a weight of 250lb. is placed upon it; what will be the height of water in the pipe?—W. B. S.

[2205.]—PROBLEM.—What is the atmospheric pressure when the barometer stands at 30in.?—W. B. S.

[2206.]—CERAMIC MANUFACTURE.—Thanks to "Beta" and H. B. Miller for their information. On inquiring, however, at Barth's and Quaritch's, I find that instead of 20s., 28s., &c., Brongniart's book is 56s. Are there different editions at different prices? It is not needful that the works sought should be in French—a good practical English or French book at a moderate charge, especially if treating on the preparation of colours for painting, and printing, is what I require.—IOTA.

[2207.]—CRICKET BATS.—How are cricket bats made? I have tried my hand at one several times and failed?—A SUBSCRIBER IN CANADA.

[2208.]—REFINING BEESWAX.—Some time ago "Feu Follet," in reply to "Pulp Maker," offered to detail the process of refining with chlorine: would he please do so, as I wish to try my hand at it?—A COLOURMAN.

[2209.]—OVERLAND ROUTE.—Will "Selwyn" explain why, if the Overland route *via* Marseilles is also *via* Southampton, the "Postal Guide" makes the distinction of the routes for letters, thus—India *via* Marseilles 1s., *via* Southampton 9d.? How do the 9d. ones go?—IOTA.

[2210.]—BAR MICROMETER.—Might I ask Mr. Proctor or some obliging correspondent to be kind enough to favour myself and your innumerable astronomical readers with a drawing or description of a bar micrometer and its field of view, and explain its uses? What is the difference in use between it and a ring micrometer?—IOTA.

[2211.]—OBJECT GLASSES.—Referring to Mr. Purkiss's letter on this subject in the ENGLISH MECHANIC for March 4th, might I ask him to be kind enough to say in what year he knows γ^2 Andromeda to have been divided by Mr. Buckingham's instrument with a power of 2[illegible]? and also if he can inform me how many seconds apart they then were, and how many at the present time?—IOTA.

[2212.]—SPIRAL SPRING.—Is the spiral spring reliable as used for steam pressure gauges? I presume that steel springs are only useful within narrow limits—say a range of 40lb. or 50lb. What I want is an extremely accurate means of registering pressure, increasing by a pound at a time, between the two extremes I have stated. I suppose this might be done by communicating the pressure to a hand travelling round a well-divided dial, but my difficulty is in what way to communicate it? The principle of the steelyard would seem the best way of applying the weight for the division of the dial. Can anyone suggest a better?—F. Q. Q.

[2213.]—STANWAY'S VELOCIPEDE.—I hope Mr. Stanway will answer a few questions respecting his velocipede—a description of which is given in the MECHANIC for March 4th. Does he propel his velocipede by means of his feet as well as his hands? and how does he manage to steer it, as the handle appears to be fixed between the levers, in consequence, there would not be room to get it round a sharp curve? Is it steered with the feet or hands? What is the distance between the front wheels? Please to describe the method of steering, &c.; also what is the price of such a velocipede, and the name and residence of the maker? If he will describe how it is constructed in front as well he will much oblige.—AN ADMIRER OF THE VELOCIPEDE.

[2214.]—CANOE.—I am about to build a canoe. Would some reader kindly let me know where I can obtain a book containing practical information on the subject?—C. D. RICHARDSON.

[2215.]—STAMPING SHEET BRASS.—Can any reader tell me how to give brass the appearance of bronze, and where I can get dies made for stamping sheet brass?—TYNO.

[2216.]—CARRIAGE PAINTING.—Would someone kindly inform me how the paint for carriage work is mixed? and also how to mix the paint for striping?—YOUNG PAINTER.

[2217.]—WHAMPOOM MONEY.—Our ENGLISH MECHANIC has spoken several times of Cowrie money or shell money. I should feel obliged for some information on the Whampooms of North America.—PIONEER.

[2218.]—GEOMETRY.—Is there any geometrical means for proving the following theorem?—Having three circles on a plane, and drawing tangents common to two, those common tangents have their intersections on the same straight line.—X. X.

[2219.]—SILICIOUS GALENA.—Could some reader give me a few details on the modern methods of reducing silicious galena, also on the substitutes for nitro-glycerine (blasting purposes)?—FEU FOLLET.

[2220.]—SOLDERING.—I want to solder a 2in. cast iron pipe to a 2in. lead pipe. I find a difficulty in tinning the cast iron pipe. Can any friend inform me how I can do it?—G. D.

[2221.]—SHORT SIGHT.—Are there telescopes sold for short sighted people?—ETHARDO.

[2222.]—REDUCING LEATHER TO PULP.—Do you or any of your chemical readers know of a solvent that will reduce sole leather to a state of paste?—W. W.

[2223.]—ENGRAVING ON SLATE.—What kind of knife or graver is employed to engrave the lines and figures on a slate sun dial?—F.R.A.S.

[2224.]—BOILER.—Thanks to "Vivas Sperandum" for his kind answer to my query, but will he be kind enough to give me a few more particulars? 1. Could I not put in the feed cistern at once without pipe and funnel as shown? 2. What would be the quantity for 50-horse power boiler per week (75½ hours); pressure, 45lb.? The water is very much impregnated with lime; scale very hard—like porcelain almost. 3. Has my brother reader ever tried carraqun in a boiler much incrusted, for my boiler is very intricate?—ONE IN A FIX.

[2225.]—VACUUM IN CYLINDER.—Will some brother reader kindly inform me if the exhaust steam on leaving the cylinder of a high-pressure engine causes a partial vacuum, or has the piston to be forced against the full atmospheric pressure, or 15lb. on the square inch?—VACANT HEAD.

[2226.]—TINCTURE OF IRON.—How is the tincture of iron used in medicine made, and what complaints is it supposed to cure?—VACANT HEAD.

[2227.]—LIFE BELT.—Where can I get or how could I make a life belt for boating purposes?—AVALONENSIS.

[2228.]—ADDRESSES WANTED.—Will any kind English brother reader give the full addresses of some of the most important coal mines in Great Britain?—A FOREIGN CORRESPONDENT.

[2229.]—WORKS ON CHINA GRASS.—I want some good works on China grass—either English, French, or German, &c. If a brother correspondent will answer my query, stating purchaser and price, he will much oblige.—A MELLIST.

[2230.]—REMOVING FLY SPOTS.—I have a very fine old engraving, but, unhappily, quite covered with fly spots. How can I remove them? I have tried several ways, but failed.—PERA Y NO PERRA.

[2231.]—ENCKE'S COMET.—Will you please be good enough to ask "Omicron" to explain what is meant by solving an equation by the method of least squares—an expression that occurs in his account of Encke's comet?—T. WAGHORN.

[2232.]—PROBLEM.—Can any reader favour me with a solution of the following problem from Todhunter's "Smaller Trigonometry," chapter X.:—The hypothenuse A B of a right-angled triangle is divided at D, so that A D is to B D as C B is to CA. Show that

$$\tan ACD = \frac{a^2}{b^2} \quad CD = \frac{\sqrt{a^4 + b^4}}{a + b}$$

—J. M. SMALL.

[2233.]—STAINED GLASS.—Will Mr. Joseph Leicester or some other able correspondent inform me how ornamental church windows are painted and stained, as I have a little knowledge of some part, except ingredients that are used? I know there is a reddish brown colour painted on the glass for opaque and shading purposes called flux—it is mixed with turpentine. I want to know what it is composed of; when it is burnt in a kiln it is very hard, and cannot be scraped off. I want also to know what ingredients are used to stain plain glass in parts where wanted, such as yellow, blue, &c. For windows, as above, I have seen glass when taken out of the kiln with a red colour or deposit on them, and when cleaned off leave a beautiful clear yellow stain on the glass—according to the design painted on.—GUSTAVO KNOX.

[2234.]—TO "JUPITER."—Will "Jupiter" kindly tell me where he procured his 3in. refracting telescope of which he writes in evident praise in the last issue of the ENGLISH MECHANIC, and what he gave for it? Will he give me his idea of the apparent diameter of Jupiter as seen by him with a power of 75? I have this moment completed some observations with a Gregorian of 4in. aperture, and a power of about 100. Jupiter certainly did not appear to me to be more than ¼in. in diameter, nor could I detect more than a mere suspicion of the "belts," but then it was not a good night. Will "Jupiter" kindly tell me the highest power his object glass will advantageously bear, and the apparent diameter of the planet "Jupiter" has seen with highest power? This will supply me with a point of departure from which I may deduce for myself other measurements.—FUIMUS.

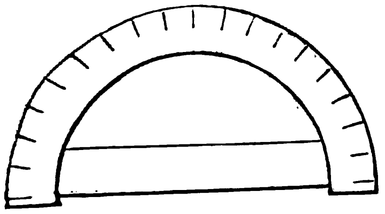
[2235.]—HOSIERY YARN.—How can I double and twist two threads of hosiery yarn from one to four per inch?—TINKER.

[2236.]—DIRTY CEILING.—Can anyone tell me why the joists show through dirty ceilings, *i.e.*, wherever a joist is the ceiling is much cleaner than the space between them, which gives it a ribbed appearance?—MINNEHAHA (GITCHE MANITO.)

[2237.]—SALERATUS.—What is it?—A. P. S.

[2238.]—FORMULA FOR CALCULATING POWER OF SPIRAL SPRINGS.—Would any reader kindly author who gives the formula for calculating the power of spiral springs (as in "Salter's Balance," &c.—Molesworth has it not. I require to calculate resistance to compression, wishing the spring to exert its power when compressed.—SEN EX.

[2239.]—PROTRACTOR.—I have a protractor (of which I send a rough sketch, half size), but I cannot see how to use it. There is no centre point, and the bottom edge is not in a line with the outside marks. Will some one tell me in which the fault lies—me or the protractor?—R. W. R.



[2240.]—BLACK LEAD.—How can I make black lead into small blocks, same as Nixey's?—W. S. H.

[2241.]—SWEET GUM.—What gum is called sweet gum in the United States?—C. D. P.

[2242.]—TO "M. P. S."—Thanks for reply relative to digitalin. I observe the formula you quote is in half quantities of the process given in one edition of the B. P. I have been considering, and have come to the conclusion that I must have been wrong in the acetic acid treatment. The words in formula are, treat the extract with 5oz. of water acidulated with the acetic acid. Now, not any special acid or mode of treatment being stated, I used glacial acetic acid in 5oz of. distilled water made pretty warm; this, I conclude, is the cause of the whole uniting into a homogeneous mass. Ought it to have been a weaker acid, and the extract treated cold? Is there any work on the above compounds?—for most of the chemical and pharmaceutical works which I am acquainted with contain but very little relative to this important class of bodies, even "Miller's Elements of Chemistry," part 3, embrace but a small quantity of them.—PHARMACEUTICAL STUDENT.

[2243.]—CONSTRUCTING FERN CASE.—Will any subscriber oblige by giving plain and simple instructions how to make the above?—FERN LOVER.

[2244.]—REFRACTING TELESCOPE.—I propose constructing an achromatic telescope 18ft. 3in. focal length; the glass I propose using will require the crown lense to be 6ft. 10in. focal length, to correct the chromatic aberration. Will our learned friend "F.R.A.S." give me a set of curves for this combination? If any other gentleman would furnish a set of curves also, it would be esteemed a favour.—NEPTUNE.

[2245.]—TIN SOLDER FOR GLASS.—Can any *reader inform me how to cause tin solder to adhere to glass, as I often see glass brooches soldered on the back?*—G. GERRY.

[2246.]—STEAM WHISTLE—Can any friend tell me the *way to make a steam whistle for a small model* engine? A diagram would oblige.—G. GERREY.

[2247.]—TICKET WRITING.—Will any of your readers inform me as to what compounds and what quantities are used by ticket writers to make black ink, also what *for red ink?*—T. W.

[2248.]—SPEED OF AIR AND STEAM.—How can I calculate the velocity with which air rushes into a vacuum? also what is the velocity of steam issuing from a pressure of one, two, three, or four atmospheres *respectively?*—CENTRIFUGAL FORCE.

[2249.]—NUT SHAPING IN THE LATHE.—Would "W. H. N." be kind enough to answer me one question? By what means is the nose-piece fixed (for carrying the nuts) to the end of the spindle that passes through the square boss, or if the thing is of solid steel?—CENTRIFUGAL FORCE.

[2250.]—THE EAST WIND.—Can any of your readers inform me if it has ever been satisfactorily proved that the unpleasant quality of the east wind is due to anything beside its dryness and coldness—say, to electrical conditions of the atmosphere during its prevalence? What is the best way of counteracting its influence within doors? Can some one refer me to any book containing a record of the temperature and prevailing winds of this country for the last century?—SAEPE.

[2251.]—RENDERING BONE SEMI-TRANSPARENT.—Can any fellow reader kindly inform me how to render bone semi-transparent as we see it in imitation of amber upon tobacco pipe stems?—AMBER TIP.

[2252.]—DISPENSING QUERY.—Can one of our M. or A. P. S.'s tell me how to make a perfectly clear mixture of pepsine porci, 28gr.; acid. muriat. 12scru.; aqua ad. 4dr.—A. P. S.

[2253.]—YACHT BUILDING.—Will some brother reader give the name of a book on yacht building which gives drawings of models to scale for small *yachts* about 5 tons or so?—STEERSMAN.

[2254.]—DOORS.—Will walnut timber require much *seasoning* before using, and if it is a kind of timber adapted *for doors*, &c., and if the labour of working it is equal the price of oak?—SHRINKAGE.

[2255.]—IRON CISTERNS.—What number of bolts would it require for bolting flanges together in 12in. length, and also the weight of red lead putty per foot run, or is it usual to allow so much per cwt. the cistern weighs of each kind respectively?—FITTER.

[2256.]—CLEANSING CASKS.—I have a number of empty beef barrels. The salt from the pickle has saturated the staves, and when wet weather comes the casks become damp or sweat—some of the casks smell foul. Can someone inform me how to cure these evils? The casks are to be refilled with liquid.—W. EBUB.

[2257.]—PAPER NEGATIVES.—I should feel much obliged by "Mus" giving me some information as to taking large paper negatives. I have a 6in. aplanatic lens by Grubb. I have worked waxed paper, plain paper, and paper saturated by liquid paraffin. I can get very good results by these methods, especially for pictures 30in. × 22in., but what I wish for is to know some method and an easy one of getting the negative on the surface of the paper instead of in it, as it sometimes happens the grain of the paper, unless very good, shows somewhat coarse and woolly. I certainly have got some good pictures from good waxed paper nearly up to the mark of the sharpest collodion picture, but I fancy improvements can be made in this direction if "Mus" or the photographers which read our journal were to experiment. Unfortunately, I have no time to spare to do so, but should be glad of anyone's experience in this matter.—GILLER.

[2258.]—EQUATIONS.—On p. 640 of the last volume, Mr Biggs very kindly promises to solve a simultaneous equation of three unknowns if our obliging editor will only allow the space. As one reader, I ask for the desired space. At the same time I append two equations which I cannot solve in any way, and shall be thankful for any help towards arriving at any easy solution. I have not the least idea what room the working may occupy:—

$$\text{Solve (1)}\qquad \frac{x-a}{b}+\frac{y-b}{a}=0$$

$$\text{(2)}\qquad \frac{x+y-b}{a}+\frac{x-y-a}{b}=0$$

$$\text{Solve (1)}\qquad (a+h)\,x+(b-h)\,y=c$$

$$\text{(2)}\qquad (b+k)\,x+(a-k)\,y=c$$

—D. E. WILLIAMS, Pontardawe, Swansea.

USEFUL AND SCIENTIFIC NOTES.

WORKING MEN'S COLLEGE.—The spring term of the Working Men's College has just commenced. Elementary and advanced classes were formed in arithmetic, algebra, geometry, book-keeping, English, French, German, Latin, and Greek grammar and literature, English history, the use of the microscope, astronomy, physiology, music, and drawing.

IRON CHIMNEYS.—A wrought-iron chimney 196ft. high and 6ft. 7in. in diameter has just been erected in Pittsburg. Another is to be put up 275ft. high. The first was rivetted together in a horizontal position, and then lifted to the perpendicular by a crane. The other will be made upright: the plates will be rivetted by means of a scaffolding running up inside.

A NOVELTY IN BUTTER MAKING.—A singular method of making butter has recently come into rather extensive use in France, based upon the fact that cream is changed into butter by being simply buried in the earth. The theory of this result, says the *Grocer*, is not very intelligible, though the fact is stated to be beyond question; and in Normandy and other parts of France, butter is prepared on a large scale this way. The process consists in placing the cream in a linen bag of moderate thickness, which is carefully closed; then burying the bag about a foot and a half deep in the earth, and allowing it to remain from 24 to 25 hours. After the expiration of this period, the cream is found to have become hard, and it is then broken up by means of a wooden beater into small pieces, and sufficient water poured in to wash out the buttermilk. To prevent any mixture of earth, it is advisable to enclose the bag in a second one of larger size and coarser quality. This method of making butter saves a good deal of labour, and separates the butter more perfectly than the ordinary process; and it is said that butter thus prepared is of a more excellent quality.

A FLOATING TELEGRAPH STATION.—In a few days a telegraphic station vessel will be moored by the International Mid-Channel Telegraph Company at the entrance to the English Channel, in from 55 to 50 fathoms of water, in latitude 49 deg. 20 min. 30 sec. N., longitude 6 deg 17 sec. W. of Greenwich. The vessel will be painted black, with the words "Telegraph ship" in white letters on her sides; she will have three masts. At the top of the mainmast a large black cone will be hoisted during daytime, and a powerful globular light at night, elevated 30ft. above the sea, which in clear weather should be seen from a distance of 6 miles. A flare-up light will be shown every 15 minutes during the night from an hour after sunset to an hour before sunrise. During foggy weather, day or night, a bell will be rung continuously for half a minute every quarter of an hour; and for the first six months, or until the 1st day of October, 1870, a gun will be fired every quarter of an hour, and after that date every hour. The commercial code of signals for the use of all nations will be used on board, to the exclusion of all other codes, and none other can be noticed.

MORTAR.—The disadvantages arising from those kinds of mortar at present in use are chiefly owing to inferior sand being used, and the great difficulty of obtaining sand at a moderate price. A material has been invented which does away with these difficulties, for when used it requires only to be mixed with water. In order to make one ton of this mortar, the following substances should be ground by machinery: 288lb. of lime (either caustic or the hydrate, 1728lb. of slag, and 224lb. of calcined coal-shale clay. These materials having been ground to the degree of fineness required, are mixed, and are ready for use. From the nature of the substances used, there would be, doubtless, a more rapid chemical action than that which takes place in ordinary mortar. For plastering purposes the compost seems to be eminently suitable.

TIN IN CALIFORNIA.—The Chief of the Cabinet of Practical Geology and Mining of the United States General Land Office, has very recently written a letter stating that additional information in reference to the discoveries of tin in San Jacinoto, San Bernadino county, Cal., has been received, and specimens of the ore have arrived. The analysis of an average specimen by a competent chemist and mineralogist shows that the ore contains 13·37 per cent of pure tin. The ore is intermixed with tourmaline, containing boracic acid, and with cassiterite. This combination is reported to be unusual and highly interesting, and the yield of tin is double that of the ores at the Cornwall mines.

ACTION OF MAGNETISM ON VARIOUS GASES.—M. Treve has communicated to the French Academy some remarkable results of experiments upon the action of magnetism upon the various gases. When the spark from an induction coil passes through a Geissler tube filled with hydrogen, the gas becomes luminous, having a blue tint, plainly violet at the extremities of the tube, and of a fine red colour in a capillary prolongation. But upon placing the latter part of the apparatus between the poles of a magnet, the red instantly disappeared, giving place to a perfectly white light. In like manner oxygen, which gives a milky white light in the capillary tube, became red; nitrogen deepened its blue to a still deeper blue; the brilliant white of carbonic acid became deep blue; the blue of silicium fluoride became a bluish violet. The spectra of these luminous tubes changed when the capillary portions were subjected to the action of magnetism.

NEW METHOD OF OBTAINING GELATIN.—Crude animal substances, such as the flesh, fat, skin, tendons, bones, etc., either with or without a previous treatment with lime, are treated with benzine, or some other similar hydrocarbon, in a vessel provided with a condensing apparatus for saving any vaporised benzine, or in a closed vessel at an elevated temperature. After a few hours' digestion, the hydrocarbon solution of the fats and oils is drawn off, and may be treated by any of the well-known methods for recovering the volatile hydrocarbon, which may be again used in subsequent operations. The oils and fats are saved and utilised. The animal matters, or purified glue-stock, is now ready for conversion into gelatin by heating with water in the ordinary way.

INTERESTING FACTS.—A legal stone is 14lb. in England and in Holland. A fathom, 6 feet, derived from the height of a full-grown man. A hand, in horse measure, is 4 inches. An Irish mile is 2240 yards; a Scotch mile is 1,984; a German, 1,806; a Turkish, 1626. An acre is 1810 square yards 1 foot and 3½ inches each way. A square mile 1760 yards each way, contains 640 acres. The human body contains 240 bones, 9 kinds of articulation or joinings, 100 cartilages or ligaments, 400 muscles or tendons, and 100 nerves besides blood, arteries, veins, &c. Potatoes planted below three feet do not vegetate; at one foot they grow thickest, and at two feet they are retarded two or three months. There are no solid rocks in the Arctic regions, owing to the severe frosts. The surface of the sea is estimated at 150,000,000 square miles, taking the whole surface of the globe at 190,000,000 square miles. Its greatest depth is supposed to be equal to the height of the highest mountain, or four miles.

CHIPS.

SPHEROLOCOMOTION.—This is a new system of transportation of goods, in cast steel hollow spheres rolling in pneumatic tubes. A process patented in America and in Europe.

SUEZ CANAL.—At an Indian Conference at the Society of Arts on the 3rd inst., the influence of the Suez Canal on trade with India was considered. During the proceedings, Mr. J. B. Smith said, "India must improve her cotton cultivation by irrigation, and then she could easily produce 800lb. of cotton per acre."

TCHUANTEPEC CANAL.—The Mexican Minister of Public Works has sent a letter to the Congress of Mexico, transmitting the original project for concession for a ship canal through the Isthmus of Tchuantepec. Article 1 authorises the Tchuantepec Railway Company to construct that canal.

ANTIDOTE FOR PHOSPHORUS.—Dr. Andant, of Dax, France, has stated that in six cases spirit of turpentine was an antidote for phosphorus.

A NEW KIND OF COTTON.—A new sort of cotton called Bubuy is said to be produced in the Philippine Islands; it is probably a variety of *Bombax down*.

CURIOUS FACT.—An Italian chemist has discovered that the animals of several shells of the Genus *Dolium*, *Tritonium*, &c., have a gland secreting free sulphuric acid.

THE ISTHMUS OF CORINTH.—The concession for the Canal of the Isthmus of Corinth has been signed.

THE *ENGLISH MECHANIC* LIFE-BOAT FUND

Subscriptions to be forwarded to the EDITOR, at 31, Tavistock-street, Covent-garden, W.C

	£	s.	d.
Amount previously acknowledged ...	£160	19	1
P. B. McG		2	6
Two sisters (2nd donation)		5	0
Saept		10	0
John Ross		1	0
J. Coxell		1	0
	161	18	7

ANSWERS TO CORRESPONDENTS.

◆

ANOTHER ADVERTISER'S TESTIMONY.

SIR,—Really your journal is an excellent medium for advertisements, for at a cost of about 4s., I have received as many orders as I obtained at a cost of *seven guineas* through another journal.

W. GYNGELL, Woodbine-cottages, Tewkesbury.

◆

The following are the initials, &c., of letters received up to first post, Friday, the 18th of March :—

RECEIVED.—J. H. T., Marine, Wm. Lewis, W. H. T., T. Thomas, W. Short, James Lee, J. Spurgeon, R. Morrison, Louis Simon, Henry Ussher, S. Turner, Tintac, J. H. T., W. Bear, A Well Wisher, T. S., T. Cooke and Sons, E. Kernan, Rev. P. W. M., E. G. P., Richard Cunliffe, W. Hewartson, P. Champs, J. W. Wetheral, W. Dolan, S. W. and Co., T. Brown, W. Matthews, A Working Man, T. J. O'C. Charles Collins, Rev. E. Kernan, W. Hewartson, Rev. J. B., J. Waghorn, W. Moor, Jun., Richard Cunliffe, Wm. Grosvenor, J. B., J. H., J. H. S., E. M. T. Tydeman, On Guard, D. Alston, Boaz, *a* Ursæ Minoris, E. W. Streeter, John Young, R. A. Proctor, E. D. Rogers, W. Prossor, A Man of Kent, Joseph Newton, Beta, Excelsior, Arthur, Blue Ruin, Ross, Chain, J. B, Knox, B., R. B. J., J. T. Forbes, G. N. Stanley, Astronomer, B. W., Arthur Jones, Cornelius Varley, H. N. H., J. S., Castor, J. C. Shewan, W. H. P., Fortunatus, Cylinder, Iota, J. W., JA. Banner, Q. Q. R., Jas. Rogers, G. P., Cantab, J. W. Castle, Caution, B. C. W., Rivot, Belle Isle, Forward, C. R. H., J. T. Sprague, A. E. B., A Young Irishman, A Subscriber, E. V. Y., R. T. S., One of the Old School, A. B. Pater, R. E. Barfoot, J. B., Glycerine, V. Glasbury, Old Coin, Salmo Poler, Wilholm, Alfred Savage, Jack Plane, C. H. W. Biggs, Edwin Pears, James Wilkins, A. Brothers, J. R., F. R. C. S., G. Firth, Amateur, Raimond Staes, Nobody, Edwin Baker, A Delighted Subscriber, Physiologist, Henry Ussher, Vigie, T. Cooke, F. F. C., Geo. Webster, Bruin, F. Coles, L de Fontainemoreau, J. V. Frisby, W. C. and Co., H. C., D. Mason, Perry Davis, Amateur.

MARK ELLOR will oblige by sending us his address.

W. L. LANCASTER.—Consult Index published in last number.

A CONSTANT READER.—Write them for a circular or description.

JOSEPH GODBULL (Ipswich).—We only insert advertisements when they are paid for.

H. CROWTHER.—Try Sixpenny Sale Column.

D. E. WILLIAMS.—We do not remember either of your previous letters. Sometimes we receive so many answers to one question that it is impossible to insert them all.

W. LEWIS.—Every number of our last volume contains information about telescopes.

W. FISHER.—Consult our advertisement pages.

F. Q. Q.—Part of your query can only appear in Sale Column.

C. C.—It would be illegal, and we could not therefore give the information.

F. MARSH.—No charge whatever is made. We have inserted a query for you.

G. M. TODD (Guelph, Ontario).—Your query is inserted. Thanks for your kind wishes. Recommend us to the Canadians.

S. T. PRESTON.—Would all depend on the merit of the article. We have no lack of valuable contributors on the subject, but are always glad to receive really good matter.

CARAVAN.—Your query cannot appear (except as an advertisement). It would not in all probability be answered, nor would it interest anybody besides yourself.

W. C. NOTTS.—Answered very recently. We cannot repeat so often.

G. D.—Second query inserted. Recipes for harness and other blacking have appeared in back numbers.

SUMMERHOUSE.—Many lists of varnish have been given; some very recently.

RUSTICUS.—Indices, with the exception of the one published last week, are published, twopence each. For answers to other queries see back numbers.

J. T.—You should have sent your address.

Y. P. W.—Premiums are generally paid. Salary afterwards will depend on ability.

MUS.—If we felt inclined to give poetry, your very complimentary lines would be inserted.

F. FORBES.—Your letter, or some parts of it, were illegibly written, and was therefore not sent to the printer's. Correspondents who write on technical matters and use technical terms cannot be too particular in their caligraphy.

ROBERT CHARNLEY AND A. L.—Something soon.

J. W. WARD.—Read the letters and answers to queries which have appeared on telescopes.

J. W. D.—Consult back numbers.

S. J.—We have not time to search. Possibly the name you refer to was an assumed one.

ATHEIST.—The insertion of your letter would inevitably lead to a profitless controversy.

NOMME DE PLUME.—"Gitche Manito" does not wish to rub against the grain of anyone's sensibilities, as indicated by "Sergius" last week, and will, therefore contribute in future under the name of "Minnehaha." One would suppose that "Gitche Manito" has read Longfellow's "Hiawatha" with unusual satisfaction.

J. M. SMALL.—Query inserted. Reply to 1935 not inserted for want of room.

W. S. T.—Your query was not inserted because it was answered a short time since.

E. W. D.—Can you not put a ring round the tree and fix the hooks in the ring?

1870.—Consult a few back numbers.

W. PAWSON.—Your request has been attended to.

TYRO.—You must know that your request is an advertisement.

POOR MECHANIC.—We can't inform you.

CHARLES REVELL.—We believe your suggestion to be impracticable. Try it, and let us know the result.

R. RUMSEY.—No stamps enclosed.

TURRET CLOCKS.—Sydney Maddison, who wrote a short time since on turret clocks, would oblige by sending his correct address to Mr. Lloyd, 135, Steel-house-lane, Birmingham.

F. OUSMAN.—Your letter came to hand.

PROBLEMS.—Several problems, and answers to others, are not insereed on account of the space they would occupy.

VERITAS.—The last letter appeared exactly as you sent it to us.

WM. MORRIS.—Your answer is an advertisement.

W. FINCH.—No stamps enclosed.

ROTHERWOOD.—On reference to our "Sixpenny Sale Column" in this number, you will find a communication addressed to you.

NORTH BITCHBURN.—Can only appear in Sixpenny Sale Column.

TINKER.—No charge; query is inserted in this number.

QUERCUS.—Must purchase indexes and search. We have not time.

R. H. HULL.—We willingly insert free of charge all queries asking for information; but those which inquire for addresses of manufacturers, prices, &c., we are obliged to consign to the Sixpenny Sale Column. They are only of interest to the party who asks them, and take up too much valuable space. Your query is one of these.

JAMES GOUGH.—We discourage private communications. Put your query in another form and it shall appear.

L. H. WIDDOWSON.—Many thanks for your replies. You are, however, a little behindhand in sending them, and as the queries have already been similarly answered we are unable to insert your replies.

G. P. FYE.—First query cannot appear except in the Sale Column. Second query has been answered very recently.

W. FLUKES.—Why write to us when you know the author's address? The contributor you name will probably again appear shortly in these columns.

P. A. FOTHERGILL.—We have not received the communication you mention.

HARCOURT'S BRAKE CHAIN.—R. W. Rose, of Haddenham, Suffolk, wishes us to state, "for the benefit of those who are cautious, that he has tried the above and finds it first-rate."

TINTAC.—Your question on rifles would involve an answer that would occupy several columns.

W. R.—Inquire in Paternoster-row.

GEO. DAVIS.—We are quite disposed to give the widest latitude to correspondents. Dr. Bedford may certainly be left to take care of himself.

DAVID FISHER.—You know as much as we do about the "Macclesfield" velocipede.

THOS. J. O'CONNOR.—Your reply throws no additional light on the poker question.

C. WRIGHT.—Question too insignificant.

C. R. C.—We should think not.

X. Y. wants to know whether we can recommend any "jobbing mechanic" to make a working model. The Sixpenny Sale Column is sure to bring him what he wants.

TAUTAU.—Thanks for promised co-operation.

A. S. C.—It matters little, but *all* communications addressed to the Editor are sure to be attended to.

T. J. O'CONNOR.—Yes, post free 1s. 9d. each.

BOAZ.—We cannot speak of the respectability of advertisers. Carbon filters may be had in Fleet-street, London. See our advertisement scale.

H. D.—Thanks for the suggestions.

THE LONG FIRM.—We find several have been duped by Claude and Co., of Cheltenham. We have reason to believe that the same "firm," under the name of Parks and Co., hail from Abington. Next week in all probability it will assume another name in some other town. We can only say to everybody, Be on your guard.

THE INVENTOR.

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IN obedience to the suggestions of a number of readers, we have decided on appropriating a portion of our space to a condensed list of patents as nearly as possible up to the date of our issue.

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APPLICATIONS FOR LETTERS PATENT DURING THE WEEK ENDING MARCH 14, 1870.

677. C. J. Fox and R. Larchin, 61, King's Cross-road, reaping machines.
678. J. Piegrome, Plaistow, rails for railways.
679. G. W. Wigner, 1, Saint Swithin's-lane, London, centrifugal drying machines.
680. S. Brooks, West Gorton, G. Harrison, J. Wardle, of Leigh. spinning and doubling.
681. A. Villepigue, of 4, Maismore-place, Peckham, apparatus for boring—A communication.
682. R. A. Wiffen, Romford, new construction of tapping-cock.
683. J. Polson, Paisley, improvements in treating grain.
684. C. H. Williams, Westbury-on-Severn, curing skin diseases.
685. W. C. A. Donaldson and J. Sandilands, Edinburgh, dry gas meters.
686. J. L. Norton, Belle Sauvage-yard, looms,
687. J. Lang, of Cockspur-street, fire-arms.
688. W. R. Lake, Southampton-buildings, submarine constructions.—A communication.
689. G. Preston and J. Prestige, Deptford, preventing waste of water.
690. C. Wyndham, of Southover Grange, near Lewes, bicycles.
691. W. E. Newton, 66, Chancery-lane, motive-power engines. A communication.
692. J. Hopkinson, of Southport, furnace and boiler.
693. H. Putter, Fisherwick, Dough, bleaching.
694. J. Duffey, Chelsea, protection from fire.
695. T. S. Truss, 434, Old Kent-road, boilers.
696. J. Neilson, Glasgow, cast-iron cooking utensils.
697. G. Fowler, Basford, smelting iron ore.
698. W. O. Wilson, Liverpool, millstone picks.
699. M. Frow, Leake, binding of cut crops into sheaves.
700. W. R. Lake, Southampton-buildings, London, etching.—A communication.
701. W. R. Lake, threshing machines.—A communication.
702. O. Ormrod and R. Hall, Eagley, finishing threads or yarns.
703. T. Newnton, Manchester, fire-arms.
704. R. Blakeborough, Brighouse, and S. Sanderson, Huddersfield, consumption of smoke.
705. H. L. Gibson, Liverpool, hats.
706. C. A. Winder, Sheffield, drawing and forcing fluids.
707. J. W. Grover, 9, Victoria Chambers, rolling stock of railways.
708. J. Brady, Manchester, skirts.
709. J. A. Tatro, Hartford, distillation of crude petroleum.
710. J. H. Johnson, Lincoln's-inn-fields, wheel tires.—A communication.
711. J. Jeavons, Sheffield, armour plates.
712. T. W. Walker, Sandford, enamelling.
713. J. J. Lundy, Leith, purification of sewage.
714. W. R. Lake, extinguishing fire.—A communication.
715. S. Chatwood, and J. Sturgeon, Bolton, machinery for crushing.
716. M. Henry, 68, Fleet-street, tanning.
717. J. Wallace, Belfast, distilling.
718. J. and J. Hopkinson, Huddersfield, indicators.
719. F. Brusch, Kingston-upon-Hull, dampers of boilers.
720. G. Paley, Preston, Lancaster, Cotton Manufacturer, putting twist to rollers of frames.
721. J. Wright, Birmingham, watering gardens.
722. J. Moysey, Leytonstone, and C. Thorne, Mark-lane, hackling machinery.
723. G. Atkin, E. Atkin, and A. A. Atkin, Birmingham, reducing bones.
724. J. H. Johnson, combing flax and hemp.—A communication.
725. H. A. Bonneville, 10, Sackville-street, setting types,
726. C. Jackson, Birmingham, vulcanising india-rubber.
727. J. Siddons, West Bromwich, clocks,
728. P. C. Thamsen, 40, Great Tower-street, artificial leather.—A communication.
729. M. Henry, 68, Fleet-street, piers.—A communication.
730. L. Silberberg, Cheapside, cigars.
731. J. Connell, Mincing-lane, sugar.
732. W. Pennington, Manchester, plaiting and sewing.
733. A. Kay, 91, Kennington-road, Lambeth, railways and tramways.
734. J. Brown, Gildersome, carding engines.
725. J. Dunnachie, Glenboig, drying bricks.
736. J. Polson, Paisley, machinery for treating grain.
737. G. Tynack, North Shields, windlasses and capstans.
738. W. Nicholson, 148, Holborn Hill, clog for roughing horses.
739. A. Du Bled, P. Chennallier, and J. Aufpret, all of Paris, holder for cartridges.—A communication.
740. J. Morris, Belfast, Jacquard apparatus.
741. W. Payne, Liverpool, furnaces.
742. G. Townsend, Wimbish, lawn edge clippers.
743. J. Glover, 46, Sekforde-street, Clerkenwell, regulating flow of air into furnaces.
744. W. R. Lake, indicating deficiency of water in steam boilers A communication.
745. S. D. McKellen, Manchester, watches.
746. J. J. Stevens, J. J. F. Stevens, and W. A. Stevens, 237, Southwark-bridge-road, signals on railways.
747. W. Arkell, Cheltenham, raising and lowering heavy bodies.
748. T. Routledge, Ford Works, near Sunderland, manufacture of paper.

PATENTS BEING PROCEEDED WITH.

3154. L. Wray, motive power engines.
3169. W. Birch, sewing machines.
3171. P. Jensen, guns.
3180. C. E. Cawley and J. Newton, tramways.
3182. S. Leoni, cooking and lighting by gas.
3183. A. Grothe, registering number of passengers.
3184. T. Wright and I. Fox, lace machines.
3189. N. W. Blanchard, substitute for curled hair.
3191. J. McDowell, sawing timber.
3205. J. Maiden, lubricators.
3207. J. Turnbull gears in steam engines.
3217. T. Perkins, ploughing.
3225. G. D. Davis, rudders.
3230. J. Tracy and H. Tracy, umbrellas, parasols, whip and other handles.
3238. J. Ingleton, waterclosets.
3241. I. Battinson and George Battinson, combing wool, and other fibrous substances.
3246. M. Tuthill, horse gear.
3249. I. Nasch, sewing machines.
3257. P. Wilson, locks and latches.
3258. H. Rochatte, breech-loading fire-arms.
3269. W. E. Dobson and F. Dobson, lace machines.
3272. G. H. Hannaford, signals.
3276. C. H. Holt, furnaces.
3289. F. Clarbour, and W. E. Teale, mining lamps.
3220. P. Brampton, locks.
3291. F. Clark, bricks, tiles.
3300. W. H. Tucker, locks.
3302. W. Srigley, motive-power.
3337. R. K. Miller and A. B. Herbert, pumps.
3403. F. W. Webb, rolling stock.
3407. E. F. Goodall, ink bottles.
3412. L. Mount, filling match splints.
3439. W. Cross, shawls.
3620. W. R. Lake, electro-magnetic circuits.
3717. J. B. Gough, collar stud.
3735. T. G. McDiarmid, sails of ships.
3745. E. P. H. Vaughan, manufacture of fluoride of potassium and sodium.
108. James Greenshields, obtaining oil.
203. W. T. Waite, animal charcoal.
204. W. T. Waite, filtering.
205. W. Garton, saccharine matters.
262. R. H. Durie, railway brakes.
264. W. Orr, Scotch caps.
316. J. Davenport, riddle for cleansing potatoes.
408. J. Thompson, door handles.
415. W. R. Lake, drying sugar.
419. B. Looker, horticultural structures.
422. J. Morrison, gas stoves.
455. T. Whitehead and H. W. Whitehead, spinning fibrous substances.
458. G. Twigg, shearing and clipping apparatus.
483. S. W. Clark, lamps.
505. S. Hulme, removing paint from wood.
512. W. B. Adams, tramways.
516. W. Adams, dressing stone.
523. W. E. Newton, springs for carriages.
524. H. A. Bonneville, boots.
530. G. Rydill, purifying mill waste.
541. H. A. Bonneville, steam engines.
564. J. H. Jonson, sewing and other machines.
578. A. Godillot, military tent.
599. L. Sterne, wheel tyres.
604. H. Hayward, yarns.
630. J. C. Morrell, sanitary apparatus.
649. J. Allmann, dressing wheat.

All persons having an interest in opposing any one of such applications are at liberty to leave particulars in writing of their objections to such application at the said Office of the Commissioners, on or before the 4th of April, 1870.

PATENTS SEALED.

2686. W. E. Newton, furnaces and ovens.
2692. T. Restell, breech-loading fire-arms.
2693. G. Shaw, combined buckle and button hole.
2707. G. A. C. Bremme, breaking flax.
2736. A. Brooman, chains.
2742. J. I'Anson, railway signals.
27[illegible]. J. F. R. Badiou and F. Bernard, shoes for horses.
2842. A. E. Fridlander, watches and chronometers.
3092. W. R. Lake, sewing machine needles.
3208. W. R. Lake, sewing machine needles.
3558. J. Loader, meters.
3690. W. Galloway, joints or couplings for pipes.
146. H. B. Read, wrapping rug.
2713. T. and W. Wheatley, fastenings for carriage doors.
2730. J. Polson, grain.
2732. W. E. [illegible]edge, bed.
2733. M. Doirier, velocipedes.
2734. P. Wisdom, machine for twissing hair.
2767. W. E. Gedge, drying machine.
2777. B. Hunt, railway brake.
3571. J. Willis, umbrellas.
3709. J. Asbury, screw spanners.
3716. J. Woodward, bricks.
99. W. Goreham and L. White, Portland cement.
213. W. Lake, reaping machines.

PATENTS ON WHICH THE STAMP DUTY OF [illegible] HAS PAID—1867.

511. J. Marshall, safety gauges.
660. G. H. Daw, cartridges.
702. T. Burt, apparatus for moving mud.
688. H. Sharp, manufacture of iron.
684. H. A. Bonneville, preserving solutions of plants.
687. A. Kimball, sewing machines.
738. P. T. Goodwin, animal charcoal.
708. B. P. Walker, valves.
707. John F. Briajes, animal charcoal.
723. F. R. A. Glover, tackle for weighing anchors.

PATENTS ON WHICH THE STAMP DUTY OF £100 HAS BEEN PAID.—1867.

651. C. H. Lea, closing the gates of railway crossings.
658. W. Inglis, steam boilers and engines.

The English Mechanic
AND
MIRROR OF SCIENCE AND ART.
FRIDAY, APRIL 1, 1870.

A PRACTICAL TREATISE ON THE HARMONIUM.*

By Hermann Smith.

THIRD DIVISION.—CHAPTER I.

Of the Couplers and Coupling Movements.

> The education of the muscles to delicate manipulation is more difficult than the acquisition by the mind of the principles which govern it.—Waif.

THIS treatise was commenced so long ago, and suspended during so prolonged an interval, that but for the repeated solicitations made to me personally, and in correspondence, to continue my labour, I should be justified in resigning the vocation of the teacher. My unbroken silence may have seemed to indicate a total disregard of wishes so frequently expressed. It has not been so. There are periods in life when circumstances arbitrate against our inclinations; there are other periods when the turn of the tide favours our designs.

I accept the opportunity of renewing my acquaintance at a time when the ENGLISH MECHANIC is starting on a new stage of its career of usefulness. Many thousand new subscribers have been added to its circulation since my hand was familiar in its pages, and I know of a surety that it retains the old readers who were wont to give me welcome. Let me hope to obtain from all readers, both from the old and the new, the same kind indulgence and consideration in the task I now resume.

The treatise was framed to embrace the theoretical and *the* mechanical exposition; it is *to the latter branch of the subject* the first link *shall be made. The* amateur *constructor* of *harmoniums is seldom content with the* early *efforts of his ingenuity; larger* and larger his ambition grows until nothing less than a double-manual instrument will satisfy his desires. To have an instrument like an organ, that is the thought that holds him with irresistible fascination. *He decides* on his two manuals, and perhaps on pedals, although the probability is that the latter will be postponed until the former has been attained. Couplers are an important feature in an organ, and how to provide for these in the harmonium becomes a matter of solicitous regard, for the coupling movements of an organ, hidden, complex, and involved in mystery, present themselves but vaguely to his imagination, and in proportion as they seem to defy his scrutiny, so his anxiety increases to ascertain the details of their *construction.* On no question have we found amateurs more curious than on this concerning couplers.

The modes of adaptation to organ requirements are indeed *numerous* and ingenious; it is fortunate *for our labour* that in harmoniums the coupling *movement* is almost wholly restricted to one kind and two varieties. The connection to be effected is "swell to great," and it is attained in two ways which, in whatever mode they appear, are essentially the "sticker-action" and the "wedge-action." Utility has dictated the restriction. Large harmoniums are of necessity cramped for room; space for complicated or duplicating actions is hardly to be found, and no good purpose would be served by the addition of movements capable of acting in reverse order, as "great to swell," and "pedals to great." The amateur may fancy such accessories; the practical musician finds he does not require them. The harmonium coupler is designed to give the lower manual the power of acting upon the upper manual, to combine with its own whatever power the swell or upper sound-board may possess. Generally this upper sound-board will have but one, or at most three rows of reeds; it is inferior in strength or body of tone, and is therefore held to be subsidiary to the lower sound-board. The keyboard is sometimes termed a "bank." Two manuals are two banks, one above the other. Between the two sets of superposed keys, there is a vacant space from end to end, and usually the distance from the top of the lower set of keys to the under side of the upper will be found to be about one inch and a quarter, or in some instances an inch and a half. We refer to the stem portions of the keys beyond the ivories, and beyond the key-pin rail or centre rail supporting the keys, which, for this class of instrument, are "balanced keys." The keys would be between sixteen and seventeen and half inches long, balanced at eleven and a quarter inches from the front. Within the space under the far ends of the keys we are at liberty to arrange a coupling action.

FIG. 1

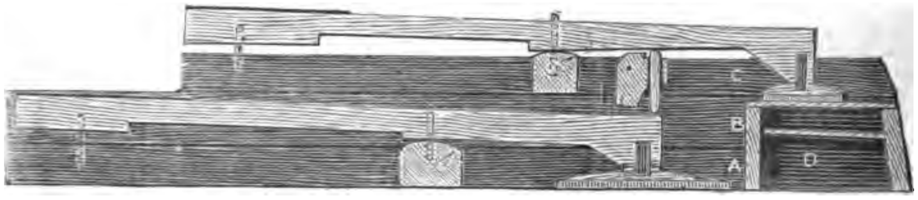


FIG. 3

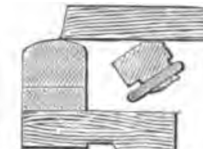
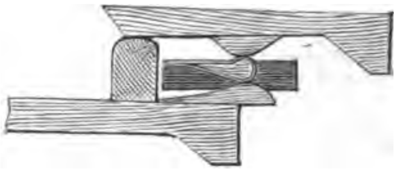


FIG. 2



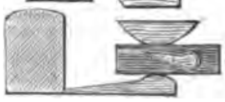


FIG. 4

The problem is how to provide a means of contact between upper and lower set—contact that may be made or broken at pleasure. Cut a piece of stick one inch and a quarter long, insert it between two such keys, and your contact is complete, your coupler is made. Strike the key of the lower manual, and the corresponding key of the upper manual repeats to it. Strike it again, and your stick that ought to be a sticker shirks its duty and goes off without leave. You want to provide for a certainty of action, and to be able to claim its aid or to dispense with it at pleasure, therefore a mechanical means has to be devised for the fulfilment of that end.

Simple as the requisition is in the form we have expressed it in, the mechanism that will fulfil all your demands is equally simple. Contemplated in this way there is no mystery or perplexity; knowing exactly what you have to do, how to do it is a easy problem. A "sticker" or a "wedge" will do it, these are the two forms. A sticker is a little rod, it is fitted to slide with upward movement through a perforated bar. A wedge is a little block of tapered wood fitted also to slide horizontally between projections fixed on the key-stems. Notice the distinction: In Fig. 1 we have the sticker coupler, in Fig. 2 the wedge coupler.

In Fig. 3, the same sticker coupler shown out of gear; in Fig. 4, the wedge coupler out of gear. The lettering in Fig. 1 indicates—A, the key-frame of the "great" or lower manual; C, the key-frame of upper manual; B, the block-frame intervening; D, the swell sound-board.

Of these we decidedly give the preference to the latter, because it may be drawn into action at any moment without risk of damage. The sticker movement is much more liable to derangement, if drawn on suddenly when the hands are on the keys. The action being of a rotating kind, such stickers as come in contact with the ends of elevated key-stems are in danger of being broken. The wedge motion being a horizontal one, no such harm can happen under any circumstances if the framework is properly made and accurately adjusted. In some instances we have so great a depth between one portion of the key or stem-work of the harmonium and other portions with which we desire to make contact, that it becomes advisable to combine both wedge and sticker coupler; these conditions can arise only under some peculiarities of construction, and then to accomplish our purpose we make the sticker a fixture upon the stem, with the wedge working above it.

In the proper shaping, fitting, and arrangement of coupling movements, great delicacy of manipulation is required. It is of the utmost consequence that there should be no difference in the depression of the keys moving under the coupling action, and the depression given to the same keys by the fingers. Unless this nicety of adjustment is cared for, the pitch of the notes will vary, and the instrument will always be out of strict tune whenever the couplers are in use. Between any two sets of keys certain inequalities will always be found to exist as to depth of space to be filled under each key; if the wedges or stickers are all cut to one pattern, all will not be equally effective, therefore such inequalities will have to be made up by the requisite thicknesses of leather.

The construction of the sticker action is in this wise:—Take a piece of hard wood of the length of the inside of the key-frame, shape it into the form shown, which is that best adapted for strength. On one ridge mark off spaces corresponding to those of the ends of the key-stems, drill sixty-one holes of about quarter inch diameter, bush or line these holes with fine cloth, and fit them with stickers of suitable length. Find the proper position for the working of this bar, which should be as far as possible from the key-pin rail, in order to obtain such an elevation or throw as will most nearly correspond with the depth of finger-touch at the ivory end of the keys of the upper row. Should the stickers strike the under side of keys too near to the key-pin rail, the difference of leverage would be objectionable, and perhaps cause the elevation of the key on its pin To obviate this error you will keep the swing bar ar far as possible backward, or else will have to leave the stickers with an extent of play prejudicial to the quick repetition of the keys.

Pivot the swing bar within the key-frame in any suitable manner, and so adjust it in connection with the stop-rod action, that it may be rotated a quarter of a turn, and at each end a spring should be placed to return the bar out of gear. The stickers, when in gear, will be in upright position, and when thrown out of gear will be in a slanting position, inclined at an angle of about 45 degrees, when the movement of the keys either above or below will not affect them. The stop-rod action for the sticker plan of coupling is best placed at end of keyboard. To prevent noise or rattling in the working, the key-stems should be faced with cloth or leather at the parts where the stickers would touch them. Probably this operation may be dispensed with if the stickers are light or are held by the "bushing," because there is the objection that the leather or cloth may be roughed up by constant wear, unless very carefully fitted. The points of stickers should also be nicely rounded, and to prevent the stickers falling out of the bar, it is necessary to drive little sprigs of wire into the sides, allowing only the play sufficient for the due performance of their duties.

With attention to these particulars the success of a sticker coupling movement thus constructed will depend on your own accuracy of work and skill in adjustment.

Whenever there is room in the instrument it will be desirable to adopt the wedge form for the coupling. Make a rectangular frame very firm and light, so fitted in grooves made in or attached to the upper key frame, that it will slide backwards and forwards to the extent of an inch, more or less. As to exact measures you will be guided by circumstances, variations will not effect the method pursued nor the plan of construction.

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* The copyright of these papers is reserved by the Author. They were commenced in 94, and continued in Nos. 96, 98, 100, 105, 109, 116, 118, 124, 126, 132, 133, 135, 141, 151, 153, 166, 172, 180, 190, all of which are to be had except No. 98.

Supposing the lower key-stem rises in its throw a quarter of an inch at the position for contact of coupler—probably it will be less than that—it is clear that you can occupy all the depth or space between lower and upper keys excepting that quarter of an inch, without interfering with the proper movement of the keys; but if you fill that quarter inch with a wedge the keys will be in contact. It is not needful for us to draw quite so fine a limit. Enough if you understand the calculations to effect your purpose. On every key-stem glue projections of wood shaped as shown, those above and below will meet within a quarter of an inch or so, and your wedges at the thickest part should be of a thickness that will fill that space and produce contact the moment a key on lower manual is struck. These wedges, 61 in number, should be covered with a clean firm leather, fitting them to slide easily, the smooth or grain surface outwards; leave a tail of leather, or better still, of parchment, by which to affix the wedges to the front rail of your rectangular frame, each will then have free movement, held by a firm hinge of parchment. On your frame, screw a strip of hard wood bevelled inward, covering with it all the parchment hinges, and bearing up that the points of the wedges may, as it were, have foothold during the moment that the action returns them out of gear, because at the first instant of the start, some may be held under pressure, in event of the hands being on the keys. We have called these little blocks wedges, but when all properly arranged, symmetrically in line, they appear like a row of pianoforte hammers; and if covered with scarlet leather, will look highly ornamental when the instrument is opened for examination. If the Harmonium affords ample room, these wedges or hammers may work on an action rail as stems do, be of larger size, and with wire pivots instead of parchment hinges. So also it is perfectly immaterial whether the thin ends of the wedges are turned to front or back, whether the couplers are thrown into gear by a forward or a backward movement. As a rule we should predict that you will have to work in close quarters, with not an eighth of an inch to spare; and then it will be found that practically it will be best that to "bring into gear," the action should throw the frame forward, and have springs at each end of frame to "return out of gear" promptly; and check-blocks to determine accurately the traversing distance to be allowed in the backward and in the forward movement of the frame. The stop-rod action for this coupling movement we should desire to place as near centre of key-board as can conveniently be arranged. The devices of leverage suitable for the purpose in relation to the stop-rod are so obvious that it were needless to present further description or illustration. Methods to be adopted for pedal coupling will be described in chapters connected with other particulars of the pedal harmonium.

(To be continued.)

ELECTRICITY—ITS THEORY, SOURCES, AND APPLICATION.

BY J. T. SPRAGUE.*

(*Continued from page 622, Vol. X.*)

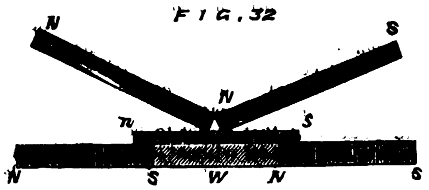
88. BY means of electrical currents, which consist of energetic polarisation of the molecules of the bodies they traverse, and which induce similar and parallel lines of polarisation in all surrounding bodies, magnetic effects can be developed in all substances, and Faraday and others, by means of very powerful magnets, have proved that magnetic actions do thus occur, modified by the nature of the substances and their molecular arrangement, which lead to a classification of substances, as magnetic and diamagnetic. Iron is the most highly magnetic substance known, then nickel and cobalt, but the first alone has any particular interest for us.

89. Whenever iron is attracted, magnetic polarity is induced in it, and the attraction results from that process, but on removal from the inducing magnet, the iron returns almost entirely to its previous inert or unpolarised state. Steel, on the other hand, is much less strongly attracted, but retains the polar state; both circumstances resulting from a resistance in the molecules to an alteration in their state. This, no doubt, is connected with the fact that steel is a compound of carbon and iron, and thus its molecules are very different from those composed of two atoms of iron only. This resistance is termed the coercive force of steel, which varies very much in different samples. Those in which the coercive force is greatest are the hardest to magnetise, but make the strongest and most permanent magnets. This property, therefore, furnishes a limit to the magnetism any steel can possess, and is called its point of saturation; temporary power may be given beyond this, but will speedily be lost. Another element in the power of a magnet is the force of the source from which it was derived; thus, if magnetised from another magnet, its force cannot exceed that of the magnet used: that is to say, its relative molecular force in proportion to weight; hence powerful magnets should be employed to impart the force.

90. MAGNETISATION.—Steel may have magnetic power developed in it by drawing a bar magnet along its several surfaces, always in one direction, or the same process may be adopted with a horse-shoe magnet; in both cases it is still better to arrange a complete system of bars forming an octagon or square, and draw the magnet round and round, always in one direction; in this plan the bars may be all steel, or alternate steel and iron.

If the operator has two bar magnets, an excellent plan is to place them with opposite poles together over the middle of the bar to be magnetised, and then to draw them slowly asunder to the ends, repeating this six or eight times on each face. This process is still more effective if the ends of the bar rest on two other magnetic bars with their opposed poles in the same direction as the moving magnets. Fig. 32 shows this process, *n s* being the bar to be magnetised and W a piece of wood to support it and steady the lower magnets. This is called the method of single touch, and is best suited to thin needles and bars, not more than a quarter inch in thickness.

FIG. 32

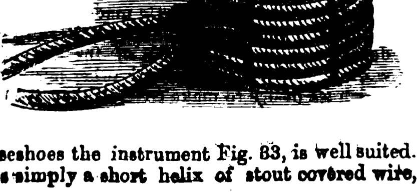


The method of double touch may be illustrated by the same figure. The triangular space between the two movable magnets is filled with a piece of wood, and their upper ends connected by a bar of soft iron, and both are moved to and fro along the bar *n s*, without separation. This process gives more magnetic power than the other, but it is apt to be irregular, and to produce *consequent points*—that is to say, reversals of magnetic polarity within the bar.

In magnetising steel in the horse-shoe form, two should be placed with their ends together, and the magnets carried round the system, or if two are not needed, the ends should be closed with an iron armature.

THE BATTERY PROCESS.—This is the most effective, and will develop the greatest power—needles may be magnetised by enclosing them in a helix extending their whole length and passing a strong current for a few minutes; for large bars and horseshoes the instrument Fig. 33, is well suited. It is simply a short helix of stout covered wire, the central opening of which is large enough to allow it to be passed over the bar. It should be arranged at the middle of the bar, and connected to a battery, sending a powerful current through it, and regularly passed along the length both ways several times, allowing the ends to half enter the helix, and brought back to the middle before the current is stopped, and the action is facilitated by slightly tapping the magnet during the process to produce vibration. The laws of this process will be explained under the head of electro-magnetism.

FIG. 33



91. QUALITY OF STEEL, AND TEMPER.—For large magnets, hardened cast steel is best; for compound horse-shoe magnets, the same steel annealed at 500°, or hard shear steel; for needles, cast-steel annealed in boiling oil. Steel made of the best iron, such as Swedish, makes the best magnets, and the hardening or tempering should be equal throughout.

92. FORM AND ARRANGEMENT.—For compass needles, the best form is a flat, tapering from the middle to the points; for bar and horse-shoe magnets, the mass of material should be divided into a number of plates not exceeding a quarter inch in thickness, separately tempered and magnetised, and arranged with their similar poles together; they should be insulated from each other by sheet brass, or cardboard, and bound together either by screws or external bands of brass. The ends should not be flat, but tapering, so as to concentrate the action on small terminal surfaces; and in some cases, it is well to terminate the whole by pieces of very pure soft iron, shaped as desired, fitted to the end of the bars, and secured to them.

93. When a number of bars are thus united, the total force is never equal to the sum of the whole separately, because the similar poles tend to neutralise each other; in some cases, the central bars will even be reversed by this action, for which reason they should be the longest. This is the reason, together with the superior temper of the surfaces, that a number of separate pieces give more power than a solid bar of the same mass, as in this the interior portions are apt to take reverse magnetism to the exterior, thus completing closed magnetic circuits, and leaving little force to be exerted on external objects.

94. PRESERVATION OF MAGNETS.—They should be carefully handled, and all jarring *actions* avoided; when not in use, needles *should* be placed in the true magnetic direction, and with their south ends raised to an angle equal to the latitude of the locality; the same with bars; but either may be still better preserved by placing two together with their poles reversed, and a small piece of soft iron between them at each end. Horse shoes should always have the keeper or armature on, and their powers may be greatly increased by hanging them up with a weight attached, which can be gradually increased. Care should be taken, however, never to violently detach the keeper, and when this is removed for use, it should be done by sliding it off across the poles, not by pulling it away.

95. THE DIRECTIVE FORCE.—A magnet capable of free motion, if approached by another magnet, is attracted by this, if extremities of opposite names are nearest, and the ends of similar names repel each other. This repulsion, however, like that of electricity, is only apparent; it is the consequence of the fundamental principle of magnetism, the polarity of the molecules. It is simply the effort of these molecules to place themselves in the parallel and consecutive order described in section 87. In soft iron this is effected by molecular reversal; the coercive force of steel resists this, and therefore the mass of the magnet tends to turn round to effect the same result, and if this be resisted the molecular action very commonly occurs, resulting in the permanent weakening of the magnetism, or even in the total reversal of that of the magnet whose intensity is least. The direction in which the free needle will arrange itself depends on the positions and distances—in fact, it ranges itself on the lines of the magnetic force of the fixed magnet, viz., on the curves shown in Fig. 29, and the apparent repulsion as well as attraction are due, not simply to the visible bodies or magnets, but to these lines of force or chains of polarised particles of air, &c., which surround them to a considerable distance. This is very distinctly shown by the process of attraction upon iron. If a piece of soft iron is applied to the N. end of a bar magnet, it is attracted because polarity is induced in it; it be-

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* "Sigma."

comes itself a magnet with its S. end in contact with the magnet. If, now, a second bar magnet is applied with its S. end to the other end of the iron, the action is increased, the iron held with double force; but if the N. end of this second bar be applied, the two actions neutralise each other, and the iron, though in contact with two magnets, will have no attraction exerted upon it.

96. The earth itself acts as a large magnet, and hence a free magnet arranges itself in relation to the magnetic poles of the earth, which are not at the same points as the true poles of its axis of revolution, nor are they even permanently fixed. The consequence is that the compass does not point true North and South, nor exactly in the same direction at all times. So also it does not rest in a horizontal direction, but in the Northern hemisphere, with its N. pole lowest, or *dipping*, pointing to the magnetic pole, and thus occupying the magnetic curves of the earth in a manner exactly similar to the behaviour of a suspended magnetic needle in relation to a large bar magnet. Terrestrial magnetism is a subject by itself, and one of vast practical interest, but it is out of the scope of these papers. Our concern with it is simply to regard the earth as a huge magnet, and to see, where necessary, that its actions are the same as those of any other magnet, and to see if the probable causes of its magnetism aid us in studying electricity.

97. Ampère's Theory.—As before remarked, magnetism was formerly explained by the invention of two fluids; but the theory now universally received is that of Ampère, which, though properly belonging to electro magnetism, it is necessary to touch on here to complete the explanation given in Section 87. Working from the fact that a circular electrical current constitutes a magnet at right angles to its plane, and that electro magnets are practically composed of a series of such circular currents ranged in the form of helices, and also from the fact that the force is evidently possessed completely by the molecules of permanent magnets, he taught that magnetic substances are composed of molecules around which currents of electricity are constantly flowing; that magnetism consists in ranging all these currents in parallel order, and it has been thoroughly proved by the most stringent mathematical analysis, that this beautiful idea explains *all the facts of* magnetism. Fig. 34 exhibits

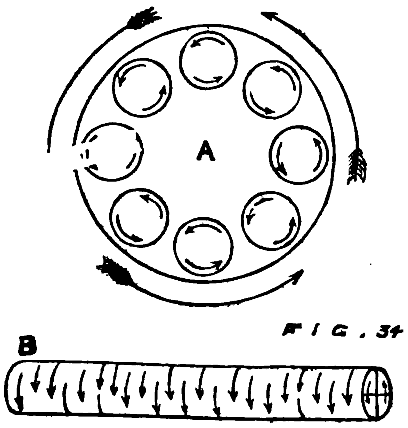

FIG. 34

n, showing the supposed molecular currents, the sum of which acts like an external current, and B represents a cylindrical magnet, of which A is the end shown, or any section looked at from that end.

98. But beautifully scientific as this theory is, there are fatal objections to it, not generally seen. In the first place, it is based on the idea of electricity being an entity, a something which can circulate round the molecules in a real stream, and therefore it is inconsistent with more recent views as to the nature of electricity; but apart from this, though we might assume it to be possible that such circulating currents might be confined to the molecules, it is impossible to conceive how they fail to arrange themselves symmetrically always, or why once arranged, as in magnetised iron, they derange themselves at once the moment the inducing magnet is withdrawn. The very nature of electric currents would require a *coercive force* to prevent the magnetic condition being always existent, whereas the reverse is the fact.

99. The molecular theory, or rather that modification of it which I am setting forth in these papers, takes possession of all Ampere's work, steps at once into the position mathematically proved true, but avoids these objections. It replaces the molecules with their separate circulating currents, by molecules in a static polarised condition. Fig. 35 shows at once the resemblance and the difference in the two theories. A, regarded as a permanent magnet, shows the molecules retained as a polarised chain, analogous to the conditions of static electricity, and it shows how an electric current generates this state in a bar around which it circulates. The coercive force of the magnet is due to the resistance of the molecules to the change of condition, either to being magnetised or demagnetised in the case of steel, the molecules of which are compound, while iron has little power to resist either. What it is in the molecules of iron and steel which gives them these properties, we do not know.

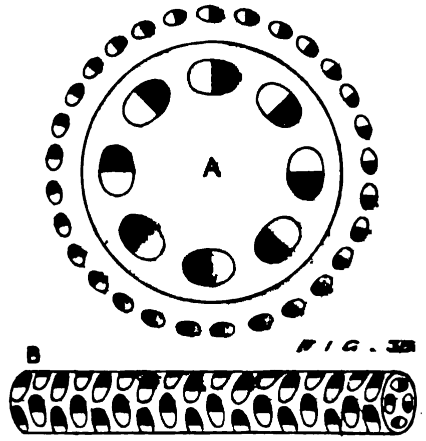

FIG. 35

100. Laws of Magnetic Force. Many attempts have been made to fix the laws of attractive force of magnets, and the result appears to be that it varies inversely as the square of the distance, as it must indeed from the cause which generates this universal law of actions proceeding from a centre, as it is a necessary consequence of the fact that the areas of spheres increase in that ratio; but this *only* applies to each point of a magnet regarded by itself; practically no distinct law can be laid down, as the force is a compound action and varies with the form of the magnet. Thus the poles of a magnet are the centres of action of each half of the magnet, not necessarily the points where attraction is strongest, which is usually at the end, while the poles are generally at about two thirds the distance from the centre to the ends, and in tapering needles, still nearer to the centre. As to the attractive force or weight-supporting power, this varies with the quality of the steel and also with its form, length being the chief element in this latter, but this and all other details of magnetism will be best studied under the head of electro magnetism, which must be preceded by that of current electricity and its sources, to which we shall now pass.

(*To be continued.*)

PLATINISED LOOKING-GLASSES.*

By C. Widemann.

NO. II.

THE glass being prepared by the usual method is soaped, polished and cleansed. The Platinised Glass Works, at Wailly-sur-Aisne (France), where this new industry is carried on, possesses highly improved polishing tables, so much so that the polishing operation occupies only three hours. At the St. Gobain Works this operation requires a manipulation of 48 hours.

After the cleaning operation the glass is carried into the platinising shop, and the composition giving the metallisation is applied to the glass by means of a brush; the plate is placed vertically and receives the platinising liquid to a convenient thickness. It is first applied from bottom to top, then from left to right, and at last from right to left; by these means the oily coating is equalised. This composition, containing a large quantity of essence of lavender, spreads itself instantly over the surface, drying slowly and without any running. Great care must be taken to avoid all dampness and dust; dampness would crisp and wrinkle the surface, and the dust would destroy the regularity of the work, as every grain of dust absorbs liquids concentrically, and thus deprives the surrounding parts.

The platinising composition needs nothing else to be perfect than great cleanliness on the part of the operator.

In making the platinising liquid the following materials are used: 100 grammes carefully laminated platina in very thin sheets are taken. It is soaped, in order to remove all the grease that might have accumulated during the laminating operation. It is then dissolved in an aqua-regia, composed of 400 grammes nitric acid for 1000 grammes pure hydrochloric acid. It is heated by means of a sand bath to dryness, care being taken not to decompose the chloride by excessive heat. It is then crushed in a porcelain or glass morter, and laid on a grinding glass plate, where it is mixed with small quantities at a time of essence of lavender (rectified), care being taken not to work at too high temperature or the reaction would take place on this glass plate. Having added about 1400 grammes of essence of lavender, the mixture is collected in a porcelain dish and left to itself for eight days without the least disturbance. The liquid is next decanted, filtered, and left again for six days, and this filtered liquid must then be about 5° at the acid test Baumé. For the above quantity, 25 grammes litharge and 25 grammes barate of lead are taken, and ground to an impalpable powder, with 8 to 10 grammes essence of lavender. This last mixture is then added and stirred with the platinising liquid. It is then applied as above described, care being always taken to avoid dampness and dust.

As soon as the glass plate to be platinised has received the metallic coat and is sufficiently dry, it is placed in muffles, formed of a frame of cast iron, tongued and grooved, and the parts of which slide in each other.

The fire-place is placed at the back of the oven, which arrangement gives free access to the door, through which the glass is placed in the oven. Movable frames are placed in the cast-iron frame, and receive the glasses to be heated, maintaining them in a parallel and vertical position. Hooks, properly constructed, support a large number of these frames. Also, movable sheets allow glasses of different sizes to be placed in these frames.

The vertical and longitudinal section of the oven is a long parallelogram, and its cross section is a square. The cooking is regular; and the accidents of fire are regulated by registers or iron gates in the posterior and anterior part of the oven. A series of muffles are placed under the dome.

The platinised mirror thus obtained is of great solidity, and no metal is more resistant to the influence of atmospheric agents. Even when a mirror is thrown into a great fire, at the temperature at which the glass melts, it will have retained its metallic surface. The mirrors do not give false tints to coloured objects, as the common mercury alloy does.

The reflection being obtained by the anterior surface, there exists no double reflection; but what is still more remarkable is that the substitution of platina for tin and mercury is that it allows any kind of glass to be transformed into a mirror. The nitrous matter is polished on one face only, and having been submitted to the platinising process reflects images without distortion from the surface of the metal itself.

Let us now come to the actual process in use; the following conditions had to be filled:

After having suppressed the use of mercury, the glass was to be perfectly colourless and deprived of every defect. The cost had to be reduced, or the old routine would not give place to progress. Not only has Dodé suppressed the use of mercury, but he has by his improvement been able to make better mirrors, for he hides by his process the faults in the glass plates, and obviates half the work of planing and polishing. In order to obtain this result it was necessary to apply the reflecting surface on the front of the glass plate, and not at the posterior surface.

MECHANICAL MOVEMENTS.*

(*Continued from page* 5.)

NO. 1. Apparatus for disengaging the eccentric rod from the valve-gear. By ullin up the spring handle below until it catches in the

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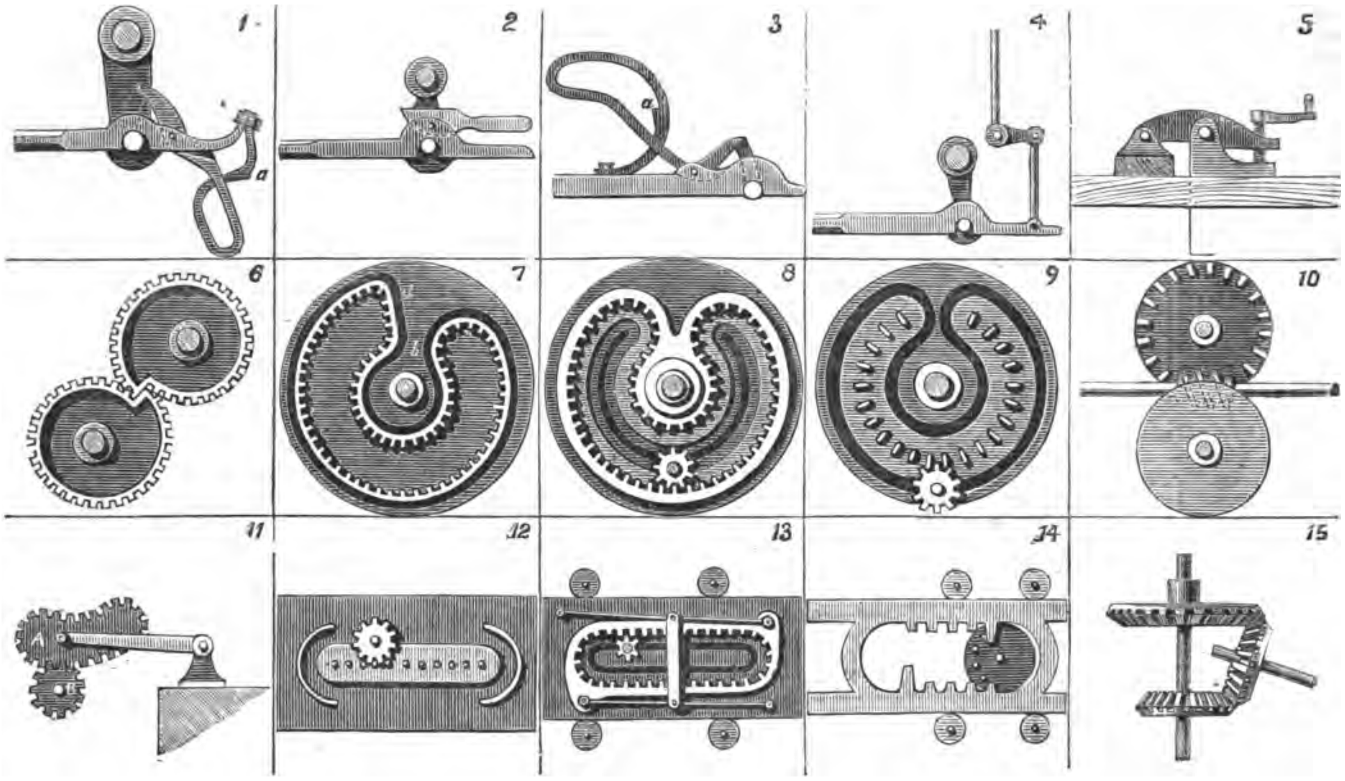
*From the *Scientific American*.—Continued from p. 631, Vol. X., of the English Mechanic.

* Extracted from a compilation by Mr. H. J. Brown Editor of the *American Artisan*.



MECHANICAL MOVEMENTS.

notch, *a*, the pin is disengaged from the gab in the eccentric-rod.

2 and 3. Modifications of 1.

4. Another modification of 1

5. A screw-clamp. On turning the handle the screw thrusts upward against the holder, which, operating as a lever, holds down the piece of wood or other material placed under it on the other side of its fulcrum.

6. Scroll-gears for obtaining a gradually increasing speed.

7. A variety of what is known as the "mangle-wheel." In this one the speed varies in every part of a revolution, the groove *b*, *d*, in which the pinion-shaft is guided, as well as the series of teeth, being eccentric to the axis of the wheel.

8. Another kind of mangle-wheel, with its pinion. With this, as well as with that in the preceding figure, although the pinion continues to revolve in one direction, the mangle-wheel will make almost an entire revolution in one direction and the same in an opposite direction; but the revolution of the wheel in one direction will be slower than that in the other, owing to the greater radius of the outer circle of teeth.

9. Another mangle-wheel. In this the speed is equal in both directions of motion, only one circle of teeth being provided on the wheel. With all of these mangle-wheels the pinion-shaft is guided and the pinion kept in gear by a groove in the wheel. The said shaft is made with a universal joint, which allows a portion of it to have the vibratory motion necessary to keep the pinion in gear.

10. A mode of driving a pair of feed-rolls, the opposite surfaces of which require to move in the same direction. The two wheels are precisely similar, and both gear into the endless screw which is arranged between them. The teeth of one wheel only are visible, those of the other being on the back or side which is concealed from view.

11. The pinion, B rotates about a fixed axis and gives an irregular vibratory motion to the arm carrying the wheel, A.

12. What is called a "mangle-rack." A continuous rotation of the pinion will give a reciprocating motion to the square frame. The pinion-shaft must be free to rise and fall, to pass round the guides at the ends of the rack. This motion may be modified as follows:—If the square frame be fixed, and the pinion be fixed upon a shaft made with a universal joint, the end of the shaft wi describe a line similar to that shown in the drawing around the rack.

13. A modification of 12. In this the pinion revolves, but does not rise and fall as in the former figure. The portion of the frame carrying the rack is jointed to the main portion of the frame by rods, so that when the pinion arrives at the end it lifts the rack by its own movement, and follows on the other side.

14. Another form of mangle-rack. The lantern-pinion revolves continously in one direction, and gives reciprocating motion to the square frame, which is guided by rollers or grooves. The pinion has only teeth in less than half of its circumference, so that while it engages one side of the rack, the toothless half is directed against the other. The large tooth at the commencement of each rack is made to insure the teeth of the pinion being properly in gear.

15. A mode of obtaining two different speeds on the same shaft from one driving-wheel.

THE EAR—ITS USES AND ABUSES.

By Dr. Ussher.

(Continued from page 6.)

SOME of my readers may remember that I told them on a far back occasion how a pet canary of mine, since defunct, was very partial to my clarionet, seeming to derive comfort from a plaintive air, and eyed me from his perch, but at once sought the bottom of his cage if I played a loud, quick measure. His demise took place one day at dinner time, to the inexpressible grief of one of my little ones, whose sobs refused comfort, deriving a post satisfaction from the decent interment of the bird within sight of the garden window. "The faculty of imitating sounds possessed by certain birds proves that the hearing must be exceedingly delicate, and though we suspend our belief of the great musical talents which some birds are said to have derived from education, we find many well attested instances of a delicate ear in species by no means remarkable for vocal execution." Madame Piozzi gives an account of a tame pigeon, which answered by gesticulation to every note of a harpsichord. As often as she began to play, the pigeon hurried to the concert with every indication of rapturous delight. A false note produced in the bird evident tokens of displeasure, and if frequently repeated, it lost all temper, and tore her hands. "A no less remarkable instance of the effect of music on a pigeon is related by Lockman in his reflections on operas, prefixed to his musical drama of 'Rosalinda.' Being in the house of a Cheshire gentleman whose daughter was a fine performer on a harpsichord, he observed a pigeon, which whenever the young lady played the song of 'Speri Si,' in Handel's opera of 'Admetus,' would descend from an adjacent dovecot to the room window where she sat, and listen with every indication of pleasure till the song was finished, when it uniformly returned to the dovecot." These quotations are full of interest. You all know the story of the watchful geese in the Roman Capitol. Throughout creation you will come across people as diverse in their hearing as in their tastes; some cannot for the life of them turn a tune, and others will twist it and torture your ears by such wretched discords that escape is impossible and endurance a virtue—others can't abide it; of them I would say, "Shun that man or woman who dislikes to hear music *or the* voice of a child!" And what is more *musical than* the unrestrained laugh of a coterie of *little ones?* It is a happy power—the laugh of the maiden is contagious, and if she is ringing the silver bell of her voice it is a pæan of victory, and reminds me of a dear old song:

Toujours gai, toujours gai,
Always meet a smile half-way,
Always meet a smile half-way,
And follow my example.

The passage to the drum of the ear is chiefly remarkable for containing in its walls the glands furnishing the wax or cerumen, the use of which may be to entangle such small foreign bodies as would go in, or the too adventuresome fly. This much is certain: I have over and over again, after removing a hard plug, the accumulation it may be of years, found ants, flies, &c., in the body of it; and the wax must have a bitter taste, for no leech will cross it, nor will it adhere to the skin until it is perfectly well cleaned of every portion of ear wax. The colour varies from pale straw, as in the infant, and of a honey consistence, to the darkness of mahogany and the hardness of old india-rubber. I have often taken an hour for its removal with the result of restoring hearing. And here let me make a digression on the common and indiscriminate use of the syringe. If there is pain in the ear it should not be thought of; great injury as well as intolerable agony might result. Should the ear passage be impacted the speculum is of no use, and a cautious removal of the plug is all the more necessary, for it may become moulded to the drum, and even inflame it. I have seen an old person faint from the violent injection of a stream of water into the ear, and violent cough or vomiting may be equally unpleasant. One portion of the ear passage is so intolerant of touch that a probe moved over it will cause the sensation of nausea; why, I believe anatomists are ignorant of, although compelled to accept the fact they cannot explain. The tube of the ear in most persons is not straight, and it becomes necessary to stretch the auricle backwards and upwards to see the membrane; some, on the contrary, have the passage so large that the membrane of the drum is seen

FIG. 1

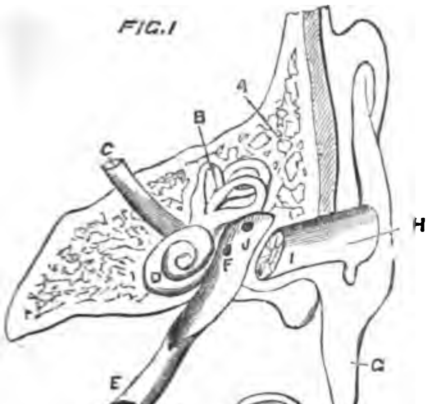


FIG. 2

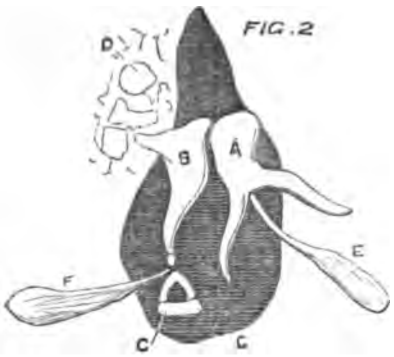


FIG. 3

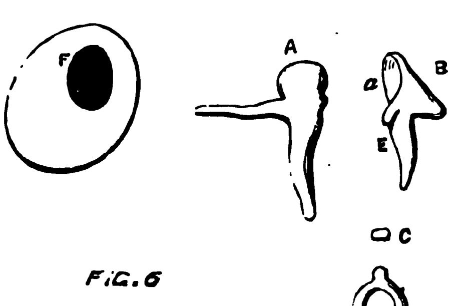


FIG. 5

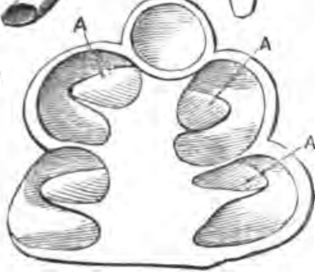


FIG. 4

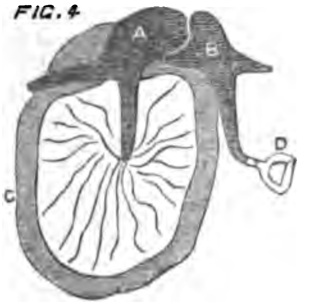


FIG. 6

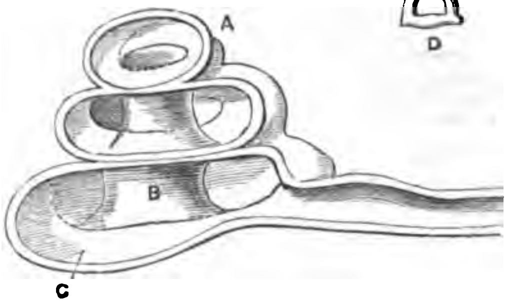


FIG. 7

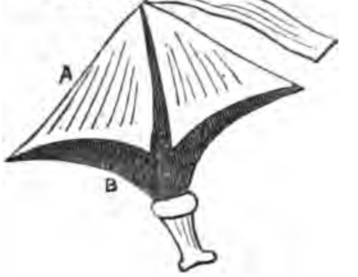


FIG. 8

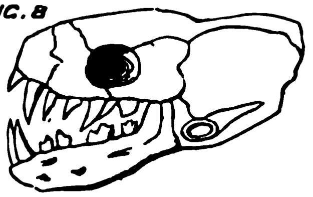
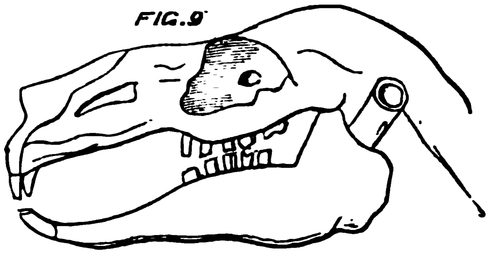


FIG. 9



THE EAR—ITS USES AND ABUSES.

without difficulty. The direction of the meatus seems to be for the facility of catching sounds, addressed as they usually are to the face. In *animals*, where hearing is necessary *for their safety, things* are otherwise ordered; take the *hare for example*, Fig. 9, and also in the polecat, Fig. 10. Our ear passage is not of uniform calibre, but wider or funnel-shaped below, so that in using the speculum it is only possible to see a portion at a time. The bony passage is incomplete in the young, and in their case we get a better view of the parts; what we see may be briefly described, and Fig 1 will convey some idea thereof. The first thing that attracts you if you are sharp-eyed is a spot of white and a line of white where the handle of the malleus or hammer bone is attached as if sewn to the membrane; you next perceive that the light shines off one part that is higher than the rest, and if you look closely and in a good light having a suitable ear for observation, you may possibly be gratified to see one part of it vibrate; to do this, however, you must possess a Brunton's speculum, which magnifies the object, and a first-rate light. In colour the drum membrane is a mother of pearl white, like thin gold-beater's skin. It readily inflames, then assumes a pink colour, at all times sensitive to the touch, the slightest pressure causing pain and sickness. I believe it was Sir A. Cooper who conceived the idea of puncturing the membrane, an operation that would require the nicest touch, and, after all, of questionable utility. Although surgeons might be numbered by the thousand, few have ever taken the trouble to see the ear-drum, and I have seen some who considered themselves very intelligent observers, direct the tube of the speculum to the wall of the meatus, and describe what was *out of sight*. Fine hairs line the passage, a *cheveaux de frise* in the face of an intruder. The adaptation of means to end is remarkable, and to be traced everywhere in nature; for instance, the ear passage in the owl is high up, just where he wants it—the hare's is directed backwards with a long canal and highly movable ear, so that puss may be a match for her pursuers; the reverse obtains in the polecat, who "follows his nose," and so deaf are they to what goes on at their back, that a story is told of a farmer who in trying to shoot one missed fire five or six times, and not a move was apparent on the part of the polecat until he was turned out of life. The fox, predacious enough in all conscience, has his external ear passage expanded from behind into a circular aperture, and his ungainly appropriations are thus favoured. To strengthen the assertion of the hare's deficient hearing in advance of her, the story is told of one pursued by greyhounds along a turnpike road; a woman was approaching immediately in front of her, she knelt down and the hare ran fairly into her apron, which was stretched out to receive her. This circumstance clearly proves that poor puss was much more occupied with dangers from behind, and heedless of those before her; she preferred, however, to yield herself to her who is ever the refuge of the persecuted and oppressed, and we may hope for the credit of her sex *she* did forego the temptation for once of roast hare and currant jelly. You know, of course, that in the martial instrument of percussion, provision is made for bracing up or tightening the drum-head. Well, the ear is provided with a tensor tympani muscle or stretcher of the drum, and as the hole in the instrument is supposed to be an air hole, so our cavity of the drum is supplied with one. Some contend that there is no analogy, and that the air sent through the Eustachian tube from the throat is to counterbalance the atmosphere and prevent concavity of the membrane. This tube, called after one Eustachius, opens into the throat behind the soft palate, and performs a most important function in hearing, for its closure is followed by deafness; its calibre is small, although the opening in the bell-shaped extremity of the throat is large and wide; if the lining coat of it is inflamed, easy closure results, or it may be rendered more or less impervious by mucus filling it up. To remedy this defect a Eustachian catheter or tube is devised to pass by the floor of the nose into the bell muscle, and is connected with an air reservoir exhausted and closed by a stop cock; the connection being established, a jot of air is forced into the cavity of the drum. In two instances death has followed the use of this elaborate machine, and its employment is perfectly unnecessary, for if you inflate the cheeks, having stopped the nostrils with a finger and thumb, you may fill the cavity if the canal is pervious, and the bursting of a bubble of air is audible to the stethoscope of a listener. Catheters and probes are sold by the boxful to go into this passage, but they are too large to gain admission; however, as long as there are people who like such devices they will be paraded. It requires a nice sense of touch to be able to hit the passage with a proper catheter, the bubble heard being your test of success. Attached to the drum membrane is part of one of the chain of ear bones, a truly wonderful structure, ever on the move; no noise of clockwork here, balanced to a nicety, and retained in that balance by ligaments or binds to the bone walls adjacent. Every vibration is conveyed by this swinging chain of ossicles, or little bones, to the fenestrum, or window of the vestibule, the fourth bone, or the third, according to some, closing that opening with a stopper shaped like a stirrup. The hammer bone, Figs. 2, 3, and 4, acts on its neighbour the anvil, and this in turn on the stirrup, which is supposed to be a compound bone. You can easily imagine that if one of these bones was to be dislocated or thrown out of its joint, what mischief would ensue; the outer membrane of the drum is often destroyed, and impaired hearing results. That the ear bones are not an absolute essential of the hearing organ is evidenced by their absence in fishes; and in man the foramen ovale may be at times seen through the disrupted membrana tympani, and yet the relic of hearing remains, of course useless if the liquor Cotunnii (called after Cotunnus, an anatomist) is evacuated. A broken external membrane may be replaced by an artificial drum of Yearsley's, a neat little disc of india-rubber, wired, but if the inner membrane is gone, the "sanctum sanctorum" of the ear is invaded, and all is lost. Those of you who have seen boys lifting a stone with a leather sucker, get some idea as to the action of the artificial drum; it is the putting of a new patch on an old garment, or a patching operation like what we see on an old drum worn out in the vigorous service of a Punch and Judy proprietor.

The vestibule into which the stapes is fitted communicates with the semi-circular canals and cochlea. See Fig. 1. The auditory nerve comes through the internal passage from the brain, and is in that opening said to be in close communication with the facial nerve, a fact of the highest importance in diseases of the ear. The vestibule I might liken to the hall of a house, the oval window being the door; it has no great vestibular proportions, being about the 8th of an inch in diameter. Numerous openings for nerves and vessels occupy the walls, and the apertures of the semi-circular canals are there noticed; another opening leads into the cochlea, which has been aptly compared to a winding staircase or a whelk shell. Figs. 5 and 6. Two of the semi-circular canals join at their extremities. The upper diameter is about the 20th of an inch; the lower part has a dilatation, or ampulla, on it. One of the canals is horizontal, the other perpendicular, and as this mode of arrangement is widely observed in nature, it is supposed that they regulate the direction of the sound. This winding staircase makes two turns and a half, and is about an inch and a half long; its central stem, called axis, or modiolus, terminates above in a funnel-like expansion. These several cavities have linings, and contain fluid which appears to be useful in the transmission of vibrations, and another fluid or layer of peri lymph is said to exist between the membrane and the bone proper. There is a curious powder found in the ear called *otoconia*, a compound of carbonate and phosphate of lime, crystalline. The diameter of some of these mysterious grains, the use of which we are unacquainted with, is $\frac{1}{3000}$ of an inch; they are supposed to be analogous to the otoliths or ear bones of fish, and the presence of this otoconia in the lower types of organisation leads to the conclusion that they are for hearing purposes. This vestibule is a chamber in which the auditory nerve is spread, and receives its impressions. It may seem marvellous, but M. Savart states that sounds are still audible which result from the succession of 24,000 impulses (Carpenter), and this probably is not the extreme limit of acuteness. These vibrations are determined, either by a number of apertures passing a sounding pipe in a given time, or the number of teeth caught by a spring in the same period.

(*To be continued.*)

CHAPTERS ON CURIOUS CATERPILLARS.—APRIL.

By J. R. S. Clifford.

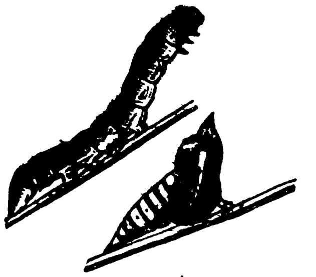
WHEN vegetation, generally, has fairly yielded to the influences of Spring, and almost before many of the trees have been able to display their leaf-glories in full perfection, a numerous and indefatigable host of insect adversaries is sure to be engaged in attacking bud, leaf, flower, or even the wood of the tree itself. Sometimes the attack is carried on in the broad daylight, at other times it is insidious; the marauder lurking during the day, and sallying forth at night, leaving, however, manifest traces of the execution done by his jaws. The first general brood of the caterpillars, which produce our butterflies and moths, emerge from the egg, in great part, during April, though a few are delayed till May. Others, which ceased to feed in the early chills of Autumn, and were too cautious to be tempted from their winter retreats by the transient fine weather of March, crawl forth in the milder month of April, and, regardless of its showers, regale themselves on the fresh spring leaves. "Regardless of its showers," did I say? Not altogether so; for many caterpillars succumb to them, and will be "found drowned" after a heavy rain fall chiefly those which have not long emerged from the egg. In the gales, too, which continue some seasons to prevail through part of April, others are blown from their food-plants into roads or other positions, where they are either readily seized by birds, or die from starvation, through being unable to regain the plant or tree which yields their wonted diet. So that gardeners and agriculturists have reason to rejoice that the ravages of caterpillars, at their greatest, are nothing to what they might be, were all circumstances favourable to their nutriment and growth. Nor must we forget the singular circumstance, that in addition to external enemies, every species of caterpillar has, as we believe, an internal enemy, in the shape of some parasite, which, at a certain point in the career of a large number of each kind, deposits its eggs upon the skin, and the grubs produced therefrom devour, slowly or gradually, the luckless individuals attacked.

Surely the most abundant of the April caterpillars, is that which produces the Winter Moth (*Chimatobia brumata*), and common as it is, some of its habits are very curious. Indeed, much attention has been directed to these in late years, since the ravages committed by them on the apple and pear trees in some Midland counties have been serious. The parents of the numerous broods of these ravenous rovers, which seem to feed on almost any tree in wood or orchard, come forth from the chrysalis state in the dreary months of November and December; the male moths, with semi-transparent, dull brown wings, sitting quietly on palings through the day; the females, which are nearly wingless, running along the trunks and branches of trees, where they deposit their eggs, each one usually laying 200. The small caterpillars which emerge, begin by gnawing the just opening buds, when great numbers are destroyed by birds, which visit the buds in search of them, and frequently destroy buds on which, apparently, no caterpillars were feeding: a weakness which the gardener is inclined to punish severely. As the foliage becomes full the caterpillars of the winter moth prepare for themselves habitations, constructed by drawing two or three leaves together, in which the little tenant dwells with tolerable safety, thrusting his head a little beyond it to feed, but rarely exposing himself entirely to view. When disinclined to eat, he reposes with his head on one side and partly curled round; and when a tree or shrub haunted by them is tapped smartly, out tumbles a host, some descending to the ground, others swinging by silken threads. In appearance these caterpillars vary very greatly, the general colour being various shades of green, or even brown approaching to blackish, a central stripe down the back, which marks the position of the alimentary canal—or long stomach, shall we call it?—being seen in all, and other fainter stripes each side, more or less distinct. When of full size, they descend to the ground, and enter the earth to complete their change, and the sudden disappearance of them towards the end of May from this cause is striking; where a few days before the insect-hunter, in beating the bushes, shook forth thousands, only a straggler or two appears, but the dismantled bushes do "a tale unfold" of what has been done by the individuals now reposing quietly as chrysalides.

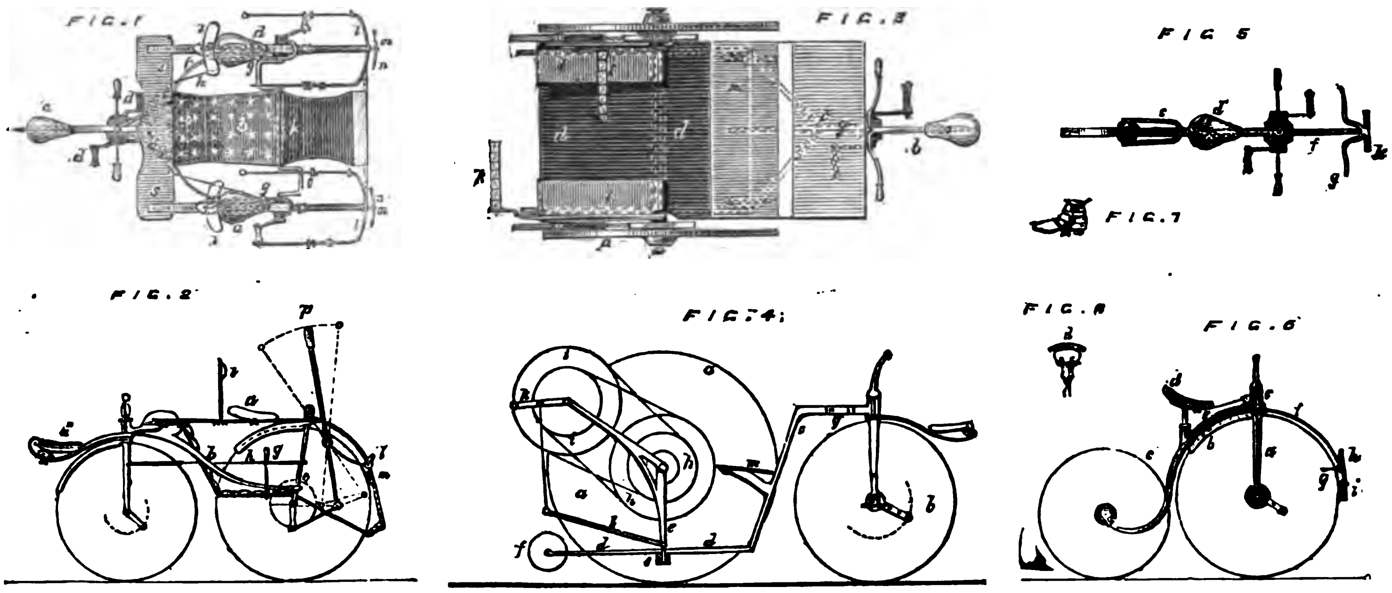
A rather odd caterpillar, not frequently found by the collector, because it is most partial to gardens and their vicinity, which he is apt to be negligetn in hunting, is that of the Swallow-tailed Moth (*Ourapteryx sambucata*), this moth floats slowly about the hedgerows on July evenings, and is easily taken. The caterpillar, which is getting of some size in April, is of a varying brown hue, and looks exceedingly like a bit of twig which has been snapped off, and the resemblance is kept up by little humps along the back, almost resembling buds. The elder is a tree on which it often feeds, as also on fruit trees in gardens and orchards, extending itself usually at full length along a branch when not eating. In June it suspends itself in a sort of hammock, made of bits of leaves and silk intermixed, in which it turns to a palish chrysalis, spotted with black.

Amongst the night-feeding caterpillars, the individuals belonging to the genus *Tryphæna*, are to be detected at night, and are occasionally looked for with a lantern by those interested in the doings of insects. Most of them have lived through the winter, and in April they ascend the trees at night and nibble the buds and young leaves, retiring to the ground at early morning, and hiding amongst the short herbage. That of the very handsome moth, called the Broad Bordered Yellow Underwing (*T. fimbria*), is fond of making midnight excursions on birches and sallows, where it may be rather readily found, being noticeable by its numerous markings scattered over the clay-brown velvety skin; the head is very small, shining, and mottled. So also acts the caterpillar of the smaller and more abundant Lesser Yellow Underwing (*T. arbona*), but as it rolls, when touched, into a compact ring, it often falls to the ground and is missed. The colour and markings resemble those of its relative, and at certain times it appears to feed also on chickweed in the daytime. When of adult size, it becomes a chrysalis on the surface of the ground, and the moth appears about a month after. The Lesser Broad Bordered (*T. janthina*), another of the family, in its caterpillar state, prefers to feed on garden plants of a variety of kinds, feeding in the daytime on the roots, and emerging from the ground at night to nibble the leaves. The most abundant of the genus is the well-known Yellow Underwing (*T. pronuba*), a moth which frequently enters houses, and is as variable as the caterpillar which produces it. This latter also, like its brethren, lives through the winter, but seems to feed on without cessation, living in the roots of plants, or concealed in the stem. When brought to view it rolls up into a compact ring. The colour is most frequently some tint of brown, though sometimes the ground is yellowish-green; a number of narrow stripes run from head to head to tail, interspersed with black markings. When it has ceased to eat, it scoops out a slight cell in the earth, and appears as a moth in June and July.

The caterpillar and chrysalis shown in our figure are those of the Brimstone Butterfly *Gorepteryx Rhamni*): the former begins to appear in April on the species of buckthorn; the curiously sculptured eggs are deposited at the beginning of the month on the tips of the young leaves. Until they get to be of some size, the caterpillars lie along the mid-rib of a leaf, when at rest, and thus escape notice. In favourable seasons they grow with great rapidity. I have had them arrive at their full size in twenty-five days from the time of emergence from the egg; and in a fortnight afterwards the brilliant butterfly comes forth from the chrysalis. The caterpillar is of a dull green, curiously shagreened over with minute points, with a paler line along each side. The chrysalis, rather singular in shape, is green tinted with yellow. Common as is the Meadow Brown Butterfly (*Satyrus janira*), its caterpillar has, as yet, been little noticed; it must be got by stooping down and examining the grass fields in April and May. In the day it is usually at rest near the bottom of some stem of grass, and when touched falls off in a tight ring, remaining doubled up for a good while. This is one of the caterpillars which has been called rolling-pin shaped; the surface is rough, and also studded with scattered hairs, and on the last segment are two little points; the colour of the body is apple-green, with a darker stripe. The chrysalis is attached by silk to the grass.



An interesting family of moths, which haunt aquatic places, is that which includes the Wainscot Moths, which flit to and fro, as soon as evening sets in, some appearing in July, others in August and September. The habits of the caterpillars are in many respects singular, most of them living through the winter, and feeding up in the spring. Some of these may be readily found in April, in marshy ground, and on the banks of streams and ditches. The Smoky Wainscot (*Leucania impura*) is a London insect, occurring about the Thames, and common throughout the three kingdoms. The caterpillar, yellowish grey, with paler lines, feeds on different grasses, and may be swept from them with a net. So also does the caterpillar of the Common Wainscot (*Leucania pallens*), which is full grown in April, and is greyish-brown in colour, dotted along the back with black, and marked with delicate longitudinal lines. In the reed mace, in many places, the larger caterpillar of the Bull-rush Moth (*Nonagria typhæ.*) may be found, though as yet small, since it is not full grown till July. This caterpillar is long, and has a smooth head, and a strong plate in the second segment, which enables it to move with facility within the stem of the plant, where it subsists on the pith. By a remarkable instinct, when about to change, it cuts a circular hole in the side of the stem, coming close to, but not through the surface, and leaving a thin film through which the future moth easily pushes its way. Another lover of fens and marshes is known, as the Fen Wainscot (*Calamia phragmitidis*), once abundant near Greenwich, and still plentiful in Cambridgeshire. The caterpillars live in the stems of the common reed, where they may be found near the tip in April. These are rather maggot-like, and when removed from their retreats, crawl about restlessly. The head is small



THE TRUE VELOCIPEDE.

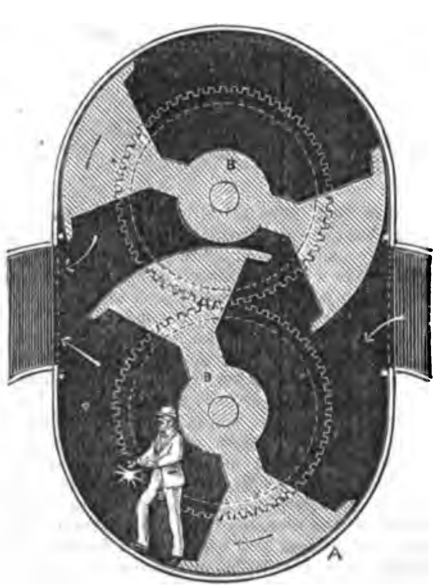
tific principles which should guide in the construction of velocipedes." Starting on the assumption that, with a properly made velocipede, and on level roads, an economy of time and power is gained, Dr. Clarke adverts to the delusion entertained by many mechanics, that *power* may be created by mechanical aids. Our subscribers are tolerably familiar with some of the contrivances produced by such persons—machines with any number of toothed wheels and pinions, each additional complication entailing a loss of power rather than a gain. In the construction of bicycles and other loco-machines, the principles to be chiefly borne in mind and acted on are safety, simplicity, and cheapness. The medium must be sought between lightness and strength, the loss by friction must be reduced to the lowest point, and the power be applied to the wheel as directly as possible. As also there are two sets of independent muscles in the human body—one below and one above the waist—it is essential that, in a properly constructed machine, the two sets shall be able to act either independently or combined. These and other objects appear to have been kept in view by Dr. Clarke in the construction of the machines invented by him, drawings of which are given with his book, and which we reproduce. Fig. 1 and 2 are a plan-view and a side-drawing of a tricycle of a superior description to carry four—two men sit over the front wheels, a third over the back, and the fourth in a cushioned seat in the middle; though the single wheel may be put in front, if preferred, and the middle seat be put looking backwards. Again, a perfect change of muscular power is provided for, as the front men work a power and half levers, and the hind one foot cranks—as in Machine No. 3 and 4. It can be steered from behind, from the middle seat, or by the front wheels, as the axle is boxed in the middle. Foot rests are provided as a fulcrum for the feet, and a back rest as one for the back, enabling the whole power to be spent upon the levers. It can be dragged both from the front and hind wheels. One man on the hind seat has propelled himself and the machine carrying another person with the greatest ease. If the middle seat is removed and the mid-fork is strengthened so as to do away with an axle, it is, Dr. Clarke believes, the very lightest and easiest-worked carriage possible that could be constructed to carry three persons.

In Figs. 1 and 2 *a* are the saddles; *b* middle seat, cushioned; *c* inner foot-crank for inside lever; *d* foot crank for hind seat; *e* anterior forks; *f* mid-fork fastened to anterior fork; *g* small hand-levers to turn the hind-wheel, for middle man; *h* the cords for do.; *i* movable back-rests; *k* axle, boxed in the middle; *l* foot rest for front men; *m* the drag; *n* horizontal projections for toes to press the drag on the wheel; *p* hand levers (a power and a half); *s* luggage shelf. In Figs. 3 and 4 *a* are the front wheels; *b* hind wheel; *c* middle fork; *d* platform on which workers stand; *e* bent axles to support platform; *f* small supplementary wheel to prevent tilting forward; *g* slot or sliding joint to lengthen or shorten carriage; *h* cone drums or pulleys on nave; *k* handles to pulleys; *l* treadle for foot in down stroke; *m* seat for men resting. Figs. 5 and 6 are plan and side views of a new bicycle. In this machine, according to the inventor, all complications are weeded out as far as possible. It can be taken to pieces in a few minutes, and packed in a box a yard square. The hind-fork is curved, and may be made *springy* to distribute the shocks of the roadway, as well as lessen their force. The mud-protector fits on a square at the top of the front-fork, the foot-rest with the foot-drag above that, and the hind-fork over all, protected by a thick india-rubber washer and kept in its place by a screw—the mud-guard and the foot-rest turning with the wheel. In level countries the foot-rest will not be needed at at all; and no one should use a foot-rest, *i.e.*, go down hill, until he has the machine under perfect control. The ordinary leg-rest is a dangerous feature in the common bicycle. On the new plan there is quite sufficient play for guiding the wheel round any curve in the road. *a* is the front fork; *b* guard; *c* hind fork; *d* saddle and spring; *f* curved bar supporting foot-rest and drag; *g* foot-rest; *h* projection to press the drag; *i* drag. Fig. 7 shows a semicircular metal clip to fix underneath the foot, the better to grasp the foot-crank.

THE BROADWAY PNEUMATIC TUNNEL, NEW YORK.

(*Illustrated on pp.* 36 *and* 37.)

WE give a series of engravings illustrating the progress and completed appearance of the pneumatic tunnel now nearly completed in New York.



The tunnel commences at the corner of Broadway and Warren-street. The portal of the tunnel, as shown in our engraving, is a massive ornamental structure, of circular form, nine feet in diameter, its bed twenty-one and a half feet below the surface of Broadway. The mouth of the tunnel opens directly into a large underground apartment, one hundred and twenty feet in length, fitted up in good style, for the purposes of a waiting and reception station. This apartment is lighted from the pavement, and occupies the entire space under the Warren-street sidewalk. The tunnel starts from the east end of the reception-room, and extends on a curve to the centre of Broadway, thence in a straight line down to a point a little beyond Murray-street, where the shield, or tunnelling machine, now rests. We present two views of the novel mechanism by which the tunnel is bored, one of which shows the workmen engaged in driving the machine ahead; the other a sectional diagram, showing the details of construction. The shield consists of a large cylinder, open at both ends, with shelves arranged within the front end to receive the earth and prevent it from falling too rapidly into the shield; at the rear of the latter, placed around its periphery, is a series of *powerful* hydraulic rams, eighteen in number, *all connected* with a single water-pump. From the rear of the shield, and passing entirely around it, extends a hoop or band of sheet steel, two feet wide, and one-eighth of an inch thick, termed the hood. The brick tunnel is erected within this hood, which at all times covers the end of the masonry, and prevents the earth from falling upon the workmen. After a section of the tunnel sixteen inches long has been erected within the hood, the pump is operated, which causes the rams to slide out from the shield and push with great force against the front edge of the tunnel, driving the shield forward into the soil. As the shield advances, the earth presses through between the shelves, and falls down upon the bottom of the shield, whence it is removed in barrows and cars. As soon as the shield has been advanced sixteen inches its movement is stopped and a new section of the masonry tunnel is erected within the hood. The shield is then again pushed forward, and so on. By means of this machine tunnels of all kinds and sizes may be quickly constructed under the streets, without disturbing the travel of vehicles over the surface. The shield may be readily moved around circles or on grades. It was designed by Mr. A. E. Beach, of the *Scientific American*.

In the pneumatic system the cars are propelled wholly by atmospheric pressure. One of our engravings gives a view of the interior monster blowing engine used by the Pneumatic Transit Company for this purpose. Its shell (A) is 21½ft. high, 18ft. long, and 13ft. broad. It contains two pairs of wings or blades (B), which roll together in such a manner as to exhaust and compress an immense quantity of air at every revolution. The machine is made on Root's patent, and is by far the largest of its kind. It has capacity for delivering about two hundred thousand cubic feet of air per minute.

ON THE PHENOMENA OF COMBUSTION.

SPECIAL REPORT.

DR. BENJAMIN PAUL, F.C.S., delivered his third lecture on this subject in the Lecture Room of the Society of Arts, John-street, Adelphi, on Monday evening last, to a large audience.

2nd. The condensed gas gives a well-defined and brilliant spectrum, and when the current is of sufficient intensity and the gas is one, such as chlorine or nitrogen, which gives a double spectrum, both spectra may be observed, the one in that part of the tube opposite to the magnetic poles being more intense than that in the main body of the tube. It is considered as proved that the double spectrum is due to a difference of temperature, and not to impurity of the gas, as was supposed by M. Dubrumfant. A very striking result was presented by the hydrogen tube. In this the light brought under magnetic influence became of a bright yellow colour, while the other part was of a magnificent roseate tint, the blending of the two colours strongly resembling in their shades the solar protuberances (red flames) of the eclipse of 1860. The experimentalists think this effect partially due to the decomposition of the glass under the great heat of the current.

Father Secchi suggests that a simple solution of the phenomena observed may be summed up thus. Magnetism acts as though it contracted the bore of the tubes, and by producing an elevated temperature causes the gas to give a spectrum similar to that which would be given in a tube of small capacity, and so it may be ascribed to diamagnetism. In conclusion, he says it is impossible to observe these phenomena without comparing them with the magnificent phenomena of the solar chromosphere, and thinks that by similar experiments it may be possible to carry the analogy farther.

G. M. W.

[We are indebted for the above communication to G. M. Whipple, Esq., of the Kew Observatory. In regard to the first class mentioned, we showed precisely similar results in 1856 to Faraday. We produced the vacuum in an ordinary barometer tube, 36in. long, in the top of which a platinum wire was soldered, the mercury serving as the other conductor from a Rhumkorf. Faraday exhibited the experiment at a subsequent Friday evening's meeting at the Royal Institution, while lecturing on the induction coil.—Ed. *E. T. and R. R.*]—*Electric Telegraph and Railway Review.*

ASTRONOMICAL NOTES FOR APRIL.

BY A FELLOW OF THE ROYAL ASTRONOMICAL SOCIETY.

THE Right Ascension of the Sun on the 1st of April will be 0h. 42m. 31s., and his North Declination 4° 34′ 30″. He will, therefore, be close to δ Piscium; and reference to our maps on p. 64, will show what constellations will in consequence be lost in his rays, and therefore invisible. The Equation of time to be added to the instant indicated by a sundial, will on the 1st day of the month be 3m. 56s. It will diminish until the 15th, when there will be no Equation at all; the clock and dial being coincident. After this the Sun will south before mean noon, or the Equation will become subtractive, and on the 30th, 2m. 55s. must be taken from the instant of apparent noon to obtain the time, which a properly regulated clock ought to show. The Sun is now longer above the horizon, in these latitudes, than he is beneath it; the length of the day at the beginning of April being 12h. 53m., and on the last day of the month 14h. 42m.

The Moon enters her First quarter at 25 and a half minutes past 4 a.m. on the 9th; is Full at 10h. 26m. on the night of the 15th, when, as she will be in Perigee, or at her nearest to the Earth, about half an hour afterwards, a high tide may be looked for: She will enter her Last Quarter at 4h. 25m. on the afternoon of the 22nd: and be New at 6h. 37m. on that of the 30th. The Moon will be in conjunction with Jupiter at 49 minutes past 10 on the morning of the 4th: in conjunction with Uranus at 2h. 38m. in the early morning of the ninth: in conjunction with Saturn at 3h. 40m. a.m. on the 20th: in conjunction with Venus at 9h. 53m. am. on the 26th: and finally with Mars at 4h. 10m. on the afternoon of the 9th. Practically the first and two last of these conjunctions will be invisible. During this month Five Fixed Stars, and the Planet Saturn will be occulted. At 1h. 47m. in the early morning of the 9th, 56 Geminorum will disappear at the Moon's dark limb; and re-appear at her bright limb at 1h. 59m. At 2h. 15m. a.m. on the 12th, 34 Leonis will disappear at the dark limb; to re-appear again at the bright one at 4 minutes past 3. At 48 minutes after midnight on the 13th, *b* Virginis will be occulted by the Moon's dark limb, and emerge from her bright limb at 2 minutes past 1. The bright limb of the moon will occult θ Libræ at 12h. 16m. on the night of the 17th, and at 6 minutes past 1 it will re-appear from the dark one. The occultation of Saturn will take place during the early morning of the 20th. The planet will disappear at the bright limb at 2h. 55m., and re-appear at the dark one at 4h. 5m. Lastly, γ^3 Sagittarii will be occulted by the Moon before she rises after midnight on the 24th; but, after she has risen, will re-appear from her dark limb at 6 minutes past 1. The Moon's age on the 1st, at noon, is 0·4 days; She is 1·4 days old at noon on the 2nd, and so on. At 9 o'clock in the evening of the 9th, Libration will bring a portion of the S.E. part of her disc into view; while at midnight on the 21st an additional portion of the surface in the S.W. quadrant will become visible from the same cause. These details, as has been before explained, are given to facilitate the observation of the various features of the Lunar surface.

Mercury is practically invisible during the first two-thirds of April; but becomes an evening Star, and may be looked for towards the end of it. During the las two or three days, he may be seen glittering close to the horizon, to the North of West after Sunset. Venus is a morning Star during the entire month. Southing at 9h. 31m. a.m. on the 1st, and at 9h. 5m. a.m. on the 30th. She is still a fine telescopic object, albeit the difference in the thickness of her crescent is very marked when contrasted with the extraordinary tenuity which it exhibited in February. Mars is still too close to the Sun to be visible. Jupiter is now visibly creeping towards the West. It is on the Meridian at 3h. 38m. on the 1st, and at 1h. 10m. in the afternoon on the 30th. We shall soon be losing him as a conspicuous celestial object, for the season. He remains in Taurus during the entire month. Saturn is a morning Star until the 19th, after which he rises before midnight: he is, however, close to the horizon, and wretchedly situated for observation. He is on the confines of Sagittarius. Uranus may still be observed before midnight; his position is Gemini has not sensibly altered from that laid down in our little map on p. 470. Neptune is now invisible, in fact he is actually in conjunction with the Sun about 8 o'clock in the morning of the 9th.

The Phenomena exhibited Jupiter's Satellites are very much fewer, the Planet's approach to the Sun interfering materially with their visibility. On the night of April 1st there will be a transit of the 1st Satellite. It will enter on to Jupiter's disc at 9h. 7m. On the 2nd the 1st Satellite will re-appear from Eclipse at 9h. 29m. 52s., but Jupiter will be very low down. The shadow of the same Satellite will pass off the Planet's limb at 6h. 41m. on the next evening: the Sun, however, will only *just* have set at the time. Strong twilight may also prevent the Emersion of the 3rd Satellite from Eclipse at 7h. 19m. 59s. on the evening of the 4th from being observed. On the 5th the Ingress of the Shadow of the 2nd Satilite will take place at 7h. 30m. The Satellite itself will pass off at the opposite limb at 8h. 20m., and its shadow *may* probably be seen to follow it at 9h. 55m., but Jupiter will then be on the Point of setting. On the 9th, Satellite 1 will be occulted at 8h. 30m. On the 10th the same Satellite will leave Jupiter's disc at 7h. 52m., to be followed by its shadow at 8h. 36m. On the 11th the 3rd Satellite will re-appear from occultation at 8h. 42m., only to be Eclipsed by Jupiter's Shadow at 9h. 29m. 26s. This is only some 18 minutes, though, before he will set. The 2nd Satellite will enter on to the Planet's limb at 8h. 42m. on the night of the 12th. On the Evening of the 17th there will be a transit of the 1st Satellite. It will pass on to Jupiter's disc at 7h. 40m., and its shadow will come after it at 8h. 18m. The first Satellite may also be seen in the twilight to re-appear from Eclipse at 7h. 49m. 16s. on the evening of the 18th. Five minutes before Jupiter sets—viz., at 9h. 15m. 33s. on the night of the 21st, the 2nd Satellite will re-appear from Eclipse. The 2nd Satellite will be occulted at 8h. 34m. on the 28th, or on the succeeding Evening, the 29th, the ingress of the shadow of the 3rd will take place at 7h. 26m.: the egress of the Satellite itself occurring at 7h. 56m. We should perhaps add, that as many of the phenomena, which we have included in the foregoing list will take place in strong twilight, or when the planet is almost close to the horizon, it will require a good telescope to observe them: even assuming, what is problematical, that such an instrument will render all of them visible.

There would seem to be some reason to expect Shooting Stars in April, during two intervals; the first between the 4th and the 11th: the second between the 17th and 25th of the month. Watch should, therefore, be kept about these dates.

CONSUMPTION OF FROGS IN FRANCE.—The *Echo du Luxembourg* states that the exportation of frogs from that country to France has increased considerably of late. Upwards of 200,000 were sent in three weeks by one dealer, and on one day 30,000 were sent by the same person. They are sent principally to Rheims, Nancy, and Paris. A thousand frogs fetch 13 francs (10s. 5d.), and weigh 50 kils., or about one cwt. No duty is charged by the French Custom-house on frogs. At Rheims, 25 pairs of frogs' legs can be bought for 60 centimes. The autumn and spring are the best times of the year for frogs.

COMPOSITIONS FOR THE BOTTOMS OF VESSELS.—Mr. Gibbs, of Milton-street, City, proposes to coat the bottoms of iron vessels, to preserve them from fouling by the employment of a mixture of tallow, or other greasy or fatty matters and resin, to which is added a saturated solution of sulphur (in caustic or carbonate alkali or lime), in which copper has also been previously dissolved. The compositions are prepared by the agency of heat or otherwise, and they are to be applied hot to the ships or vessels by means of a brush. The composition is prepared by taking sulphur, such as is known in commerce under that term in the proportion of 17lb. to 52lb. of potash leys of 35deg. strength, and 1lb. of pieces or plates of copper, which are all mixed together in a vessel heated by steam or otherwise, the heat being kept up until the sulphur and copper are thoroughly dissolved. In another vessel, heated in like manner as aforesaid, is mixed tallow in the proportion of 7½cwt. to 1½cwt. of resin or resin oil, and the heat is to be kept up until the mixture is well liquefied. The two mixtures thus separately prepared are to be mixed together and thoroughly amalgamated by agitation in the heating vessels.

LETTERS TO THE EDITOR.

[We do not hold ourselves responsible for the opinions of our correspondents. The EDITOR respectfully requests that all communications should be drawn up as briefly as possible.]

*** All communications should be addressed to the EDITOR of the ENGLISH MECHANIC, 31, Tavistock-street, Covent Garden, W.C.

All cheques and Post Office Orders to be made payable to J. PASSMORE EDWARDS.

I would have every one write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that, as to other things, knows no more than what everybody does, and yet to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks: a vice from whence great inconveniences derive their original.—*Montaigne's Essays.*

THE TELESCOPE, &c.

SIR,—"J.T." p. 640 says: "it requires at least a 6″ (meaning, I assume a 6in) refracter to see the Satellites of Uranus." Will he kindly tell me where there is a 7in. in England which will show the two brighter ones; or an 8in. that will exhibit all four of these Moons? The possessors of such instruments should, if they be readers of THE ENGLISH MECHANIC, in the interests of science publish the names and addresses of their makers in your columns.

In answer to "Jupiter," (2039), p. 642, the cheapest form of Equatoreal with which I am acquainted is the invention of a Mr. Vallance, and is described with engravings, at p. 304 of your second volume, (No. 52). A much more elaborate one is figured on p. 284, Vol. 8 of THE ENGLISH MECHANIC, (No. 195); and this latter possesses the advantage of adjustability to different latitudes; or is of the form known as the "universal equatoreal." The tripod stand shown in your engraving, though, should be carefully eschewed, as vibration, greater or less, will take place with the best possible wooden legged support. A brick or stone pier is the only legitimate one. Horne and Thornthwaite, the opticians, of Newgate-street, London, make a cheap and efficient mounting on this principle. If, however, "Jupiter" seeks excellence and not merely low cost, I have no hesitation in saying that the most perfect form of Equatoreal extant is that of Cooke and Sons, of York. A Dallmeyer object glass on a Cooke mounting would be the very luxury of observational astronomy.

I am unaware that I ever promised to *do more than* examine the region round about *Mizar and Alcor.* I am very certain that I never set *myself the dreary* and difficult task of gauging the *magnitude of every* point of light I might pick up. However, as a matter of fact, the weather has been so wretchedly bad for the last month or two, as quite to put a stop to mere star gazing. If your correspondent will ensure me a night at once moonless and cloudless, and state in your columns for what date he has secured it, I will devote that night to his interests.

Apropos of the 3in. telescope which showed Jupiter's Satellites before sunset on the 26th of last February, I may observe that its definition must be remarkably sharp, as must also your correspondent's eye; and further, that the air must have been exceptionally clear on the occasion to which he refers. The instrument of which he speaks could shew Polaris (a 2nd magnitude star) at 2 p.m. on a sunny day, were the air tolerably free from vapour, but then, as he knows, the Pole Star is in the least illuminated part of the sky. I question extremely if he could pick up a 3rd magnitude star in any portion of the Heavens under the circumstances specified.

The "Irish Mechanic" (208), p. 660, will find that 2in. is the minimum aperture of a telescope with which he can hope to do any good whatever in astronomical observation; and the range of this is very limited indeed.

"A Poor Lad" (2140), p. 21, should, by all means, expend his £2 in the purchase of a 5in. speculum. Assuming it to be properly parabolised, it would be equal in separating power to an achromatic of the same aperture, *i.e.*, would divide double stars 0″·87 apart; while, according to Browning's formula, its light-grasping power would be equal to that of an object glass of about 4·2in. in diameter. A 2¼in. object glass could not possibly divorce anything closer than a pair of stars 2″·5 distant from each other, and a standard 11th magnitude star would be its minimum visible, while with a 5in. speculum your correspondent would see those of the 12·3 magnitude.

"H. F." (2199), p. 22, should read Vols. VIII. and IX. of the ENGLISH MECHANIC.

"Ethardo" (2221), same page, has only to push in the eye tube of any telescope sufficiently beyond the point of adjustment for ordinary sight, to suit his own.

If "Neptune" (2224), has been a subscriber to the ENGLISH MECHANIC for any length of time, he must know that I have, over and over again, declined to solve Equations, or, in fact, to execute any merely mechanical computation, or "do sums" in any shape or way. But, even if I made an exception in his favour, I could not do it with the data which he gives. There is not a single syllable about the refractive or dispersive indices of the crown and flint glasses that he proposes to use. The sole item of information is confined to the assertion that he means to use a crown lens of 6ft. 10in. focal length. Now, if he has got hold of two of Chance's discs of glass, of which the dispersive powers are, probably, somewhere about ·055 for the flint, and ·069 for the crown, I do not see how he can possibly achromatise such crown (assuming its focus to be 6ft. 10in.) without combining it with a flint one of about 9ft. 8in. focal length; which would cause the joint focus to approach to some 23ft., or 8ft. longer than he seeks to obtain. This is the result of the very roughest conceivable calculation on the margin of my writing paper, and has no pretension to be considered rigidly accurate through.

If "Neptune" will get "Coddington's Optics," can use a table of logarithms, and will, first and foremost, determine the refractive and dispersive powers of the materials he proposes to work with, he ought to have no very hard task in getting out the curves for himself. It is not so much a *difficult* calculation, as a long and very dreary one.

A Fellow of the Royal Astronomical Society.

DEPRECATORY AND EXPLANATORY.

Sir,—Boswell records of Doctor Johnson that "A lady once asked him how he came to define *Pastern* the knee of a horse? Instead of making an elaborate defence, as she expected, he at once answered "Ignorance, Madam, pure ignorance." May I be allowed to vindicate myself in the same way with reference to the charge brought against me on p. 655 by "Omicron" of joking at his expense? D'Arrest's comet I did know; the name of the computer of its Ephemeris I did not know. I was thankful to "Omicron" for the offer of what I know would be useful to a considerable number of observers, and I took (what I believed to be) his spelling on trust. *Hinc illæ lachrymæ.*

If it will afford Mr. Proctor the very smallest satisfaction I will confess that I think it extremely likely that I was wrong in my conjecture as to the possible mode of action of an object glass of large aperture in rendering solar detail visible; but at the same time I must assure him that it was not to escape making this admission that I terminated the discussion, as far as I was concerned. To render myself amenable to the charge of ceasing to argue when I find argument going against me, I ought, as it seems to me, to continue to argue when I am on the winning side; whereas it is notorious to every one of my brother readers of the English Mechanic, that I have eschewed discussion *ab initio*, on every moot point whatever. I have in the outset, said my say, and if ever a second letter from me has appeared on the same subject, it has been merely explanatory, or to remove some misconception of my meaning. I suppose that there are very few men of science who would value, or defer to, Mr. Proctor's opinion more than I should; but even such deference and appreciation would not prompt me to crumple up a polemical pewter pot merely that I might figure among Mr. Proctor's "strong men."

A Fellow of the Royal Astronomical Society.

LIGHT.

Sir,—The following table will probably meet the requirements of Mr. A. J. Smart (2064) p. 642.

Colours.	Length of Undulations in parts of an inch.	Number of Undulations in an inch	Number of Undulations per second.
Extreme Red	0·0000266	37640	458,000000,000000
Red	0·0000256	39180	477,000000,000000
Orange ..	0·0000240	41610	506,000000,000000
Yellow ..	0·0000227	44000	535,000000,000000
Green ..	0·0000211	47460	577,000000,000000
Blue	0·0000196	51110	622,000000,000000
Indigo ..	0·0000185	54070	658,000000,000000
Violet ..	0·0000174	57490	699,000000,000000
Extr. Violet	0·0000167	59750	727,000000,000000

With reference to the request of "T. A." on p. 658, I must regret my inability to make even a guess worth listening to, as to the reason why the more refrangible rays of the spectrum are absent at times from the light of the sky. I have myself noticed when photographing, that the time of exposure which sufficed on one day was wholly insufficient on another; but, inasmuch as this deficiency of actinism seems to follow no law, I was always content to recognise it as a fact, without attempting to account for it.

A Fellow of the Royal Astronomical Society.

THE "NAUTICAL ALMANAC" AND "F.R.A.S."

Sir,—I freely admit, *in limine*, the correctness of the assertion of "W. E. P.," p. 14, that, "It is the duty of computers attached to that (the 'Nautical Almanac') establishment to use, and not to form tables." The Superintendent of the "Nautical Almanac," as such, is by no means bound to make his own. All he has to do is to see that the computations executed by the aid of those supplied to him are correct; and that Mr. Hind does this, and does it with the very utmost efficiency, no one is readier to allow than I am.

The question, however, is a little wider than this. Surely your correspondent does not mean to contend that a mass of observations of Jupiter's Satellites has not accumulated which would have sufficed, a long time since, to have formed the basis of new and improved tables? Suppose that a man had, in the year 1820, gone up the top of S. Paul's Cathedral in London, and had taken a series of horizontal angles subtended by the various visible church spires. Suppose, further, that year after year he published his results to the decimal of a second of arc, admitting candidly all the time that his theodolite was so abominably centered and badly divided that it could not be depended upon to read within 3 degrees! Assuming this, I say, should we not be a little disposed to laugh at our hypothetical observer, when, in this Year of Grace 1870, he defended the publication of such admittedly erroneous results on the ground that they might some day prove of the greatest use, in correcting the theory of instrumental construction and adjustments? I wonder what Sir Henry James would say if he were restricted to such materials and ordered to make a map of London from them; and whether he would be contented with them on the ground that they might possibly be useful in so remote a contingency?

There is a popular superstition that the materials for the use of the computers of the "Nautical Almanac" are supplied by the Royal Observatory at Greenwich. Is the theory of the Jovian System beneath the notice of that August Establishment; or do the Heads of it consider that (as the servants say) "it is not their place" to help to remove, what I must persist in considering to be, a blot from our National Ephemeris? I fear that we have here only another illustration of the truth of the old proverb, that, "What is everybody's business, is nobody's business."

I suspect, however, that, after all, it is merely a question of money. Tables are somewhat costly, and until public opinion is brought to bear very much more directly upon the heads of the State than it is now, there will always be great difficulty in getting pecuniary aid from the Exchequer for anything, the use of which does not appeal immediately to the official mind. As far as the immediate object of this discussion is concerned, though, the abolition of a single embassy to one of the beggarly little German Courts would pay for the tables demanded at once. The first year's salaries of the well-bred hangers on who idle there at the Public Cost, would more than suffice to secure us trustworthy data to eliminate a glaring disfigurement from what is, otherwise, a perfect marvel of accuracy.

A Fellow of the Royal Astronomical Society.

THE BELTS OF JUPITER, &c.

Sir,—Many thanks to Mr. Proctor and "F.R.A.S.," for their answers to my question on the above subject, and particularly to Mr. Denning, whose concise and appropriate letter (page 655), is all that could be desired. I regret that I cannot say so much for Mr. Grover's letter (on the same page), and had he given the same attention to my remarks that he supposes I have failed to give to Mr. Browning's remarks in the *Student*, Mr. G.'s letter might have been more to the point; as it is, he makes the question (if I understand him rightly) a question of *chromaticity*, instead of one of *relative luminosity*. In my letter I purposely avoided the word *colour*, to prevent misconception, but as Mr. Grover's letter is almost exclusively on colour, it fails, so far, to touch the question. Lest, however, his remarks should be considered by some of your readers to be a satisfactory answer to the question in hand, I cannot allow them to pass unnoticed. In the first place, there can be no doubt that large apertures, combined with high powers, are necessary to bring out delicate gradations of colour or chromaticity; but the same rule, I imagine, does not apply to the broad masses of *light* and *shade*. As an instance of this, I may mention that when using a 3in refractor, by Wray, simultaneously with my 9in. reflector, the dark belts have appeared much darker with 3in. than with 9in. aperture, notwithstanding the advantage which the reflector possessed over the other in point of definition, and a precisely similar effect was produced by diminishing the aperture of the mirror. Just in proportion as this diluted the brilliancy of the bright belts, so it rendered the dark belts still darker, and thus the same *relative* contrast between the light and dark belts remained unchanged, whatever aperture was used; and more than this, when the air has been unsteady, I have always found the belts more positive and conspicuous with a small, than with a large aperture. I cannot quite agree with Mr. Grover's opinion that no pigments or materials with which we are acquainted can be made to accurately represent the differences which do exist; and yet he has just admitted that "Mr. Browning's drawing is too vivid in colour." Perhaps Mr. Grover can throw a little more light upon this apparent paradox. In the meanwhile, my humble opinion is, that at the period at which Mr. Browning's drawing was taken, Jupiter appeared even *more vivid* than the engraving in the *Student*, and I cannot, for my own part, see the slightest difficulty in finding pigments that would have exactly expressed this brilliancy, without the heaviness and opacity which now exist in the engraving, and which fault, I cannot but think, is more the result of accident than of any error in the *original drawing*. Again, the final paragraph in Mr. Grover's letter will not bear criticism, for if delicate gradation of shade require to be so much exaggerated to give sufficient intensity to the lights, how is it that artists are able to give in a painting the relative degrees of light, shade, and perspective to the clouds of a summer sky, and yet preserve throughout such a glowing luminosity as to far exceed the brightest tints of the landscape? Unfortunately for the science of astronomy, it would seem that but few skilful draughtsmen enlist their talents in her service, and so difficulties are made of things which ought to be comparatively easy; if, however, we are yet to gain any further knowledge of the physical constitution of these remote worlds, it can only be by scrupulous accuracy in observation, delineation, and description, and anything emanating from so good an authority as Mr. Browning certainly *deserves* criticism, and that is far more than can be said of the miserable attempts at planetary drawing which too often find their way into public journals and treatises on astronomy.

In answer to the question by "Iota" (page 22), I may tell him the announcement by Mr. Wray as to the separation of the close pair γ^2 Andromedæ, by Mr. Buckingham's refractor, was made in the "Astronomical Register" for September, 1867 (page 201), and as he speaks of the glass being "just finished," the observation referred to must then have been quite recent. The central distance between the components of this pair is commonly estimated at half a second. The late Mr. Dawes' measure in 1863, was 0"·59; most observers agree as to its being rather over half a second, although Mr. Browning, in his "Plea," says it is under half a second. At any rate, the discrepancies are not great. I believe the two stars still keep about the same distance, no widening having been as yet observed.

With regard to Andrew Johnson's inquiries on page 21, I should recommend him to read a little more on the subject, from some good treatise, such as "Herschel on the Telescope;" as his questions at present evidently show he needs more information than space will permit in the pages of the Mechanic; for although four words would suffice to answer his questions, I fear the information would not be of much service to him.

W. Purkiss.

THE SUPPOSED PLANET, VULCAN.

Sir,—Some of your readers may be interested in learning that another systematic search for the suspected intra-mercurial planet, Vulcan, commenced on March 20. There will be about twenty-five gentlemen engaged in the affair, many of whom are in the possession of very powerful telescopes. The observations will extend over the period from March 20 to April 10. During this time the solar discs will be continually under observation when visible. The following are the names of observers, together with a description of the telescopes employed and the times of observation:—

Observer.	Place.	Telescope.	Time of Observation.
Albert P. Holden	London	3in. refractor	sunrise to 7.30 a.m.
John Watson, F.R.A.S. ..	Sunderland ...	5½ and 5½in. refractors	7. 0 to 8. 0 a.m.
T. W. Backhouse	Sunderland	4½in. refractor	7.30 to 8. 0 "
T. P. Barkas, F.G.S.	Newcastle-on-Tyne ...	3in. refractor	8. 0 to 9. 0 "
H. W. Hollis, F.R.A.S. ..	Newcastle ...	12in. reflctr., 6in. refrctr.	8.30 to 10. 0 "
J. R. Bridson	Bolton le Moors ...	6½in. refractor	9. 0 to 10. 0 "
Philip Vallance	Hurstpierpoint ...	12in. reflctr., 6in. refrctr.	9. 0 to 10. 0 "
W. R. Birt, F.R.A.S.... ..	London	2½in. refractor	at 10 and 1
George J. Walker	Teignmouth	— refractor	10. 0 to 11. 0 a.m.
E. B. Knobel	Burton-on-Trent ...	3in. refractor	11 to 12
James Cook	Preston	10in. reflector	12 to 1 and 3 to 4 p.m.
Rev. J. Parkes, F.R.A.S. ..	Banbury...	8½in. reflector	12. 0 to 1. 0 p.m.
John Tuck	Romsey	6½in. reflector	12.30 to 1.30 "
Henry Ormesher	Manchester ...	5½in. refractor	1.30 to 2.30 "
Rev. R. J. Gould	Reading	5in. refractor	1.30 to 2.30 "
Thomas Wilson	Skipton	4½in. refractor	2. 0 to 3. 0 "
S. Chick	Sidmouth	3 $\frac{7}{10}$ in. refractor	2. 0 to 3. 0 "
T. G. G. Elger	Bedford	4 in refractor	3. 0 to 4. 0 "
W. J. H. Beechey	Bracknell	3½in. refractor 6½in. reflector	4. 0 to 5. 0 "
William F. Denning	Bristol	10½ in. reflector 3in. refractor	5.30 to sunset

There are several gentlemen who intend making solar observations at irregular times. These include J. Birmingham, Tuam; Henry Pratt, Brighton; Edmund Neison, London; Capt. H. Chichester, Fartown, Huddersfield; H. M. Whittey, Penarth; and A. W. Blacklock, of Manchester.

Should a transit of the suspected planet occur, the position of its path across the solar disc, the time occupied in the transit, and its apparent diameter will be carefully noted. If the observer possess micrometric apparatus, measures of its position on the disc will also be made.

The fact that the period of maximum frequency of the solar spots has arrived will give additional interest to the observations. I will duly report to you particulars of the result.

William F. Denning, Hon. Sec. Observing Astronomical Society.

POISONOUS POSTAGE STAMPS.

Sir,—With reference to Mr. Denroy, I cannot help thinking that his friend's illness was not caused by the composition on the *back* of the stamps, which consists only of dextrine, or starch-gum; and so far from being unwholesome, is actually nutritious. It is far more likely to have been caused by some of the red colouring matter, which so easily comes off. In wetting a quantity of stamps, some portion, more or less, would probably be swallowed. By the way, do you suppose it is generally known that penny and twopenny stamps cost more to print than the higher-priced and more elegant varieties, the former being copper-plate printed and the latter surface printed. This seems a curious anomaly. Let me thank several who have answered queries of mine lately, and congratulate you on the improved form of our Mechanic.

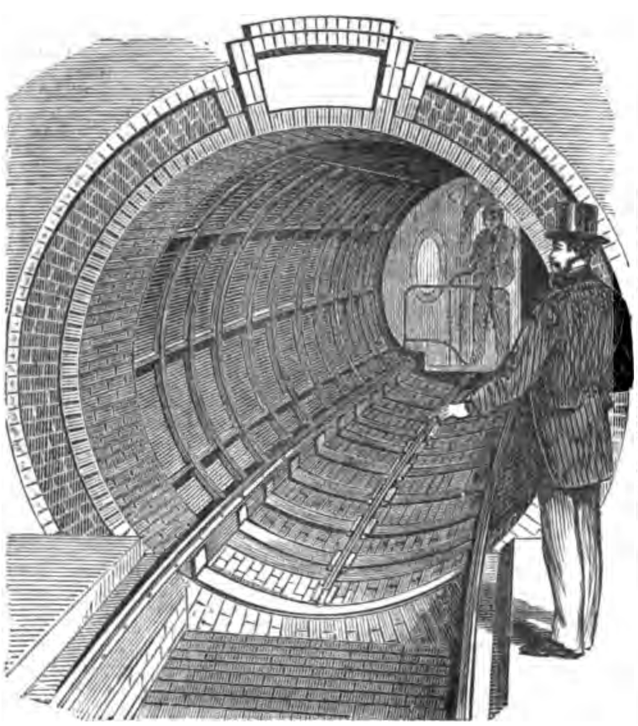
A. S. C.

EQUATION.

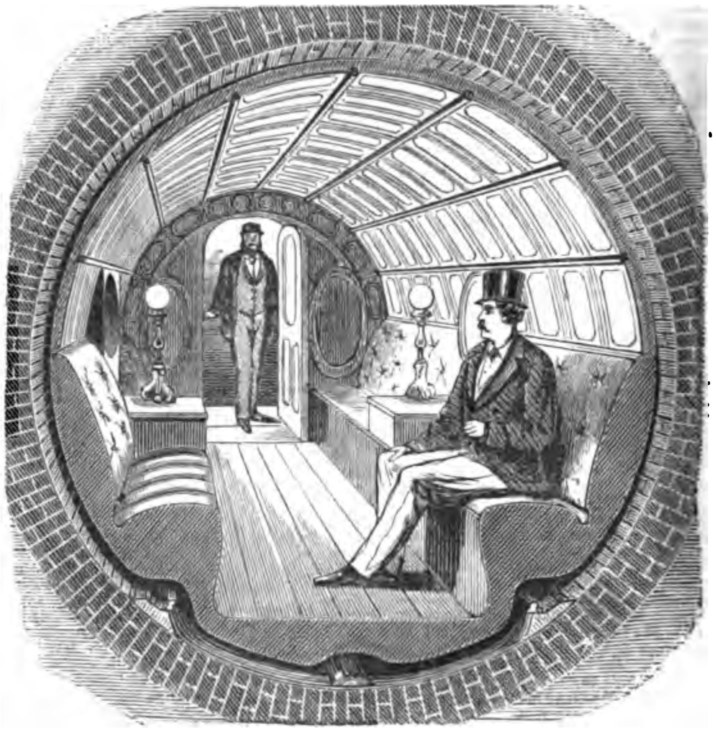
Sir,—"Hugo" rightly complains of my slip in not putting signs, but he has in the latter part of his letter overlooked the fact that I have not taken the square root, or why do I use the sign $\sqrt{}$? As an excuse for carelessness I must plead illness. I sent a solution to the problem without revision, as I could scarcely bear to look at a paper, and hence this confusion. If "Hugo" will kindly wait a little, he shall have my ideas upon algebra.

C. H. W. B.

THE BROADWAY PNEUMATIC TUNNEL, NEW YORK.—(Described on page 32.)



ENTRANCE TO TUNNEL, WITH PASSENGER CAR COMING IN.



INTERIOR OF PASSENGER CAR.

TO MILLERS.

Sir,—I am a miller of 24 years' standing, and do not remember that I ever met with a scientific correspondence between men of my trade until I saw it in your **Mechanic**.

With your permission I will make a few remarks on some of the assertions of your "dusty" correspondents. I am not too old to learn, and if I get hold of an idea that is erroneous I am thankful for correction.

J. Sharp says, in No. 258: "As to stones working well when out of standing balance, it only proves the stones are in running balance." I ask him kindly to explain, as I have a notion that if the face of a pair of stones is true, the bedstone level, the driving irons and pitch of cogs of both driver and pinion correct, a standing and running balance are the same. My stones are balanced by Clarke and Durham's patent balance, and I have invariably found irons, face, &c., correct, after I had given them a perfect standing balance; the running balance was exactly the same. This I prove not only with a twig or chip, but I place a gas jet on one side of the stones when running, and go on the opposite side and look between them, when if there is the slightest variation in the face it may be seen.

But I have one pair of stones on faulty universal irons, and on them I find a standing and running balance are not the same; from which I infer that if the above conditions are observed, a standing balance will suffice. A boy's top, when not truly turned, or with a crooked peg, would scarcely spin upright.

If my memory does not deceive me, I saw, about ten years since, an advertisement of the "patent balance," and to me it conveyed the idea that millers were at a loss to account for their stones dragging when at work, and the "patent balance" professed to remove the evil. It is true many millers cannot account for it, looking only to the face of the stones for the cause, and forgetting irons, level, cogs, &c. This has often come under my notice, and surprised me. When I first saw the above advertisement, I said, "If a stone will balance standing, it will running," and I am still of the same opinion, after seven years' experience with the "patent balance."

Probably "Cumberland John" may glean a hint from the above.

With reference to Mr. Lomax's "Improvements in Driving Millstones" (No. 259), I cannot help but think it must be a great nuisance when taking out of or putting into gear the stones. I thought the fly-wheel was intended to keep the engine steady; if not, millers should take the hint, and take care their engine has two cylinders. "Prevention is better than cure."

A Stoneman.

Sir,—In answer to G. Scott's queries, I beg to say that a pair of 4ft. French burr mill-stones (close), with 12 master furrows 2¼in. behind the centre, and two short furrows to each, ought to grind 16 stones per hour, going at 130 revolutions per minute. But the quantity depends upon the quality and condition of the wheat, and whether ground "high" or "close," and also if the exhaust is used. With respect to the wire machine, there ought to be 8 brushes in a 20in. cylinder going at 400 per minute; but the number of brushes is only a question of speed. I had a wire machine at work about ten years ago; it was 6ft. long by 20in. diameter, with 8 brushes; it had 4in. to the foot fall (some machines have more); it made 400 revolutions per minute, and dressed 6sks. of 20 stone each per hour. There were only 3½ sheets of wire for fine flour, the rest was covered for white, grey, and brown sharps; the bran went through the end.

If Mr. G. Scott is making improvements in his mill, why does he retain the wire machine? I don't think there are half a dozen wire machines in Ireland; and if he has "plenty of power," why not get 4ft. 4in. stones? If he prefers the wire machine, I think I could give him and others interested in the matter some assistance in erecting one.

J. Sharpe, Mount Down Mills, Templeogue, Co. Dublin.

MILK.

Sir,—Milk being an important article of diet, a few remarks upon its nature and adulterations may not be out of place.

Milk consists of water holding in solution *casein* or *cheese*, *sugar*, and *various salts*, and in suspension, *fatty matter*, in the form of numerous semi-opaque globules which give the colour and opacity to the fluid.

FIG. 2.

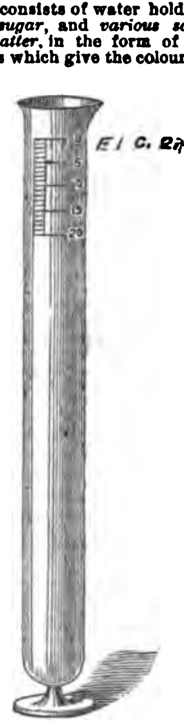
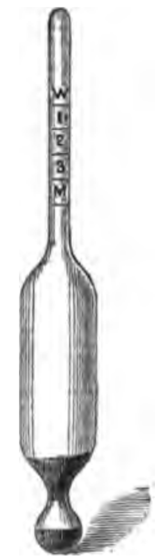


FIG. 1.



Under the microscope it is seen to consist of oil globules of various sizes floating in a transparent fluid called serum or whey.

Its composition varies considerably, being influenced by the following circumstances:—The age and condition of the cow, the time and frequency of milking, the quality of the food supplied, the housing, weather, &c. Into these details it is not necessary to enter. The *average* per centage composition of pure milk is as follows:—

Water 86, casein 5, butter 3½, sugar (lactose) 4½, mineral matter 1. The specific gravity is 1·030.

In the above analysis the casein represents the "flesh and force producer," and "force-producers" which develop heat and mechanical force in the system consist of the butter and sugar.

Few articles of consumption are more "doctored" than milk. The principal addition is water, but as this has the effect of giving a "sky-blue" tinge and reducing its flavour, it is necessary to employ correctives in the shape of *treacle* or *sugar* for sweetening, *salt* for flavouring, and *annatto* for colouring.

Chalk, starch, sheep's brains, &c., are said to be also used; but this is very doubtful, as their presence would be betrayed by their insolubility.

The adulteration with water is easily shown by the "Gravity Lactometer." This is an instrument (Fig. 1) about 6in. long, and constructed to float at certain points, according to the quality of the milk. Thus the marking on the stem denotes as follows:—At W the lactometer floats in water; at M in pure milk; at 3, 2, 1, in milk containing respectively *one-fourth*, *one half*, and *three-fourths* water.

Another mode of testing is by ascertaining the quantity of cream yielded. Fig. 2 represents a glass tube about 11in. long, with a foot, and with the two upper inches graduated. The tube is filled up to 0 with the suspected article, and placed aside for twelve hours. The percentage of cream can then be read off. Although the quantity of cream yielded by milk is subject to much variation, yet we ought not to be content with less than *ten* per cent. from good milk.

Both forms of "testers" can be purchased at a small cost of the operative chemists and opticians.

The detection of the other adulterants is attended with some difficulty, and involves an acquaintance with chemistry and the use of the microscope.

Beta.

BUILDING AND STEERING VESSELS.

Sir,—Although "Scrutiny's" query regarding sailing vessels, p. 579, Vol. X., was answered by "Cape Horn" (page 633), yet I think I can offer a few remarks on the subject which may be of use, if not to "Scrutiny," yet to some of your young readers who may have a nautical ambition, and find a difficulty such as "Scrutiny" complains of in his younger days, in getting his "lugger" to behave herself on a wind. We must not "despise the day of small things" in mechanics or nautical science any more than in religion, and therefore I will try to help others who are following the path of inquiry as I have done, from sailing models in the Serpentine some forty years ago, to the handling of Her Majesty's ships of larger tonnage than "Cape Horn" speaks of, but in all of which the same principle is involved, viz., the centre of effort, due of course to the masting and rig of the vessel and trim of the sails set; however correctly this problem may be solved theoretically when the vessel is upright, all is thrown out when the pressure of the wind causes the vessel to heel over, as "Scrutiny" observes, the curve of the lee bow being increased while that at the weather bow is decreased at the float line, causing the vessel to rush up into the wind and requiring, as "Cape Horn" states, a good deal of weather helm to check and overcome; this action of "griping" as it is termed, is common to all rigs and all vessels, from a toy to a firstrate, and it is the perfection of seamanship to so adjust the "centre of effort, or "trim" the sails and hull of the vessel as to reduce this action to the correct proportion; as it is evident that if allowed to exist in excess, the leverage of the rudder surface required to overcome its force will seriously retard the speed and, in a storm, endanger the wringing off the rudder head; while, if it is totally counteracted, so as to cause the vessel to carry (as it is called by seamen) "a slack with loose earth. A 10-horse power engine, weighing eight tons, ran with four waggons attached to it out to a colliery 12 miles from Edinburgh; there received a load amounting, with the four waggons, to 32 tons, making the weight of the whole 40 tons; and then returned up inclines of 1 in 16 to Edinburgh. It wended its way, with its train of 90 feet, with perfect facility through the narrow streets of the old town, which chanced on the occasion to be thronged with vehicles carrying people to some open-air festivity. It turned all manner of sharp corners, ran down the steep hill to Leith, entered a lane, and drove in through the gates of the factory, where it delivered its load. An engine was driven into a newly dug potato field, and there ran about in every direction, leaving the soil quite undisturbed. A 10-horse power engine, drawing a load of 17 tons of pig-iron, was driven along the Granton road at the rate of 8 miles an hour. The same engine was run along the sea sands from Portobello to Joppa, running through the loose, dry sand, over the soft, wet sand, and even through a creek of running water, with as much ease as if it had been driving along a turnpike road. It was driven over long beds of broken flint laid down for road mending, and the motion to those riding on it was as smooth and pleasant as if it had been going over a lawn, while the stones remained quite undepressed. A six-horse power engine, weighing 6 tons, took a load of 34 tons up an incline of 1 in 18. Engines with omnibuses attached to them have run frequently through Edinburgh up the long steep hill from Leith, and up and down the steepest streets of the city, always without a break. Their speed is from eight to ten miles an hour, and some very handsome steam omnibuses are now being constructed on this principle. In Leith the road steamer is constantly employed in conveying marine boilers (weighing 25 tons), marine screws, railway locomotives, and other enormous pieces of machinery to the docks or the railway stations. When harnessed to its load, it is driven straight to its destination without a single stoppage, and without interfering in any way with the street traffic. The road steamer is likewise found to answer admirably in street-rolling, drawing the roller, which is separate, behind it. A road steamer of six-horse power, which belongs to the owner of some very extensive flour-mills, has been running for seven months between Aberdeen and the mills. The distance each way is three miles, and this it accomplishes in an hour. At first it performed four trips a day, but latterly it has been making six, taking a load of ten tons each time. The road over which it travels is perhaps the worst bit of road in the kingdom, being narrow and tortuous, and the gradients for one-half of it varying from 1 in 9 to 1 in 8. Up to this incline of 1 in 8 the road steamer, which weighs six tons, takes in tow a load of ten tons. It may help to realise what 1 in 8 represents, to mention that the steepest gradient in crossing the Simplon is 1 in 13. This engine has already run over 2500 miles, and has carried nearly 8000 tons, running six times daily through the chief streets of a busy city. To prove how incapable the steamer is of injuring the road, various substances, such as bits of coal, potatoes, carrots, &c., have been thrown in its path, and after it had passed over them they have been picked up uncrushed. The india-rubber tires have often been compared to the elephant's foot, with its soft and yielding pad. The road steamer is exceedingly trim and compact. It runs on three wheels, two large ones, and a smaller one in front. The india-rubber tires for the three wheels of a ten-horse power engine weigh 14 cwt. To cast such enormous masses of vulcanised india-rubber was in itself a question demanding no little ingenuity, study, and enterprise. The tires are guarded by flexible shields, formed of open steel bars, which give an excellent "bite" or hold, upon the ground, and while they do not in any way, interfere with the elastic play of the indiarubber, they afford such protection to it as to render it virtually indestructible. The shields, which are removable, are not used for driving over ice or frozen snow, as on such surfaces iron will not bite, and here the india-rubber is of immense advantage, as it runs over them with perfect ease, and without slipping. In running through sand, also, as in Egypt, the shields are entirely dispensed with. These engines are now being built for the most various purposes, both for home and foreign use, and are being sent to the remotest localities. Till within the last few months, the advantages of the road steamer had been regarded as consisting entirely in its carrying powers, but during the past summer a new field of action opened out to it, which eminently enhances its value. The judges of the Royal Highland and Agricultural Society, held on Tuesday, August 17, on a farm at Liberton, near Edinburgh, a trial of the ploughs, reaping and mowing machines, exhibited by them at their last show, and in their presence, and that of a large assemblage of farmers and engineers, the road steamer accomplished what has been so much desired, but had hitherto been considered unattainable—ploughing by direct traction. With two double furrowed ploughs attached to it, it commenced its operations, and without a single hitch, difficulty, or impediment, drew four wide, deep, even furrows. It went straight from one end of the field to the other, then turned far more easily and in less space than the horses were doing, and ploughed its way back again, having on its return journey to plough up a hill with gradients 1 in 12. It was a six-horse power engine, but its strength was greatly in excess of its work, so that it was requisite to keep the furnace door open, and it was evident it would have drawn six furrows instead of four. Occasionally its progress was too rapid to suit the convenience of the ploughman, but a single "woa" from him checked it instantaneously. It was pleasant to contrast the smoothness and ease with which the engine performed its task, with the desperate struggles of the horses ploughing alongside it, through the stiff, heavy soil. The work done by the road steamer was as perfect as work could be, the ploughs being set as deep as possible, and the furrows entirely true and accurate. The surprising capabilities of the road steamer are due to the fact that owing to the india-rubber tires, the wheels do not sink in the least degree on the softest grass land, and at the same time they bite the surface with such extreme tenacity, that not the slightest slip was visible, even when passing up the steepest incline. The engine runs in front of the ploughs on the unploughed land, whereby all possibility of compressing or poaching the soil after it is turned over is avoided, while on the unploughed land no indentation whatever is made, as the soft india-rubber cushions preserve it from all pressure. When the road steamer had completed its work, all present expressed the greatest gratification, and the benefits to be derived by farmers from this new implement were eagerly pointed out. Ploughing by steam has hitherto been so costly a process, that only very large farmers could employ it. The road steamer does not cost a third of the price of the cumbrous engines at present in use, and it, of course, does away, likewise, with the constantly recurring expense of repairing wire ropes and tackle. At first sight it might appear that more power would be consumed by a travelling engine than by an engine which stands in one spot, and works by means of a rope. This, however, is not the case, for the friction of the wire rope and the gear and tackle connected with it consumes more power than is needed to propel the road steamer backwards and forwards over the field. This will be very clear to railway engineers, who know how far more expensive it is to pull a train up an incline by means of a fixed engine and rope, than to draw it up even stiff gradients by a locomotive. But the chief merit of the road steamer to farmers will be that it will allow them to dispense very greatly with horses, which the so-called portable engines do not permit them to do. It is as much as the portable engines can do to move themselves, and even their fuel and water have to be carried for them. The road steamer, on the contrary, runs with the greatest ease over any kind of land, turns in less space than horses, and fetches its own fuel and water. Besides ploughing, it can perform every other farming operation—it can drive the thrashing machine, draw the reaping and mowing machines, bring manure to the fields, and cart the grain to the market, so that, by its adaptability to these various purposes, it will enable farmers to reduce their staff of horses to a *minimum*, which in these days of dear provender, will be counted no light gain.

REPLIES FROM "AN ADEPT."

SIR,—Finding so many inquiries addressed to me by various correspondents, I feel it incumbent upon me to endeavour to reply, although still exceedingly unwell in health. I should advise your correspondent, S. Samuel, No. 2019, page 641, No. 259, to make the series of experimental pipes, as what I have commenced and purpose doing under the section "Pipe Construction" is to place before the amateur the various plans, leaving the selection to the taste of the individual. If the following arrangement will be of use, however, as a guide—being something like the arrangement I should use myself—it is much at your correspondent's service: Swell. Open diapason, principal, hautboy, great, stop diapason, dulciana, flute, fifteenth.

In reply to "M. P. S.," No. 2062, page 613, I should advise him to use 60 valves, such as I have described, not increasing the size, as if that is done the angular motion and consequent loss of wind increases at a disproportionate ratio.

Whilst thanking your correspondent, "C. R. O., Hants," on page 657, for his courtesy, may I venture to inquire if the idea has never struck him of placing the 12 bourdon pedal pipes in *two* rows, the five largest at the back and the remaining seven in front of them? This will answer well, and as he states that depth is not so great an object, I presume it will meet his requirements.

In reply to "W. D.," No. 2154, on page 21 of the last number, he will find the description and figures of the bellows' valves he mentions in my communication on page 212, No. 242; the other inquiries he makes are not in my department, but no doubt some of the skilful writers who grace your columns with their contributions upon the harmonium will afford the requisite information.

I presume your correspondent, "Organine," No. 2190, page 22, is a new subscriber, from the nature of his inquiry. I beg, in reply, to refer him to page 330, No. 223, where he will find I have given, I trust, a full description of what he asks for. AN ADEPT.

MANGANESE BATTERY.

SIR,—With regard to the manganese battery, I may state that I use a saturated solution of common salt in the outer jar; for what is the difference between a saturated solution of chloride of ammonium and a saturated solution of chloride of sodium? The difference is this: chloride of ammonium is 1s. per lb., and chloride of sodium 1d. for 3lb.; and I find that chloride of sodium is equal to chloride of ammonium, and both these solutions are greatly improved by the addition of 3 drops of common hydrochloric acid to the quart of solution. I can say that one quart cell has been in action ten months with a saturated solution of common salt. I have also used these batteries for electroplating, and can therefore recommend them to anyone who wishes a clean, cheap, and efficient battery for all purposes where a constant battery is required. Query: Why should this battery not answer for the electric light? Six quart cells, when connected, intensify fusion and give a powerful flash. The mixture I use in the porous cell is 1lb. of pounded gas carbon and 3lb. of black oxide of manganese. This mixture must be moistened with the saline solution when the battery is first made. A. J. JARMAN, Ramsgate.

ZINC PLANT, *ALIAS* LEAD TREE.

SIR,—I have been much amused by reading in our improved journal sundry recipes for the production of what I have always known as a lead tree, although it now appears under a misnomer—zinc plant. "Ernest" says, use a "feeble" solution of lead; "A. A. A." says, put a "little" sugar of lead in—meaning after the zinc and wire are arranged; "Beta" says, "granulated zinc in a *strong* solution; Henry Chapman does not say whether the solution should be "feeble" or strong; but he alone advises "copper" wire; and likewise says, use a "*small* lump of zinc."

Now, surely *all* these recipes will not grow a "zinc plant" (!) in perfection. I always imagined the *rationale* of this "pleasing ornament" (as the man in the streets says), was that the acetic acid had a greater liking for the zinc than the lead, and so the lead was deposited in flake-like chains suspended from the zinc. So, of course, the smaller the zinc, so much the less the growth of the plant; and the weaker the "solution," the smaller the quantity of lead to be deposited; for when the zinc is all appropriated the excess of acetic acid remains with the lead, and, *per contra*, if the "solution" is exhausted before the zinc is "dead," it is obvious the tree will not be the size it might have been. If my notion is wrong, I will thank our friend "Sigma" to set us right.

SAUL RYMEA.

MEAN DISTANCE OF THE SUN.

SIR,—I was in hopes that some of your qualified correspondents would have answered "Veritas'" queries about the eccentricity of the earth's orbit, &c.

The ·005998 is the fraction between the two distances he gives as the mean and aphelion (p. 529, Vol. X.). The eccentricity is equal to the difference between the mean distance and the perihelion divided by the mean distance, as—

$$\text{Mean dis.} - \text{perih. dis.} = \frac{\text{difference}}{\text{mean dis.}} = \text{Ecctd.}$$

Now the horizontal parallax is stated by Main to be 8″·982; this would give a mean distance of—

91·516 000 miles = to log. 7·961500

Earth's radius vector, Jan. 2 = in perih. „ 9·992660

Miles 89·983·000 = perihelion distance .. „ 7·954160

$$\left.\begin{array}{l}\text{Mean } 91{\cdot}516{\cdot}000\\ \text{Perih. } 89{\cdot}983{\cdot}000\end{array}\right\}\ \text{diff.} = 1{\cdot}533{\cdot}000 \text{ miles.}$$

Then diff. divided by mean dis.

Log. of diff. = 0·185542

„ mean = − 7·961500

0·01675 = eccentricity 2·224042

$$\text{Sun's distance} = \frac{R\ 206264''{\cdot}8 \times 3963}{8{\cdot}932}$$

Log. of R = 5·314425

„ 3963 miles 3·598024

8·912449

„ 8″·932 − 0·950949

91·516·000 miles = 7·961500

Sun's diameter (mean 32′4″)

$$= \frac{32'4 \times 3963}{8{\cdot}932}$$

Log. of 1924″ = 3·284205

„ 3963 = 3·598024

6·882229

Log. of 8″·932 − 0·950949

853·650 miles = 5·931280

The 3963 miles is the latest determination of the equatorial semi-diameter by Capt. Clarke, of the Ordnance Survey. S. B.

ON THE METHOD OF LEAST SQUARES.

SIR,—The object proposed in the *solution* of Equations, however formed, is the *determination* of the value of some unknown quantity involved in the equation, by certain operations with given numbers and accompanied with appropriate symbols which direct these operations. In the case of one unknown quantity, affected by co-efficients absolutely known, the determination of the unknown, in terms of the known quantities, is a problem that offers little difficulty, and provided that the number of equations is equal to the number of the unknown quantities, the discovery of the unknowns is a simple algebraical operation. But when the unknown quantities are affected by co-efficients only approximately known, the resulting value of the term sought will be affected by a certain error. To those who have not advanced into the higher branches of mathematics, it may seem probable that if a certain result absolutely satisfies an equation, then a quantity very nearly equal to that result will very nearly satisfy the equation, nearly being understood in the same manner in both cases. But this does not necessarily follow, and we are led to ask what is the test of approximate equality. Let us take the equation $x - a = o$, then $x = a$, or $\frac{x}{a} = 1$. In this equation there is absolute equality. Now, we can give to the word nearly any signification we please. Let us suppose that an error of 0·0001 is a quantity so small that it can be neglected, and that the result of our solution of the equation has given us $x = 0{\cdot}00009$ and $a = 0{\cdot}00001$, $x - a$ then gives us 0·00008, which as it is less than 0·0001 can be neglected. Are we entitled to assume that the equation is approximately solved? Certainly not. Try the other test, $\frac{x}{a} = 1$. Inserting the values of x and a, we have $\frac{0{\cdot}00009}{0{\cdot}00001} = 9$, which is not by any means a small quantity.

Now, the method of least squares assumes that the most probable values of the unknown quantities, in any system of equations, are those which make the sum of the squares of the residual errors a minimum. By the residual error, we mean the value of the equation after the approximate values of the unknown quantities have been substituted. This principle may serve as the basis of the solution of many otherwise indeterminate problems, and its adoption is justified by the calculus of probabilities, but which is of a too mathematical nature to be recapitulated here. We will proceed at once to explain the method employed in solving equations of condition, and to fix our ideas let us suppose that these equations arise from comparisons of observed and tabular places of a planet. If we suppose that the elements of a planet's orbit are not exact but only approximations to the truth, and if we suppose that the formulæ for deducing a place of the planet from these elements is absolutely exact, every observation will differ more or less from the computed place. This error, which is called the error of the tables, must necessarily be a function of all the elements that enter into the computation of the planet's place, which we will call e, and if we denote the elements of the orbit by x, y, z, &c., the equation must take the form

$$e = ax + by + cz, \&c.$$

Another observation will give

$$e' = a'x + b'y + c'z, \&c.$$
$$e'' = a''x + b''y + c''z, \&c.$$

and there will be as many equations as there are observations. Now, there can be at the most, in a problem similar to that that we are considering, seven unknown, and therefore seven observations would be sufficient to determine the corrections to the elements. But each observation is effected by an error, or rather numerous errors, arising from accidental causes, and which cannot be subjected to computation, such as tremors of the instrument from wind, errors in refraction produced by changes in the temperature of the atmosphere, which will also produce anomalous changes in the parts of an instrument, and above all by imperfection of the senses, and an incapacity in the observer to estimate very small intervals of time and space. The only method of removing these errors is to multiply the number of observations, when it is assumed that all small accidental errors will destroy one another. But to increase the number of observations is to increase the number of equations of condition, and hence arises the necessity of inventing a method of solution in which each equation shall equally participate, and of deriving a result that shall be as little affected as possible by error, and if possible to determine the amount of probable error in the result.

Squaring each of the equations of condition, and taking the sum, we shall have an equation of the following form:—

$$e^2 + e'^2 + e''^2 + \&c. = (a^2 + a'^2 + a''^2 + \&c.)\,x^2 + 2xy\,(ab + a'b' + \&c.) + 2xz\,(ac + a'c' + \&c.)$$

An equation evidently of the form,

$$E = Mx^2 + Nx + P$$

And if we are to make it a minimum, the first differential co-efficient must be equal to zero,

$$\therefore Mx + N = 0$$

And

$$x\,(a^2 + a'^2 + \&c.) + y\,(ab + a'b' + \&c.) + z\,(ac + a'c' + \&c.) + \&c. = 0.$$

Hence we have the following rule to form the equation that gives a minimum for any one of the unknown quantities: Multiply each equation of condition by the coefficient of the unknown quantity in that equation, taken with its proper sign, and then add together all these products; and this being repeated for each unknown quantity, there must result the same number of equations as unknown quantities, whence each is reduced by ordinary algebraical operations.

We give as a numerical example the following equations that are given by Gauss, and have been employed ever since as an example:—

$$x - y + 2z - 3 = 0$$
$$3x + 2y - 5z - 5 = 0$$
$$4x + y + 4z - 21 = 0$$
$$-x + 3y + 3z - 14 = 0$$

If only three equations had been given, a very slight knowledge of elementary algebra would have been sufficient to obtain a correct result, namely:

$$x = \frac{18}{7},\quad y = \frac{23}{7},\quad z = \frac{13}{7},$$

And these values would be final, with no means of judging of their accuracy. But if these values be substituted in the last equation, the second member becomes $-\frac{8}{7}$ instead of zero. This $-\frac{8}{7}$ is termed the residual error; and if a result be deduced from any three equations, the fourth will not be satisfied, but leave a small error. We must use the rule given above for the normal equation of x, multiply each equation by 1, 3, 4, and -1, and take the sum, for y, it will be necessary to multiply each equation by -1, 2, 1, 3, and add the results similarly for z, we shall have, then,

$$27x + 6y - 88 = 0$$
$$6x + 15y + z - 70 = 0$$
$$y + 54z - 107 = 0$$

The solution by ordinary methods gives,

$$x = 2{\cdot}470,\ y = 3{\cdot}551, \text{ and } z = 1{\cdot}916$$

If these values be substituted in the original equations, it will be found that no one equation is accurately satisfied, the residuals being

$$-0{\cdot}249,\ -0{\cdot}068,\ +0{\cdot}095,\ -0{\cdot}069,$$

To determine the probable error of each unknown is a rather long and intricate computation: we indicate only the method here, the proof of what is inadmissible. In the first normal equation write -1 for the absolute term, and in the other equations zero, for each of the absolute terms: the value of x' then found from these equations will be the reciprocal of the weight of the value of x found by the general elimination; similarly for the other unknowns. Writing then,

$$27x' + 6y' - 1 = 0$$
$$6x' + 15y' + z' = 0$$
$$y' + 54z' = 0$$

$$27x'' + 6y'' = 0$$
$$6x'' + 15y'' + z'' - 1 = 0$$
$$y'' + 54z'' = 0$$

$$27x''' + 6y''' = 0$$
$$6x''' + 15y''' + z''' = 0$$
$$y''' + 54z''' - 1 = 0$$

(employing dashes to distinguish the particular results) we shall derive by the ordinary methods of elimination,

$$x' = \frac{809}{19899},\quad y'' = \frac{54}{737},\quad z''' = \frac{41}{2211},$$

which, being inverted, give the required weights, which we will denote by px, py, and pz. In order to find the mean error of x, y, and z, we must take the sum of the squares of the residual errors that we have already determined. The squares will be respectively 0·0620, 0·0046, 0·0090, and 0·0048, the sum of which is equal to 0·0804, the square root of which is $0{\cdot}284 = \epsilon$. The mean errors of x, y, and z are given by the formul

$$\epsilon x = \frac{\epsilon}{\sqrt{px}},$$ similarly for y and z, *mutatis mutandis.*

Hence

$$\epsilon x = \frac{\epsilon}{\sqrt{px}} = 0{\cdot}057$$
$$\epsilon y = \frac{\epsilon}{\sqrt{py}} = 0{\cdot}077$$
$$\epsilon z = \frac{\epsilon}{\sqrt{pz}} = 0{\cdot}039$$

which are the mean error of x, y, and z. This is a general outline of the method employed in solving equations of condition by the method of least squares. The computation is necessarily long and troublesome, but the accuracy of the result has never been doubted, nor has any other method been suggested that promises by shorter computation to give a result equally correct. The late Professor Encke employed this ingenious process in a variety of ways, and it has now become a most formidable engine in modern astronomy.

OMICRON.

VIOLIN VARNISH.

SIR,—As regards the letter of "J. T." page 14, respecting "Violin Varnish," I quite agree with what he says. The information which he desires would be acceptable to many of your readers. I have myself, at the present moment, a valuable Italian instrument, on which I have played for more than 20 years, but its belly is without varnish. The cause of this is as follows:—I purchased the instrument, at a high figure, at the sale of an eminent violinist's effects, and by imagining that another coat of varnish would improve the tone of the old violin, I made and applied a varnish of naphtha and shellac, but the result very much disappointed me, for the sound was somewhat deadened, although the alluring sweetness of tone remained.

In a few weeks I determined to scrape off the varnish, and did so carefully with a piece of glass, but unfortunately the first coat of varnish came off with the second, and the belly of the violin has, since that time, remained bare, for I have been afraid of again meddling with it. I keep the instrument in a silk bag in a mahogany case, and thus the air does not appear to affect it. Notwithstanding this, I should, of course, be highly pleased if I could restore it to its original appearance.

I know there are many "Violin Varnishes," but I cannot venture to apply any of them, neither would I place it in the hands of a violin maker until a suitable spirit varnish (like the Italian varnish spoken of by M. Griveb), has been tried and approved. It is strange, and I have often thought so, that neither Rode nor Louis Spohr, the latter of whom has touched upon almost everything connected with the greatest of all instruments, has said anything in reference to the varnish.

There can, however, be no doubt, amongst violin players that the quality of the varnish affects in a considerable degree the vibration of the instrument, and I am glad that your correspondent "J. T." has drawn attention to the subject, although I had intended doing so myself.

TAUTAU.

ENGINEERING QUERY.—ANSWER TO "RELWOT."

SIR,—So long ago as October last year, in the number for the 22nd of that month, on page 140, "Relivot" gave some of the dimensions of his compound engine and boiler, and solicited the opinions of "practical engineers" upon the same. I replied, asking him to send more particulars, and promising to give him the information he required. He gave the required dimensions in the number for November 19th, on page 242, and I at once set about writing this letter, but I laid it by for reasons I need not trouble you with, and did not resume it till now. I hope it is not too late to be useful to "Relivot."

With your permission I will just recapitulate his questions here. First, "Will the boiler supply those engines with steam?" Second, "Are the areas of pistons, and ports, and travel of valves, properly proportioned?"; and after stating in his last letter, "That those engines are working in connection with a water wheel," and that "their load is varying from day to day," he asks "Would an independent cut off valve be advisable?" The dimensions of his boiler are—"Shell 30ft. long, 7ft. diameter, containing two furnace flues, 2′ 7″ diameter, with grates 7ft. long." This boiler is capable of evaporating about 50 cubic feet of water per hour, with good coal and sharp draft, and the steam from that quantity of water if used in a well-constructed condensing engine, cutting off at about one-third of the stroke, will produce about 100 to 120, or perhaps more, indicator horse power.

The stroke of the high pressure cylinder is 42in., or 7ft. for the double stroke, and it makes 60 strokes per minute, or 420ft. per minute piston speed, and the diameter of the cylinder is 16in. The steam port is 11in. long, and 1⅜in. wide, or 15⅛ square inches, which is very good proportion. The speed of the low pressure piston is the same as the high pressure one, and its diameter is 22in.; the steam port is 15⅛in. long, and 1½in. wide, or $22\frac{11}{16}$ square inches area; this I consider rather small, and if designing such a cylinder with equal piston speed, I should give a steam port of 28 or 29 square inches area, but such as it is it will do very well. There are worse things by a great deal about this engine than the proportions of its steam ports, as we shall see by-and-bye.

The steam is cut off from the high pressure cylinder at 34 per cent. of the stroke, or 14¼in., and the diameter of the cylinder being 16in., we have a space of 1·65 cubic feet to be filled twice every stroke, or 3·30 cubic feet per revolution of the crank shaft; this at 60 revolutions per minute is equal to 198 cubic feet, or 11880 per hour, to which we may add one-fourth for waste in filling ports, piston clearance, leakage and cooling, and we have 14850 cubic feet of steam required per hour; this at 60lb. per square inch above the atmosphere, or 75lb. total pressure above a vacuum, requires for its formation 39 cubic feet of water, but the boiler is capable of evaporating 50 cubic feet per hour, so there can be no question of its sufficiency.

We will now take a look at the proportions of the slide valves, and see how they acquit themselves in the performance of their duty of distributing the steam to the cylinders, but before I do so I shall just state what are the proper proportions and essential conditions of a good compound steam engine as far as its valve gear is concerned.

The valve which admits the steam from the boiler to the high pressure cylinder should be capable of cutting off at any point, from, say, 10 to 95 per cent. of the stroke, and of detaining the expanding steam in the cylinder to do duty on the piston to nearly the end of the stroke, and this valve should, if possible, be placed under the direct control of the governor.

The communication between the high and low pressure cylinders should be free and unrestricted from the beginning to very near the end of the stroke, in order that no illegitimate or unnecessary back pressure may exist to retard the motion of the high pressure piston, and that the low pressure piston may receive the full benefit of the unrestricted expansion of the steam contained between the two pistons.

The communication between the low pressure cylinder and the condenser should also be freely open from the beginning to nearly the end of the stroke, in order that its piston may continue to receive the benefit of the vacuum as long as possible.

"Relivot's" high pressure valve has 7¼in. of travel, $3\frac{1}{16}$in. of lap, and no lead, and the exhaust edges of the valve and those of the ports are equidistant; with these proportions this valve cuts off the steam at 34 per cent. of the piston's stroke, or 14·25in., and exhausts at 78 per cent., or 32·75in., and at the same instant compression begins on the other side of the piston. The valve of the low pressure cylinder also has 7¼in. of travel, $2\frac{13}{16}$in. of lap, and $\frac{3}{16}$in. of lead, and the exhaust edges of the valve and ports are equidistant; these proportions cause it to cut off the communication with the high pressure cylinder at 36 per cent., or 15·12in., and to exhaust at 78 per cent., or 32·75in., exhaustion ceasing and compression beginning at the same instant on the other side of the piston.

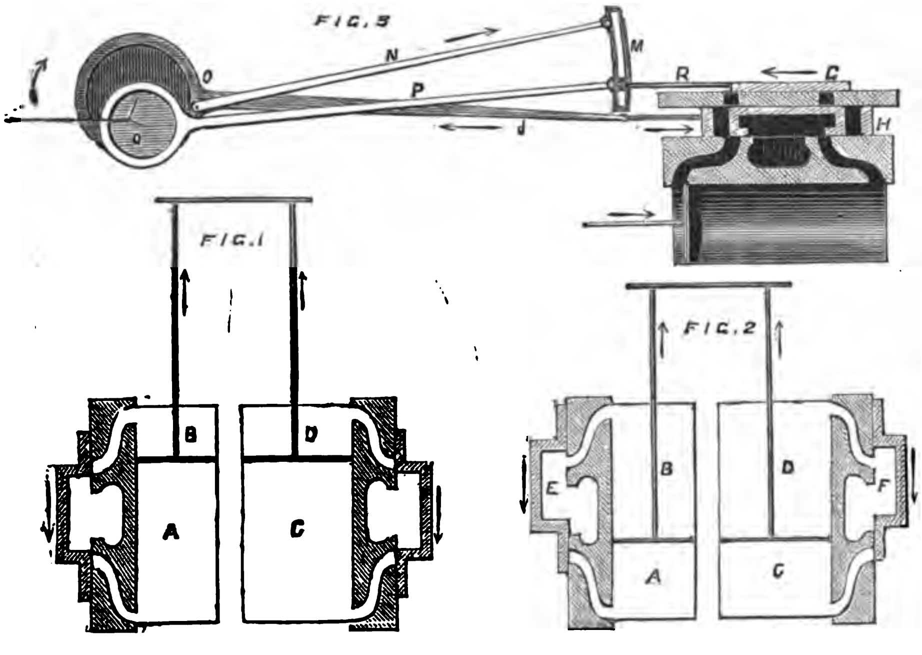
Now two serious evils due to this early exhaust at once become apparent, and are plainly illustrated in the annexed sketch, Fig. 1, in which I have placed the cylinders side by side, and attached their piston rods to the same cross-head, so that they make their strokes simultaneously.

I do not know whether this is the arrangement of "Relivot's" engine or not, but that is of no importance, as it does not affect this discussion in the least, and moreover it is a common way of constructing compound engines.

The cylinders are drawn to a scale of half-inch to the foot, but the valves and ports, for sake of greater distinctness, are exaggerated to the inch scale. The pistons in both cylinders are at the point when exhaustion takes place, viz., 78 per cent. of the stroke, and they are moving in the direction of the arrows, and both valves are at the middle of their excursion, just closing the exhaust on one side, and opening it on the other side of their respective pistons. The steam from end A of the high pressure cylinder is passing away into the connecting pipe and valve chest of the low pressure cylinder, thus undergoing considerable expansion and reduction of pressure at the very time when it should be securely bottled up in the cylinder, and driving the piston at least 19 per cent. further on its way to the end of its stroke. At the same instant that the steam is thus recklessly permitted to escape from the positive side of the piston A, compression begins on the negative side B, for it will be seen from the position of the valve, that exhaustion from that side has just been intercepted; the piston, therefore, during the remainder of its stroke encounters a great resistance in gradually compressing the unexhausted vapour back into the port and small space allowed for piston clearance. To be sure, a part (and only a part) of this power is restored to the piston on its return stroke by the re-expansion of this compressed vapour. But why compress it at all? The evil resulting from doing so can be avoided by using a properly-constructed valve motion.

At the same time that the above bad work is going on in the high pressure cylinder, similar bad management and prodigal waste are going on in the low pressure one, for the steam, which up to this instant has been driving the piston on its way, is suffered to escape to the condenser from end C, instead of being kept on the piston at least 19 per cent. longer, and compression also takes place on the other side D, as in the high pressure cylinder, for the communication of this end of the cylinder with the condenser is prematurely cut off, and the vacuum applied to the wrong side of the piston.

But I have yet to point out the greatest evil resulting from the bad proportions of these valves, which is



o be found in the restriction of communication between the two cylinders.

I have said at the beginning of this letter that one of the essential conditions of a good compound engine is "that the communication between the two cylinders should be free and unrestricted from the beginning to the end of the stroke," but how do we find it in this case?

The valve of the low pressure cylinder cuts off at 36 per cent. of the stroke, that is to say, the communication between the two cylinders is improperly intercepted at that point, see Fig. 2, which shows the position of the several parts at that instant. The low pressure valve F has just closed, and no more steam can pass from the exhausting end B of the high pressure cylinder to what should be the receiving end C of the low pressure one. The high pressure piston has to spend its energies in cramming the unexhausted steam into the passage of communication and valve chest of the low pressure cylinder. The 36 per cent. of steam which has gained admission to the low pressure cylinder makes a faint effort to drive the piston by its expansion. It is but a faint effort compared with what it should be, for it is unsupported by the great body of steam which should have free ingress to its assistance, but from which it is cut off—isolated—by the premature closing of the valve.

If that engine were mine I should make the following alterations in it:—

I would make the ports in both valve chests exactly alike in their transverse dimensions, that is to say, I would cut ¼in. off each of the admission edges of the ports in the high pressure one, and ⅛in. off each of the exhaust edges of the ports in the low pressure one. I would then cut $2\frac{7}{16}$in. off each of the admission edges of the low pressure valve, which would leave it ⅝in. of lap, and I would make its exhaust edges 7⅛in. apart, or the same as the exhaust edges of the ports, and I would then reduce the travel of the valves from 7¼in., as at present, to 5in., by putting on a new eccentric, which should drive both valves, and this eccentric should be set to give the valves ¼in. of lead. I would do away with the present high pressure valve, and introduce a compound valve, as shown at Fig. 3, which consists of three pieces, viz., slide valves G and H, and an interposed plate I. The valve H should be worked direct from the eccentric by rod J. This valve is made with an exhaust cavity K, whose edges are equidistant with those of the ports, and two admission passages L L′ straight through its solid ends; the admission edges of this valve have ⅝ of lap, the same as the valve of the low pressure cylinder, and of course the same lead. The interposed plate I has two ports cut through it exactly opposite the steam ports in the cylinder face, and of the same dimensions; this plate lies loosely upon the back of valve H, and valve G lies loosely upon the back of I, and all three are pressed up together by the steam. I is prevented moving from its proper position by studs or stoppers fixed to the sides of the valve chest. Valve G is a plain solid plate, having ⅝in. of lap at each end beyond the ports in plate I; this valve is worked by a "link" M, one end of which derives its motion from a rod N, pinned to the main eccentric rod at O, and the other end is worked by a rod P, from a small eccentric Q, fixed on the shaft beside the main eccentric. Q has 2¼in. of "throw," and it is keyed on the shaft with its centre line, making an angle of 158° with the crank (I am now speaking of a horizontal engine). The effects of this construction are—that when link M is lowered so as to bring eccentric rod N into line with valve rod R, the movements of valves H and G will be very nearly simultaneous, and steam will not be cut off till the piston has performed 95 per cent. of its stroke, and exhaustion will take place at 97 per cent. But when the link is moved from this position, simultaneous action of the valves ceases, and the movements of valve G become in anticipation of those of valve H, and this anticipation increases gradually till eccentric rod P is placed in line with valve rod R, when steam will be cut off at 10 per cent. of the stroke, or 2¼in., and any amount of admission between these extremes is to be found between these two extreme positions of the link.

It will be seen, therefore, that this simple apparatus possesses the inestimable advantages of a variable cut off between very wide limits, united to an invariable exhaust taking place at a late period of the stroke.

The effect of these alterations on "Relivot's" engine would be that the communication between the two cylinders would be kept open during 97 per cent. of the stroke, instead of being prematurely cut off as it is now at 36 per cent., and the steam by its uninterrupted expansion between the two pistons would continue to do good duty upon the large piston for 61 per cent. longer, at the same time relieving the small piston from the enormous back pressure which at present paralyses its action and reduces its useful working effect. Also the communication between the low pressure cylinder and the condenser would be kept open during 97 per cent. of the stroke, instead of 78 per cent. only as at present, and its piston would, therefore, continue to receive the full benefit of the vacuum for 19 per cent. longer.

If "Relivot" should wish to hear from me further, I shall be always at his service, with your permission, through the medium of the ENGLISH MECHANIC, and I shall not again keep him waiting four months for an answer.

JAS. BASKERVILLE, 5, Westland-street, Limerick.

WRAY'S OBJECT GLASSES.

SIR,—In reading over "F.R.A.S.'s" letter, it gave me great satisfaction to hear him speak so well of Mr. Wray's object glasses, as I have a 4in. which I got from him. On Jan. 24th, 1869, I had the pleasure of observing three occultations of the stars 115, 119, and 120, in Tauri. These stars were quite bright and clear until they disappeared behind the moon. In July I had some good views of Saturn, although he was low at the time. Venus has shown very sharp, so much so that some of my friends thought it was the moon that they were looking at. On Jan. 25th, 1870, and on March 5th, I had the pleasure of seeing six stars in the trapezium of Orion, and two small stars a little below in the nebulæ.

Since I have read "F.R.A.S.'s letter," I must acknowledge that I am proud to be the owner of such an instrument. I think that I was the first who made mention of Mr. Wray's object glasses in the ENGLISH MECHANIC, some time ago; and as an act of gratitude to Mr. Wray I cannot refrain from writing, as his name is now before the readers of the ENGLISH MECHANIC. If not trespassing too much, I wish to say a few words of encouragement to my fellow working men. When I first made a start, 2s. was all that I could spare for an object glass, and no ENGLISH MECHANIC to help me on—no "Chats on the Stars." I had not the privilege that the working men have now of getting every question answered through the columns of the ENGLISH MECHANIC; but perseverance has done more for me than money could ever have done; and now that I have overcome the difficulties that I have had to contend with, and am in possession of a good telescope, I do not wish to put it under a bushel, but I am ever ready to bring it out to any one that can make it convenient to call on me. Working men, think of this; and let your motto be *Nil desperandum*.

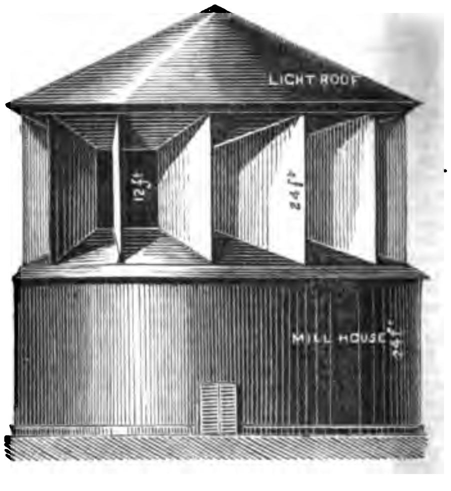
D. ALSTON, Clyde-street, Merefield, Rochdale.

THE HORIZONTAL WINDMILL.

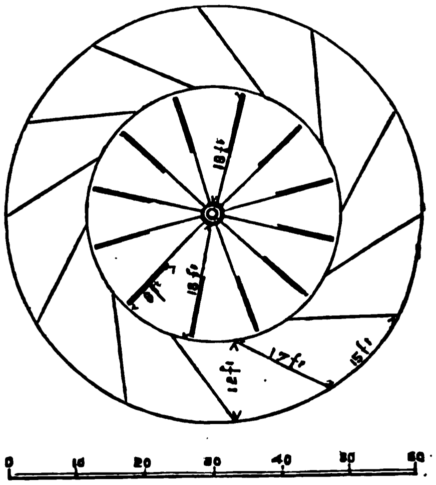
SIR,—I take the liberty of sending you for publication a plan for this purpose, on a scale of 1-12th, capable of doing real work, and suitable for driving two pair of usual 4ft. stones—or, say, three, as one may be frequently up for repair. The sails are enclosed in a windcap, because the open horizontal windmill cannot produce profitable work, on account of the wind only catching one sail at a time, and that for an instant only, besides the insuperable difficulty of getting the sail frames back against the wind; whereas in the common vertical windmill all the sails act at the same time, and moving edge on, atmospheric friction is very slight.

In the horizontal enclosed form it will be seen that five sails are always acted upon by wind concentrated by the funnel-like openings. The latter are 24 × 15, and as four catch the wind, the total aperture is over 1400 square feet. The sails are 12 × 8, and five together present a surface of more than 400 square feet. The difficulty of getting the sails back is entirely obviated by their being enclosed in the windcap, because the building presents such an obstacle that in a strong wind there will always be a partial vacuum on the lee side, which acts as an exhaust, so that nearly the whole of the concentrated blast is available for work.

ELEVATION



PLAN



SCALE OF FEET

The mill-house must be, of course, a substantial brick building, either square or round, according to fancy. The windcap above may be of thin board, but the joisting must be strong, in order to stand the strain of the upper gudgeon.

The regulation is a very simple matter, because the twelve sails are on rollers, which can be reefed or let out by hand gear round the main shaft, or better, perhaps, by means of a self-acting governor. The pressure of a good working wind of 20 or 30 miles an hour is found to be from 3 to 4lbs. per square foot, or at least at double that upon the sails.

HENRY W. REVELEY, Reading.

PHRENOLOGY AND BIG HEADS.

SIR,—Having for many years taken great interest in the study of phrenology, I beg you will allow me to say a few words in reply to some of your correspondents, who have, through great ignorance, endeavoured to throw discredit and ridicule on the science. It is a great mistake to say that phrenologists assert that big heads have *always* the most power. All true phrenologists maintain simply that size is a measure of power, with this reserve—viz., *all other things being equal*, and they will invariably maintain that temperament or the quality of the brain is most essential to the effective working of the organs; therefore an averaged-sized head with well-proportioned organs and an active mental temperament will produce far greater and better results than a large head with ill-balanced organs and a slow lymphatic temperament.

I make this statement from personal knowledge and many years' experience. I know a man who has a head 23in. in circumference—which, by the way, is a very large size—and although he has had many advantages, has produced little either good or great; and on the other hand, I know a man with a head only 21½in., but the preponderance of brain being in the upper region, and with a most remarkably active mental temperament, who has taken a most prominent part in the political and literary world.

I may observe, for the information of those little acquainted with the subject, that temperament is, in regard to the human brain, much the same as blood or breeding is to the horse. Self-made men have, I believe, invariably big heads or remarkably active temperament.

S. H. A.

FIG. 1

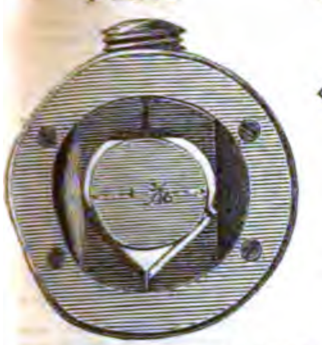


FIG. 4

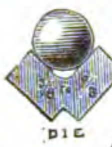


FIG. 2

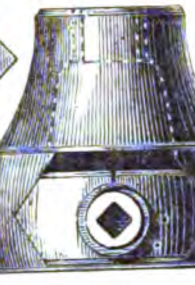
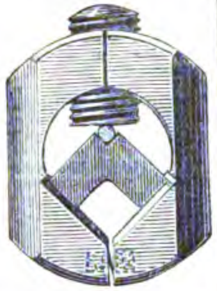


FIG. 3



BENNETT'S CHUCK.

SIR.—In compliance with "Kennington Amateur's" request, I send drawing of Bennett's chuck. Fig. 1 shows front view, with work 1$\frac{3}{16}$ diameter, the greatest the chuck will take in. Fig. 3 shows the internal sliding pieces taken out, and the steel die in its place, grasping a small wire. Fig. 4 shows the die turned the other way up for a bar from ¼ to ⅜ diameter. Fig 2 is a plan view. The inner, faces of the sliding pieces are lined with steel plates the nibs at the upper corners being sawn into some distance, and slightly bent downwards, so as to grasp the corners of the die to prevent it falling out. The slider moves strictly across the centre, and when the screw is tightened by means of a square-ended screw-driver, with a very large powerful handle, the slider sets fast in its groove, partly by the oblique pressure of the work or the die, and partly by that of the thread of the screw. There is a small spiral spring let half into each of the sliding pieces, at the lower end, to keep them steady, and prevent their falling out, and a flat steel ring, held on by 4 screws, protects the hands. I believe it is a very good chuck, and the reason I do not like the one I made is, that it is not so well fitted as it ought to be. It was invented by Mr. Bennett, one of Mr Evans' workmen, and is in common use in that establishment. I think usually they are made with a large screw at back, so as to go on to a plate chuck, instead of screwing direct on to the nose of the mandrel itself. J. K. P.

THE IMPROVEMENT OF OLD COTTAGE AND CABINET PIANOFORTES.

SIR, — Although many valuable improvements, especially in the action, &c., of old upright cabinet or cottage pianos may be carried out, to the great improvement of both touch and tone, it is obvious that *no great augmentation of the power of the latter can be got without resorting to the use of either more or thicker strings, which usually necessitates employing some means to do what, in many instances, would greatly benefit their owners also, viz., to* "strengthen their backs."

In a former series of papers on this subject, written by me, one of which was printed in No. 239, Vol. IX., I mentioned a very effective method of doing this in new instruments, employed by Messrs. Rolfe about A.D. 1854, for which Mr Molyneaux afterwards solicited a patent, which patent was not completed. In this plan, each wooden bracing is grooved to admit the central web of a ⊤ iron bar; of course this may be done to an old piany, but it is done much more easily *before* the bracings are fixed in their places; so, instead of doing it to an old piano, I would suggest the following method of forming grooves or recesses for the ⊤ or angle iron, which, instead of weakening the original bracing adds considerably to the total strength of the instrument.

To form these recesses conveniently, I would insert additional wooden braces between the original ones, leaving from ½in. to ⅝in. space between them, according to the thickness of the angle iron which is to be inserted. These additional wooden braces ought to be well fitted against the back of the wrest plank, so as to form a sound joint when glued, also under the wrest plank if shouldered on. Should the belly bars be in the way of the additional bracings, they may either be grooved to admit the belly bars, or, what I think preferable, two pieces of wood, of the required section, may be glued and nailed on the front surface of each brace, leaving a groove or recess between them to admit the belly bar. As it would be difficult to fit each brace so that it shall bear firmly *under* the wrest plank and *on* the bottom, I would recommend to cut them about ⅜in. too short, also about 1/16in. shorter at back than front, and to form a perfect joint between the brace and the bottom, by driving in a hard wood wedge, having first secured a cleat on the bottom (in front of the brace), so that the latter cannot be forced forward against the belly by the act of driving in the wedge.

The new bracings will of course be secured to the wrest plank at top, not only by glue, but also by a strong screw, or what is preferable, a screw bolt and nut, bearing against a large washer; the hole for this bolt should be bored 1-16th inch large, so that it may not act as a dowel, and prevent the wedge from forcing the shoulder of the brace up against the under edge of the wrest plank; this bolt also forms an excellent clam to press the glued surfaces together, which is an important consideration when the work has to be done by an amateur, or by a workman who has not plenty of iron clamps at hand.

It is obvious the recesses thus formed between the bracings are capable of receiving either the central webb of a bar of ⊤ iron, or one of the members of a bar of ordinary L or angle iron. The latter is now kept in stock by Messrs. Moser and Sons—and by no other London firm I know of—of very suitable sections, say 2 × 1 × ¼, or 3 × 1½ × 5-16th. From three to five such bars as these, securely bolted through the wrest plank at their upper, and through the bottom at their lower ends, would "strengthen the back" of any sound well-made cabinet or cottage piano. There are many thousands such, made within the last thirty or forty years, which are much too good to be allowed to perish and "go to the fire," as if they were of no more value than ancient human animals—sufficiently not only to enable it to resist the strain of *two* thick strings, from one-tenth to one-fifth longer than those formerly employed to utter sounds of given pitch; but even if desired, a third string to each note, from fiddle G up to the highest note in the compass of the instrument. I should much like to see the opinion of your *very practical* correspondent, "W. T.," on what he may term my unpractical proposed method of doing what is needed, which opinion he might include in the next of his promised papers on the economical improvement of old pianos—a contribution, now at least due, if not overdue, and which, judging from the communications which have been addressed to me privately, from several and sundry of my fellow readers of the ENGLISH MECHANIC, would be of considerable interest to those of my fellow readers who possess old pianos, and desire them to be economically improved. THE HARMONIOUS BLACKSMITH.

OXYHYDROGEN GAS STOVE.

SIR,—I fear that to give a reply to "Houblon," page 643, No. 2074, Vol. X., will occupy too much of your valuable space, although his question brings up a suggestion truly valuable to a great many of my brother readers, in obviating the pernicious stench and securing a greater intensity of heat given by the ordinary means of heating, &c., with coal gas. Fig. 1 represents a suggestion for boiling water for washing, for boiling and stewing in saucepans, and where frying may be done, and *a* shows the oven, in which roasting or baking may be done. Fig. 2 shows the top part of this gas stove. Two cast iron covers, *a a* and *e e e e*, of reasonable thickness, fit down a little within the outer edge of the top part of this stove, resting on bracketing, as seen by the dotted line *n n n n*, which bracketing forms the seat for the washing boiler B, as seen in Fig. 3. Three holes of sufficient diameter are cast in these plates, two in the plate *e* and one in the plate *a*, with lids *h h h*, Figs. 2 and 3, hinged into the top bed of the stove. The two doors *h i* are laid back on the bearances *b*, when the cover plate *e e e e* is lifted off by the ring *v* to set in the large boiler for washing. Cooking may be going on in the oven *m* and on the back burner *g*. Fig. 2, a saucepan, may be set at the same time the washing is going on. The centre of these holes in the portable top plates, for stewing, frying, &c., must be direct over the gas burners. *o o* are the two front gas cocks, and *s s* the two front air cocks into the burner *g*. The air-vents *w w* are small holes about ¼in. diameter, one to each burner, the holes *y*, which may be each 1¼in. diameter, holes fitted with segment dampers, such as are put on oven doors to vent out, or regulate the heat of the stove.

FIG. 1

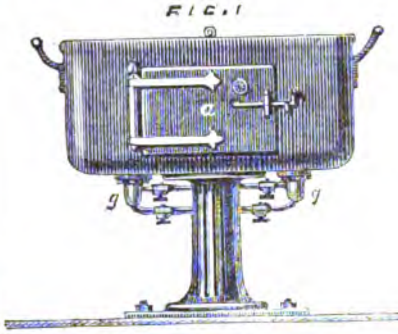


FIG. 2

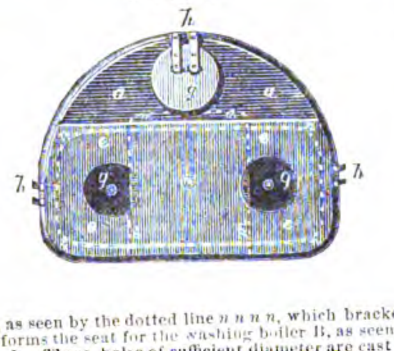
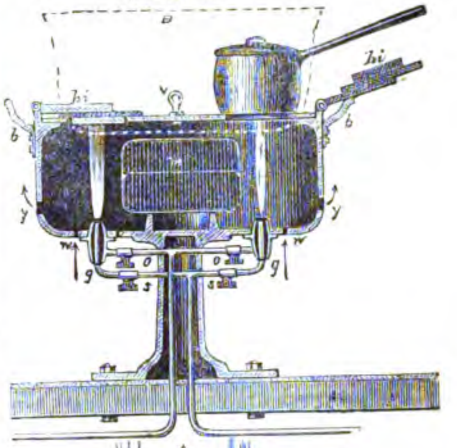


Fig. 4 represents a small portable acorn-shaped heating stove, having but one burner. This stove is in two pieces, *c* and *e*. The part *e* has a number of small ⅛in. holes, level with the bottom of which is the top of the burner, fitted in the upright of the stove. *a a* represents a number of small holes in the outer edge of the top part of the part *e* all around. The top part or cover *c* may be taken off, and eggs or anything may be boiled in a pan placed on instead. For the supply of air continually, and sufficiently compressed, I recommend my centre fluid hydraulic, drawings and explanations of which shall, by your kind permission, appear in the ENGLISH MECHANIC shortly. JOHN C. SHEWAN.

FIG. 3



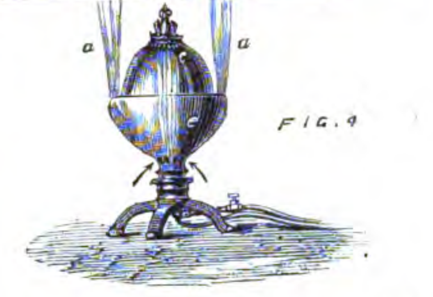


FIG. 4

HARMONIUM REEDS—VARIETIES OF THE TIMBRE OF.

SIR,—"P. E. H." asks if additional vibrators act only like additional strings on a piano, *i.e.*, only increase its loudness, or if they can be made to imitate the sounds of the trumpet, oboe, clarionet, flute, &c. The only possible reply is that of the puppet showman, who exhibited the battle of Waterloo, in which the *artist* did not very clearly indicate the leading characters of that remarkably Christian-like and benevolent military encounter of the fellow worshippers of Him who taught brotherly love and peace to mankind, when the good little girl asked him, "Please sir, which is Napoleon, and which is the Duke of Wellington?" "Whichever you please, my pretty little dear. You *pays* your money and can have your own choice." If "P. E. H." is prepared to pay his money—and a good deal of it—he may purchase, within certain limits, the right to choose, not only as much tone as he desires, but the different kinds of tone he prefers.

It is sufficiently obvious that if two harmonium vibrators be made as much alike as possible, and employed to produce musical sounds under as *nearly as possible the same conditions*, the sounds they cause the utterance of will not differ much in character; in a word, they will act just like the second, third, fifth, sixth or seventh unisonous string of a pianoforte, and only *augment the loudness* of the instrument; but just as one string, tuned to the same pitch, may differ from another in thickness and length (and consequently its sounds differ in timbre), so the sound of one reed, which is thicker or wider in proportion to its length, may differ from another reed in its sound, not to mention that the character of the sounds, which are caused by the same reed, may differ greatly according to the *treatment* to which it is subjected, for in this respect harmonium reeds resemble human beings, and utter very different sounds, according as they are *well* or *ill* treated.

The most obvious means of varying what I may term the *original* sounds of harmonium reeds is to vary the proportions their lengths bear to their widths. It is hardly to be expected that the sound of a reed which is only twice as long as it is wide will very closely resemble that uttered by another whose length is from eight to twelve times its width, any more than we can obtain sounds of the same timbre from the long narrow pipes of the dulciana rank identical with those uttered by open diapason pipes of more than double their diameter. The character of the sounds we obtain from each will be in proportion to their sectional areas, like producing like, and we might as reasonably expect to gather grapes from thorns, or figs from thistles, as to obtain the full broad tone of the wide scale open diapason pipe from the narrow dulciana, or the beautiful quality of the latter from the former. No doubt the *skilful* voicer can do much by *making mouths*, but neither manipulation nor chemistry can yet wash the blackamoor quite white, without also washing out his individual life; both he and the pipe whose *mouth* is *opened too much* are only fit to go "down among the dead men,"—you can't well make them shut up.

Besides that variation of quality of sounds, induced by varying the proportions of length to breadth, different methods of affixing the reeds to their frames, and different methods of forming the reeds, considerably influence their timbre. Good workmanship can do much, but, according to the late Mr. Myers, nothing can compensate for the injurious consequences of the reed and its frame being formed out of two pieces. He used to say, which is true, that absolute contact between them was beyond human art to effect, and that an uncertain amount of chattering invariably ensued when the reed was simply held to its frame by a saddle or cross bar, screwed down on it. Also, that the best rivetting did not prevent chattering if the reed was made of thin material instead of being forged out of metal from 1-10th to 1-16th inch thick, and very slightly shouldered on the side nearest its frame. I have found this a very effective method of preventing chattering, but Mr. Myers had a great faith in his patent method of construction, in which the reed is cut out of the same substance of its own frame, and only remains attached to it at the fixed end. That his colophons, with hardened and spring tempered steel reeds thus formed, produced tones of far greater purity than any of their contemporary seraphines, I can avouch, but that this was entirely due to their reeds being made of the same piece of steel which also formed their frames, I can't help doubting. I suspect good workmanship had something to do with it; but whatever the cause or causes might have been, the effect was excellent. The colophon differed from the thin reedy seraphine nearly as much as a fine organ reed, employed in unison with the open diapason, differs from ye ancyente oboe, or vox humana stop, voiced *à la Punch*, whose dulcet sounds ye ancyent voicer of pipes evidently considered the *ne plus ultra* of reed tone.

Not long since I heard an harmonium, by Ramsden, whose *strident* tones might have satisfied our MECHANIC's princess "Alexandra" herself. This instrument, which drowned every other in the room, had but one and a half row of reeds, whose tones remarkably resembled some of those German concertinas which so greatly surpass their English namesakes in power and—if I may be allowed to coin an adjective—also in *horniness*. Possibly great pressure of wind had something to do with the matter, for I find the steel reeds of my Day and Munck's colophon assume this quality when forced. I suspect the physharmonica with a swell (not, of course, the organist himself, although some of them are both great swells and heavy swells to boot), with its free reeds blown by 10 or 12in. wind, has something of this *strident* character, and sounds very unlike the tender reeds of an Evans's or Hermann Smith's chamber harmonium, which are delicately blown, and perhaps also—as all good tender children should be—well wrapped up to keep them from squalling.

This wrapping up is a very effective method of subduing unpleasant sounds. Every paterfamilias knows—to his horror—that his infant's cries are *strident*, indeed, if heard in their native nakedness, but become quite bearable when its dear little head is under the bedclothes. It won't do to let the infant *breathe too freely*, or he becomes "the son of the sleepless"; and even if this mode of *quieting* sometimes be fatal to it, we have at least the consolation of knowing that its departure to the world of spirits diminishes that pressure of population on the means of subsistence which political economists so earnestly deprecate. No doubt the reader will say there is nothing new in this, it having long been familiar to "ye family man," but if not new itself, we have not long since become acquainted with a new application of this very old fact, which new application well deserves letters patent not only to be granted gratuitously, but also that its inventors should be fully *paid* for their ingenuity. I need hardly say that I allude to the late Shoreditch infirmary practice, in which a noisy pauper—what *right can paupers* have to make a noise?—was duly and effectually *quieted* by having a cloth forcibly held over his wicked mouth, while the *nuss* prepared a sufficient dose of morphia to *quiet* him effectually until the day of resurrection, on Count Fosco's principle of assisting tired Nature's tendency to permanent repose. Verily we do improve in the treatment of insane paupers, for not only do we liberally provide wet cloths for their *crying* necessities, but also expensive medicines, dispensed with a liberal hand by *nusses*, to assist their progress out of all mundane miseries.

To return to our dead sheep (muttons, as the French say). I very strongly suspect the reeds whose draw stops are duly labelled clarionet, hautbois, and most of the other varieties of timbre we hear from the harmonium (or rather *ought* to hear). Too often the real tones are *very far* indeed *from* that instrument, are much more due to the different areas of the spaces between the reeds and the pallets (within which spaces the air, under the influence of the reeds, becomes resonant), and the quantity of what I take the liberty of terming *bedclothes* (interposed between the reeds and the hearer), than to any other causes—of course I mean the extent to which the reeds are covered up. I am told the popular *voix celeste*—which can only be termed *celestial* on the hypothesis that the angels practice singing the music of the spheres (whatever that music may be), with remarkably thin *reedy* voices—is produced by another dodge, but instead of enlarging and perhaps yet further exposing my own ignorance on this not very celestial subject, I would recommend the reader to peruse Mr. Hermann Smith's paper on it, for an expert can, *if he will*, almost invariably give us more information than any mere amateur, however clever he may make the very common mistake of thinking himself.

But few modern harmoniums which I have seen are constructed with the means of blowing their reeds with wind of different pressures, without using the expression stop. Myers and Storer, 1839, and Hewett, 1838, patented methods of doing this, with only one bellows, and, I believe, others have since invented other ways of effecting it. The thing seems to me so very desirable, especially for instruments with two or more ranks of keys, that perhaps "Eleve" (who is no *eleve* at all in the matter of harmoniums, excepting in the sense that the wisest of us have something to learn) or Mr. H. Smith would kindly express his opinions on this method of varying both the power and quality of the sounds of this instrument, for, if desirable, it is extremely cheap, only requiring one or two extra weights to be put on the bellows at the performer's pleasure, and this may be readily done by disconnecting their supports; or if the use of weight be prohibited, by allowing additional springs to come into action.

That any free reed instrument will ever render that wide variety of timbre obtainable from organ pipes is hardly to be hoped for. If anything at all like it could be done, the instrument would well deserve the name of wind organ, but I am far from believing that our so-called wind instrument stops, whose names are engraved on its draw, exhaustively represent the capabilities of reeds for producing sounds of different timbres. I suspect it is rather because no one has yet shown what can be done, and how to do it, such an instrument has not been made, and that no commercial demand exists for harmoniums with greater variety of tone. "Alexandra" only asks for what every organist who performs on a tolerably large instrument with a swell, already possesses; and if she can induce some expert, *cheaply* to supply her requirements with free reeds, which at present are only to be supplied by pipes at great original expense, not to mention the cost and trouble of the oft-repeated tunings which a large pipe organ with many reeds requires, she will have the satisfaction of having caused an addition to the number of the good things of this world to be brought into existence, and for one I heartily thank her for asking for it; indeed I consider her request an example of that refined musical taste which *invariably* distinguishes her sex.

THE HARMONIOUS BLACKSMITH.

REFLECTORS AND REFRACTORS.

(*Continued from page* 11.)

SIR,—The telescope was next directed to the two nebulæ before-mentioned. We shall now only give our impressions of the latter (M. 13 Herculis); and what a wonderful sight we beheld when it was brought into the field of view! With a low power a small, bright cloud, all sparkling with diamond points of light, but with a higher power how magnificent the change! Stars piled upon stars, not one trace of the cloud remaining, but star-dust, even to the very centre, where they seem so infinitely close, that one wonders they each can still be seen separate from the other.

Here is a test for the perfection of figure of a speculum, than which none could be more severe. To completely resolve this superb cluster, even to the very centre, with such an aperture, is work any man might feel proud of. On the second evening I examined this object most carefully, and for some time, and could most distinctly trace the two dark rifts first seen in the Earl of Rosse's great telescope. They were best viewed with the highest power I used (350).

But enough has been said to show the extreme excellence of the speculum I was employing, and the sufficient adaptability of the mounting described in a former letter. Let every amateur take courage, and if he only possess a little ingenuity and patience, he may do even better than I have done. The above is but a short account of one or two nights' work—very favourable nights, I will admit, and such as do not come very often, but when they do amply repay the earnest student any small additional outlay he may have made in procuring a really good speculum or object glass. Whatever he does, let the beginner beware of cheap object glasses or specula; they always break down when such "testing times" come, and prove ultimately a loss rather than a gain.

I would rather possess a really good 2½in., or even 2in. object glass, than a cheap 3in.; and this reasoning holds good, *a fortiori*, with regard to specula of respectively larger aperture, as with them the evil is increased in a threefold degree.

There is one fact, however, which I have learned from constant observation; it is that when the air is unsteady there is no use in trying to use an aperture of 8½in.; perhaps this may seem too strong an assertion to some, but certainly the position in which my telescope is placed—a position very similar to that described by Mr. Purkiss (near a large city—has taught me its truth. Many nights come when I can use smaller apertures, and see planetary and lunar details sufficiently well to learn something of phenomena taking place in those bodies, which a larger aperture would not even suggest.

Nights often come when it is vain to attempt to divide even such a star as α Herculis with the whole aperture, or see the transits of Jupiter's satellites, yet a lesser aperture of 5 or 6in. will accomplish both tolerably well; unfortunately too, these are the kind of nights which predominate in our climate. This I say with great deference to Mr. C. Key's opinion, which is deserving of the highest respect, but it has forced itself again and again on my notice, and were I asked to advise one of your correspondents who was anxious to possess a telescope which he could use on most bright nights, and was not willing to keep a large one in reserve to use on good occasions only, I should strongly recommend a refractor of from 3 to 4½in. There is a calmness of definition in a refractor, arising from the air between the object glass and eye-piece being shut in, and nearly free from disturbance, which has greatly tended to induce a preference for that instrument over the reflector. This freedom from air currents is frequently mistaken for a greater sharpness of definition, whereas it may be stated with all confidence that a reflector, if it be a really good one, is, on favourable occasions, equal to the very best refractor of the same aperture, only those favourable occasions do not come quite so often with the former as with the latter.

The position of the eye-piece in the Newtonian telescope, as it is generally placed, has something to do with these tube currents, for the heat from the observer is almost necessarily brought in contact with the air in front of the tube, and with the surface of the tube itself; it would be very difficult to estimate accurately the exact ratio of disturbance originating from this source, as it varies so much under different circumstances, nor can we hope to eliminate it entirely until the good old form of the Cassegrainian or Gregorian telescopes come again into general use. An open tube could then be used with great advantage, which seems rather to increase the disturbance from this cause in the Newtonian telescope.

There is, however, no comparison whatever in the relative greatness of this source of indistinctness between the Newtonian and front view constructions. Of all the forms ever devised, the last-mentioned telescope is so completely at the mercy of these troublesome cyclones that, leaving out of consideration the spherical aberration, sharpness of definition is almost, if not quite, impossible, in such a telescope—certainly, if the correspondent, who sent you a sketch of his telescope lately is the happy possessor of one of those large heads, so highly spoken of in a recent number, very little light, and that of a very tumultuous character, can ever reach his 12in. mirror.

While speaking of this form of telescope, was sorry to read the abrupt manner in which your talented correspondent "F.R.A.S." took up a remark of "Arcturus" with regard to spherical mirrors. Your worthy correspondent has always been so courteous in his replies, and so ready to assist us at all times, that we should expect, for one who has taken so much trouble to enlighten our minds on the mechanical minutiæ of speculum grinding and polishing, and to teach us lessons which are rarely, if ever, learned from professional astronomers or opticians, better treatment at his hands. I can hardly see how "F.R.A.S." would, in any degree, trench upon the just estimate he has formed of the absolute necessity for the parabolic curve, if true definition is to be attained, were he to confess with Sir John Herschel, "that for this construction it is needless to insist on the parabolic curve." My own experience is, that the spherical aberration of a mirror, parabolised in the usual way, is quite equal to, if not greater, than that of a good spherical one, when tilted at an angle of [illegible] and 4 degrees, and that experience was learned from a most perfect 4½in. speculum by With. For preserving the silver films of these glass mirrors, if the observer does not wish to remove them from the telescope each time he has finished using it, I have found no plan so efficacious as to turn the tube itself into an air-tight cell; this is easily done by having it made perfectly staunch in all its seams, and having a lid for the mouth which fits most closely and neatly; to this lid is attached, by a string, a long roll of some light fabric, which has been steeped in chloride of calcium, and thoroughly dried in an oven or at the fire, before inserting it into the telescope. It will quickly absorb all the moisture in the tube, and as no more can creep in so long as it is closed, will keep the silver surface perfectly dry and bright. I have often thought, however, that some of your clever chemical correspondents would be conferring an incalculable benefit on the possessors of these telescopes if they could discover some method for precipitating pure aluminium on glass; it is of an exquisite white colour, of very close grain, and receives a higher polish than even silver itself, and might tend to render them quite equal to refractors in light-*grasping power*, as they are at present in defining power.

I see in a letter from one of your excellent practical correspondents, that he paid £2 for a "focussing motion" to the eye-piece of his telescope; now for about one-sixth of that sum he could have procured a ½ plate lens, secondhand, with rack motion. Having taken out the lenses, he could easily have fitted the spring-tube of his eye-piece to this, and thus have obtained a most excellent and simple focussing motion. This plan is not mine, as I feel sure many of your correspondents have seen telescopes so mounted.

The most pleasant "finder" possible, can be formed by placing a rectangular prism before the eye-piece of the finder, and so turning the rays out parallel to those from the large mirror after they pass the "plane." By this plan you have only to turn your eye from one eye-piece to the other, while still reclining in your chair, and need not strain either your neck or your eyes to find what you may wish to observe.

I cannot close this letter without two words of thanks, first to yourself for the successful manner in which you have conducted your most excellent journal of late, and the abundant store of really useful information you have managed to obtain for its pages from those whose "fame is in all lands," and secondly, to your generous and patient correspondent, Mr. Purkiss, who has made a real discovery in the science of speculum testing, and one of the very greatest value to all those interested in the subject. I have tested it myself, and believed it possible, with due attention to particulars, to attain, by the means he suggests, a mirror of any size, perfectly free from spherical aberration.

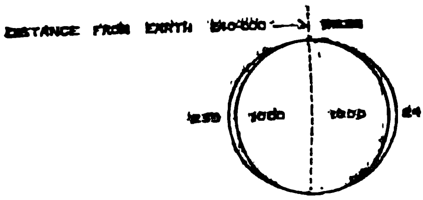
P.S.—I am very glad to see Mr. Wray's name brought before your readers in a recent number by the Rev. Mr. Webb. I have two object-glasses by him, one a 2 8-10ths inch, already mentioned, the most perfect of its kind I have ever seen, the other a 4in., recently obtained, which quite surprised me by its light-grasping power. On two occasions I have distinctly seen the 6th star in the "Trapezium" of Orion, a test I used to consider far beyond such an aperture. I do not mention these matters by way of advertisement, but to assist those in search of really good object glasses, and to whom the price is a very important consideration. If the amateur can save [illegible] in the purchase of an object-glass, and obtain a really good one, he has the money in hand to purchase a battery of eye-pieces, no mean consideration after all.

HYPERION.

EXTRACTS FROM CORRESPONDENCE.

NOMMES DE PLUME.—"Neptune," in a letter full of congratulations, says:—"One of the interesting features of the ENGLISH MECHANIC is the great variety of assumed names under which correspondents write. Where they all come from I cannot imagine, but I wish some were more easily pronounceable When one is about it, it is as easy to write under a neat and comprehensible name, such as 'Sigma' or 'Beta,' as 'Terset Denroy,' or 'Ab-oth-Yate.'"

THE MOON.—Cornelius Varley says:—"Our side of the moon is 1000 miles nearer than its centre, so needs to move quicker, but cannot, so it falls that little towards the earth, whilst the outer side, being 1000 miles farther than the centre, would move slower, so the moon has to drag it along, and thereby gives it some projectile force outwards, and thus the moon becomes somewhat oval; the near side pulling towards the earth, whilst the farther side is pulling outwards, makes it keep one face towards us. But the moon, as an enormous fly-wheel, cannot alter its rate suddenly, so it keeps an equal or uniform rotation on its own axis during the very unequal speeds round its orbit almost as 5 to 4 from Perigee to Apogee; and this discrepancy in the two motions is the cause of libration; for when the moon is farthest it passes us very slowly, though its own rotation continues uniform, so it shows us more on one side. Then when the moon is nearest it passes quickly, and shows us more on the other side. Thus, the moon's very uniform rotation on its own axis, and very unequal speed in its orbit, most beautifully shows the two separate motions. But this same action that so slightly elongates the moon is shown with the greatest intensity in the rings of Saturn; for they are so near their primary as to be not only stretched out flat, but have been obliged to separate into several rings by the differing speeds due to their respective distances."



TYPOGRAPHICAL ERROR.—"Ab Initio" writes: —There is a sad error at page 23, under the heading "Interesting Facts." An acre is said to be 1840 yards *square*. I think it should be 69 yards 1ft. 8½in."

THE TRANSIT INSTRUMENT.—"R. E. T." says:—"Apropos to the very able and interesting article on the Transit instrument and its use, in this week's number of the ENGLISH MECHANIC, will you allow me to inform your readers that the gentleman who was the originator of cheap telescopes is now engaged in an endeavour to construct a cheap transit instrument for working men, which, while it will not aspire to the accuracy of the most expensive instruments, will enable a person to get correct mean time to within 5 or 10 seconds? When complete, it will be brought under public notice through your journal."

SPLICING LEATHER BELTS.—"R.T.S." says:— *"The following cement requires only to be tried, and it will come into general use. If properly done, it is quite as strong as the solid leather*:—Dissolve Nelson's opaque gelatine in acetic acid by adding as much of the acid, and no more, as will dissolve the gelatine by putting it on a warm place on an oven or boiler. The splices should be made nice and thin, pasted with the cement, put together, and cramped between two pieces of wood, or, if a large number of joints are to be made at one time, lay the belt at full length on the floor, paste each splice separately, and rub it on the top with a piece of thin wood, squeezing as much of the cement from between the joints as possible, and left overnight until properly set."

BREAD MAKING.—"A. B." writes:—"T. Estee asks for a good method of making yeast for home use. He is welcome to the following, which I had from a cook in a first rate family in London, who never used baker's bread:—Take 2oz. of hops as fresh as possible, with 3qts. of water, and boil two hours; let it stand about five minutes after taking off the fire; then pour through a sieve over 1qt. of malt; let stand until only warm—not cold; then put in 1pt. of patent yeast, or some of the same sort previously made, which is far better; let it stand all night to work, then bottle off, and it will keep good for two months. It is best not to let yourself run entirely out of the last brew, as some of it is required to mix with the new yeast to work it properly; if you have none, a pint of patent yeast from the baker's will do. If T. Estee tries this, I should be glad to hear with what success."

TO MR. HENRY D. BARNES.—"The Secretary of the Museum of Fire Arms, Peckham-rye, presents his compliments, through the Editor, to Mr. Barnes, and begs to know if he would have any objection to exhibit a model of his invention for preventing gun accidents, in this museum, for the benefit of its members, who are all shooting men"?'

ELECTRO-DEPOSITED IRON.—Mr. W. C. Roberts, the chemist of the Mint, availing himself of Jacobi's process, has achieved something surprising with his specimens of electro-deposited iron. The source of the deposit is a solution of sulphate of iron and sulphate of magnesia; the rate of deposit is about the same as with copper, and the iron thus obtained is so hard that it will scratch glass, and has been found eminently useful for *cliches* and plates for printing purposes. Among Mr. Roberts's specimens, exhibited at the Royal Society, were bank-note plates, medallions, mouldings, and raised work of various kinds; and one plate had been converted into steel by a process which was not revealed. It is easy to foresee that so successful a method of depositing iron of exceeding hardness may be largely employed in giving a surface to rough iron-castings.

REPLIES TO QUERIES.

[1611.]—**APPARENT PARADOX.**—"U.B." is dissatisfied with "Quilosa." "Pneuma" has confused division with multiplication, and "U. B." rejects my explanation because "J. B." says nothing is not equal to nothing. I must remind "J. B." and "U. B." that the base of the operation is the assumption that *a* does equal *b*. This should satisfy "U. B."—EXCELSIOR.

[1886.]—**MEASURING PATTERNS.**—The method given by "C. J. B.," for finding the cubic contents of *patterns*, is evidently correct, but the same method would not always do for finding the cubic contents of the *casting* from the pattern (which, I presume, is what "Green" wants). Very often the interior, or any part, has to be taken out by means of a core—a common pipe, for instance; the pattern is generally made solid, and the interior is formed by a core. If the pattern is solid, the way to find the contents of the castings is this:—Find the quantity of water displaced by the pattern and the core separately, and subtract the latter from the former, and the remainder will be the cubic contents of the casting. When the casting is large, the pattern is not made solid for obvious reasons; sometimes the mould is built up with bricks and loam, and swept up to the required shape by a few boards, and no pattern is required at all. In all cases, when the castings are large, the contents must be found by calculation, the rules for which are to be found in any work on mensuration—SCIRE VOLO.

[2014.]—**TRICYCLE.**—I apply the motive power on a double 5-in. crank axle direct from the shoulder, without the aid of levers of any kind.—W. P. J. P.

[2027.]—**INDICATORS FOR ELECTRIC BELLS.** —"R. T." understands the electrical action but not the mechanical. The adjusting weight is so balanced that a current through either magnet attracts the armature, and leaves the same in the *attracted position* after the contact is broken. The kitchen push, therefore, is used to throw back the card by making contact.—EXCELSIOR.

[2033.]—**CLEANING SLIPPERS.**—"Inquirer" wants to know how to clean his slippers. Let him dissolve ½oz. of oxalic acid in half a pint of warm water, and when cold, sponge his slippers over with it. This will fetch the dirt and grease off, and when nearly dry rub a little olive oil in; this will soften them and improve them, no doubt, to his liking.—UNLEARNED MAN.

[2085.]—**SOLVENT FOR MARINE GLUE.**— *Mineral* naphtha is the proper solvent for this substance.—W. W.

[2085.]—**SOLVENT FOR MARINE GLUE.**—Has our friend "J. S." tried *heat*? Marine glue is made liquid enough when held in a flame.—IOTA.

[2090] and [2138.]—**HARDENING MILL BILLS.**— The VIII. and IX. vols. of the ENGLISH MECHANIC contain practical recipes which have been amply *tested*, and acknowledged to be of *great service*. It strikes me very forcibly that there is the same difference among millers in handling the mill bill, as between one writer in holding the steel pen. I have seen a stone-dresser cast aside one bill after another, as not fit for use, when the same tools, in the hands of his comrade, dressed the stone properly. Before diamond dressing machines came in, millers were proud of their good work, and in a visit to a mill lately, where, in times gone by, I have dressed many a pair of stones, I was deeply impressed with the dependence placed by the present race of millers on improved machinery. —ONE OF THE OLD SCHOOL.

[2091.]—**PENDULUM.**—$xA = xB = xy = 41''$

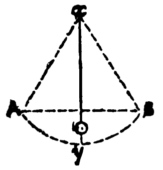
$$A x B = 3^\circ$$

$$x A B = x B A = 88^\circ\ 30'$$

$$\log. AB = \log. \sin. 3^\circ + \log 41 - \log. \sin. 88^\circ\ 30'$$

$$= \cdot 3317329$$

$$AB = \log. \cdot 3317329 = 2\cdot 1465''$$



Or if "Pendulum" mean that the angle $A x y = 3^\circ$

$$\therefore A x B = 6^\circ$$

$$\therefore x B A = x A B = 87^\circ$$

$$\therefore AB = 4\cdot 2915'',\ \text{Answer.}$$

—BLUE RUIN.

[2091.]—**PENDULUM.**—The distance, straight, from point to point, is 2·146454in. The distance along the curve traversed by the point of the pendulum is 2·14675407095302in.—MAIDEN NEWTON.

[2094.]—**SOLID CONTENT OF CYLINDRICAL FIGURE.**—$r = 2'$, $h = 10'$.

$$\text{Content} = \pi r^2 \times h + \frac{4 \pi r^3}{3}$$

$$= 3\cdot 1416 \times 2^2 \times 10 + \frac{4 + 3\cdot 1416 \times 2^3}{3}$$

$$= 125\cdot 664 + 33\cdot 5104$$

$$\text{Answer} = 159\cdot 1744 \text{ cubic feet.}$$—BLUE RUIN.

[2094.]—**CONTENTS OF CYLINDER.**—I can answer only the last part. The contents of a cylinder with hemispherical ends are obtained thus:— Diam.^{3} × ·5236 gives cubic contents of the two ends. Then diameter^2 × ·7854 × total length, less the diam. = the contents of the cylindrical part, the sum of the two products being the total cubic contents. In the case in point, 4ft.^{3} × ·5236 = 31·51 cubic feet; and 4ft.^{2} × ·7854 × (10 — 4) = 75·39 cubic feet. Total capacity = 108·9 cubic feet.—Q. Q. R.

[2091.]—**PENDULUM.**—The swing of a pendulum 41in. in extreme length, for 3 degrees, is found thus—

$$\frac{3^\circ}{360^\circ} \times \frac{\text{circumference of circle}}{82\text{in. diameter}} \left\{ \begin{array}{l} \text{inches.} \\ = 2\cdot 146 \\ = 2\tfrac{1}{8} \text{ full.} \end{array} \right.$$

or ·715 of an inch for each degree of swing.—Q. Q. R.

[2097.]—**STAINING WOOD.**—If F. Drop will put some iron or steel filings in a 2oz. bottle and fill up with vinegar, the mixture, after standing some hours with occasional shaking, will stain wood a jet black if the wood has been previously washed, once or twice, with a strong decoction of logwood chips, which should be boiled and applied warm.—SCRUTATOR.

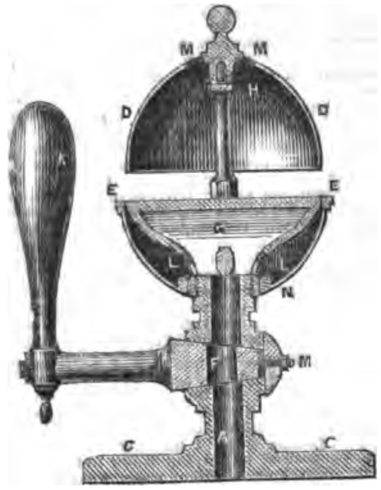
[2097.]—**STAINING WOOD.**—I may say that a jet black stain for wood is sulphuric acid (oil of vitriol), with which the wood is to be brushed over, and held close to a fire. The acid really *carbonises* the wood to a slight extent. Experiment will best show whether the acid requires to be diluted or not. It is better not to use it stronger than necessary, and the woodwork should be well washed afterwards, to remove all traces of acid.—Q. Q. R.

[2098.]—**DISCONNECTING STEAM PIPES.**—I think leather washers would probably suit "Scotch Mechanic"—IOTA.

[2098.]—**DISCONNECTING STEAM PIPES.**—If "Scotch Mechanic" would whiten one side of his india-rubber washer with whiting when making his joints, he might disconnect them many times without breaking them. I have used india-rubber washers for manhole joints on steam boilers for years and by whitening them they have lasted for years, being taken off every few weeks for cleaning.—B. W.

[2101.]—**DARK TENT.**—An amateur photographic friend of mine has used successfully for several years a dark tent, composed of three or four thicknesses of black and yellow calico, which I understand quite shuts out all hurtful light. Will not this suit "G. R. F."? It is light and durable, and when worn out costs but little for renewal.—Q. Q. R.

[2106.]—**STEAM WHISTLE.**—I send a sketch of a section of a steam whistle, which is formed of either brass or bell-metal. A is cast hollow with a flange, and bolted on the engine at C c. F is a cock placed into it working with the handle K, and a screw M, to keep it tight. The cup G is screwed on to the stem A, and leaving a narrow passage, E E, all round. The piece G is hollow, having holes L L in its sides, and a pillar H standing on its centre, on which is screwed the bell O O, the thin edge of which is brought just over the opening E, and half an inch above it. On opening the cock F, the steam enters the cup N, through the holes L, which causes the shrill screaming sound. Holes M M are made at the top of the bell O, to allow the steam to pass out, and improves the sound. The sounds of the whistle are regulated from shrill to hoarse by the size of the concentric part where the steam escapes, depth of bell, and their distance. —F. B. KNOX.



[2111.]—**TESTING MILK.**—The lactometer sold in the shops at 1s., with directions for use, is the most ready way of ascertaining the quantity of cream present; the hydrometer for determining the density, or relative richness in caseine matter, and dilution with water.—PATER.

[2112.]—**CONFECTIONERY.**—"Practical Confectioner," by Cox, Longman, and Co., 8s.; Confectionery in "Industrial Library," Houlston, 1s. 6d. Every description of lozenge, drop, candy, &c., is to be found in Cooley's "Cyclop. of Practical Recipes," published by Longman and Co., price 28s.—A LOVER OF BOOKS.

[2114.]—**GUTTA PERCHA STRAPS.**—I have used many straps and bands, for which, when running at high speeds, the best lubricant is cold water. Whenever they became stiff, as they will in cold weather, or when out of use for a time, I soaked them in warm water, and brushed them with a stiff brush.—H. B. M.

[2116.]—**WATER POWER.**—200 gallons per min. falling 30ft. produces 11 h. p., but as about one-third of this would be absorbed in overcoming the inertia of the wheel and gearing, the wheel being of good construction, with properly ventilated buckets, there would remain for useful work 7 horse power. But a turbine would be preferable to a wheel under the circumstances stated.—C. S.

[2117.]—**CEMENT FOR IRON ROOM.**—"T. S. H." should put strips of well tarred felt between the iron sheets, where they overlap, or he may caulk the joints with oakum, and then tar it all well, and throw on sand.—IOTA.

[2121.]—BOILER TAP.—If the plug of the tap is so made as to be removable by taking out the screw underneath, take it out, and having put some oil and flour emery on the part that works in the tap, re-insert it, and turn it about, frequently withdrawing it, until the surface is ground bright, and the plug perfectly fits the tap. Then wipe off carefully all the emery, and smear the plug with tallow. On re-inserting it, it will be found that owing to its diameter being reduced by the grinding, it will go through the tap too far for the washer to get a bearing on the under part of the tap; the square on which this fits must therefore be filed as far up as is found to be necessary, and the hole in which the screw works drilled and tapped deeper. If a new tap is wished to be put in, there is no cementing required, but some white lead well worked into a washer of felt, which is put on the screwed end of the tap after it is inserted into the hole, and the screw nut is then tightly screwed down on it. To prevent a tank from leaking, let nothing but *rain* water be put into the boiler.—W. W.

[2124.]—EARTH CLOSETS.—If "R. M." can manage to get a drain from the bottom of the vault to carry off the liquid matter, he will find his alterntion a successful one. A second pan connected to the drain, when the place is used only as a urinal, will make the ob better still.—SCRIBBLER.

[2124.]—EARTH CLOSETS.—I believe the same difficulty was experienced at the gaol at Reading, Berks, and that a remedy was found. If the Governor there were applied to, he might furnish the required information; and if "R. M." by this means, finds what he wants, it would be useful to others, if he would send it for insertion in the ENGLISH MECHANIC.—C. S.

[2126.]—JOINING WIRE.—If "E. H. B." wishes to splice copper wire, he has only to twist the ends together; if strong iron wire, each end should be turned up and laid over one another for a length of about 2in., and then wrapped tightly with copper or good iron wire.—IOTA.

[2128.]—ASSAYING.—The process, as performed at the Royal Mint and Goldsmith's Hall, occupies five closely printed pages in Ure's, "Dictionary of Arts, Manufactures, and Mines." There are numerous illustrations of the apparatus, and tables, to which it would be better to refer than attempt a clumsy abridgment of so lucid an account.—A LOVER OF BOOKS.

[2131.]—PUMPS.—"Plumber" seems to have got somebody else's work. However, if he has it and has to make the best of it, perhaps this reply may be of service to him. From 40 to 50 (call it 45) gallons of water per minute falling 8ft. will produce a tenth of a horse power, but as the friction of the turbine and gear will absorb about one-third of the power expended, there will remain but the fifteenth part of a horse power for useful work. A turbine might be made to utilise this, but it would be a mere toy machine. Supposing it made, however, it would deliver through the pipe described, and to the height named, 3 gallons of water per minute. This quantity is so small as to be practically useless, and therefore some other means of supply should be advised.—C. S.

[2131.]—PUMPS.—The quantity of water available, say 50 gallons per minute, being so small, and the fall only 8ft., would it not be well to inquire whether, instead of a small turbine, a water ram would not prove more efficient, thus dispensing with the machinery of pumps, &c.? I have seen them employed for the purpose of supplying water to houses in the country, where a small fall of water was at hand, one great advantage being that the action is continuous, requiring little or no attention. There are one or more firms in London who pay great attention to this class of water engine.—H. B. M.

[2135.]—WASHING BLUE.—Mix finely-powdered indigo with starch paste, and make it into cakes of the required size and form.—GUILLAUME.

[2135.]—POWDER BLUE.—"Roasted cobalt ore and carbonate of potassia, of each one part; siliceous sand three parts; fuse together, cool and powder Used for bluing the starch in getting up linen."—Cooley.—H. B. M.

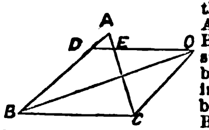
[2140.]—POOR LAD'S QUERY.—If he will write to me, I will give him the best advice I can.—T. W. WEBB, Hardwick Vicarage, Hay, S. Wales. [It is very kind of the rev. gentleman to answer "A Poor Lad's" query by post. But would not the same or similar information be useful to other inquirers if sent to our columns? We are sure that Mr. Webb would so word his reply as to be interesting to all.—ED. E. M.]

[2147.]—DIVIDING PLATE.—As to holding the pulley still with a division peg, as usually made, that amounts to an impossibility. You have a long, thin spring, with a peg sticking out some ⅞in. at the top, instead of the peg being as short as possible, say ¼in., with a knob that you can lay hold of without impeding your sight, as well as saving your finger nails, and avoiding hurting the fingers in pulling back the strong springs that *are* sometimes put to make up for the abominable length of the peg. The peg ought to be fixed to a bar that will not bend at all, working on a joint at the lower end, and forced up to its work by a spring of some sort, or a wedge jammed in behind it, against something solid; and this plan would help to preserve the holes. I think a good plan of holding a pulley steady would be to let the edge run close against a firm block of wood, and set it fast after every time of shifting by a loose clip like a carpenter's bench vice on a small scale.—J. K. P.

[2165.]—THE WORKMAN'S INTERNATIONAL EXHIBITION will open at the Agricultural Hall on July 5th. The last day on which applications for space will be received is April 25th. I shall be happy to forward every information, and space papers, &c., to any-one sending a stamped directed envelope, or they can be had on personal application at 150, Strand, or between 7 and 10 p.m. at the St. Mark's Club, 11, Brown-street, Duke-street, Oxford-street, W.—ROBERT BURGESS, Local Secretary, 22, George-street, Oxford-street, W.

[2166.]—MAGNET.—One or two pairs of Smee's elements, quarts, in moderate action, will make your magnet permanent if you wind plenty of insulated wire round it.—BRUIN.

[2167.]—LATIN.—"A New Subscriber" will find Beard's "Lessons" in the *Popular Educator* all that he requires. The numbers are published at 1½d. a week; but he might possibly obtain one of the previous editions second-hand. If "A New Subscriber" knows the rudiments, he might find the *Popular Educator* lessons *too full* (at least, that is my opinion). Under those circumstances, I would recommend him to get "White's Valpy's Delectus" and "Chambers' Grammar" (the best, bar none, at the price). Both are to be found on second-hand book-stalls; the first at 6d.; Chambers' Grammar about 1s. 6d.; full price 3s. 6d.—SAUL RYMEA.



[2169.]—PROBLEM.—Draw a line D E parallel to the base B C of a triangle A B C, so that D E is equal to B D − C E. Solution: Construct interior and exterior bisectrices, and through their intersection a parallel to the base: the isosceles triangles B D O and C E O give D E = D O − E O = B D − C E. Remark: For two interior bisectrices we have the parallel = the sum of the segments.—BERNARDIN.

[2170.]—UNANSWERED QUERY.—Old coins are generally black enough, but if you cover them with fine plumbago powder, heat moderately, and rub briskly, you may make them as black as you like.—BRUIN.

[2172.]—BINDER'S CUTTING PRESS.—I should be most happy to give "Maschil" a description of a cutting press, but it would only be wasting our Editor's space, for the tools and wood would be more expensive than buying the articles properly made. A new cutting press, plough, and pin can be obtained for 32s.; a secondhand apparatus for less.—AB INITIO.

[2175.]—LIFTING POWER.—The screw and the wedge are on the same mechanical principle—that of the inclined plane; and therefore, if the angles are equal and the external force applied equal, they should raise the same weight. Which it may be best to use must depend on each particular case.—BRUIN.

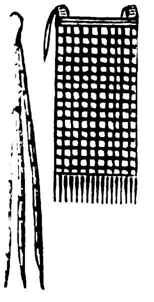
[2181.]—DERBY CEMENT is a proprietary article, and its manufacture a secret. Ask how to make a good cement for mending jet, china, &c., and you will get lots of good answers.—LUKE THE LABOURER.

[2182].—CONSTRUCTING COIL.—If "Nemo" has not already got his wire for the primary coil I would recommend the following dimensions:—Diameter of soft iron core, 1⅛ in.; length, 16 in.; diameter of primary wire, about No. 12; quantity required about 6lbs., cotton covered. There may be a little left, but that can easily be cut off, whereas it would not be so well to join a piece on. This should be laid on in three layers and well coated with shellac varnish and dried before putting on the wire for secondary coil. If he uses No. 16 he will require about 4 or 5 pounds, say 4½ lbs. to be safe, laid on and coated as above. With regard to the tinfoil for the condenser, he will require about 60 square feet, which will weigh from 1½ lb. to 2lb.; let him be very careful to insulate each sheet well. With a proper battery, equal to 6 cells of Grove's with platinums 6″ × 3″, he ought to get from 4in. to 5in. spark, but as a trifling error causes a great difference, he might depend on about 4in. with ordinary care. I should not advise him to use the bottle batteries, as he would require a larger number, but if first cost be a drawback would prefer Bunsen's of a rather larger size than that given for Grove's to compensate for the slight difference in power, Grove's being the best. It has generally been found that there is nothing better than the best *white* silk and cotton for insulating the wire; the dye gives a little loss but not much; there is no special peculiarity about either the cotton or the silk used except that the quality be good. With a coil of the size that "Nemo" mentions, he had better keep to the old method and use guttapercha tissue with paper soaked in a mixture of guttapercha, pure benzole, and solid paraffin, which must be made with careful heat so as not to ignite the benzole. By giving four coats of shellac varnish to each layer of wire, using about three thicknesses of tissue, and say (for safety) two thicknesses of the prepared paper, he ought to have a coil which it will be almost impossible to break down. Should there be any other little point which "Nemo" does not understand, I shall be pleased to explain it as far as lies in my power.—T. S. C.

[2188.].—BICYCLE WHEELS.—As I make bicycles which drive by the back wheel (see page 506, Vol. X., I think I can give "Gimcrack" advice as to sizes of his wheels. If he has the small wheel in front he can have the seat as low as he likes, and he can also use with advantage a larger driving wheel than if it were driven *direct* on the cranks and placed in front. Still from what I can tell it is never an advantage to have higher than 48″ (beyond which, also, the machine would look a monster.) I cannot see how he can make the same ironwork do. I should get a 40in. wheel for the back and 30 to 33in. in front. Allow me to mention here that the roller referred to in the description of my back wheel bicycle is not needed in turning.—SAML. JAMES.

[2196.]—NAMES OF PUBLISHERS.—"Annals of England," 3 vols, 8vo, 15s., Parker, 1853. On Bell Ringing, "Clavis Campanalaria" I am unable to give the price or date of; "Campanologia Improved; or, the Art of Ringing Made Easy," 3rd edit., London, 1733, is a little book that contains all the terms made use of, and may be met with occasionally on a book stall. It is now many years since I ceased to be—A COLLEGE YOUTH.

[2217.]—THE WAMPOOM—or better, the Wampum—was the money of the Indians of N. America (wampum is an Iroquois word meaning mussel). It consisted in little tubes made of shells, fastened upon belts or strung on deer sinews and worn as necklaces. The purple beads were made of the clean parts of the common clam shell (*Venus mercenaria*), the white of the columella of various shells (*Strombus gigas, &c.*). A piece being split off, a hole was drilled in it, and the form, which was that of the beads known as "bugles," was produced by friction; they were about half an inch long, generally disposed in alternate layers of white and blue, and valued about two American cents for three blue beads or six white. A fathom of white was worth about 2½ dollars; they were of less value at the time of the War of Independence. The wampum was used in traffic, in treaties, and as a token of friendship or alliance. Wampum belts also constituted records of public transactions in the hands of a chief. Mr. J. K. Lord brought from Vancouver's Island a belt composed of dentalium shells much resembling *Dentalium entalis*, L., but described by Nuttall as *Dentalium pretiosum*; Dentalium is a white cylindrical shell, resembling the shank of a common clay pipe. What is more curious, the remains of a Celtic warrior were found near Salisbury, and among the ornaments was a necklace of dentalium shells. Two skeletons found in Dublin, 1838, had necklaces of *Nerita littoralis*. The ancient Egyptians had also necklaces of enamel beads alternately blue and white. The Gauls had beads and pierced discs. Might not this bead money have been the origin of the Chinese pierced coins? Much more could be said about the different objects used instead of money. I annex a sketch of a wampum string and belt.—BERNARDIN.



[2221.]—SHORT SIGHT.—TO ETHARDO.—I am shortsighted, and can always see better through a telescope by keeping my spectacles on. There are no telescopes specially constructed for myopy.—G. E. CRICK.

[2223.]—ENGRAVING ON SLATE.—I do not know whether there are any special tools for this purpose, but if I wanted to do anything of the kind, I should get some of the larger kinds of wood engravers' tools. They are to be obtained at any of Buck's shops in London. If the figures on the dial are required of a large size, they should be cut out with a chisel.—SAUL RYMEA.

[2223.]—ENGRAVING ON SLATE.—To F.R.A.S.—Use the ordinary gravers, of a large size. The work is very pleasant. Sold at Buck's.—G. E. CRICK.

[2225.]—VACUUM IN CYLINDER.—In a high pressure non-condensing engine the piston has frequently to be forced back at a pressure of three or four pounds above the atmosphere. This is partly owing to friction in the steam ports, pipes, &c. If the exhaust pipe is too small, there will of course be a great amount of back pressure. I once heard of a partial vacuum being obtained by leading the mouth of the exhaust down to the surface of a stream, but I cannot say if this was actually the case.—MACHINATOR.

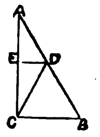
[2226.]—TINCTURE OF IRON.—To "Vacant Head."—You had better buy what you want, at *6d. per* oz. It will never pay a man to make *his own* medicines. A little knowledge is a *dangerous thing* where the stomach has to be acted upon.—*G. E. CRICK.*

[2226.]—TINCTURE OF IRON is made from the sesquioxide of iron, hydrochloric acid, and rectified spirit. No one can make it as cheaply as he may buy it in small quantities. An ounce may be procured for 6d., and will make 30 or 40 doses. As to its medical properties, no human being can condense an account of them into three or four lines. It is a tonic, and is used in 20 different diseases at least.—LUKE THE LABOURER.

[2227.]—LIFE BELT.—The most reliable life-belts are those which are sold by the Royal Humane Society.—G. E. CRICK.

[2231.]—ENCKE'S COMET.—For an elaborate answer to this query see "Omicron's" letter on another page.—ED. E. M.

[2232.]—PROBLEM.—The hypothenuse A B of a right-angled triangle is divided at 8, so that A D : B D :: C B : C A. Show that tan. A C D $= \dfrac{a^2}{b^2}$ and C D $= \dfrac{\sqrt{a^4 + b^4}}{a + b}$



Solution: Let A C = b, C B = a, const. parallel E D. We have:

$$ED : a :: AD : AB :: a : a + b, \text{ hence } ED = \frac{a^2}{a + b}$$

$$EC : b :: DB : AB :: b : a + b, \quad ,, \quad EC = \frac{b^2}{a + b}$$

in the triangle E C D we have tan. A C D $= \dfrac{ED}{EC} = \dfrac{a^2}{b^2}$

and C D $= \sqrt{ED^2 + CD^2} = \dfrac{\sqrt{a^4 + b^4}}{a + b}$

—BERNARDIN.

[2237.]—SALERATUS.—This is much used in the United States for making cakes. It is a carbonate of potass, and contains a trifle more carbonic acid than pearlash; but, for domestic purposes, saleratus and pearlash may be considered as one and the same thing.—TAUTAU.

[2237.]—SALERATUS—Is a carbonate of potash which contains a greater quantity of carbonic acid than pearlash, and is used in cookery.—MINNEHAHA

[2242.]—DIGITALIN.—Let "Pharmaceutical Student" take this advice: In all his proceedings in acquiring a thorough knowledge of pharmacy seek for a definition of the articles he uses, and he will scarcely ever fail. Had he turned up the P.B. for acetic acid he would have found the acid ordered in the formula for digitalin clearly defined.—H. E. Godfrey.

[2242]—DIGITALIN.—From "Pharmaceutical Student's" letter (1945) it seems that he not only distilled off the alcohol from his extract of digitalis, but carried the evaporation to perfect dryness, perhaps even applying the heat afterwards, as he seems to have made the extract so dry that he could powder it. I should suggest this as the probable cause of his failure.—E. K.

[2240.]—NUT SHAPING IN THE LATHE.—The nosepieces carrying the nuts are held in place by a small taper steel pin, which, going through the two sides of the hole and the nosepiece, holds the latter firmly in place.—W. H. N.

[2253.]—YACHT BUILDING.—I think "Notes on Yachts" by Edwin Brett, Low and Co., may suit "Steersman."—G. E. Crick.

[2254.]—DOORS.—Walnut timber requires quite as much seasoning as any other wood, and is not at all adapted for making doors, being now used principally for veneers. The labour of working it will more than amount to the price of oak.—Minnehaha.

[2256.]—CLEANSING CASKS.—First wash the inside of the cask with cold water till it is perfectly clean, then, for an 18-gallon cask, mix two gallons of cold water with half a pint of chloride of lime, which pour into the cask and shake it for about a quarter of an hour. Then turn it out, and again wash the cask with pure cold water. A strong smell of lime will arise for some time, but in two or three hours it will be entirely gone. No fear need be entertained that any taste or smell of lime will be given to the ale.—Tautau.

[2258.]—EQUATIONS.—I beg to send a solution to the equations in the first number of the present volume. In the 1st equation we have given

$$\frac{x-a}{b} + \frac{y-b}{a} = o \quad \ldots \quad (1)$$

$$\text{and } \frac{x+y-b}{a} + \frac{x-y-a}{b} = o \quad \ldots \quad (2)$$

From (1) we get $a x - a^2 - b y - b^2 = o$ .. .. .. (3)

From (2) $b x + b y - b^2 + a x - a y - a^2 = o$

or $a x - a^2 + b y - b^2 = a y - b x$ .. .. .. (4)

But from (3) $a x - a^2 + b y - b^2 = o$:

$$\therefore o = a y - b x, \text{ or } b x = a y \therefore x = \frac{a}{b} y: \quad (5)$$

Now substituting this value of x in (3) we get $y = b$;

$$\text{and } \therefore x = \frac{a}{b} y = \frac{a}{b} b = a$$

In the 2nd Equation we have given

$$(a+h)x + (b-h)y = c \quad \ldots \quad (1)$$

$$\text{and } (b+k)x + (a-k)y = c \quad \ldots \quad (2)$$

$\therefore$ by subtracting (2) from (1)

$$-(b+k)x - (a-k)y + (a+h)x + (b-h)y = o;$$

$$\text{or } (a+h)x + (b-h)y = (b+k)x + (a-k)y;$$

$$a x + h x + b y - h y = b x + k a + a y - k y;$$

$$x(a+h-b-k) = y(a+h-b-k)$$

$$\therefore x = y$$

And substituting this value of x in (1) we get

$$y = \frac{c}{a+b} \text{ and } \therefore x = \frac{c}{a+b}$$

—Y. P. W.

[2258.]—EQUATIONS.—Solve

$$(1) \quad \frac{x-a}{b} + \frac{y-b}{a} = o$$

$$(2) \quad \frac{x+y-b}{a} + \frac{x-y-a}{b} = o$$

I write (2) as follows:

$$\frac{x}{a} + \frac{y-b}{a} + \frac{x-a}{b} - \frac{y}{b} = o$$

and subtracting (1) I have $\frac{x}{a} - \frac{y}{b} = o$

Hence $bx = a y$ and $x = \frac{a}{b} y$

Substituting this value in

$$(1) \quad \frac{a}{b^2} y - \frac{a}{b} + \frac{y}{a} - \frac{b}{a} = o$$

$$y\left(\frac{a}{b^2} + \frac{1}{a}\right) = \frac{a}{b} + \frac{b}{a} = \frac{a^2+b^2}{ab}$$

$$y\left(\frac{a^2+b^2}{ab^2}\right) = \left(\frac{a^2+b^2}{ab}\right) \text{ or } y = b, \text{ and } x = a$$

$$\text{Proof } \frac{a-a}{b} + \frac{b-b}{a} = o, \; \frac{a+b-b}{a} + \frac{a-b-a}{b} = o$$

—Bernardin.

CANDLE-BEARING TREE.—This curious tree is only met with near the river Chagres, in the Isthmus of Panama, and was discovered there by Dr. Siemann. It is the fruit of this tree which so perfectly resembles, in shape and colour, that of unbleached wax candles, which has given rise to its popular name, *palo de velas* (candle tree); the botanical name is *Parmentiera cerifera*, and its fruit is eaten by sheep. The fruit known as quamxilotte and eaten by the Mexicans as a delicacy, is produced by the *Parmentiera pendulus*.

NOTES AND QUERIES.

[2259.]—TO "FEU FOLLET."—Will "Feu Follet" be pleased to give his process for bleaching wax by chlorine without destroying its burning qualities?—A Young Mechanic.

[2260.]—PORTABLE CARPENTER'S BENCH.—Will any reader furnish me with a plan or a few suggestions for making a portable carpenter's bench?—Alpha.

[2261.]—PITCH OF PROPELLER.—Will some brother reader give me the most correct method for calculating the pitch of a screw propeller? A diagram, showing how the blade should be divided, will greatly oblige.—Thomas J. O'Connor.

[2262.]—RHUMKORF'S COIL.—Will "Sigma" have the kindness to explain the manner in which the primary and secondary wires are wound on the bobbin of the Rhumkorf coil? I believe this is the most powerful machine at present known.—Thomas J. O'Connor.

[2263.]—DISSOLVING AMBER.—Will any brother reader tell me how to dissolve amber?—Catseye Diamond.

[2264.]—PENDULUM.—Having hung two pendulums on a rod and setting one in motion towards the other, the one that was remaining perfectly still, after a few moments, began to move with the other. Will someone describe what caused the other to move?—Catseye Diamond.

[2265.]—SCREW CUTTING.—I want to form a screw 4in. pitch, 4in. diameter, and 12in. long, on a piece of 4in. wrought tubing, with sheet zinc. What shape will it require to be cut in the sheet, so as to form the screw round the tube? A rule for doing this from some of our correspondents will much oblige.—J. G. W.

[2266.]—WASHING MACHINE.—Will some reader kindly inform me how to make a washing machine for domestic use? Being only an artisan I cannot afford to purchase one of those expensive machines advertised.—Artisan.

[2267.]—WORK ON ELECTRICITY.—Will some reader (perhaps "Sigma") kindly recommend me a good modern work (stating price) on electric science, describing in detail the theory of the induction coil? A work—whether in English, French, or German, would suit.—S. T. P.

[2268.]—POLES OF MAGNETS.—If my question will not be anticipating "Sigma's" intention, I should like to have explained to me why the magnetic poles or points of maximum attraction lie, not at the actual extremities of the magnet, but a distance within, &c.? The reason of this fact in magnetism has always puzzled me, especially as I find the same fact mentioned, but not explained, by several other eminent electricians. Electro-magnets, I understand, have their poles much nearer their extremities than permanent magnets, thus explaining, according to the law of inverse squares, why the magnetic field in one case is so much greater than in the other; but what I want chiefly to know is, whether there is any theory explaining the point in question.—H.

[2269.]—FOSSILS.—Will any correspondent inform me in what way slabs of stone containing small fossils are prepared? It appears that acid of some kind is used, which eats away the stone around the fossils, leaving them standing out like basso-rellievos from the surface of the stone. If washing with acid be the only preparation, I cannot understand why the fossils, as well as the stone between them, should not be destroyed.—H.

[2270.]—MOTION OF WATER.—What quantity of water will pass through a 1in. hole (round) at 38lb. per square inch?—J. Crompton.

[2271.]—PURIFYING NITRIC ACID.—Will anyone give a method for purifying nitric acid after having used it for dipping brass castings?—J. Crompton.

[2272.]—GALVANOMETER.—Will "Sigma" or any other electrician kindly give me a description of an indicator or galvanometer for indicating the strength or the induced current from an induction coil?—A. J. Hayward.

[2273.]—DR. KITCHENER'S TELESCOPES.—Is it known to any of your readers taking an interest in the telescope what became of Dr. Kitchener's instruments (about 60 in number, I believe) upon his death? Were they sold by auction, and is it known who possesses the Beauclerc object glass?—G.

[2274.]—VARNISH.—Many thanks to "Worcestershire Sauce" and "Gilder" for their prompt replies to my query. In regard to woodcuts and prints, I suppose the same process will apply to them as to maps, but will it answer with pencil drawings?—Inquirer.

[2275.]—SUN GLASS FOR TELESCOPE.—Will any of my brother readers kindly inform me what kind of glass is placed before the eye-piece of telescopes for viewing the sun?—J. H. Ward.

[2276.]—GRANITE POLISHING.—Will any brother mason kindly inform me the process adopted in polishing granite?—whether putty powder or emery is employed, and how to apply it? Full particulars will greatly oblige.—Marble Mason.

[2277.]—GRINDING.—How much wheat should millstones 3ft. 4in. and 4ft. respectively, grind in 12 hours on an average, with power in plenty? Would any practical brother reader kindly give the result of his experience?—Sergius.

[2278.]—DRAINAGE.—Can any of your correspondents inform me the names of books or pamphlets, also prices and the names of publishers, treating on drainage and sewage irrigation?—Izgitzar.

[2279.]—WATER.—Can you inform me how to test and analyse water, and how the standard solution of permanganate of potash is made for detecting the presence of organic matter in water?—Izgitzar.

[2280.]—CHINA GRASS.—I should feel obliged if "Ernest" (query 1894) would inform me where to procure seed of the China grass plant or *Urtica Nivea*, and also the best means of separating the fibre from the stalk, with the various processes it goes through until fit for the market?—Ross.

[2281.]—AURIFEROUS ORES.—Can any of your numerous readers give me information as to the treatment of auriferous ores, and of ores containing sulphur, arsenic, and other base metals, with the view of utilising each, together with drawings of furnaces, flues, condensing chambers, &c. used to carry out the work, also the best way to separate the gold from the pyrites—commonly called black sand—that is sent from Australia, and whether the sulphur and arsenic is saved; if so, by what process? Would the introduction of electricity into the mass while under treatment of chlorine be of any advantage, or whether it would prove dangerous? Would a hot or cold blast be of any service?—Ross.

[2282.]—POWER OF STEAM.—Will any reader inform the writer if steam passing through a tube 32ft. long to a small high-pressure engine would act with as much power as if nearer to the boiler? Of course he is aware of the greater loss by condensation; but, apart from this, will steam act with as much force after passing through 32ft of a tube as if it only passed through five or six feet?—B.

[2283.]—PAINTING THEATRICAL SCENES.—Can any of your readers give me information on the following points:—1. How to paint theatrical scenes on coarse calico with (if possible) water colours? in order to prevent the smell of oil. A full description, including how to prepare the calico for the colour, and how to mix the colour, is requested. 2. Where to obtain the necessary colours? 3. Could any varnish be applied that would not crack on being rolled up, to protect the colour?—H. N. H.

[2284.]—MEDICAL COIL—TO "SIGMA."—Will "Sigma" oblige by telling me how I am to know the primary or secondary handle of his medical coil as described in Vol. X., p. 513?—J. S.

[2285.]—MIXING BRASS.—Will some reader tell me the way to mix common soft brass?—Caster.

[2286.]—GENEVA CYLINDER.—Will some horological reader kindly give directions for selecting and turning in a Geneva cylinder, describing how to arrive at the different heights, and stating whether the cylinders when bought from the shops are with or without plugs, or are the plugs to be bought separately? also if the cylinders are ready escaped, or is that left for the workman?—Cylinder.

[2287.]—DAMAGED LENSES.—Is there any means of making a telescope of service again, the glasses of which have become opaque—having been in a fire? If so, how can I do it?—W. H. P.

[2288.]—CHARCOAL FOR RUBBING DOWN SILVERED CIRCLES.—Can any of your many well-informed correspondents give me a few hints for making the above? What kind of wood to use? what heat to apply? whether to be burnt alone or mixed with any other substance? Any information would be welcomed.—Iota.

[2289.]—GLYCERINE.—I find that it does not pay to distil my glycerine. Will any scientific friend inform me how I can make glycerine of a brownish tint perfectly clear, with a small outlay of money, and little loss of material?—Glycerine.

[2290.]—BROAD LEAD PENCILS.—A very useful pencil for drawing foliage, &c. was in use some time ago, invented by an artist, Mr. Galpin. Can anyone tell me where they are to be purchased now?—Inquirer.

[2291.]—ENGRAVING ON METAL.—Will "Engraver" kindly tell me the use of the scrapers and points which he mentions in his query 2010, and to what temperature the gravers are lowered?—Young Country Watchmaker.

[2292.]—GEOMETRICAL METAPHYSICS.—What could be the origin of the notions geometers get of regular figures—such as point, line, surface, circle, sphere, cube, &c.?—F. Bosmans, Louvain.

[2293.]—STRANGE MECHANICAL MOVEMENT.—Let a top—such as is used for astronomical demonstrations—be put into motion, present to the upper part of its axis the edge of a metallic spiral, the axis of the top will adhere to the metal as if it were a loadstone, enter the spiral and follow its curvation; at the end of the spiral it returns backwards, and repeats again the same motion. The sight of this struck me because it appears against the rules of common mechanics. Could any of your readers favour me with a satisfactory explanation of that curious phenomenon?—E. V. V., Louvain.

[2294.]—THEOREM.—Would some of your mechanical correspondents favour me with a demonstration of the following?—With the same perimeter the area of the circle is greater than the area of an ellipsis.—E. V. V., Louvain.

[2295.]—PROBLEM.—Where ought to be the centre of a circle C for bisecting another C^1 in two equivalent parts?—E. V. V., Louvain.

[2296.]—MONOGRAM DIE.—Can anyone tell me how to set to work to cut a copper counterpart to a steel monogram die? What tools are required?—Cantab.

[2297.]—VIOLET INK.—Will anyone give me a recipe to make good dark violet ink?—Cantab.

[2298.]—REMOVING OIL PAINT FROM SILK.—I have a large bit of white silk which has been sized and painted on with ordinary oil colours. Can I get the paint off without injuring the silk?—Cantab.

[2299.]—GENERATION OF ELECTRICITY.—TO "SIGMA."—I venture to ask "Sigma" to tell me what is the cause of the spindles in our spinning mules generating electricity when running to such a degree that if I touch one with my finger it will make sparks fly off and electrifies the piecers every time they piece a thread. If he could give me any advice how to cure this he would be conferring a great favour.—Lancashire Lad.

[2300.]—MOULDS.—What material is best for moulds for fancy ornaments? Would gutta percha answer as well as beeswax?—B. C.

[2301.]—WEIGHT OF WROUGHT IRON GATES.—Will some reader inform me of the best method to obtain the weight of wrought iron gates and fencing y measurement, or where I can get good books on the subject?—W. R. Southwell.

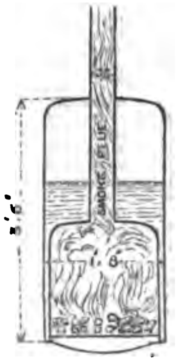
[2302.]—POLISHING SCOTCH PEBBLES.—Would some one inform me how to bring the surface of a pebble to an even face, and afterwards how to polish?—Amateur Lapidary.

[2303.]—TEA URN.—I have a tin tea urn which makes the tea a very dark colour, and quite tasteless. Some time ago the tap came out, I had it put in by a common tinman, and since then it has never been right, although before it was an exceedingly good one. What is the cause?—Caution.

[2304.]—PALO DE VELAS.—What is it?—Robt. J. Johnson.

[2305.]—FORMANISING.—This is a process of preserving wood. I wish a few particulars about it from some of our kind brother readers.—Contractor.

[2306.]—MORE STEAM WANTED.—The enclosed is a section of a small boiler I have 3ft. 6in. high and 1ft. 8in. diameter, and which I wish to make drive an engine with a 3½in. cylinder at a about 60lb. or 70lb. pressure, but I find I cannot make steam fast enough. I therefore wish to ask some of my fellow readers to kindly inform me if putting in—say, four or five 1½in. tubes round the smoke flue (which is only 3½in. diameter) would make it answer my purpose, or is the only remedy a larger boiler, and if the latter, what sized boiler should I require?—D. C. W.



[2307.]—RIVET MAKING.—How and in what way are rivets made by machines—about ½in. diameter?—Rivet.

[2308.]—MELTING CAST STEEL.—I have been trying to melt some old scrap steel in a crucible, and have succeeded, but I find it too hard to work. I should feel obliged if "Practical Moulder" would give any information regarding flux.—Scrap Steel.

[2309.]—ETCHING ON GLASS.—Would any brother reader kindly give me a few hints on etching on glass with fluor spar?—Belle Isle.

[2310.]—SPIRIT TAPS.—Wanted a good method of grinding spirit taps.—Belle Isle.

[2311.]—NEW WORM FOR VICE BOX.—How can I put a new worm to a vice box that has slipped thread? I have seen one or two that have been done, and which are as good as new.—A. E. B.

[2312.]—HISTORY OF IRELAND.—Will any of your numerous Irish readers kindly inform me of a complete, reliable, and moderately-priced history of Ireland?—A Young Irishman.

[2313.]—ENAMELLING CAST IRON.—How can I procure a white enamel on cast iron, with full particulars?—Arthur Jones.

[2314.]—POLISHING FRETWORK.—I should be glad if "Guillaume" or some other correspondent would inform me of the whole *modus operandi* of polishing—whether he uses any size to stop up the little holes and crevices in woods like oak preparatory to applying the polish. The objects I wish to polish are fretwork; also where to buy the proper polish? The stuff I have by me is very thin.—C.

[2315.] TELESCOPE CONSTRUCTION.—Why are astronomical telescopes constructed so long, as I have two of 2ft. and 4ft. focus respectively, and I find that by using an eye-piece (with the small telescope) half the focus of that I use with the large telescope, it equals the large one in every respect, and I cannot see what advantage the large one has over the small one?—Astronomer.

[2316.]—THE SLIDE VALVE.—Can any of your correspondents recommend a good book on the slide valve and the valve motion, and the name of the publisher, and the price?—A Constant Reader.

[2317.]—CURVATURE OF THE EARTH.—Perhaps some professional correspondent will give his "field notes" of practical curvature allowance, so that others may plot and test it. Along a still water line preferred.—Theodolite.

[2318.]—ETHEREAL SOLUTION.—Will "Sigma" kindly inform me where to procure the ethereal solution of gold spoken of in reply to Mr. Sharp (2040), also the means of applying it, and whether the steel requires any preparation? If he will he will greatly oblige.—B. S. Burden.

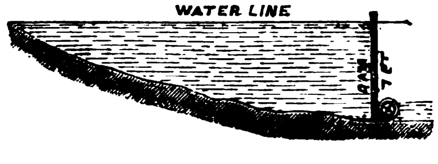
[2319.]—BOILER.—I am about putting down a small steam boiler—the steam to be used for boiling two troughs for bone button making, &c. I should be glad if some of your readers could inform me the best way, and if I can put water in the boiler when steam is up without a pump? steam will not be required very high.—John Jones.

[2320.]—CHIMING.—I want to make or alter a clock so as to make it chime the half hours as a ship's bell is struck—thus, at half-past 12 to strike 1, at 1 to strike 2, at half-past 1 to strike 3, with the same pause between the second and third strokes as in an ordinary clock exists between the strokes for the quarter and half hour; this would go on till 4 o'clock, when it should chime 8 in four pairs of beats, and then commence again at half-past 4. The pauses to be between the second and third, the fourth and fifth, and the sixth and seventh beats. Can any brother reader say how this can be done?—An Old Salt.

[2321.]—SWAN'S PROCESS.—What is the *modus operandi* of the autotype or carbon photographic process invented by Mr. Swan? and is it successful upon parchment?—Scribo.

[2322.]—PRIE DIEU.—Can any reader tell me where I could obtain designs for a prie dieu to be executed in oak wood—not too elaborate—but that necessitates a little carving in the panels, &c.?—Good Catholic.

[2323.]—WATER POWER.—Can a brother reader inform me what power may be obtained to work machinery from a runner of water I have—about 200 cubic feet per minute (often more) by causing a dam to be put across the brook, and giving a pressure as shown on sketch to turbine or other form of wheel? Will the accumulated water in brook be an aid as force to the quantity regularly running as named above, a length, say, of 80 yards, being back water to dam?—G. P.



[2324.]—GYMNASTICS.—As I am going to construct a pair of parallel bars, I wish to know the best plan of having them fixed up. What I have seen were fixed in the ground, but I fear they would soon get rotten, being exposed to the weather. In "Modern Gymnast" a sketch is given of a portable pair fixed to a frame. Would "Bierlala" or any of your gymnast correspondents who have had experience in the matter be so kind as to advise me which is the best plan? Is there not a process which would render the wood not so liable to decay?—Gymnastikos.

[2325.]—IRON ORES.—Will G. E. Davis inform me how to estimate the quantity of protoxide and peroxide in iron ores?—J. N., North Country.

[2326.]—VIOLIN.—Can any of your readers tell me the exact pressure on the belly of a violin strung to concert pitch?—Cremona.

[2327.]—READY RECKONER.—Can any brother reader inform me where I could procure a ready reckoner for calculating tons and cwts., giving the fractions from 1d. to 5s. per ton?—J. W. M.

[2328.]—DEFECTIVE GUTTER.—I have a double-roofed building; the gutter is of Glasgow cast iron, and in wet weather the water oozes through the pores in small drops and makes the building very wet. Can any of your readers inform me what is the best thing to do to make it perfectly waterproof?—Salop.

[2329.]—MATTING.—Can any reader tell me how to clean matting?—Minnehaha.

[2330.]—THE BOOMERANG.—I possess three specimens of the boomerang, but they totally fail to achieve what I have read of them. Will someone suggest the true method of using them?—Salmo Salar.

[2331.]—PATENT DRYERS.—Can any of our readers inform me of what patent dryers (for paint) is composed?—H. Beech.

[2332.]—UNNOTICED QUERY.—How are the perforated and traced patterns for embroidery and braiding effected on paper, and on the materials, directly?—Stitch.

[2333.]—BRILLANTINE.—Will some kind reader of the English Mechanic inform me how brillantine is made?—Perfume.

[2334.]—POLISHING HORN AND SHELLS.—Will some brother reader kindly tell me the way to polish buffalo horns and tortoise shells?—W. Crocker.

[2335.]—CONTACT BREAKER.—Can any of your readers advise me the best form of contact breaker for an induction coil to give a 7in. spark? The ordinary forms are a source of continued expense by the platinum points melting away.—A. E. Tucker.

[2336.]—BRONCHITIS.—Can any brother reader inform me of a cure for the above complaint, or rather what it has left behind it? About three years ago I had a very severe attack of it, and ever since I have been more or less affected in the chest and windpipe, with a husky voice; very apt to take cold, with a cough not very violent, but very distressing. All that I have taken seems to have no effect on my voice. I sometimes fear it will end in consumption if no remedy can be had. My age is 28. Any information will be a great favour.—A Three Years' Sufferer.

[2337.]—STEAM INDICATOR.—Will some reader kindly tell me of any work on the steam indicator?—Marine.

[2338.]—SAW TEETH.—Would "Mill Sawyer" be so good as to give a sketch of what he considers to be the best form of circular and deal frame saw teeth?—R. T. S.

[2339.]—SIZE OF PULLEY.—I have an 8in. centre screw cutting lathe with overhead motion, and I want to drive it from a shaft that is running at 24 revolutions per minute. Will any brother reader kindly tell me the diameter of pulley I require on this shaft to drive the lathe to speed?—Marine.

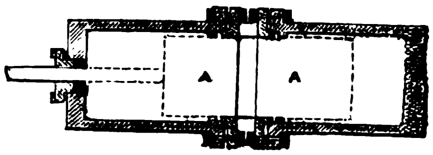
[2340.—WIRE COVERING.—No one seems to have noticed my query asking what sort of cotton is most suitable for covering wire. I have a covering machine, but cannot get a suitable cotton for my purpose. Perhaps some one will give me the requisite information?—Over Sands.

[2341.]—CANOE.—I thank "Maty" for his notice of my question respecting a canoe, and beg to inform him I want it of suitable size to carry one person, and to be similar in shape of those used by the canoe clubs. Would be glad of any instructions he could give me as to best material, or anything else.—Over Sands.

[2342.]—FACINGS FOR HARMONIUM KEYS.—My harmonium keys are of worn-out ivory. Can anyone suggest a method of facing them either by enamel or otherwise?—Progress.

[2343.]—LUBRICATORS.—I shall deem it a great favour if some of your numerous correspondents who are qualified by experience of Roscoe's self-acting lubricators will advise as to the following:—I am the owner of a 10-horse traction engine, and have had one of Roscoe's No. 2 lubricators fixed by a practical mechanic on the top of the dome—the engine was built by Fowler, of Leeds; my driver received the instructions from the mechanic how to work it. When tallow is put in (when there is steam) it is all blown out over the top of the engine. The fire is kept on in the engine all night, so that we cannot get any tallow on the lower end of the lubricator before the end of the week; also, will you inform me the best way to apply the needle lubricator to the motion bars—the present oil-cup is fixed in the centre of the bars? I find the needle lubricators act first-class on all the bearings of the engine, and are most invaluable. I would advise all owners of engines to have them applied, as they are moderate in price and most simple to fix, and when filled a quarter of a pint will last a week.—Progressive Age.

[2344.]—CYLINDER.—Perhaps some of my fellow readers will give their opinion upon the following form of cylinder—it occurred to me a day or two back. Possibly it may be useful to some who cannot bore a true cylinder:—A A is a long cylinder sliding steam-tight in the outer cylinder—it is made steam-tight by glands, the same as in the piston-rod. Steam being admitted at one end of the outer cylinder, it naturally acts upon the inner one as on the piston of other engines.—W. H. Thorpe.



[2345.]—REPTILES.—Will some reader give me a diagram, &c., showing the geological distribution of reptiles throughout the globe?—Lynx.

[2346.]—GEOLOGY.—Can some one mention the name of a good manual on geology—price about 10s.?—Permian.

[2347.]—THE TELESCOPE.—1st. How can I get my telescope set exactly north and south, also east and west? It is fixed with cement into the top of a large drainpipe filled up solid, to which is attached a triangle of iron with legs—one at each angle, one of which, much longer than the other two, is let into a large square of freestone, and fixed with lead. The whole telescope, stand and all, can move round this leg to any distance, and can be raised or lowered by means of two nuts as much as needful. The two other legs rest on pieces of tin, and can be shifted east or west, as required. 2nd. Wishing to look at the sun, I took out my "flat" and removed all the silver and then replaced it, and then found that by using a piece of coloured glass between my eye and the power, I could do so with little or no danger to my eyesight—at least, so I think—am I right or not? 3rd. How can I convert north polar distance into north or south declination?—H. A. C.

[2348.]—ELECTROTYPES.—I thank "Sigma" for the ready way in which he answered my question. *It is the outer surface* that I meant, *and not the one in* contact with the mould, so I shall have *to make my* moulds on a different principle, as he says the *outer* surface is generally rough, and the articles I am coating are small wax figures in the shape of a man, so that the inner or smooth surface is inside, and is not seen, while that part that is visible is the outer and rough surface. Will he kindly tell me how I should make moulds for this purpose, as it seems to me to be different to making medallions, which I can manage very well?—E. R. H.

[2349.]—BILLIARD BOARD.—Can any of your readers give me some practical advice on this matter? How to set about making one, and the *modus operandi*? Where to obtain a slate bed of 8ft. by 4ft., and probable price? Is not also the cloth very expensive if wanted for a larger-sized table? Can you buy the cushions ready made? Guess (excuse the Yankeeism) there be a proper place for each of these things, but where is it, and how do you work the oracle? Any information will be very acceptable. If a billiard table of an average character could be economically made by an amateur, doubtless many of your readers will feel inclined to try it.—Cantab, London.

[2350.]—RAISING WATER.—What is the best and cheapest way of raising water from a well 30 yards deep?—W. S. O.

[2351.]—ALCOHOL.—What is the best chemical test to find the presence of alcohol in any kind of liquid?—Alcohol.

[2352.]—OVAL.—How can I get a correct oval, and whether the width is governed by the length? I can strike them several ways, but they are not correct, as I think an oval should not contain any part of a circle.—G. Hunt.

[2353.]—WORK ON THE VALVE.—Does any reader know of a work in which I could find a calculation on the dead weight valve. Say, suppose I have a 2in. dead weight valve to fix on a boiler, and to be weighted to 80lb. By what rule am I to make my calculation?—John Kershaw.

[2354.]—SPRING STEEL.—I wish to temper a large quantity of springs, similar to the bicycle spring upon which the saddle is fixed. As I cannot make these sufficiently elastic by tempering in the smithy fire, I should be very much obliged if some experienced hand will give me the best shape of oven, &c., for this purpose, with description how to go about my work to accomplish this object.—Brittle.

[2355.]—CANOE BUILDING.—Will "Steersman" or one of my fellow readers be kind enough to inform me what wood is best for the keel and ribs, also the dimensions for the same for a wooden canoe about 20ft. in length? I have examined several, and find the keel is curved at the ends to form the bow and stern-post. How is this managed, and how are the ribs bent to their proper size? A section would assist me very much.—C. D. R.

[2356.]—GOLD.—I have some gold in a finely-divided state mixed with sand. Will some chemical contributor inform me the easiest way of separating the same—

quantity of gold is about 10 grains, and of sand about 200 grains?—RUDIS.

[2357.]—IRON SECONDARY.—Has any brother reader made an intensity coil, using fine ironwire for the secondary, if so, will he please state the quantity and result?—GT. BOURTON.

[2358.]—WINTER'S ELECTRICAL MACHINE.—I am about to construct an electrical machine on this principle, but do not exactly understand how the cushions are made and fixed. Will some brother reader who has one be kind enough to describe this part minutely, with drawings?—SAPIENT.

[2359.]—GALVANIC BANDS.—Will "A 'Suffolk amateur" be so good as to give us a drawing of his galvanic band? I do not quite understand the joining of the metals. Why must they be whipped together with thread and varnished?—MINNEHAHA.

USEFUL AND SCIENTIFIC NOTES.

METHOD OF COPYING STATUARY IN VARIED POSITIONS ON ONE PLATE.—I can best explain my method by giving my first experience. I had occasion to make some card copies of a small marble statue of the "Greek Slave," and thinking it would make a much more attractive picture if it could be copied in a variety of positions on one card, I resolved to attempt it. I took for the background a strip of dark brown cotton velvet, arranging it so that the lower portion covered the top and hung a few inches over the edge of a small stand. Placing the image on the centre of the stand, I got the proper size and focus with the ordinary camera, and made a faint mark around the base on the velvet, then moved the image to the right and left of the first position, being careful that one position should not interfere with the other, and marking around the base each time, that I might know just where to place it in the subsequent operations. I then prepared and exposed my plate, covered the camera, moved the image to the next position, and exposed again as before. On developing my plate, I found I had a remarkably fine negative of one object in three positions. Almost any number of positions may be obtained in this way, but the time of exposure must be lessened as the number of positions increase, and each position should receive an equal exposure. Whether the idea is new to every one I cannot say, but that it may be a useful one to many is evident. To such I give it. Those who photograph statuary for the stereoscope would do well to try it.—G. W. White, in *Phil. Phot.*

INFLUENCE OF SEWING MACHINES ON HEALTH.—Some prejudice has been excited against the use of sewing machines on the score of their alleged injurious effects on health. As the result of some investigation on the subject, we (*British Medical Journal*) may avow our conviction that these statements have been greatly exaggerated. They apply, we believe, chiefly to those worked by one foot only; and we are quite unable to discover that there is any kind of objection on the score of health to those in which both feet are employed. In America, where the use of machines is yet more common than with us, the attention of medical men has been a good deal directed to the subject, and with, we believe, tolerable unanimity of result. Against the double pedal machine in common use in England, as far as we can learn from inquiry amongst those who have had them for many years in constant employment, there is not the slightest evidence. Of their sanitary advantages in saving time from a sedentary and very tiresome occupation, and thus favouring relaxation and exercise, it is not necessary that we should speak.

THE AMATEUR MECHANICAL SOCIETY.—The first annual dinner of this society took place on Thursday, the 17th inst., at the Freemason's Tavern, Great Queen-street. Among the members present were Henry Perigal, Esq., F.R.A.S.; Colonel Clarke, Capt. Sandeman, and many others.

NEW DISINFECTING APPARATUS.—Mr. George Fraser, of the firm of John Fraser and Sons, exhibited and explained at a recent meeting of the Medical Officers of Health Association a new apparatus for which he has recently obtained a patent. The object is to supply a ready means of disinfecting all clothing, bedding, &c., that may have been used by persons suffering from fever or other infectious disease. If such apparatus were erected in all populous districts, it is highly probable that the spread of many diseases would be considerably checked. The apparatus and its working may be thus briefly described:—A brick oven or chamber occupying a space 8ft. square, is erected, in the lower portion of which is a covered furnace and flue capable of raising the internal atmosphere to the required temperature, the front being enclosed with a sliding door. A closed truck or carriage is provided with shelves, racks, and doors, and it is intended to collect the clothing in these carriages from the infected houses, and convey it to the chamber. The front door is then opened and the truck placed inside, the fire lighted, and the process of disinfection takes place, sulphur or other fumes being used. When the process is completed, the truck is again taken to the house and the articles removed. The chief points in this patent are: 1. The whole of the vapours given off during the disinfection are, by a peculiar arrangement of flues, made to pass through the furnace, and are thus consumed. 2. The clothing is not removed from the truck until returned to the owner. 3. The carriage which conveys the clothing and returns the same to the house from which it was taken, is itself disinfected on each occasion, with the clothing, &c. 4. The apparatus is not expensive.

VERMILION.—The blackening of vermilion which has given many much trouble, is caused by the decomposing action of light, being analogous to the darkening of the silver salt in photography, and it may be entirely prevented by mixing one-eighth part of fine flowers of sulphur with the dry vermilion before adding the oil.

DESILVERING.—In many cases it may be useful to know a liquid which will dissolve silver without attacking copper, brass, or German silver, so as to remove the silver from silvered objects, plated ware, etc. It is simply a mixture of one part of nitric acid with six parts sulphuric, heated in a water-bath to 160° Fahr., at which temperature it operates best. By this means the old silver attached to plated ware, old daguerreotype plates, etc., may be removed and saved without any necessity for wasting acids in dissolving a large amount of useless metal.

CURIOUS FACTS IN REGARD TO SOUND.—The following curious observations in regard to the transmission of sound have been carefully verified by an extended series of experiments: The whistle of a locomotive is heard 3300 yards through the air; the noise of a railway train, 280 yards; the report of a musket and the bark of a dog, 1800 yards; an orchestra or the roll of a drum, 1600 yards; the human voice reaches to a distance of 1000 yards; the croaking of frogs, 900 yards; the chirping of crickets, 800 yards. Distinct speaking is heard in the air from below up to a distance of 600 yards; from above, it is only understood to a range of 100 yards downwards. It has been ascertained that an echo is well reflected from the surface of smooth water only when the voice comes from an elevation. Other similar phenomena in connection with the transmission of sound have been observed, but the results disagree either from inaccuracy in the observations, or from the varying nature of the circumstances affecting the numbers obtained. Such variations occur to an extent of ten to twenty per cent., and even more. The weather's being cold and dry, or warm and wet, are the chief influencing causes. In the first case, the sound goes to a greater, and, in the second, to a lesser distance.

DR. USSHER'S ADVICE.—To be pasted on the fly-leaf of the ENGLISH MECHANIC and all other books—

"If thou art borrowed by a friend,
Right welcome shall he be
To read, to study, not to lend,
But to return to me.
For oft imparted knowledge doth
Diminish learning's store,
But books, I find, I often lent
Return to me no more."

Read slowly, pause frequently, think seriously, keep cleanly, return duly, with the corners of the leaves *not* turned down.

THE MANCHESTER STEAM USERS' ASSOCIATION.—We have just received the annual report of this useful association. The report says that during the past year 68 boiler explosions came to the knowledge of the officers of the association, which boilers were not under their inspection. By these explosions 86 lives were lost, and 126 persons were injured. There can be no doubt that the association does good work, and not only the steam users, but the country is indebted to it—in the first place, on account of the accidents it is instrumental in preventing; and secondly, for the practical information it distributes through the press monthly for the benefit of all.

THE SUN.—Never, surely, says the *Athenæum*, has the sun been so much looked at as now! In Europe and America, in India and at the Cape, in any place where there are telescopes and spectroscopes, and astronomers to use them, there the sun is closely watched. At Kew Observatory photoheliography is a part of the regular daily work of the establishment, and from time to time the results, and the conclusions they warrant, are laid before the Royal Society. Out of all this, it is thought that our knowledge of the sun's constitution must be increased. All possible advantage will be taken of the eclipse of the sun in December next; and under instruction from scientific committees, parties will be sent to Algiers to make observations, aided by the best of modern appliances. Meanwhile, Father Secchi, of the Observatory at Rome, is publishing every day a picture of the sun, in which all the visible spots and all the prominences, with their changes, are represented. A daily solar bulletin, though a rough one, may perhaps be useful.

HYDRAULIC PRESSES.—The hydraulic—or, as some persons erroneously term it, the hydrostatic—press was patented by Bramah in 1796. It has, therefore, been known to the world, the *Engineer* says, for seventy-four years, and is now applied in a multitude of operations, which absolutely could not be performed at all without it. Presses exerting a force of 600 tons, and having ranges of 10ft., 12ft., or even 15ft., and being capable of exerting a force we have named at any part of the stroke, are by no means uncommon. We do not stretch a single point when we say that no arrangement of screws or levers would supply us with a press of equal range, power, and speed. It is not that an arrangement of levers could not be planned quite able to exert the strain of which we speak; but such an arrangement would lack all the characteristics which are essential to a mechanical device intended to serve the purposes of manufacturers. For example, had the work done in raising the tubes of the Britannia Bridge been performed by a simple lever, one arm must have been 448,000ft. longer than the other; and to enable a lb to raise the load through 100ft., the lb. must have passed through space for a distance of 81,622 miles. In simplicity, in cheapness, and in efficiency, the hydraulic press stands totally without a rival. Whether assuming the form of the gigantic apparatus employed in bending armour plates, or that of a little 30 cwt. jack, it is equally compact, inexpensive, and elegant.

CHIPS.

Herr Redtenbacher, Professor of Chemistry in the University of Vienna, died a few days ago, of apoplexy, at the age of 60. He had been connected with the university since 1839.

Dr. Radzizewski, of Louvain, has discovered a new substance of a waxy nature in straw. This wax is a white, solid body, insoluble in water and the caustic alkalies, but easily dissolved in alcohol and in ether

ANSWERS TO CORRESPONDENTS.

HOWARD RYLAND, OF BIRMINGHAM.

A MR. HOWARD RYLAND offered last year, through our pages, to supply for 13 stamps a key label, embossed with name and address of the sender. Advertising at first from Union Chambers, Union Passage, Birmingham, Mr. Howard Ryland afterwards—probably for very good reasons—changed his address to 79, High-street, Birmingham. Five correspondents have written to us, stating that they sent stamps to Mr. Ryland, but cannot get their labels. Two of them have addressed the police authorities on the subject, and have received the following letters:—

"Borough of Birmingham Police Office, 1st February, 1870.

"SIR,—Sergeant Jenns reports that H. Ryland has an office at High-street, Birmingham, but has not been there for six weeks. The last time we heard from him was from Hereford. His letters are called for by his father. *There is no doubt but that they are swindlers.*—Yours truly,

"G. GLOSSOP, Chf. Supt., J.A., C.O.

"Mr. ——."

"Borough of Birmingham Police Office, 20th Jan., 1870.

"SIR,—In answer to your letter of the 19th instant, I beg to say that our Sergeant Jenns has been to Union Chambers, and finds that a Mr. Ryland did live there about that time, but has since removed to Hereford, but cannot ascertain where. Several persons have been making inquiries for him since he left, upon the same subject, *and no doubt he is a swindler.*—Yours obediently,

"GEO. GLOSSOP,
"Per W. MANTON, Detective Inspector.

"Mr. ——."

ADVERTISERS' TESTIMONIES.

IT will be seen that for several weeks past we have given extracts from advertisers' letters, which have been sent to us unsolicited; in fact, we know nothing of the writers of these letters personally; they all agree that the ENGLISH MECHANIC is an excellent medium for advertisers. The following is an extract just received:—

ANOTHER TESTIMONY.

VELOCIPEDE BRAKE-CHAIN.—When we began to advertise, we had no idea of the far-reaching power of your journal. By its use we have received applications for our brake-chain from all parts of the Three Kingdoms, and from all sorts and conditions of men; while numerous testimonials to its utility attest the favour in which it is held. We are confident that if we had gone to work in the slow and old-fashioned method of introducing it to the dealers and leaving it in their hands, years would have elapsed before we had done as much as we have done in the last few months. Among others, we may mention that the chain has been adopted by His Royal Highness the Prince Imperial of France, who has honoured us by expressing himself most unqualifiedly in its favour. We congratulate you on your enlargement and improved appearance.—DAVID HARCOURT and Co., Crank, Sash, and Shutter Chain Manufacturers, The Lozells, near Birmingham.

THE following are the initials, &c., of letters to hand up to the first post, Friday, March 25:—

RECEIVED.—C Fletcher, J. H. Morgan, "J. W. B," Novice, H. E. Hudson, A. Slade, Trübner and Co., W. Johnson, Jun., J. Edmonson, Hobart Lang, "G. S. M.," "E. P. H. V.," W. Moor, Junr., "A. G," J. Gillingham, Thos. Winter, Wm. Pearce, "C. H. S. D.," W. Abercrombie, "Capt. D. D. C.," W. O. Carter, J. Epps, and Co., W. A. Gibbons, Capt. O. H. Stokes, Barry Close, F. G. J. Coggin, Robert Tongue, Gower and Son, "Nemo," "Joe Miller," "Augustus," W. R. T.," "W. W." S. Taylor, E. H. Gibson, "Pro Bono Publico," J. Mills, P. Webster, A Subscriber, J. W. T., Hanes, J. T. Bailey, Thomas J. O'Connor, R. Williams, H. W. Cottman, C. Johnson, W. H. I. P., T. Carpenter, D. Wall, E. G., Capt. Noland, W. R. J., Rev. E. T., S. & M., Alfred Jones, J. Whitwell, J. J. R., J. W. M., A Bushman, A. S. S., A Canadian, W. B. J., Act on the Square, R. Jabobs, J. H., John Bull, Amateur, J. G., J. Sargent, jun.; W. B. W., R. Gay and Co., Kingsbury and Co., E. D. B., Hy. Arlington, A. Sufferer, J. D. M., John Kyle, Hy. Childs, A. Spencer, C. J. S., Chuck, Jersey, Milly, W. C. R., Sigismond, William Hewlett, Vulcanite, T. J. Evans, F. S. B., Aviary, Wm. Moor, jun.; Look Before You Leap, Q., A Good Boy, F. D. C., Jno. Musgrave, Scrutator, T. A., F. E. B., Bomba, W. J. H., And So Forth, E. W. P., C. B. A., G. H. Williams, Rev. R. G. B.

THE SIXPENNY SALE COLUMN is the only part of the paper in which can appear queries sent by John Steward, "Brightonian," "Claybrooke," "Scribo" (3rd and 4th queries), W. B. Harvey, J. Wroe, "Mosac," "Kola Nut," "Albertus Magnus," "Fred," "A Youth," E. Williams.

A. R. T.—We know nothing of the savings bank you allude to. Custom, which is sometimes more powerful than grammatical rules, has decided the pronunciation of the words you refer to.

A YOUNG ONE.—Read recent papers on the "Earth, its Figure and Motion."

SCRIBO.—First query inserted, second has been replied to recently; third and fourth we cannot reply to. We do not answer by post.

PAINTER.—Fairbairn and Co. (see advertisement).

IGNORAMUS.—See recent back numbers.

CORROSION.—See "Useful Notes."

AMATEUR cannot surely have read Mr. Proctor's papers on the earth, concluded in our last.

SWIMMER.—Sell your gold chips and buy a chain. To use your own words, "it would be cheaper."

GEO. DAVIS.—You are to be applauded for your fidelity to Dr. Bedford, but your letter, which contains insinuations, would lead to no good if inserted.

A FRIEND OF THE INVENTOR writes us a letter in which he says that a poor man whom he knows has invented a wonderful machine, which will save millions of money; and he wants us to give an opinion on the worth of the invention. If the machine is so valuable, it should be protected by patent, and then its value will mainly depend on the demand for it. But all that glitters is not gold, and particularly that which fascinates the imagination of inventors.

W. M.—Elementary information on taking photographs was given some months since.

OLD DIP writes so indistinctly that we have been reluctantly obliged to drop his letter into our very capacious waste basket.

AN OBSERVER.—The insertion of your letter would lead to no good. Immediately a publication resorts to such tricks as giving away such things for nothing, you may conclude that it is gradually dying. We never knew a respectable journal to stoop to such practices, and we never knew a weak one to gain any good by so doing.

FAIR PLAY.—We would gladly accommodate you, but to give what you require would occupy too much space.

G. GROVER.—A short description of the "Macclesfield" velocipede, appeared in No. 258, page 608, Vol. X.

ALFRED HOPPS.—See present number of the ENGLISH MECHANIC.

HARRY BROTHERS.—We occasionally, to oblige a correspondent, insert a query which savours of an advertisement: that is no reason we should do it in all instances. The less it is done, we admit, the better.

THANKS.—David Harcourt and Co. thank W. R. Rose, of Haddingham, Suffolk, for his unsolicited recommendation of their brake chain. Messrs. Harcourt's letter will be found on page 47.

VIBRATOR.—The roll came by book post, but not the letter with the stamps.

E. A. WITTY.—A recipe for welding cast steel was given by "Black Diamond," No. 238, page 113.

JAMES REEVE.—Consult the back vols. of the ENGLISH MECHANIC, or Mr. Ede's little book on the "Management of Steel," published by Tweedie, Strand.

METEOROLOGIST.—We reply to your query by another. How is it that if you evaporate a strong solution of salt and water, the salt remains?

IGNORAMUS.—Cannot say. Write the editor of the journal in which you saw the review. One of Francis' or Fairbairn's presses would suit you. See our advertisement pages.

ERRATUM.—In letter on "Opaque Lanterns," in No. 260, page 656, by an error in the punctuation, the meaning is rendered very obscure. Thus, at line 15 it reads: "A B is the front of the lantern C D E G, the part to be attached at a point E, about 2⅝in. from D. The right-hand corner is cut off," &c.; should be, "A B is the front of the lantern, C D E G the part to be attached. At a point E, about 2⅝in. from D, the right-hand corner is cut off," &c.

W. H. P.—Instructions for re-gilding picture frames were given by several subscribers some weeks back.

A NEW SUBSCRIBER (Cornhill).—A good list of varnishes appeared at the commencement of last volume. Your query about the lathe is obscurely worded.

FORWARD.—Jewellers' rouge is frequently prepared by precipitating sulphate of iron with potash, well working the yellow oxide, and calcining it until it acquires a scarlet colour.

ERRATUM.—In No. 260, Query No. 2116, in second line, for "200 falls" lead "200 galls."

SPOILED BEAUTY.—From your handwriting we think you should have written to one of the many journals who profess to preside over the toilet. We cannot advise you. Your complaint is either an imaginary one, or needs at once the advice of a medical man skilled in the treatment of skin diseases.

F. J. T.—Nothing new.

Z.—See advertisement pages.

POOR BILLY.—Numerous "Selections from the Poets" are published by different booksellers, at all prices. Any bookseller will guide you to a selection. Brass tubing for telescopes of various dimensions may be found advertised in our columns, among others by Mr. E. Tydeman, of 9, Mighell-street, Brighton.

E. H. AVIS.—Give the information through our columns.

J. H. RUMSEY.—Not in your neighbourhood.

E. LETHBRIDGE.—The fault is in your indistinct writing. Your second letter does not clearly give the name of the town you reside in.

J. W. KASEL.—First question recently; the second we cannot insert.

G. W. PALMER.—Forwarded.

CASUAL OBSERVER.—Box Tunnel, we think.

A. B. C.—Ask any engraver.

J. CROMPTON.—Send it to the watch doctor.

A YOUNG ENGINEER.—Inquire of a friend.

SHOREDITCH.—The challenge made by Mr. John Hampden, of Swindon, was accepted by Mr. Alfred Wallace, F.R.G.S.; but when it will be decided we cannot tell.

LEES.—No charge for inserting "Queries."

A WELL-WISHER.—We are somewhat surprised that you should recommend such a thing to the ENGLISH MECHANIC. It is only tottering publications that think of holding out such baits, as offering magnificent prizes to all their subscribers "for nothing." Strength stands erect; weakness is either cunning or crawling.

J. W.—Thanks. Next week. Try again.

A. G. HOULT.—Your letter came to hand.

W. RICE.—You enclosed no stamps.

AN OLD SUBSCRIBER.—You cannot be, or you would have know, that the wheel question was discussed *ad nauseum*, a few months since.

VERBUM EST VERBUM, takes us to task for alluding to "Earth Closets," and "Ketchup made from Horses' Liver," in our pages. Our opinion is that such things affect the health of the community, and ought to be talked about; and since they have been talked about and inquired into, the health of the public has improved. It is known to many that "ketchup" is made from horses' liver, and the sooner all know it the better. Is not "Verbum est Verbum" more nice than wise?

E. G. says, "I am heartily glad to welcome beck the 'Harmonious Blacksmith.' May his anvil ring loud and long!"

W.B.—We are not bound to answer every query. The obligation between the proprietor and reader is, or should be, mutual.

W. WEBBER says, "What an exquisitely happy illustration, that about the beautiful little girl selling bricks and the Temple of Knowledge! I will endeavour to send you a brick now and then." Thanks.

EARLY RISER.—Had you consulted the last index, you might have saved yourself the labour of writing.

THE *ENGLISH MECHANIC* LIFE-BOAT FUND

Subscriptions to be forwarded to the EDITOR, at 31, Tavistock-street, Covent-garden, W.C.

	£	s.	d.
Amount previously acknowledged ...	£161	18	7
Marine		1	6
Brightonian...		1	0
W. H. E., Bath		2	6
W. H.	1	1	0
G. Read	1	1	0
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THE INVENTOR.

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IN obedience to the suggestions of a number of readers, we hav decided on appropriating a portion of our space to a condensed list of patents as nearly as possible up to the date of our issue.

APPLICATIONS FOR LETTERS PATENT DURING THE WEEK ENDING MARCH 21st, 1870.

749. W. Husband, Hayle, atmospheric stamps and hammers.
750. J. Felber, Manchester, machinery for manufacture of paper from wood.
751. R. Winstanley and Barker, Manchester, excavating coal.
752. W. R. Pape, Newcastle-on-Tyne, fire-arms.
753. H. Manton and J. H. Mole, Birmingham, swivels.
754. G. Brown, Glasgow, velocipedes.
755. W. H. Samuel, Liverpool, friction lights.
756. R. S. Prowse, Liverpool, hand trucks.
757. F. Pattison, blackening (for foundry purposes).
758. J. C. McLagan, London, sewing machines.
759. J. C. Atkin, Deeley, and Newbery, of Sheffield, furnaces.
760. C. Stockbridge, Bishop's Stortford, collars and saddles for horses.
761. J. C. Ramsden, Bradford, looms.
762. J. H. Johnson, 47, Lincoln's-Inn fields, apparatus for governing speed of motive power engines.—A communication.
763. P. O. Nicholas de Ferrari, Paris, hygienic and mechanical hat
764. E. Dugdale and J. Dugdale, Blackburn, sizing machines.
765. G. Jaite, Berlin, a telegraphical apparatus "Jaite."
766. G. H. H. Brockbank, Camden Town, improvements in upright pianoforte actions.
767. P. W. Spencer, Raygill, York, gentleman, limekilns.
768. J. Beckett and R. Levers, Wandsworth, an improved buckle.
769. W. E. Newton, 66, Chancery lane; improvements in maltkilns.—A communication
770. W. D. Newton, 66, Chancery-lane, improvements in gun carriages.
771. R. Lakin, of Messrs. Curtis, Parr, and Madeley, Manchester, improvements in mules.
772. R. Tonge, Manchester, improvements in looms.
773. W. C. Mitchell, Belfast, certain improvements in books.
774. W. Morgan, 4, John's-place, Mitcham, preservation of life from fire.
775. G. Holdsworth, Halifax, producing drawings or designs upon squares or ruled design paper, for manufacturing purposes.
776. W. Rainforth, Brayford Head, Lincoln, rotary corn screens.
777. P. Murray engineer, Quebec, differential pulley blocks.
778. H. W. Hammond, Manchester, "helical" revolver.—A communication.
779. J. C. Mewburn, 172, Fleet-street, apparatus for raising and forcing fluids, and for cleaning suction strainers by steam.—A communication.
780. J. T. Walker, Albany, U.S., making horseshoes.
781. W. R. Lake, Southampton Buildings, London, forming trenches or ditches.—A communication.
782. J. Homan, 80, Coal Exchange, London, railway and other waggons.
783. J. Watkins, Birmingham, improvements in dies for metallic tubes.
784. J. H. Johnson, 47, Lincoln's Inn-fields, construction of roads.—A communication.
785. F. Virtue, Liverpool Oil Mills, Liverpool, hydraulic presses.
786. J. Moulton, Boston, U.S., elastic rolls for clothes wringers
787. D. Spill, Hackney, compounds containing xyloidine.
788. G. Buck, 28, Lawrence-lane, fire-lighters.
789. T. Williams, 1, Brunswick-street, Hackney-road, sewing machines.
790. J. Pinchbeck, 27, Leadenhall-street, London, water tube boilers.
791. G. De Lavigne, Paris, applying cork for protection from caloric.
792. W. E. Gedge, 11, Wellington-street, Strand, damping woven fabrics.
793. F. A. Barrow, Glasgow, recovering reagents from oil.
794. J. Walker, Glasgow, improvements in bottles.
795. E. R. Southby, Shotts, Lanark, distilling crude mineral oils.
796. E. T. Hughes, 123, Chancery-lane, London, lithographic, zincographic, and other printing presses.—A communication.
797. A. M. Clark, 53, Chancery-lane, moulds used in stereotyping.—A communication.
798. J. Davis and W. N. Davis, Hemel Hempstead, two furrow ploughs.
799. C. H. Rost, Dresden, washable papers.
800. T. J. Smith, Robertson, Brooman, and Company, 166, Fleet-street, apparatus for holding stamps for offices and general uses.—A communication.
801. S. Perkins, Gorton, improvements in steam boilers.
802. C. Janicot, Paris, producing photographic pictures on fabrics.
803. R. Girdwood, Edinburgh, dressing stone.
804. W. West, Leeds, boilers and apparatus for generating steam
805. C. Young, Hampstead, machinery for sawing wood.
806. J. H. Johnson, 47, Lincoln's Inn-fields, crimping machines—A communication.
807. G. White, 66, Queen-street, Cheapside, an improved propeller.—A communication.
808. H. E. Newton, 66, Chancery-lane, Middlesex, Civil Engineer, for an invention of limekilns.—A communication.
809. J. M. Napier, York-road, Lambeth, apparatus for running or pouring metals.
810. Sir W. Fairbairn, Manchester, steam boilers.
811. W. Woofe, Bedford, apparatus for guiding ploughs.
812. W. Friar, Woolwich, domestic fire-escape.
813. W. Austin, Hatton Garden, boxes and cases.
814. W. Guest, Great Saffron-hill, Farringdon-road, ropes, cords and wire ropes.
815. A. M. Strathern, Coatbridge, apparatus for getting minerals, and for compressing air.
816. T. Keely, Nottingham, looped fabrics.
817. S. Norris, Paris, wood paving.
818. J. Hockey, 187, Carlton-road, Kilburn, ventilating lights.
819. G. W. Fox, Manchester, medicinal oils.
820. W. A. Lyttle, Hammersmith, wheels.
821. W. R. Lake, Southampton Buildings, London, machinery for sewing boots and shoes.—A communication.
822. B. Wade, Copley, signals and brakes for railways.
823. J. R. Stocks, B. Stocks, and S. Hutchinson, of Leeds, scouring and shaving hides.
824. G. Weedon, Gracechurch-street, knife-cleaning machines.
825. G. Kent, 199, High Holborn, carving fork and knife sharpener.
826. C. J. H. Warden, Aldridge-road-villas, Bayswater, securing doors of railway carriages.
827. R. F. Fairlie, Victoria Chambers, Westminster, wheels for rail or tramway engines.
828. J. Stirling, Kilmarnock, railway brakes.
829. J. Ferris, Leyton, improved lubricating apparatus.
830. G. Barker and J. McFarlane, Glasgow, copying letters.
831. P. M. Walker, Ardrossan, shoeing horses.
832. J. Millar, Dalry, motors for obtaining and transmitting motive power.
833. S. Brooke, Brighouse, carding engines.
834. A. V. Newton, 66, Chancery-lane, manufacturing barrels.—A communication.
835. J. Ascough, Handsworth, candles.
836. G. Skey, Tamworth, gas purifiers and scrubbers.
837. W. R. Lake, Southampton buildings, London, wheels for railway engines.—A communication.
838. A. Barlow, Strand, jacquard mechanism for weaving.
839. W. R. Lake, Southampton Buildings, London, micrometic steelyard.

PATENTS BEING PROCEEDED WITH.

3216. P. and A. Walker, an improved gas meter.
3223. R. Jones, a paper holder.
3231. A. Rohlken, terriers or ground augers.
3232. E. Thomas, safety lamps.
3 [illegible]. W. Donbavand, balances.
3251. G. Simpson, withdrawing beverages from casks.
3261. B. Shaw, cutting soap.
3263. A. C. Brakell, obtaining and applying motive power.
3265. O. Rose, pistons.
3271. H. Minns, letter pillar posts.
3274. W. E. Gedge, a new composition for preserving metal.—A communication.
3275. W. E. Gedge, machine for cutting wood and metals.
3281. T. A. Dillon, safety lamp.
3282. W. Richardson, valves.
3283. H. H. Grierson, cutting or dressing stone.
3292. C. D. Abel, refining and desilvering lead.—A communication.
3299. G. Cherpit, healds for looms.
3309. F. Delacroix, metallic manometer.
3310. C. Ching, boiler.
3314. T. Marshall, composition for prevention of fouling of ships bottoms.
3317. E. Basin, spinning looms.
3321. G. Baron d'Adelsward, blast furnaces.
3324. C. D. Abel, utilising streams, springs, lakes, ponds, surface waters as motive power.
3329. M. Henry, moving railway carriages and other heavy bodies from place to place.
3411. T. Brown, boring rocks.—A communication.
3427. J. Brunton, railway signals.
3491. J. H. Johnson, spring mattresses.—A communication.
3518. W. R. Lake, harness for draught animals.
3521. J. L. Booth, rails for railroads.
3552. A. M. Clark, ornamenting figured muslin and gauze fabrics.—A communication.
3556. H. Byk, refining and bleaching paraffine.
3582. W. E. Newton, folding printed sheets.
3697. W. R. Lake, manufacture of steel bars.—A communication.
3718. C. H. Roeckner, disintegrating wood.
3728. A. M. Clark, curtains and blinds.
58. R. Morris, treating shoddy to obtain ammonia.
116. T. Restell, breech-loading arms and cartridges.
151. T. Whitehead, wool combing and drawing machinery.
229. G. A. Buchholz, manufacturing semolina and flour.
237. C. Lungley, construction of ships or vessels.
254. R. Haworth looms for weaving.
281. C. Mahler, improved windmill.
371. A. B. Childs, cleaning, scouring, and decorticating wheat.
42.. J. Betterill, consuming smoke and economising fuel.
487. C. Bartholomew, getting coal.
492. E. Hill, engine turning or engraving.
521. G. H. Ellis, washing, wringing, and mangling.
543. A. Dickson and T. Law, pressed leather
556. W. B. Leachman, hydraulic apparatus for raising water.
568. P. J. Livesley, manufacture of hair cloth.
576. R. J. Westley, billiard and other tables.
592. A. V. Newton, sewing machines.
600. B. G. George, ornamental and other designs and devices.
602. W. and R. Mushet, improvements in casting metals.
621. G. H. Ellis, ladders.
623. R. B. Boyman, propelling vessels.
665. E. Wood, and H. Boghill, potters' glazes.
683. J. Polson, treating grain.
690. C. Wyndham, bicycles.
744. W. R. Lake, apparatus for indicating a deficiency of water in steam boilers.

All persons having an interest in opposing any one of such applications are at liberty to leave particulars in writing of their objections to such application at the office of the Commissioners before the [illegible]th of April, 1870.

PATENTS SEALED.

2738 C. R. Schoeller, copying presses
2739 H. Ceckey, scurfing retorts
2743 P. J. Kurtz, chaff cutters
2744 J. Jacobi, removing phosphates from ores
2752 R. R. Gibbs, improvements in pumps
2755 C. L. Light, construction of tram-rails
2757 W. R. Lake, sewing machine and other needles
2761 W. J. Turner, manufacturer of bisulphites
2780 G. A. C. Bremme, untwisting and unlaying shreads, yarns, strands, ropes
2779 R. Collis, velocipedes
2788 J. T. Gase and J. Hymas, fire bars
2790 J. P. Turner, in buckles or fastenings
2801 F. W. Fox and E. Walker, engines and their boilers.
2818 C. D. Abel, a new green colouring matter for dyeing and printing
2824 A. V. Newton, horse-shoe nails
2860 W. Edmonson, machinery for etching
2874 G. Rose, construction of annealing pots
2918 W. E. Newton, wheel for propelling ships
3242 J. Logan and W. Gardner, ornamenting textile fabrics
3433 G. Bertram, straining paper pulp
3538 C. Vavin, separating metals and magnetic substances from other bodies
72 C. D. Abel, treatment of cast-iron for production of castings
187 F. Whitfield, improvements in locks
2[illegible]1 J. H. Johnson, applying anti-friction rollers to wheels
261 W. R. Lake, mechanism for spinning wool
279 W. R. Lake, apparatus for producing rotary motion
282 F. Claudet, treatment of cupreous ores containing silver
2771 J. M. Spence, disinfectants
2773 J. Mackenzie, weighing machines
2776 J. E. Hewett, designs on metal surfaces
2778 W. Strang, preparing warps for the loom
2795 J. Stuart, treatment of ores
2806 E. O'Brien, improved self-feeding, discharging, and registering beam balance
2820 J. Bullough, looms for weaving
2830 W. Walker, furnaces for steam boilers
2806 E. A. Pontifex, refrigerators for cooling worts
2883 J. Chandler, drawing and preventing waste of water from pipes
2942 A. H. Brandon, improved means of locomotion
3303 M. Sautter, improved reloading cartridge shell
3335 G. F. Cornelius, manufacture of paint and varnish
3351 T. Aitken, improvement in "washer cloth"
3394 J. Dunkerley, machinery for "planking" bodies of hats, bonnets, or other coverings for the head
3476 A. R. Henderson, apparatus for shearing or clipping animals
3524 H. H. Murdoch, forming and joining ends of pipes
3540 J. Childs, manufacture of bread and biscuits
3754 W. R. Lake, improvements in sectional steamboats
121 W. Sinton, improvements in churns
123 A. Courvoisier, improvements in double-faced watches
141 T. Peard, for adjusting and securing knobs of locks
147 H. Haines, of lead-encased tin pipes
256 A. W. G. Weeks, G. Deal, G. Lillywhite, and A. O. Lauders, of hot water boilers, joints, and valves
259 E. S. Cathels, apparatus for manufacture of gas, part also applicable for ventilating mines, promoting combustion, and pumping, measuring, and forcing fluids
331 W. R. Lake, improvements in machines for mowing grass

PATENT ON WHICH THE STAMP DUTY OF £50 HAS BEEN PAID.

755 W. R. Lake, improvements in rotary engines and pumps
779 W. H. Parsons, improvements in setting boilers and safety valves for the same
883 E. B. Bigelow, looms for weaving
768 T. Shedden, fire-arms
776 F. H. Wenham, heated air engines
789 C. Allhusen, obtaining sulphur from pyrites
797 W. McAdam and S. Schuman, protecting bottles
1027 W. Adair, pumps
774 J. Smith, cleaning waste and preventing adhesion of sediment in steam boilers
863 J. W. Yates, improvements in handles of spades
857 T. Pebardy, stays or artificial supports
856 H. Fassmann, metal ties for securing bales of cotton
787 F. Gregory, improvements in machinery for refrigerating purposes
818 H. Clifton, improvements in refrigerators
822 J. A. Limbert, lowering, and moving heavy bodies
837 J. Lawson, spinning flax, tow, hemp, and other fibres
915 M. P. W. Boulton, apparatus for receiving motion or energy from fluids and for imparting it to them
755 W. R. Lake, improvements in rotary engines and pumps
842 H. Wilde, electro-magnetic and magneto-electric induction machines
1049 W. T. Henley, machinery for the manufacture and treatment of wire
1126 W. Weild, machine for winding yarn or thread

PATENTS ON WHICH THE STAMP DUTY OF £100 HAS BEEN PAID.

719 W. Symington, apparatus for roasting and treating coffee and other organic substances
717 G. De Laire, improvements in the manufacture of brown colouring matters
732 A. Merel, apparatus for generating carbonic acid

formula of this latter chemist was in many cases double that of Gerhardt, thus the formulæ for alcohol was $C_4 H_{12} O_2$ and was regarded as a compound of ether and water, and Berzelius's views on the constitution of nitric acid, were, that it contained the elements of anhydrous nitric acid and water in distinct parts of the molecule, thus:—$N_2O_5 + H_2O$ or $\overset{\therefore}{\bar{N}}\ \dot{\bar{H}}$, an electro-positive and an electro-negative group. The opinions of Gerhardt received much attention, and the modified system, which it is as well to add, is neither strictly, Berzelius's nor Gerhardt's, generally spoken of as the new notation, is now universally adopted, as it agrees with Gay Lussac's law of volumes, Ampères law, and with Dulong and Petit's law of specific heat.

Ampère's law states that in equal volumes of gases under the same temperature and pressure exist an equal number of atoms, and likewise in equal volumes of the compound gases under similar circumstances exist an equal number of molecules; therefore, if 2 volumes of hydrogen unite with 1 volume of oxygen, it must be in proportion of 2 atoms to 1.

Dulong and Petit found that by multiplying the specific heat of an element by its atomic weight, that a nearly constant number was obtained—namely, 6·5, and the atomic weights of the new system are in accordance with their experiments; thus the specific heat of mercury is 003247, and this multiplied by 200 (the atomic weight) gives 6·494, a number which nearly approaches the average 6·5. The specific heat of silver is 0·05701, and this multiplied by the atomic weight gives a result which is rather lower than the last, 0·05701 × 108 = 6·157. All the solid elements conform to this law, with the exception of several of the metalloids, carbon, silicium, &c. The graphite form of carbon, to conform to the law, ought to possess an atomic weight of over 30.

The following table will show at a glance the atomic weights corresponding to the different systems. The compounds introduced by Dalton are intentionally omitted, as the reader well knows that in Dalton's time, the alkalies and the alkaline earths were supposed to be elements, but Lavoisier's theory of salts was that they were composed of an acid and a metallic oxide, therefore potash and soda were long suspected, and after the isolation of potassium by Davy, the metals of the alkaline earths were soon obtained.

Only a few instances are given, the whole number of the elements occupying too much space, and those elements which are marked with an asterisk indicate Berzelius's double atoms:—

Name of Element.	Symbol	Dalton	Berzelius	Gerhardt	New.
Hydrogen ..	H	1	12·5*	1	1
Oxygen ..	O	7	100	16	16
Nitrogen ..	N	5	175·16*	14	14
Carbon ..	C	5	75·12	12	12
Sulphur ..	S	13	200·75	32	32
Silver.. ..	Ag	100	1349·66	108	108
Zinc	Zn	56	406·591	32·6	65·2
Lead	Pb	95	1294·645	103·5	207
Mercury ..	Hg	167	1251·29	100	200
Iron	Fe	38	350·527	28	56
Copper.. ..	Cu	56	395·6	31·75	63·5
Platinum ..	Pt	100	1294·645	98·5	197

In our next chapter we will consider the application of formulæ to molecular grouping.

(To be continued.)

HALLEY'S COMET.

By "Omicron."

In every age of the world, and in every region of it, there has been noticed among the fixed and regular constellations, a class of phenomena that has arrested the wandering attention of the uninterested spectator, as much by the brilliancy as by the irregularity of its appearance. To this phenomenon has been applied the term "comet" from the Greek κομετες, as the ancients imagined a resemblance between the train of light that occasionally accompanies this phenomenon and dishevelled hair. In days of superstition and astrology, the sight of a comet was sufficient to awaken a feeling of terror and a sense of coming evil, but to the astronomer of the present day, its appearance excites a sensation of triumph and of pride. However terrific their appearance, however startling their brilliancy, they possess no terror for him. All imaginary terrors have been torn from them, they are known to be "trifles light as air," the cause of their eccentric motion is no longer a secret, and the course they must pursue can be predicted. The genius of the physical astronomer is as strongly marked, and as much to be applauded for the triumphant and conclusive investigation of cometary phenomena, as in any other department of of astronomical science.

The true theory of cometary motion had its rise in Sir Isaac Newton, and the industry and intellect of successive astronomers have but confirmed his anticipations, and proved the truth of his predictions. Hardly second to Newton for his labours in this special field of astronomy, stands the illustrious Edmund Halley, the second Astronomer Royal. To Newton must be granted the merit of a suggestive theory, to Halley the merit of working out the detail of the system, and bringing it to the test of observation: assuredly not the least of the labours of Halley that has merited the gratitude and admiration of posterity, is that in which he undertook to compute on the hypothesis of Newton, the orbits of 24 comets, which at that date was the entire number that had been reliably observed—a labour of which the present Astronomer Royal has remarked that, perhaps, no other astronomer at that time was capable of undertaking and leading to a successful issue. The results of this enormous labour were formed into a table which was inserted in the "Astronomiæ Cometicæ Synopsis," and appeared in the volume of "Philosophical Transactions" for 1705. Halley there declares that his principal object was to give the means of determining whether any future comet moved in the path of any contained in his list, and with the same paper appeared his table of parabolic motion, "dedicated," as he says, "to posterity, and which will last as long as the science of astronomy shall exist."

The first to reap any benefit from his protracted labour was Halley himself, and he was the first to determine the major axis of the ellipse, in which a comet moved. In his list of orbits, he detected three, whose elements appeared to agree suspiciously closely; those of the years 1531, 1607, and 1682. The annexed table shows the elements of the orbits as computed by Halley.

Year.	1531.	1607.	1682.
	° ′	° ′	° ′
Longitude of Perihelion ..	301 39	302 16	·03 5
Long. of Ascending Node	49 25	50 21	51 16
Inclination of the Orbit ..	17 56	17 2	17 56
Perihelion distance	0·567	0·587	0·583
Direction of Motion	Ret.	Ret.	Ret.

The general elements are pretty closely analogous, but there exists a considerable difference in the periodic time of revolution. The dates of perihelion passage are as follows:—August 24, 1531; October 16, 1607; and September 4, 1682.

The interval between the two first is therefore 76 years 53 days, and between the second pair only 74 years 288 days, leaving a difference of fifteen months between the two consecutive times of revolution. But Halley was sufficiently acquainted with the general theory of perturbation, to know, or at least to surmise, that the influence of the planets might be such as to cause such a difference. He shrewdly remarked that the influence of Jupiter on Saturn was capable of varying its period 13 days, and that under certain circumstances this variation might amount to a month. Halley's memorable prediction is contained in the following words: "Nothing seems to contradict this my opinion, except the inequality of the periodic revolutions, which inequality is not so great neither, as that it may not be owing to physical causes; for the motion of Saturn is so disturbed by the rest of the planets, especially Jupiter, that the periodic time of that planet is uncertain for some whole days together. How much more, therefore, will a comet be subject to such like errors, which rises almost four times higher than Saturn, and whose velocity, though increased but a very little, would be sufficient to change its orbit from an elliptical to a parabolical one! This, moreover, confirms my opinion of its being the same comet that in the year 1456, in the summer time, was seen passing retrograde, between the earth and the sun, much after the same manner; which, though nobody made observations upon it, yet, from its period and the manner of its transit, I cannot think different from those I have just now mentioned. Hence *I dare venture to foretell* that it will return again in the year 1758." Continued researches and calculations confirmed Halley in his supposition, and his tone grew proportionately more decided. No means then existed for computing the effect of the planetary perturbations, but he sagaciously concluded from an examination of the general derangement from planetary perturbation, that the comet would be retarded in its next approach to perihelion, and that in consequence it would not be visible till the end of 1758 or the beginning of 1759. "Wherefore," says this illustrious astronomer, "if it should return agreeably to our prediction, impartial posterity will not refuse to acknowledge that this was first discovered by an Englishman." Nor has any ever ventured to attack the merit of the discovery, or attempt to detract from the glory that is due to Dr. Halley for the perseverance displayed in grasping a subject which involved such an immense amount of calculation. He assures us that his labours were "prodigiously" long and troublesome, but they have shed immortal honour on the enterprising calculator, and his discovery forms an epoch, and not an unimportant one, in the history of astronomy.

As the time, when the next return of the comet was expected, approached, intense interest was awakened in the minds of astronomers, although the task of computing the exact date of return does not seem to have been willingly assumed by anyone, owing to the immense amount of labour it must necessarily entail. We have seen, that at the time of Halley's prediction, mathematical analysis was not sufficiently far advanced to enable anyone to compute the effect of planetary perturbation upon the comet, and in the middle of the eighteenth century imperfect methods rendered this a task of great difficulty.

The attempt, however, was made by Clairaut, and it has fully deserved the applause it has received. To anyone not versed in calculations, there may not appear any difference in computing the perturbations of a planet and those of a comet, since both derive their derangement from the true ellipse described round the sun, from the same cause, and that the solution of the problem can be effected by expressing the effect of the disturbing forces, by the variation of the arbitrary constants that enter into the formulæ of elliptic motion. The differential variations of each of the elements of the orbit can be determined by this means, but in order to obtain the elements of the motion of the *comet in its disturbed orbit*, the integration of these formulæ is necessary, and this integration involves an immense amount of difficulty and labour, of which we will say more hereafter. Euler, had not yet published his general theory of the variation of elements, although it was written, and Lagrange's memoir on the same subject was not produced till some years afterwards, so that Clairaut was in possession only of the methods he had employed in his lunar theory. For the calculation therefore of the comet's perturbation, Clairaut sets out with the same differential equation for the reciprocal of the radius vector, which till within a short time has been universally adopted in lunar theories. Taking the solution (which can be expressed by elliptic terms, and terms depending upon the disturbing force under one sign of integration), he rejects everything depending on the square of the disturbing force, and transforms the expressions into others in terms of the eccentric anomaly. He also employs, for a time, the same expression as that in his lunar theory, transformed in a similar manner.* Notwithstanding, for a part of the orbit extending through 160° of eccentric anomaly, Clairaut was obliged to employ the method of quadratures. We do not propose to follow Clairaut throughout his elaborate investigation; the subject of cometary perturbation is a fertile one, and at no very distant epoch, with the permission of the Editor, may be treated separately.

The whole labour of this important investigation was borne by Clairaut, Lalande, and a lady by the name of Madame Lepaute, who appears to have rendered very material assistance. Lalonde in his "Theorie du Mouvement des Comètes," has given us a graphic account of the labour involved. "During six months," he remarks, "we calculated from morning till night, sometimes even at meals, the consequence of which was that I contracted an illness, which changed my constitution for the remainder of my life. The assistance rendered by Madame

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[*] "Monthly Notices of the Royal Astronomical Society," vol. 4.

Lepaute was such, that without it we never could have dared to have undertaken this enormous labour, where it was necessary to calculate for every degree, and for 150 years, the distance and force of each of the two planets (Jupiter and Saturn) with respect to the Comet."

On the 14th of November, 1758, Clairaut announced to the French Academy of Sciences, the memorable conclusion that was the result of such enormous labour. He declared that the effect of Jupiter, would be to delay the perihelion passage by the enormous amount of 518 days, and that Saturn would further cause it to be retarded by 100 days, the whole effect would be therefore about 20 months, and Clairaut fixed the perihelion passage to take place on the 13th of April, 1759. Great curiosity prevailed as the time approached, and intense interest was excited in the hope of the verification of the prediction. All doubt as to the identity of the comet with previous apparitions was removed, so far as the scientific world was concerned, but some apprehension was felt lest circumstances should be unfavourable to a perception of the phenomenon. "We cannot doubt," observed Lalande, in 1757, "that it will return: and even if astronomers should not see it, they will not be the less persuaded of its return. They know that the faintness of its light, and its great distance, perhaps even bad weather, may keep it from our view, but the public will find it difficult to believe us; they will put this discovery which has done so much honour to modern philosophy, among the number of predictions made at hazard. We shall see dissertations spring up again in the colleges, contempt among the ignorant, terror among the people; and seventy-six years will elapse, before there will be another opportunity of removing all doubt."

Lalande's fears were not realised. On Christmas Day in the year 1758, a farmer and amateur astronomer, named Palitzch, living near Dresden, first perceived the comet in a telescope of eight feet focal length, aided by his powerful sight. It has been said that Palitzch perceived the comet with his naked eye, at a time when it was invisible to every European astronomer, assisted by their telescopes, but the Baron de Zach has corrected this error, and appears to have been personally acquainted with this diligent observer of the heavens. Palitzch saw the comet again on *the 26th of December*; and on the 28th of December it was detected by Dr. Hoffmann. Messier, "the comet ferret" as he has been styled, had been looking out for the comet for *two and a half years* previously, instigated by Delisle, who was then the director of the Paris Observatory, but notwithstanding his long and diligent search he was one of the last to detect it, owing to the weather being unfavourable for observation. Messier detected the comet on the 21st of January in the following year, and observed it regularly for the next three weeks ensuing. Delisle would not allow Messier to give notice to the astronomers of that city, that the long expected body was in sight, and he remained the only observer before the comet was lost in the sun's rays. Such a discreditable and selfish concealment of an interesting discovery, is not likely to sully again the annals of astronomy. Some members of the French Academy looked upon Messier's observations, when published as forgeries but his name stood too high for such imputations to last long, and the positions were soon received as authentic, and have been of great service in correcting the orbit of the comet at the last return.[*]

A discussion of these observations would show that the perihelion passage took place on the 12th of March, just one month previous to the date fixed by Clairaut, but we should have said that at the time Clairaut made his prediction to the French Academy, he pointed out, that, having been pressed for time he had neglected various small quantities, depending upon the perturbations of the Earth, Mars, &c., which might exercise an influence one way or the other, to the amount of a month, so that his prediction really was within the limit of time he had allowed himself, and if we consider that the received values of Jupiter and Saturn were very much in error, and that the existence of Uranus and Neptune was not even suspected, we must allow very great praise to the accuracy to which Clairaut was able to bring his investigation. Laplace has shown that if the mass of Saturn had been as well known to Clairaut, as it was in his time, the error of time in the perihelion passage would not have amounted to more than thirteen, instead of thirty days.

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[*] "Hind on Comets."

THE EAR—ITS USES AND ABUSES.

BY DR. USSHER.

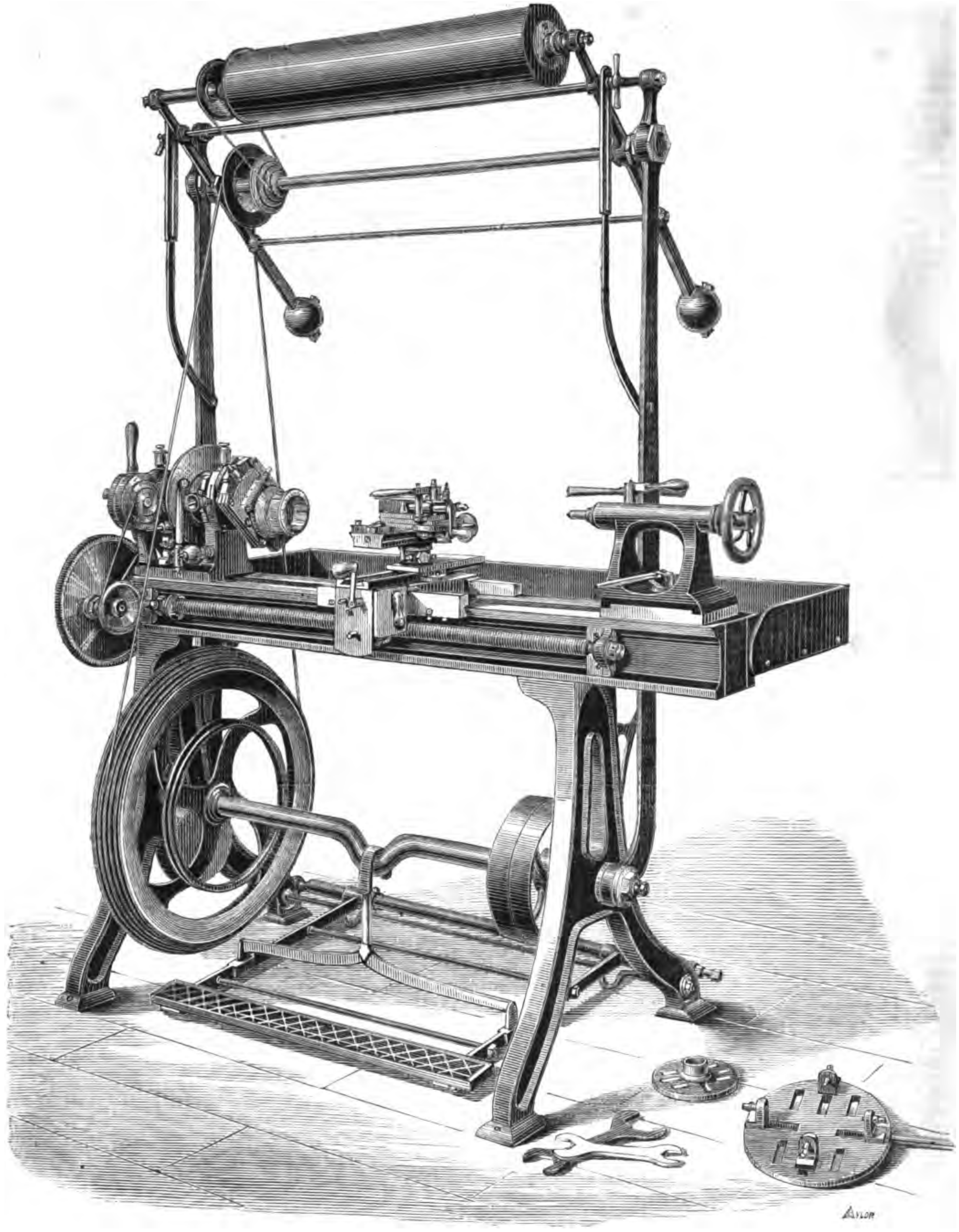
(*Concluded from page* 30.)

WE are all familiar with the fact that sound comes better through water; a musical box placed on a tumbler of water sounds far louder than on a table. We doctors use the stethoscope, or chest tube, with our patients because it conducts to the ear sounds that we would otherwise be in ignorance of. The smitten tuning fork gives a feeble sound until it is placed on a solid body; what, then, more probable that these mysterious parts of the ear, of which we know but little, aid in multiplying sounds, and may, by diseased conditions of body, be altered, giving us the well-known deafness of the typhus fever, or the exalted hearing of cerebral conditions?

In molluscs, or the the mussel tribe, in annelids (leech tribe), and also in cephalopods (or the cuttle fish tribe) the granular vibratory bodies above spoken of are found. Insects, moreover, says Carpenter, are capable of attracting each other by the noises they make, although the organs of hearing cannot be discovered, and the strong analogy of the case leads almost to certainty, although demonstration may be impossible. A special organ in spiders has not been discovered, but the story of the imprisoned c er quoted gives no doubt on that score. In man the organ of hearing is amplified into a *perfect ear*, and as we go down the scale of creation all manner of modifications are found; each and all apportioned by a beneficent Creator to the diverse existence of the being. The nervous supply of the ear is one of the mighty problems that baffle the perseverance of anatomists, nor can the microscope invade the subtile mystery. The auditory nerve is connected and interlaced with so many others, that compound or complex actions arise which we recognise only in their results, but cannot unravel. Man has wearied himself over the problem, and is apparently as far as ever from the solution; the day may arrive when the Creator will permit light to penetrate the mystery of brain action, and the convolutions of grey and white may unfold their meaning, but the territory of mind and matter as it exists in our brain-case, seems to be beyond man's reach; the one may be shattered, the other spoiled, and we become mere examples of animal life, wrecked and helpless, on the shores of Time. A slight blow, a terrible shock, may send the throne of man, his ever-busy brain, reeling in the dust, and small may be the interval between the kingly state of a Nebuchadnezzar and the grovellings of lowest life. Such is often, aye, I might say an everyday result, of grasping and unsated ambition, or the reckless victim of gaiety, or the worse slave of lust, whether of the world, the eye, the flesh, or the pride of life; powers sacrificed, alienation of useful faculties, talents thrown away, souls perilled, if not lost. These are the means and ways by which our lunatic asylums are filled—vessels, I might compare them to, freighted for the green hills far away, unsatisfied with the daily manna of a blessed contentment, fretting their lives against a cage of their own making, dying of unrest, deprived even of the stimulus of a purpose, they have their use, but it is as *beacons* to warn the thoughtful among the crowd not to speed, for the very life of them, after illusions and shadows that may be touched but never grasped. Why is it that so many fail in life? Because they are not in earnest. You rarely see a man with any measure of success who has not made it for himself. I remember once meeting with a very excellent man, who, in early life, up to two or five-and-twenty, had been living a useless existence, "lying on his oars." He had the ability, as the result proved, but preferred to bury his talent in the earth. A true friend one day accosted him and said, "How long are you going to continue this kind of existence, do you ever intend to be in *earnest?*" The young man felt the rebuke just; and went home. He that day took to his Latin grammar, became assiduous, at length entered the University, obtained his degree, and became no longer the "idler about town," but one of God's ministers, and the deepest pang that good man ever felt was a retrospect of the misspent past. The pernicious example of such an idler is baneful to hundreds, his influence, like that of the good, is far and wide. Can you or I tell the good that a single number of the ENGLISH MECHANIC can accomplish?—No! but I tell you what we *can* do—our best to help. A kind word or look may keep some one within the path of duty, and men will be forced to say, "Here is an influence at work that is not of earth, and there is a prospect at the end of the path giving us such light and comfort that our hearts are warmed, and open to the wayworn and toil crossed at our side." We think only of the help from hand to hand, and if the recipient is surprised that good comes without either motive or reward, he believes, that the way of the world is *not so*, and the gift is God-sent.

Now let us have a word or two about the abuses of the ear. Truly it has been a long-suffering organ. The armamentarium medicum that old ladies had in reserve was fearful! Each possessed her peculiar "leperous distilment," which, producible at a moment's notice, led to the supposition that she carried her medications in a girdle near of access. First in the armoury came a pewter syringe, large enough to shoot a fly, and which boys used to look upon as a special perquisite, a weapon of surprise for their sisters in every nook and corner. These spray producers did neither good nor harm, unless you pricked the unlucky wight in his ear-passage with the point of the pewter and startled him into an attitude of combativeness. Worse, far worse, was in store for you if your ear ached. Laudanum, one of the least offensive of the compounds, hot oil and laudanum, oil of cloves, vinegar and cayenne pepper, cloves of garlic, and roasted onion, may be taken as samples; in fact, anything the druggist recommended was safe to have a trial. Leeches, tartar emetic ointment, savin ointment, were mild agents, and then runnings from the ear were common enough, traceable, as a surety, to these female mediciners and their male coadjutors, whose only authority was the recipe book (that valuable relic), or the equally incontrovertible authority comprehended in the *ipse dixit* of your grandmother, or her dame, which it would have been rank heresy to reject. More fashionable days arrived, and people, ashamed of folly, coated it with mystery. *Black wool* was inserted, procured possibly for *gold*, and cut by a "cunning woman" in the mysterious light of the young moon, from the head of a two-year-old ram, midway "between the horn and the leg." Fairies were perhaps invoked for its safe keeping, the *fortunate* possessor withdrew it with an air of solemnity, which seemed to say: *You* do not know its virtues—" leastways they were 'id," like the money of Tenneyson's Northern Farmer, whose scion committed the awful wrong of being "sweet upo' parson's lass." If you had the temerity to ask the *sheepish* owner what the product was, there was such a hemming and hawing, preceeding the "Don't know" (which in plain *unvarnished English* was a lie) that the fool blushed to the eyes, and anywhere that blushes could go. On another occasion *you* found some of your respected relations with their heads encased in a pillow-shaped concern, looking uncommonly wet and uncomfortable, not taking their ease for certain in this pillow of home-grown camomiles and bruised poppy head, heightened into activity by a little medication poured near the seat of pain, "but it didn't do no good," and the light of our grandmother (God bless her!) died out in a proper way, and we are forced by way of epitaph, to say, "They did their best, angels could do no more.", Now people are wiser, they respect the *argumentum ad hominem*, but they keep it at a respectful distance. Hardly anyone in those days had seen the drum of the ear in the living, although some must have been actuated by curiosity. The silver speculum was not divined, or the lamp of Avery, or the contrivance of Brunton, means for casting the glowing beam into the dark recess. Illumination then was confined to the monks, but in these days of endoscopes, laryngoscopes, and ophthalmoscopes, we can see in the living what our fathers little dreamt of, and in a generation or so to come the readers of the existing serials will think us as great fools as we sometimes consider our respected ancestors:—who, however, managed to live longer, and kept better order, when life was less sacred than now, and crime had a show of modesty.

LATHE MADE FOR TITUS SALT, ESQ.



A MOST EFFICIENT LATHE.

We illustrate a very complete amateur lathe, belonging to Titus Salt, Esq., of Saltaire, near Bradford, who kindly furnished us with some very fine photographs of it, from which our illustrations have been engraved. This lathe was designed for Mr. Salt by Mr. Smith, of Jersey. It was chiefly made at Saltaire, but was finished by a London maker. As, with its apparatus, it has cost, we believe, upwards of £1500, we think it may justly be considered the most complete amateur lathe in existence. It is capable, we believe, of efficiently performing all, or very nearly all the operations that can be accomplished in the lathe; and this not by means of makeshifts, but through mechanism which has been carefully considered with a view to simplicity with efficiency, and constructed throughout regardless of expense.

A lathe of this sort necessarily contains many ingenuities which are not only interesting to the fortunate very few who can afford such costly apparatus, or as illustrating the perfection to which the lathe can be advanced, but also as guides in constructing any apparatus for executing any one of the purposes of which this lathe will do all.

The crank and treadle are much the same as those in ordinary use; but the crankshaft also carries a pair of pulleys, one fast and the other loose, for taking a flat belt proceeding from some source of motive power. Mr. Salt, we believe, has

SCIENCE FOR THE YOUNG.

Series I.—Mechanics.

Introduction.

By the Rev. E. Kernan.

THE object of these papers is to lay out for the beginner in Mechanical and Physical science a course from which he will never require to deviate permanently, no matter to what extent circumstances may induce him in after years to increase his scientific acquirements.

For such an elementary course, however, no great mathematical knowledge is required; the use of simple algebraical formulæ, some geometry, and the first principles of trigonometry are, as a rule, enough. Where exceptions occur the means by which full satisfaction may be obtained later on can be indicated. Moreover, in many branches of science, the great principles can be acquired scientifically, and yet simply, without that mathematical learning employed for their full theoretic development by the more advanced scholar.

Mechanics being the foundation of all true knowledge, claims the first place in a scientific course. The series on mechanics may be divided into three parts. The first sets forth some necessary preliminaries, which, once determined and understood, facilitate the work to come; the second contains all that is usually understood by mechanics in its widest sense; the third treats of bodies in a state of vibration, *practically* sound, acoustics, which is so closely connected with mechanics that it can be shown to be contained in the definition of this science.

Part I.—Preliminaries.

These may be classed under three heads: The object of mechanics, with the division of the subject; the general properties of matter; and the explanation of terms required for study.

CHAPTER I.

OBJECT OF MECHANICS; DIVISION OF THE SUBJECT.

Before answering directly to the question, "What is mechanics?" it would be useful, if not even to a certain extent necessary, to say what it is not. First, then, mechanics is not the method of working in wood or in iron. They who are thus occupied are called "mechanics," but they are not thereby designated as having acquired the science of mechanics. Not but that they could possess it, and would profit much by a knowledge of its principles. Frequently their knowledge is but a mere routine of facts, handed from one to another, the cause of which they do not understand. The small amount of mind required to obtain knowledge of this class, and the fact that such knowledge is not unfrequently combined with great mental deficiency, are the reasons why the "mechanic" is not considered as having the higher gifts of intellect. Secondly, the science of mechanics is not the dull, dry study that some imagine.

It is quite true mechanics do not possess for some the interest which, for example, the brilliant experimental part of chemistry excites. But if so it has none of the dull, plodding, mere memory work of theoretic chemistry. Every proposition of mechanics sparkles with proof, mathematical and experimental. With a pencil and paper the thousand phenomena which may occur are discussed, and their cause, result of combination, &c., declared; the instruments are brought forward, and experiments prove the truth of the theory. Again, the constant occurrence within us and around us of the exemplification of mechanical principles is a new source of interest to an intelligent mind. So far what mechanics is not. Now, on the other side, mechanics is that part of natural knowledge which best deserves the name of a "science." For its principles have, of all others, been put to the severest of tests—length of time, found as they are in the very first pages of the history of science; extent of application, including, as they do, everything in the cosmic system that has as yet been brought into a really scientific form. And so strictly is this latter true, that the fundamental principles of mechanics are every day extending themselves to new branches, rendering clear and logical what was before but a collection of facts, without explanation other than obscurities or contradictions. Thus from the principles of mechanics of solids applied to the liquid state has arisen the science of hydrostatics and hydrodynamics; from their extension to the gaseous state has resulted the science of pneumatics. Passing to the confines of the ponderable world, to the connecting link between matter tangible and untangible, sound is discovered to require no new principles. Reaching farther, to the region of what are usually termed imponderables, the principles of mechanics have seized upon light, and made it subject to their unerring laws. By this great conquest are explained phenomena most complicated and apparently contradictory, which had before been but an enigma. By it, without fear of error, it can be shown that in such and such conditions, certain extraordinary phenomena should be observed which reason would be inclined to reject as impossible or absurd; for instance—that two lights can be a cause of darkness. It is not surprising, then, to find Dr. Lloyd in his lectures on light, say of Fresnel, the French philosopher, who worked out the mechanical theory of light, that he has "reared the noblest fabric which has ever adorned the domains of physical science—Newton's system of the universe alone excepted." Even beyond light has mechanical investigation progressed. Heat, less tangible, is being proved, every day, more and more, to be but a "mode of motion." The time is perhaps not far off when electricity shall cease to be that unknown mysterious agent, shall yield its secret to mechanics; showing to the wise ones to what a distance from the truth they have wandered, how they have groped in the dark, wasting their energies in theory and speculation.

What, then, is this so much lauded mechanics? It may be differently defined, according to the point from which it is viewed. The following definition will suit the form of the present series: *Mechanics is the study of the laws which regulate the action of external forces upon all bodies.* Bodies exist in some one of the three states, solid liquid or gaseous, and the student cannot begin too soon to keep this triple state of matter before his mind. That solids can be affected by forces requires no proof. For liquids it is only necessary to place a tray with water on a table; the least stir ruffles it's surface; for gases, the rushing of the "thin air," the winds, the storms supply superabundant proof. By the word *external* is to be understood some *manifest* action or effort at action; and this effort may be from the nature of the body itself, or from some external source. Thus is mechanical study distinguished from others in which action not directly manifest is the chief object: for instance, chemistry. The *study* of the laws includes not only the mere statement of them, but also the proofs of their truth, and their actual or possible existence in action, in natural or artificial combinations; in a word, the applications of the principles contained in the laws.

(*To be continued.*)

A GRAND ORGAN.

A TRIAL has been made of the tone of the grand organ which is being built for the Royal Albert Hall, at the works of Mr. Willis, at Camden-town. This magnificient instrument is remarkable not only on account of its size and the number of its pipes, but also on account of the excellence of its design and construction. It is 65ft. wide, 70ft. high, and 40ft. deep. It weighs over 150 tons, and has nearly 10,000 pipes in it. The largest pipes are 2ft. 6in. diameter—the smallest about a couple of inches long, and not much thicker than a barley straw. In all there are some nine miles length of pipes of various sizes. There are no less than 138 stops, 20 couplings, and 60 combination pedals and pistons. The extreme range of compass from the highest to the lowest notes is nine octaves apart. There are four sets of manual keys and one set of pedals. The manual keys extend from C C to C in altissimo, or sixty-one notes; and the pedal from C C C to G, or thirty-two notes. The pedal organ consists of twenty-one stops, the choir organ of twenty stops, the great organ of twenty-five stops, the swell organ of twenty-five stops, the solo organ of twenty stops, and there are fourteen couplers. Eight pneumatic combination pistons govern the whole of the stops of each manual range of keys, and these are so placed below and in front of the keys as to be at all times within instant reach of the hands of the performer. Six pedals govern the stops of the pedal organ. The "Swell" is, as usual, in the rear of the organ, and will be in a separate chamber, 20ft. by 20ft., and 20ft. high The key notes, or "claviers," as they are technically called, are made of massive ivory, and so exquisitely balanced that the least touch is sufficient to sound them, and, in fact, notwithstanding the size of the organ, any lady could play upon it with the same ease and with the same rapidity as she could on a cottage piano. If anything, the notes are almost too easily sounded, and scarcely give that rest for the hand to which organists are so much accustomed. This, however, is a fault on the right side, and one which will bear good fruits when rapid and brilliant execution is needed to develop the infinite variety of tone of this great instrument. All the internal metal pipes are made of an alloy of 5-9ths tin and 4-9ths lead. The front pipes are almost entirely of tin, there being 90 parts of that metal to only 10 of lead. The outer pipes are burnished and polished in the same manner as those of the great continental organs; the burnished metal, in fact, is made the chief ornament, and a most effective one it is. The organ will be supplied with wind by means of steam power, as in the case of the Liverpool organ in St. George's Hall. Mr. Penn is making two eight-horse power engines for this work, which will be able to work up to 50-horse power with ease and give the very decided pressure of air required for playing with full power when all the stops are opened. The main reservoirs into which the compressed air is forced are placed in a chamber in a dry position. The feeders supplying the air are of a most ample size, and constructed to receive their wind from the room above, and not from the locality in which they are placed. To carry out this arrangement, which is one of the highest importance, passages are provided for the windshafts to and from the organ to the chamber in which the main reservoirs are placed. The main reservoirs in turn deliver their wind to numerous subsidiary reservoirs in immediate connection with the pipes. The mechanical arrangements effected by the pressure of attenuated and compressed air vary from four to forty inches. The light touch of all the key-notes is alike. The pedal arrangements are divided into ten distinct parts. The external aspect of the grand organ is very imposing. It is not disfigured by a case. The pipes, carefully graduated as to height, rise in four great clusters of spires, two at each end and two in the centre. In the three sides which front the audience are three vaulted lofty openings which allow all the works to be seen, and in the background is a perfect forest of pipes. The base, or stand, of the organ is about 21ft. high. This is of carved oak with a recessed Italian doorway in the centre, in which, at the keys, the performer sits. The oak screen which forms the external face is, however, merely a screen, for the organ itself is built on massive stone foundations, which the oak work encloses. The instrument will cost, when completed, about £10,000. It has been built under the direct supervision of Sir Michael Costa, assisted by Mr. Bowley, of the Crystal Palace, and Sir Michael pronounced it to be perfect in tone and working.

THE DETERMINATION OF THE PERCENTAGE OF SULPHUR IN IRONS.

THE analysis of irons is becoming increasingly important, and the small quantities of impurities, which greatly alter their quality, renders accuracy indispensable, and adds to the difficulty of ensuring it. Although not sulphur, but phosphorus, is the greatest hindrance to the production of good iron, being generally present in a larger quantity, the former is nevertheless injurious. It may therefore be acceptable to those who are interested in the subject if I describe the method which has to my mind been the most satisfactory in the estimation of the quantity of sulphur in irons. I have analysed several specimens of pig iron according to the solution in nitrochloric acid method, with all due precautions, which, although exceedingly important, are often omitted in explanations of the process. The following are results of the analyses:—

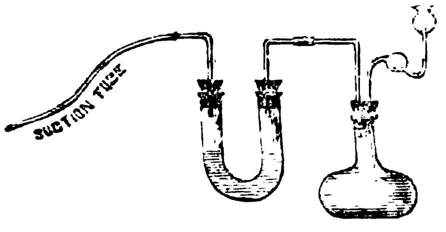
Sample	1st anal.	2nd anal.	Dif.
No. I. per cent. of S.	0·48	0·45	0·03
No. II. „ „	0·62	0·69	0·07
No. III. „ „	0·45	0·8	0·15
No. IV. „ „	0·23	0·26	0·03

The precipitate with chloride of barium does not make its appearance until after warming the solution for some time. After filtering and washing it well with boiling water it is seldom if ever possible to render it white, which is objectionable to a careful chemist. However, if the sulphate is precipitated it all, I am convinced that it is entirely precipttated, and with such results as I have given above there is scarcely cause to complain much of the process.

As, however, puddle bars contain a very small quantity of sulphur, at least 10 grammes of iron in fine powder must be employed in order to obtain a weighable and reliable quantity of sulphate of barium. More acid must consequently be used, and it is impossible to obtain a precipitate in the strongly acid solution, which, for well known reasons, must not be neutralised.

I will, therefore, briefly describe the method which I have employed to estimate sulphur in puddle bars and other irons containing small quantities of that element—a method which has given me highly satisfactory results.

A weighed quantity of iron is thrown into a capacious flask (about 2 pints capacity); about an ounce of water added, and the whole agitated to prevent caking in the after processes. A cork having two perforations is inserted into its mouth. Into one of these perforations passes a tube with bulb and funnel bent and containing a little mercury to allow of pouring into the flask, but to prevent back action. Into the other passes a tube bent at right-angles leading to a U tube, containing caustic potash free from sulphate. (Beyond this U tube I placed another containing hydrated oxide of lead in solution by caustic potash, which after repeated analyses was not in the slightest degree blackened.)



Hydrochloric acid is poured in at the funnel, and suction applied to draw it through the mercury into the flask; sometimes water is added, and then acid, until there is a large excess of acid. When the action, after due addition of acid, is very slow, the contents of the flask are boiled, then the flame taken away, and as soon as ebullition has ceased air is sucked through the apparatus. The boiling can after be advantageously repeated, and the suction again continued. The still caustic solution in the U tube is emptied and rinsed out into a beaker. Pure chlorine gas is passed through it; after boiling, sufficient hydrochloric acid is added to drive off the hypochlorous acid, and the boiling is continued until all or nearly all the smell of this acid is gone. The sulphate is then precipitated with chloride of barium.

The contents of the flask are filtered through asbestos. A small funnel with a rather ill-proportioned large neck is chosen. Enough asbestos loosely to fit into the neck is taken and thrown into the funnel, without any placing or pressing with the fingers. On pouring water in to fill the funnel, the pieces of asbestos swim about in the liquid, and gradually settle in the neck in such a manner that the acid solution can be filtered quickly and perfectly clearly. After it has all gone through, the flask need not be rinsed out, or the residue in funnel washed; but the latter should be transferred with the asbestos to the flask again, and the funnel washed with a very small quantity of nitrochloric acid, which is allowed to trickle into the flask also. The black residue mixed with nitrohydrochloric acid in very small quantity is heated, covering the mouth of the flask with a glass plate. Some water and carbonate of soda is added to take off the excess of acid, and the liquid, after boiling, is filtered through paper, taking care that it is still slightly acid, and, of course, washed. Chloride of barium is added to this solution, and if, as is often the case, a precipitate be produced, the whole is poured into the beaker with the former precipitate, and treated in the usual manner. By this method I obtained highly satisfactory results from irons which, according to the other process, would not show the least sign of precipitation when chloride of barium was added in large excess, and the solution heated for some hours and then allowed to stand a whole day and heated again. It may be interesting to some to give a few of my results:—

Ordinary Puddle Bars.

Sample.	1st anal.	2nd anal.	Dif.
No. I. per cent. of S.	0·038	0·026	0·012
No. II. „ „	0·073	0·088	0·015
No. III. „ „	0 045	0·033	0·015

One could scarcely expect more satisfactory results than these are.

H. B. Hamilton, Analytical Chemist.

ON THE POLARISATION OF HEAT.*

By Professor Tyndall, F.R.S., &c.

IN the *Philosophical Magazine* for November, 1835, the late Principal Forbes gave an account of the experiments by which he demonstrated the polarisation of non-luminous heat. He first operated with tourmalines, and afterwards, by a happy inspiration, devised piles of mica plates, which from their greater power of transmission enabled him more readily and conclusively to establish the fact of polarisation. The subject was subsequently followed up by Melloni and other philosophers. With great sagacity Melloni turned to account his own discovery, that the obscure rays of luminous sources were in part transmitted by black glass. Intercepting by a plate of this glass the light emitted by his oil lamp, and operating upon the transmitted heat, he obtained effects exceeding in magnitude any that could be obtained by means of the radiation from obscure sources. The possession of a more perfect ray-filter and a more powerful source of heat enables us now to obtain, on a greatly augmented scale, the effects obtained by Forbes and Melloni.

Two large Nicol's prisms, such as those employed in my experiments on the polarisation of light by nebulous matter, were placed in front of an electric lamp, and so supported that either of them could be turned round its horizontal axis. The beam from the lamp, rendered slightly convergent by the camera-lens, was sent through both prisms. But between them was placed a cell containing iodine dissolved in bisulphide of carbon in quantity sufficient to quench the strongest solar light. Behind the prisms was placed a thermo-electric pile, furnished with two conical reflectors. The hinder face of the pile received heat from a platinum spiral through which passed an electric current regulated by a rheostat.

The apparatus was so arranged that, when the principal sections of the Nicols were crossed the needle of the galvanometer connected with the pile showed a deflection of 90° in favour of the posterior source of heat. One of the prisms was then turned so as to render the principal sections parallel. The needle immediately descended to zero, and passed on to 90° at the other side of it. Reversing, or continuing the motion, so as to render the principal sections again perpendicular to each other, the calorific sheaf was intercepted, the needle descended to zero and went up to its first position.

So copious, indeed, is the flow of polarised heat that a prompt rotation of the Nicol would cause the needle to spin several times round over its graduated dial.

These experiments were made with the delicate galvanometer employed in my researches upon radiant heat. But the action is so strong as to cause a coarse lecture-room galvanometer, with needles 6in. long and paper indexes a square inch each in area, to move through an arc of nearly 180°.

Reflection, refraction, dispersion, polarisation (plane and circular), double refraction, the formation of invisible images both by mirrors and lenses, may all be strikingly illustrated by the employment of the iodine filter and the electric light.

Take, for example, the following experiments:—The Nicols being crossed, the needle of the galvanometer pointed to 78° in favour of the heated platinum spiral behind the pile. A plate of mica was then placed across the dark beam with its principal section inclined at an angle of 45° to those of the Nicols. The needle instantly fell to zero, and went up to 90° on the other side.

And, for circular polarisation:—The Nicols being crossed and the needle pointing to 80° in favour of the platinum spiral, a plate of rock crystal cut perpendicular to the axis was placed across the dark beam. The needle fell to zero, and went to 90° on the other side.

The penetrative power of the heat here employed may be inferred from the fact that it traversed about 12in. of Iceland spar, and about 1½in. of the cell containing the solution of iodine.

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* From the *Philosophical Magazine*.

ON THE PHENOMENA OF COMBUSTION.

SPECIAL REPORT.

THE last of the present series of Cantor Lectures on this subject was delivered by Dr. Benjamin Paul, F.C.S., on Monday, 28th ult., in the presence of a large audience. The lecture had specially to do with the use of combustible materials for producing light, with the varieties of illuminating materials—coal gas, petroleum, and paraffin oil, and also with the measurement of light. At the outset, the lecturer observed that the evolution of light was another of the effects of combustion which was of practical utility. It was chiefly by means of combustion that artificial light was produced. One important fact we had to consider in regard to combustion as a source of light was that all material substances became luminous when they were sufficiently heated, and this was a special characteristic of solid substances, which, however, were not changed in their condition or nature by such heating. Having shown the luminosity of solid substances by experiment, Dr. Paul adverted to the fact that liquids also became luminous when heated, under conditions, however, when they were not converted into vapour. Melted metals and glass, for instance, emitted light at high temperatures; gases and vapours were least of all capable of luminosity when heated. At a temperature of 1000 degrees, liquid substances emitted a reddish light, and this degree of heat was termed "red heat," which again, in proportion to the temperature, was distinguished by the names "red," or "dull" heat; or again by those of "cherry red" or "brick red." At very high temperatures, solid and liquid substances gave a colourless light, termed "white heat." To produce artificial light, we must first obtain a very high temperature in some substance capable of becoming luminous in that condition. If hydrogen gas were burned with oxygen, a very intense degree of heat would be attained, but the water vapour which was the product in this gas had such a degree of continuity that it gave a gas affording barely sufficient light to be visible. After explaining the production of lime-light, and showing some experiments with magnesia, the lecturer adverted to carbon. Carbonaceous substances were easy to illuminate. The chief characteristic of very inflammable substances was the presence of carbon, which in some cases was as much as 80 per cent. Oil, tallow, and the various materials used in lamps were susceptible of vaporisation, and that, too, without giving any fixed carbonaceous residue, which was not the case with coal, wood, resin, or such materials. Dr. Paul next asked attention to the form of flame, which, he said, was partly determined by the way in which the combustible gas was supplied, and partly by the reaction of the heated product of combustion and the atmosphere upon each other. The shape of the luminous flame might be different from that of a candle, but in every case there was the same relative disposition of the zones in which the progressive changes took place. The production of flame from any substance corresponded to the amount of carbon it contained, and to this was owing the difference between the flame from a candle and that from coal gas. After some remarks on the comparative merits of olefiant, marsh, and benzole gases, the lecturer alluded to paraffin oil, and said that, whereas marsh gas contained 75 per cent of carbon, paraffin oil contained 85, and the former contained half as much carbon as olefiant gas. The vapour of marsh gas contained one-seventeenth as much carbon in a given volume as the vapour of paraffin, which was very much more dense. The same was the case with benzole gas, which contained four times as much carbon as an equal volume of marsh gas. The latter gas burnt with a pale flame, leaving no sooty deposit or luminous effect, and the former burnt with an intensely luminous flame, and over and above that left a large deposit of carbon, which, unless regulated, rendered the flame sooty and smoky. In all illuminating materials it was necessary to regulate the conditions in such a way that we might get a deposit of carbon to such an extent as would make a flame in the highest degree luminous, without overstepping the line at which it became smoky. The lecturer next referred to the heat of rooms, and observed that most people seemed to forget that in proportion to the quantity of artificial heat introduced into a room in that proportion was the air deteriorated. Olefiant gas produced the greatest effect upon the atmosphere, by destroying the largest amount of air; marsh gas next; carbonic acid gas next, and hydrogen gas least of all, because it was the most volatile. Dr. Paul then referred to the complaints so rife relative to the bad quality of the gas now supplied, and said that although these complaints might to some extent be based on just grounds, yet he thought much of the fault lay with the burners in use. He here exhibited some of Mr. Sugg's improved burners, and concluded by regretting that the time at his disposal had prevented him from entering into the interesting subject of paraffin oil.

We understand that the next series of Cantor Lectures will be given by Dr. Williams, on "Fermentation," and that they will take place on the last two Mondays in April, and the first two Mondays in May.

STRUCTURE OF THE LIVER.

An important paper on this subject by Professor Hering, of Vienna, appears in the just published third part of Stricker's *Handbuch von den Geweben*. This gland is the most intricate in the body of the higher animals, and its functions present a corresponding complexity; on these grounds it has been subjected to very careful microscopical examination, as well as experimental investigation, by many of the best observers, both here and abroad, amongst whom Professor Hering holds a distinguished place. Speaking broadly, the liver consists of an immense number of pear-shaped bodies or lobuli, separated from one another by a delicate investment of connective tissue. Between these spread branches of the portal vein, conveying blood to the liver from the intestines, and of the hepatic artery, the ultimate branches of the latter discharging themselves into those of the former. The capillary vessels thus formed penetrate the substance of each lobule and reunite in a central vessel, which, issuing from the extremity of the lobule like the stalk of a pear, coalesces with others to form the hepatic veins which convey the blood that has circulated through the organ to the heart. The substance of the lobuli themselves is composed of cells, the office of which is in part to secrete bile, and in part to produce the substance termed glycogen. The writer observes that the capillary system of the portal vein, as a general rule, exhibits large capillaries and a narrow-meshed plexus, whilst that of the hepatic vein exhibits small capillaries and a plexus with wide meshes. The foregoing facts are now fairly established, but the points to which Professor Hering's attention has been particularly directed are connected with the distribution of the biliary ducts. These, he states, consist of a close network of delicate canals running between the hepatic cells, with meshes equalling the cells in diameter, or, in other words, the canals run between the flat surfaces of two adjoining cells. The capillaries, on the other hand, occupy the angles formed by the junction of three or more cells. This description particularly applies to the rabbit. In man and the dog, biliary canals are also found at the angles of the cells. For the sake of clearness, we have made use of the term biliary canals, but Professor Hering observes that they have no proper wall so long as they are contained within the lobuli. These walls are, in fact, the cells themselves, and they may fairly be represented by the tubes that would be produced by grooving two solid bodies, and applying the corresponding channels to one another. He has not been able, in any instance, in the rabbit at least, to discover a blind extremity of a biliary tube. He describes the hepatic cells as presenting various forms, according to the direction in which they happen to be divided in the section, being sometimes quadrangular, sometimes polygonal, and presenting the grooves above mentioned for the passage of the capillaries, and for the formation of the ducts. They contain one, or occasionally two, nuclei of spherical or elliptic shape, together with some granules of biliary pigment and fat molecules. He finds the liver to be richly supplied with lymphatics, which, as in other organs, chiefly accompany the connective tissue. The system presents this peculiarity, however, that both the capillaries and the larger vessels freely anastomose with each other. Though he has carefully examinedt he point, he has been unable to follow the nerves of the liver into the cells, a relation which has been maintained to exist by Pflüger. (*Academy*, No. II., p. 47.) Professor Hering states distinctly that all demonstrable nerve trunks lie outside the lobuli.

PLATINISED LOOKING-GLASSES.*

By C. Widemann.

NO. III.

(*Continued from page* 27.)

It is now unnecessary to use glass free from colour or to require parallelisms of the two surfaces. Bubbles of air, stripes, foreign bodies, pieces of the pots, &c., &c., do not interfere with the process. There is then an economy of 50 per cent. in the glass.

In order to manufacture a looking-glass of 5 millimetres thickness, they use at the St. Gobain works a plate measuring 10 millimetres thickness.

At the Wailly-sur-Aisne works, plates are used having but 7·5 millimetres thickness, as it is only necessary to polish the glass on one side. From this a saving is made of 25 per cent on the thickness of the glass.

Very correct calculations show that Mr. Dodé secures an economy of 80 per cent. on platinised glasses, as he uses for that purpose only inferior glass commonly used for flagons; even common brittle glass can be used without the least difficulty. To this saving there is another to be added, which will astonish the reader. A square metre of glass absorbs about 183 grammes of mercury and 550 grammes of tin, representing about a cost of 4 francs, 40 centimes. A square yard of platinised glass costs 1 franc and 20 centimes for platina. It results from this, that at the Wailly-sur-Aisne works, the superficial square yard of platinised glass is sold at an average of 25 francs. This price is doubled in the mercury manufacture.

There is another circumstance for which this new process is recommended to the public. It is with great difficulty that mirrors are obtained with a curved surface. By the platina process this difficulty disappears, and it is as easy to manufacture curved, round, etc., as horizontal mirrors. There is also no inconvenience arising from upsetting the glasses in transportation or in placing them in the frame.

Already in this country a company has been organised to manufacture reflectors by the means of silver mica leaves on the posterior face, and fastened together so as to obtain a large reflective surface possessing the desired curves. They are cheap, and easily repaired; but they meet with two great difficulties: the quick alteration of the silvery surface caused by the hydrosulphurous gases of coal with which locomotive reflectors are always in contact, and the want of transparency of the mica and its yellow colour. I have no doubt that by the adoption of the platina these evils would have found their remedy, for, as it has been seen before, the reflecting surface is on the anterior part of the glass.

A quite peculiar property of the platinised mirrors will no doubt be applied by architects. The platinised glasses forming mirrors are transparent when the light passes through them. A person placed in the rear of an office can see everything going on in the front office without himself being seen. I insist particularly on this property; it appears to me to give to the platinised glass quite a new application, which will increase its sale. This transparency is easily explained considering the small quantity of platina deposited on the glass, which quantity is not large enough to give opacity to the glass and prevent the luminous rays from passing through it. This transparency has received a very amusing application quite lately in Paris. Mirrors called *mirrors a surprise*, are sold, which, when a black paper at the back of the glass is removed, allows a photograph or any other image to be seen through the metallised surface appearing as a spectre; this photograph is simply applied at the posterior side of the reflecting part, and oiled in order to add to its transparency. This toy is varied in very different ways, and has just been applied in the new play of "The White Cat," at Paris, and has caused an immense sensation. So I have no doubt that the inventive mind of the Americans will find thousands of applications for this property, either in applying it to the decoration of stores, or to external ornamentation. In theatres or concert halls among flowers it produces the most fairy-like effect. The window glasses of a parlour made thus would transparent in daytime, and at night when the shutters are closed the whole window wound appear as a large looking-glass, and reflect all lights and objects in the apartment.

The manufacture of glasses with amalgam necessitates great labour. In order to obtain 50 metres of looking-glass a large number of hands and a large plot of ground are required. These glasses must remain loaded with weights from 15 to 20 days; then 20 days more are required to eliminate the superabundance of mercury, and three months more are required before they are saleable; not to mention all the precautions that have to be taken at every moment in the shipping and setting in frame. MM. Dode and Faure are able to platinise a surface of 800 metres a day, with only the aid of a few hands, as one workman is able to platinise 50 metres of glass in 12 hours' work.

EXHAUST STEAM FOR HEATING PURPOSES.

By Charles E. Emery.

Questions are frequently asked regarding the relative economy of heating buildings with live steam taken direct from the boiler, or with the exhaust steam from a non-condensing engine.

Though the steam engine is a *heat* engine, the best examples utilise only ten per cent. of the heat in the steam used, consequently at least 90 per cent. of the heat which enters the cylinder escapes with the exhausting steam, and can be made available in no way except for heating purposes.

The temperature of the exhaust steam from a condensing engine is from 130° to 140° Fahr., and that from a *non*-condensing engine is from 212° to 220° and upward, varying according to the amount of back pressure in either case. A portion of the escaping heat is generally utilised in heating the feed-water for the boiler. In the condensing engine the low temperature of the exhaust steam, and the liability to air leakages and loss of vacuum in long pipes, makes it impracticable to save any more of the heat than that mentioned, and the remainder is necessarily wasted in heating the condensing water. In the non-condensing engine there is on the average ten per cent. of the heat utilised by the use of a feed-water heater, in addition to the ten per cent. transmuted into work, consequently eighty per cent. of the original amount of heat remains in the exhaust steam, and is usually wasted in the atmosphere. If this large quantity could be used for heating buildings without interfering with the performance of the engine, there would be no doubt of the value of the system—the heat in fact would cost nothing; but it is evident that in order to cause this steam to traverse through heating-pipes and coils it must have sufficient pressure in excess of that of the atmosphere to enable it to overcome the increased resistance. The additional pressure varies from two to five pounds and upwards per square inch, and acts as so much back pressure upon the piston, thereby reducing the power of the engine. The power lost must be supplied by increasing the mean pressure upon the driving side of the piston, and the question becomes:—What is the relative cost in fuel of supplying the heating-pipes with steam direct from the boiler, as compared with that required for the extra power necessary to circulate the exhaust steam through the building?

The answer to this problem depends upon the particular circumstances of each case, and to make the subject generally understood, it is first necessary to investigate some of the known facts in regard to low-pressure steam-heating apparatus.

Manufactories where steam-power is employed generally have a large number of windows for the convenience of the workmen, and are often more or less exposed to cold draughts from hoistways, staircases, and outer doors, and though the temperature need not be so high as in dwelling-houses, it would be unsafe to allow less than one square foot of heating surface in the heating pipes and coils to every 100 cubic feet of space to be heated. In order to form a safe estimate of the amount of fuel required when the steam is taken direct from the boiler, we may assume as an extreme case that the difference between the external air and that of the room is to be 69°; then, according to the experiments and formula of Tredgold, we find that it will require three and one-eighth square feet of surface to condense a pound of steam per hour, and if one pound of coal evaporate eight pounds of water, it will supply steam to (8 × 3·125 =) 25 square feet of heating surface and will heat (25 × 100 =) 2500 cubic feet of space for one hour. This estimate will be correct for average circumstances, but will not apply to all cases of low-pressure steam-heating, especially where the rooms are unusually exposed either to draughts of air, or great extremes of temperature.

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* From the *Scientific American*.

In estimating the greatest amount of space that can be heated by the exhaust steam of an engine, it should be borne in mind that the quantity of steam discharged necessarily varies with the work being done, and as the temperature of the building requires to be constant, we can only utilise the quantity of heat escaping when the engine is lightly loaded. For instance, an engine of 80-horse power may be loaded occasionally to only 40-horse power for half an hour or more at a time. If each horse power require on the average 3lb. of coal per hour, 40-horse power will require 120lb. As has been before mentioned, the exhaust steam from an engine contains 8-10ths of the heat received from the fuel, so in the present case the maximum heating effect is equal to 8-10th of 120lb., or 96lb. of coal per hour; and as each pound of coal will heat 2500 cubic feet of space, 95lb. will heat 240,000 cubic feet, equal to the capacity of a building 100ft. long, 60ft. wide, and 40ft. high. The extra power required to overcome the back pressure in that sized engine could not well exceed 10-horse power, which would cost 30lb. of coal per hour; and as 96lb. would be required were steam taken direct from the boiler, the saving is (96 — 30 =) 66lb. per hour, or 68 per cent. If the quantity of space heated be less than that mentioned, the percentage of saving will be less; for instance, to heat 150,000ft. of space in the ordinary way would require 60lb. of coal per hour; but with the exhaust steam in the above instance the cost will still be 30lb., so the saving will be 50 per cent. In warm days in winter, when less heat is required in the buildings, the same power will be taken from the engine to supply the less quantity of heat, so that the percentage of saving will be less. There would be some saving, however, whenever it required more than 30lb. of coal to heat the rooms. In case each horse power required more coal per hour than that stated, the advantages of exhaust heating would be correspondingly diminished, unless the size of the engine and amount of power necessary to distribute the steam were also less. In some instances, probably, the system is productive of loss as compared with the use of live steam, so the true plan is to make accurate calculations in each case. The following directions may therefore assist many readers—

To ascertain whether heating by exhaust steam is economical where it has already been applied, the first step is to measure the extra back pressure on the piston, which can be done by indicating the engine when the steam is escaping freely into the atmosphere, and when the exhaust is throttled for heating purposes, and comparing the back pressures shown by the diagrams. If this be not convenient, one leg of an inverted glass siphon containing mercury may be connected to some enlargement of the exhaust-pipe, and the mean difference in level noted in the two cases the same as before. One pressure corresponds to about 2 (2·037) inches of mercury. A longer syphon filled with water may be used with some inconveniences. In such case, one pound pressure corresponds to a column of water 2·3 feet high and 60° temperature, or 2·4 feet high at temperature of 205°.

Having ascertained the extra back pressure, the horse-power required to overcome it may be ascertained by the following rule, viz.: Multiply together the back pressure, the area of the piston in square inches, and the speed of piston in feet per minute, and divide the product by 33,000.[*]

The next step is to ascertain the coal required per horse-power per hour. This should be done, when practicable, by regular experiment. In other cases, it may be assumed that engines working with a steam pressure of 50lb. and under, with little expansion, will require 5 to 6lb. of coal per horse-power per hour. With more expansion, 4 to 5lb. will be required; and the most improved form of expansive engines, working with steam at 80lb. pressure, will furnish a horse-power for 3lb. of coal per hour. By multiplying the horse-power due to the increased back pressure by the coal required per horse-power per hour, and the product by 2500, the result will be the least number of cubic feet of space which can be heated economically by the exhaust steam from that engine. The advantages under different circumstances may be ascertained in the manner previously stated.

In heating a building by exhaust steam, particular attention should be given to the size and arrangement of the pipes. A main exhaust pipe should be run up through the building and out of the roof in the usual manner. This pipe should be larger than is ordinarily employed, so as to form a kind of expansion chamber to equalise the exhaust pressure. From the vertical exhaust pipe the heating pipes may be led out for each floor of the building. A common plan is to put a good-sized cast-iron pipe under the work-benches along the sides of the rooms. Such pipes should be connected by bolted flanges, and ample provision made for expansion and contraction. Heating coils of the ordinary construction may also be used, care being taken to make the leading pipes with as few bends as possible and of sufficient size. To obtain the proper size of pipe for a given case, the following formula may be used, which is founded on some experiments made by the writer for the United States Government, viz.: $a = W \div 46\ (p + 3)$ in which a = area of steam-pipe in square inches, W the weight of steam in pounds delivered per hour, and p the difference in pressure. Assuming as an extreme that 2·4 square feet of surface (s) will condense one pound of exhaust steam per hour, then, when the difference in pressure equals one pound, $a = s \div 440$. The following is then a safe rule:—Divide the heating surface in square feet by 400, the result is the proper area of the pipe in square inches. The following table gives the amount of surface which will be supplied with steam through pipes of the sizes mentioned:—

Diameter of Pipe.	Amount of Surface.
⅜ inch	40 square feet
½ "	75 "
¾ "	170 "
1 "	300 "
1¼ inches	480 "
1½ "	700 "
2 "	1200 "
2½ "	1900 "
3 "	2800 "

The pipes should be slightly inclined, so that the condensed water will move in the same direction as the steam. The ends of the various heating pipes and coils should be connected with a water-pipe terminating near the boiler in an inverted siphon, the shorter leg of which should be about seven feet long. The bend may extend under ground if necessary. This siphon should deliver the condensed water into a tank where it can be returned to the boiler. An air-cock should be placed in the water-pipe to allow the air to escape in starting.

Arrangements should be made so that the exhaust steam can be shut off from each room separately by a valve, and in some instances it may be desirable to admit live steam into portions of the pipes when the engine is not in motion.—*American Artisan.*

THE LUMINOSITY OF PHOSPHORUS.—Herr W. Muller, of Perleberg, gives an explanation of the well-known luminosity exhibited by phosphorus in the dark. It depends on slow combustion or combination with oxygen, but does not take place in pure oxygen, except when it is diluted by other gases, as is the case in the atmosphere. In other atmospheres, as hydrogen or nitrogen, the phenomenon does not occur.

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[*] Many engineers will find the following formula more convenient:—

$$\text{H.P.} = \frac{d^2 s r p}{252{,}000}$$

which, put in the form of a rule, is: Horse-power equals the square of the diameter (d) in inches, multiplied by the length of a single stroke (s) in inches, multiplied by the number of revolutions per minute (r), multiplied by the extra back pressure (p), and divided by 252,000.

REVIEWS.

Continental Farming and Peasantry. By JAS. HOWARD, M.P. London: W. Ridgway, 169, Piccadilly.

THE comparison of results obtained from two opposite systems must always decide the question. Mr. Howard's book in this manner contributes to settle the question of large or small farming. Travelling himself through the farming districts of France and Belgium, where small holdings prevail, he shows not only that the produce does not equal that of English farming, but that the holders are worse off; do more work for less money with less results than English farm labourers, although possessed of the advantages of a more favourable climate. Mr. Howard would permit small holdings on large estates as rewards held out by the owner (as in the case of Lord Lichfield) to deserving and thrifty workmen in later life. He would not, however, encourage the sub-division of holdings into smaller lots. One fact which he calls attention to is worth notice, namely, that in Belgium, where the small farm system is said to obtain such favour, the Trades' Union Congress, which met some time back at Brussels, condemned the system of "petite culture," and resolved that when communism in land was gained it would be necessary to farm on a large scale in order to take advantage of machinery, &c., in the production of food.

Every Man His Own Lawyer. By A BARRISTER. London: Lockwood and Co., Stationers'-hall-court, E.C.

THE eighth edition of this useful book needs little more from us than mention. For 6s. 8d. our readers can obtain a trusty adviser in every point of law, whose first charge is his only one, and who will not advise with a view to litigation and long bills, as lawyers in the flesh too often do.

MATHEMATICS,

BY C. H. W. BIGGS,

(*Continued from page 628, Vol. X.*)

RECAPITULATORY EXERCISES IN FRACTIONS.

§ 32. The following exercises will test the student's capacities for applying the rules already given:—

Ex. Express in its simplest form

$$\frac{\;3\frac{2}{5}\;}{\;4\frac{1}{4}\;} - \frac{3\frac{1}{3} - \frac{5}{6}}{3\frac{1}{3} \quad \frac{5}{6}} + 12\frac{7}{15}.$$

Firstly.—Reducing these mixed numbers to improper fractions, we get—

$$\frac{\frac{17}{5}}{\frac{17}{4}} - \frac{\frac{10}{3} - \frac{5}{6}}{\frac{10}{3} + \frac{5}{6}} + \frac{187}{15}.$$

Secondly.—Take the fraction $\dfrac{\frac{17}{5}}{\frac{17}{4}}$ and reduce to a simple fraction. Thus—

$$\frac{17}{5} \div \frac{17}{4} = \frac{1}{5} \times \frac{4}{1} = \frac{5}{4}.$$

Thirdly.

$$\frac{\frac{10}{3} - \frac{5}{6}}{\frac{10}{3} + \frac{5}{6}} = \frac{\frac{20 - 5}{6}}{\frac{20 + 5}{6}} = \frac{\frac{15}{6}}{\frac{25}{6}} = \frac{15}{6}$$

$$\div \frac{25}{6} = \frac{\overset{3}{15}}{\underset{1}{6}} + \frac{\overset{1}{6}}{\underset{5}{25}} = \frac{3}{5}.$$

Hence we have—

$$\frac{4}{5} - \frac{3}{5} + \frac{187}{15} = \frac{12 - 9 + 187}{15} =$$

$$\frac{190}{15} = 12\frac{2}{3}.$$

Ex. Add together $\frac{2}{5}$ of £4 2s. 6d. and $\frac{3}{7}$ of 5⅔ guineas.

$\frac{2}{5}$ of £4 2s. 6d. = £1 13s. 0d.

$$\frac{3}{7} \text{ of } 5\tfrac{2}{3} \text{ guineas} = \frac{3}{7} \text{ of } \frac{17}{3} \text{ guineas} = \frac{\overset{1}{3}}{\underset{1}{7}} \text{ of } \frac{17}{\underset{1}{3}} \text{ of } \overset{3}{21}\text{s.} = 51\text{s.} = £2\ 11\text{s.}\ 0\text{d.}$$

And £1 13s. + £2 11s. = £4 4s., the answer.

Ex. 10.

(1.) Divide £4 11s. 10¼d. by $2\frac{4}{7}$. (C.P.)

(2.) How many yards of cloth may be bought for £5 10s. if 2¾ yards cost 5s. 4d.? (C. P.)

(3.) What fraction of 16s. is 1⅓ of £2 − $\frac{2}{7}$ of 6 guineas? (C.P.)

(4.) What is the sum, $\frac{4}{7}$ of which is £1 13s. (C.P.)

(5.) Multiply $\dfrac{3\frac{4}{5}}{3 \text{ of } 2\frac{1}{3}}$ by $\dfrac{8\frac{1}{2}}{19}$. (C·P.)

(6.) Reduce 2¾ of half a guinea to the fraction of £1 15s. (C.P.)

(7.) A house is let at 50 guineas a year, what amount is due for 10 weeks 3 days? (C.P.)

(8.) *Three* plum cakes of equal size are divided equally between *seven* boys, and *two* of them divide their shares equally with *four* other boys, *one* of whom gives his share to *three* other boys, who divide it equally. What fraction of a plum-cake is received by each boy of the first group of seven, of the second group of four, and of the third group of three? If three boys, one from each group, join their portions and share them equally, what fraction of a plum cake will each of the three have? (C.P.)

(9.) Reduce $\frac{4}{7}$ of $\frac{3}{5}$ of a guinea to the fraction of half a sovereign. (C.P.)

(10.) Find the value of $1\frac{7}{15}$ of £16 14s. 0¾d. (C.P.)

(11.) From $\frac{5}{24}$ of a guinea take $\frac{7}{12}$ of a crown, and add $\frac{9}{16}$ of a shilling to $\frac{7}{32}$ of a sovereign. (L.U.)

(12.) Simplify $\dfrac{4\frac{2}{3} - 3\frac{1}{2}}{4\frac{2}{3} + 3\frac{1}{2}}$ and $\frac{3}{4}\left\{\frac{2}{3} \text{ of } \dfrac{2\frac{1}{4} - 1\frac{1}{2}}{3\frac{1}{4} - 1} + \frac{1}{4}\right\}$ (L.U.)

N.B.—In the latter of these two, simply find the fraction within the brackets, then multiply this result by the ¾ just without the brackets.

(13.) Express £4 6s. 4¾d. + ½ of a farthing as a fraction of £5.

(14.) Simplify $\dfrac{\frac{27}{64} - \frac{8}{27}}{\frac{2}{16} + \frac{1}{2} + \frac{4}{9}}$. (L.U.)

(15.) Add together $\frac{1}{14}$ of a guinea, $\frac{3}{8}$ of £4, $\frac{13}{15}$ of half-a-crown, and ½ of a shilling. (L.U.)

(16.) What fraction of £20 is £4 11s. 6½d.? (H.)

(17.) Simplify $3\frac{2}{7} + 5\frac{3}{15} + 11\frac{7}{35} - 16\frac{17}{21} + 1\frac{20}{75}$. (C.P.)

(18.) Reduce 3qr. 5lb. $9\frac{3}{5}$oz. to the fraction of a cwt. (C.P.)

(19.) Reduce 2qr. 11lb. 3⅓oz. to the fraction of a cwt. (C.P.)

(20.) Simplify

$$\frac{3\frac{1}{4} + 1\frac{2}{5}}{5\frac{1}{3} - 4\frac{1}{4}} \text{ of } \frac{13\frac{8}{9} \text{ of } 15\frac{3}{5}}{5\frac{1}{12} \text{ of } 48} \div \frac{3\frac{1}{4} - \frac{5}{6} \text{ of } \frac{4}{15}}{\left(21\frac{1}{5} + \frac{4}{5} - 4\frac{1}{4} \text{ of } 5\right) \times 6\frac{1}{10}}. \text{ (C.P.)}$$

N.B.—Regarding bracket in No. 20 see note, Ex. 12. C.P = College of Preceptors, L.U. = London University, H. = Haileybury College.

(*To be continued.*)

NOTES ON RECENT DISCOVERIES IN SCIENCE, AND THEIR PRACTICAL APPLICATIONS.

GAS FROM SEWAGE—SOLVENT POWER OF PURE WATER—COLOURING METALS—DANGERS OF DYNAMITE AND NITRO-GLYCERINE.—AN ASBETOS AIR FILTER—MANGANESE SOME ALLOYS OF IT—RESULTS OF CARBONISING WOOD IN VARIOUS VAPOURS,

WE have at last some information on the method pursued in India to make gas from sewage, a matter which excited a good deal of attention some months ago, and produced some wonderful speculations from writers in the daily press. In noticing the subject at the time, we said that "the only conceivable mode of obtaining gas from such a material as solid excrement, is by distilling it in a retort just as we do coal," and such, we see by a letter in the *Chemical News* from Mr. Hickey, C.E., of Calcutta, is the method actually pursued. The writer calls his system "a system of conservancy." It is really a system of wanton waste, as bad as our London system. He destroys all the manurial properties of the filth and gets only a little gas, which can be good for nothing but heating his furnaces to effect the destruction. The plan of treatment may be described in a few words. The material is carbonised in a retort, and the residue is called "Poudrette coke." This serves to deodorise fresh ordure for transport. The mixture of coke and filth is carbonised in a sort of double retort, in one compartment of which the steam from the mixture is made to pass over some coke rendered incandescent, by which hydrogen and carbonic oxide are produced. These gases serve very well for heating the retorts, but have scarcely any illuminating power. The writer, however, insists "that poudrette coke surcharged with ordure will give a highly luminous gas," a statement we shall believe when we see the gas flame. Mr. Hickey should persuade the Hindoos to adopt his system of cremation along with their ordure, and then he would get an illuminating gas, for, as Sir Thomas Browne says or quotes in his Urn Burial, "from animals are drawn good burning lights." Mr. Hickey has certainly not solved the sewage difficulty.

The properties of pure water we must believe are at present very little understood. According to M. Becquerel distilled water acts on all metals, even gold and platinum, and it seems likely that absolutely pure H_2O may really be a very energetic substance.

We have noticed before some processes devised by M. Puscher for giving colours to metals. Finding more precise details we return to the subject, since the invention is likely to interest some of our readers. The process consists, as we have said, in producing a layer of sulphide on the surface of a thickness which must be varied according to the colour desired. Thus on brass, according as this layer of sulphides is varied, golden yellow, copper, red, crimson, blue, light blue, or reddish blue shades can be obtained. The colours, moreover, are very solid, and will take a polish. The preparation by which most of these effects are given consists of a solution of 45grms. of hyposulphite of soda and 15grms. of acetate of lead in a litre of water. When this solution is heated it decomposes, and sulphide of lead is formed. The object to be coloured, therefore, has only to be immersed in the solution maintained at a temperature from 190° to 212° Fah., in order to be coated with the sulphide in shades of colour varying with the duration of the immersion. A few experiments will teach the exact time required to produce the shade. Iron is always blue, zinc receives a bronze shade, copper will take the colours named above except the golden yellow. When in the above solution, sulphate of copper is substituted for acetate of lead, brass and imitation gold take first a beautiful red colour, then a green, and finally a rich brown. Marbled effects can by produced by first covering a brass object with a lead solution thickened with gum tragacanth, drying at 212°, and afterwards introducing it into the hyposulphite bath. This last we may say keeps unchanged when cold, and can be used many times over.

As regards this solution of acetate of lead and hyposulphite or soda we may say, although Puscher does not mention it, that it constitutes a very good hair dye, slow of course, but harmless.

A very curious and important fact—if, indeed, it is a fact—is mentioned by M. Jouglet, who states that nitro-glycerine and dynamite explode in contact with ozone. Ozone, as our readers are well aware, is only known in the diluted state, and it is highly important to ascertain what proportion of ozone in the air is sufficient to cause these substances to explode. Since they are commonly employed in situations (quarries in the open country, for example) where, according to the meteorologists, ozone is tolerably certain to be found in the air, we must, unless M. Jouglet is contradicted, look on the use of dynamite even as highly dangerous. If the truth of the statement be established, we have explained the cause of some explosions which have been called "spontaneous."

A very good suggestion for an air filter equally applicable for a ventilator or a respirator is made by M. Woestyn, who proposes to place in a ventilating shaft a bag of asbestos. This, like cotton, will arrest any solid particles floating in the air, and when much soiled the asbetos can be removed and made white hot, by which all organic matters will be destroyed, and it may then be put back in the shaft again. For respirators asbetos would be far preferable to the cotton wool proposed by Dr. Tyndall. It would not hold moisture like the wool, and would at the same time be most efficacious as a filter, and made so that the asbetos could be easily removed to be burnt and put back again, they might come into use and be highly recommended. There would be no obvious difficulties in the way of effectually filtering the air admitted to a large building, but we agree with M. Dumas in considering that the suggestion of M. Woestyn is worthy of serious attention.

Manganese, we fear, will never be a cheap metal, and alone would seem to be susceptible of no useful application; but we learn from the researches of M. Valenciennes that it forms very beautiful and useful alloys with copper. One in particular, containing only 15 per cent. of manganese, is almost white, and in many of its properties greatly resembles steel. Other compounds, we are told, form superb bronzes. How far these may be capable of replacing our ordinary bronze it would be premature to speculate in the present undeveloped state of the industry of manganese. The same metallurgist we have mentioned above has procured pure cobalt, which seems to be a metal that may some day be usefully applied.

People sometimes do odd things and arrive at strange and unexpected results. What M. Sidot was driving at when he carbonised wood in the vapour of sulphide of carbon we cannot imagine, but it ended in obtaining charcoal, which when struck is as sonorous as a piece of metal. He then got a bell turned in wood, carbonised it in the same way, and has an instrument which gives a sound like that of a silver bell. The carbonisation is only superficial, and possibly the bell mey not be very brittle, as it certainly would be if it were complete. Besides sulphide of carbon, the author calcined wood in the vapour of wood spirit, and so obtained a fibrous coke of silky whiteness. This is a very curious result; white coke is a novelty, and it would be interesting to know for certain what does happen when wood is heated to a carbonizing temperature in the vapour of wood spirit.—*Mechanic's Magazine.*

PHOTOGRAPHY IN BOTANY.—To illustrate venation and the nature of the surface of foliage, photography may be turned to good account—far more than is now commonly thought of. A correspondent of the *American Naturalist* says he has seen a photograph from a specimen of one of the coriaceous-leaved oaks of the Dutch Indies which was truly wonderful in its rendering.

LETTERS TO THE EDITOR.

[We do not hold ourselves responsible for the opinions of our correspondents. The EDITOR respectfully requests that all communications should be drawn up as briefly as possible.]

*** All communications should be addressed to the EDITOR of the ENGLISH MECHANIC, 31, Tavistock-street, Covent Garden, W.C.

All cheques and Post Office Orders to be made payable to J. PASSMORE EDWARDS.

I would have every one write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that, as to other things, knows no more than what everybody does, and yet to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks: a vice from whence great inconveniences derive their original.—*Montaigne's Essays.*

HAWKINS'S MUSICAL NOTATION.

SIR,—As I have been requested to send an example of this notation, which seems to have excited some interest among such of your musical readers who prefer simplicity to complexity, I will shortly send a familiar melody, written in it, I am unable to inform "Tremolo" where he can purchase music printed on this system. More than twenty years ago, I borrowed Hawkins's instruction book (the only copy he possessed), and until you printed the common chord of C. I never again saw a single bar in print. Probably Hawkins's instruction book is in the British Museum, and perhaps a copy may be in the stock of some dealer in old and forgotten music. I should be very glad to purchase a copy myself.

I need hardly inform "Tremolo," that he may put the lines of the staff in any position which likes him best; Hawkins wrote them perpendicular, and if I remember correctly, read the notes from the bottom upward, just as I have illustrated the system. They may of course be written from top to bottom, or horizontally, from left to right, just as our common notation is; I think this the preferable way, but I may be prejudiced from habit in favour of what is familiar to me, for after all we might find the Persian or the Japanese method of reading just as good as our own, if we were used to it. As Charles Dickens would say, "it's all along of our broughtens up." I don't remember my old friend mentioning why he placed his staff perpendicular but I have no doubt he could have stated why he did so, for he was pre-eminently a man who could give a reason—satisfactory to himself at least—for every faith within him.—N.B.—Some of those faiths were rather odd, to say the least of them, but for all that he was "a jolly good fellow."

To *one and all* I beg to say, that I am quite unable to describe Hawkins's notation more lucidly than I have done, so I take the liberty of advising "Flautist," page 304, to *mark*, on paper, learn, and inwardly digest (not the paper), but the system, as I have set it forth, not doubting that so astute an ignoramus as he evidently is, will require no further edification than what that process and a little thought on the subject, will afford him. The labour can hardly be great, for "Tremolo" has succeeded in the attempt at the first trial, a thing which seldom occurs in works of great difficulty.

How "One and All" can think the tonic sol fa notation simpler than Hawkins's, rather surprises me. It is true, only one sign viz. a letter, is needed for each sound of the diatonic scale, but the system is not convenient for frequent changes of key, and the notes require adjuncts to indicate their temporal value. This is expressed in Hawkins' by varying the length (only) of the note itself a pretty yet conclusive proof, which is the least complex of the two.

THE HARMONIOUS BLACKSMITH.

"F.R.A.S." AND THE *NAUTICAL ALMANAC.*

SIR,—I cannot help thinking that "F.R.A.S." is extremely unfortunate in his endeavour to fasten the duty of recomputing the tables of Jupiter's satellites on one of our national scientific establishments. "W. E. P." has denied the propriety of selecting the *Nautical Almanac* office as the proper place for computations of this nature, and "F.R.A.S." cordially agrees with him, and shifts the responsibility on to the Royal Observatory, which, I think, is still more inappropriate, as it must be universally admitted that the object for which an observatory is established and maintained is to make observations, or to give the means of forming tables, but not to actually calculate them. But I should advise, since "F.R.A.S." is so extremely anxious to have new tables computed, that he mention the subject to his friend the Astronomer Royal, who, I think I may venture to say, will convince him that the Royal Observatory is not the place for conducting calculations of such a nature.

It must be admitted with pain that this country has never shown itself ready in the laborious work of computing tables of planets, &c.; and every ephemeris that is provided by the *Nautical Almanac* Office is calculated from tables compiled by foreigners; and it seems probable that the discussion of the elements of the Jovian system will be left to some distinguished Continental astronomer, unless "F.R.A.S." is willing to undertake the labour himself, and so render himself famous even among others than the readers of your excellent periodical.

OMICRON.

ASTRONOMICAL.

SIR,—Allow me to tender my sincere thanks to "F.R.A.S." for his reply of the 18th ult. Although I believe I am a fair amateur astronomer, yet it is only lately I have been a practical observer, so am not a fair judge of what is in truth a test for a good speculum.

For instance, theoretically a very fine specimen of 5½in. aperture should divide a double but [illegible]" apart, and give a glimpse of a "come" of 12½ standard magnitude. Still there may be doubles but 2" apart and 12 mag. "comes" that the finest 6in. could not master, rendering tests apparently easy practically extremely severe. *Ergo*, "F.R.A.S." will understand why doubles, &c., that in truth may be no test, figure in this list.

32 Orionis, η Orionis and ζ Boötes, again, unmistakably divided, each being tried three times.

μ² Boötes, and γ² Andromeda, both elongated, but was unable to decide as to the notching of the latter, the definition was not steady.

35 Equulei, 128 Pi Pisces, 4 Lyncis, and 121 Pxx Ursa Major, all clearly divided—the third hardest, and I can hardly think it can be but 1"·4 apart; it seems nearly 1" apart only.

24 Lyncis. (The name is almost illegible, so I am not aware whether it is 24 or 34.) The first star on "F.R.A.S.'s" list I have not the R.A. of, neither have I it from Struve's catalogue.

ε² Equulei. I always understood this to be a triple of 1·3" and [illegible]" apart, so sometime back tried to divide the closer, as I fancied, of the two, after dividing the wider, but did not succeed, the altitude being low. I noticed, though, a star about 15" to the right of it and below. Mr. Norman Lockyer, F.R.S., was my authority.

14 Lyncis, 145 Leonis. ζ Cancri, and δ Cygni. Readily elongated all, strongly notched the first, plainly the second, and to my surprise, gave a clear and distinct pair of discs to ζ Cancri (I divided the first with full aperture). δ Cygni, was almost, if not quite divided; showed a splendid pair of discs.

With regard to light on [illegible] when the large mirror, with an aperture of just over 6in., picks up the smallest "comes" to γ Orionis, 178 Pxx Delphini, 15 Monocerotis ν (Nu) Ceti, and μ² Sagittarii, the smaller does the same with [illegible] less aperture; with perseverance the smaller (5½ aperture) picks up the "comes" to α Lyræ, γ Ceti, ε Virginis, γ Orionis, δ² Cancri, and σ² Orionis. It easily picks up the triple ο³ (Omicron) Cygni, but I have been almost sure I have seen a fourth, but I find that Smyth and Webb put it down as triple.

θ Orionis, 5th and 6th star, easily seen.

Can "F.R.A.S." tell me the smallest aperture it is possible to see the 6 with? Mr. Cooke tells me a 3¾ of his showed them; and in Guilleman's "Heavens" I also find it so stated.

There is one point in "F.R.A.S.'s" letter I cannot make out. He speaks as though a 2ft. mirror were necessary to see the satellites of Uranus. According to Arago, an 18in. metallic mirror is amply large enough, while their exact period of revolution was determined by an 11in. refracter. Moreover, I have once or twice thought I glimpsed them in a 10½in. with Browning's mirror used as an Herschellian, or front viewed telescope. Having for the last month been watching Uranus, with two friends, I have paid a little attention to it, and one of my friends' 9in. refractor, I am informed, shows traces of the largest satellite. However there is a capital test as to the capabilities of a telescope to see them. Between β¹ and β² Capricorni is a close double, under 3" apart, and of 17 mag. each. Any telescope that with a power of 500 will clearly divide this double is capable of picking up the two largest satellites, number 3 and 4. And I may remark my 10½ just divides them with a power of 700, while an 11in. Mery will divide them cleanly with a power of 300.

Will "Omicron" try as a test μ³ Boötes, 20 Draconis, γ Coronæ Borealis, γ Equulei, ω Leonis, and 4 Aquarii?

α URSÆ MINORIS.

QUESTIONS FOR MILLERS.

SIR,—I should be very sorry to strive to deprive Mr. Evans of the credit of being the inventor of the universal joint, but I believe it is a universal fact that Hood invented it long before Mr. E. was born. The only portion of it as applied to driving mill stones that he can lay any claim to is the outward ring, which he supposes originated with himself; but it is quite a common method here of having the stones built round a metal ring for the same purpose, which has the advantage of not occupying any portion of the eye of the stone, as Mr. E.'s does. I have metal boxes let into the eye of my stones for the bearings to "slide in," which I consider an improvement on Mr. E.'s "outward ring," as there is then no necessity for making one of the rings oval. When I read Mr. E.'s description of his invention I thought he only referred to the "oval ring," or I should not have noticed it at all, because I did not consider the "outward ring" an improvement, but quite the reverse, as the sliding steps are common at Templeogue, while the oval ring is confined to myself; and I now see that our motives for adopting the oval shape are quite different, as he had to resort to it in order to have the four journals the same distance from the centre, which is not necessary for the purpose of making a "true universal joint." I have seen a hole drilled through the "cock-head" of a spindle near the top, and a round pin driven in, leaving enough of it projecting on both sides of the spindle for the outward ring to rest on, and it worked as free as if it were the full size of the outward ring. But now, Sir, before giving Mr. Evans the explanation he wants relative to the sentence which appears to him "incomprehensible"—namely, that "the centres of all the journals are in the same (vertical) circle"—I think it necessary to refer to his former communication, where he says that "all the centres are equal in length and line," and to ask him what he means by "centres?" In his last letter he calls them "the centres of his invention," from which I conclude that the difficulty he experienced in reconciling the two statements which he calls "incomprehensible," arises from his own vague way of expressing himself, as I am quite certain that any ordinary intellect would be as well able to comprehend what is meant by the "centre of a journal" as by the "centre of an invention." Would Mr. Evans explain the following sentences in his first letter? "All the centres are equal in length and line; it will then be seen that the stones can be hung at 6in. or 10in., or any intermediate distance," &c. Does he mean that because the "centres are equal," &c., that therefore the stones can be hung as stated? I may here state that the "globe-head" has nearly superseded the "universal joint" in all the large mills in Ireland.

J. SHARPE.

P.S.—In a recent letter of mine (quoted by Mr. Evans on p. 11) there is a clerical error. For "feet" read "ends."

SIR,—As the subject in question is one in which we are all interested more or less, may I be permitted to make a few remarks thereupon? First, I would respectfully ask Mr. R. R. Smith if we are to understand him to say that the cross-wind in his bedstone was the cause of the trouble he had with the neck of his spindle?

And, secondly, with all deference to his opinion, I beg leave to differ with his theory of millstone balance. In answer to "Cumberland Jowhn," he says, "Put the stone in running balance, and the long spindle will make the stone hang steadier." Will it do so? I trow not. The long spindle will cause the stone to hang more sluggish, and the consequent drag on the face will cause the spindle to vibrate, on account of its inordinate length, to the detriment of the neck, and even the toe and driving gear. Let "C. J." cut his spindle so as to bring his bearings within the line of gravity. The balance will become thereby more sensitive when the stone is at its proper velocity. And if the case were mine I would do away with the cross-bar, which is not the best arrangement, on account of the excessive friction of the driver faces, which are also not unfrequently out of line with the centre bearing, and replace it with a good Universal Rynot. And I dare venture to predict that he would have no further trouble with the neck, and superior work would be the result.

THOS. EVANS.

SHODDY MANUFACTURE.

SIR,—A "willey," a "willow," a "devil" are only different names for the same thing, and is not a shoddy machine, nor would it answer for one. A willow is the first machine that wool (not cotton) passes through for the purpose of opening the wool and knocking out the dye-stuff. Shoddy does not require this operation, and therefore does not go into the willey, but into the "teazer." A shoddy machine consists merely of a drum or cylinder about 4½ft. dia. by 20in. wide (working in a frame similar to a large grinding-stone), and a pair of fluted rollers. The cylinder is made with two metal drum rings, covered with inch thick timber, on which are screwed or bolted elm lags, about 1¼in. thick, and any convenient breadth. These lags are divided into spaces about ½in. asunder, and the teeth are placed alternately in each row. They are steel, and may be any shape—either round, square, or octagonal. They are about $\frac{3}{16}$in. thick at the butt, and taper to a point. They project about 1½in. beyond the timber, and are generally kept in enough from the end of the lag to admit of a stout ½in. hoop being driven on, which keeps the lags from flying off in case any of the screws should break. When the cylinder is placed in its bearings, a rest should be made fast on the frame, and near enough to the cylinder just to allow the teeth to pass, and then, with a piece of coarse grindstone, grind all the teeth to an equal height. While this is doing, the cylinder should be driven the reverse way to the way it is to work. The burr produced on the top of the teeth by this operation is the principal feature in the machine's effectiveness. After the machine has worked some time, the burr will get on the opposite side of the teeth. The cylinder should then be reversed in the frame. The shaft or axis of the cylinder should be long enough to have a driving pulley on each end, or to remove the pulley from one end to the other. The cylinder, when at work, should go at least 800 revolutions per minute. Across the frame, and as close to the cylinder as possible, are two fluted rollers, through which the rags pass. These rollers work in a fork at each end. The top one is kept down by weighted levers. The smaller these rollers are in diameter, consistent with strength, the better. The rags are laid thin and even on a feed (which I suppose does not require any description). The whole machine is cased in with a provision to take out the shoddy from under the machine, and a flue for ventilation. The rollers and feed, which go very slow, are driven from the cylinder shaft. The operation cannot be called "tearing," as the rags are "fretted" away, something like the cracker of a whip.

J. SHARPE, Templeogue, Co. Dublin.

SIR,—On reading this week's number of the MECHANIC, I was struck with "Gitche Manito's" very abrupt remarks on "Scrutator" and the shoddy manufacture, and it occurred to me that it would have been better for "Gitche Manito," if he had remembered the time-honoured proverb "That they who live in glass houses," &c. Now, I have to charge "Gitche Manito" with the same fault that he lays on "Scrutator," viz., that he has jumbled together the willowing and scutching machines, as applied to cotton manufacture, and also with rushing headlong into print when he is not thoroughly acquainted with his subject, and I would further impose upon his memory the first few words of your quotation from Montaigne's Essays: "I would have every one write what he knows, and as much as he knows, but no more." I see that he has consulted one of our best encyclopædias on the subject, but it would be best if answers on subjects of manufactures could be given by practical persons.

Now the machine described by "Gitche Manito" is the scutcher. The willow is an entirely different machine, and is very often termed the devil; it consists of one large cylinder, containing about eight rows of spikes or teeth, and making 300 to 400 revolutions per minute; there are also two or three rows more of the same kind of teeth, fastened to the cover of the cylinder, and so arranged as to allow the cylinder teeth, when revolving, to pass between them, thus opening the cotton and throwing down the seeds and dirt to the bottom, where there is a grid for the cotton to strike against, and so free itself from the dirt, which passes through the bars of the grid, the cotton is then passed on to the machine described by "Gitche Manito."

I think it would be an advantage to the MECHANIC, if some person would give a description of the machines and processes of the cotton manufacture, for your paper has a large circulation in the district of Stockport, and yet it scarcely ever contains a scrap of matter relating to its staple trade. For myself I shall be glad at any time to answer to the best of my ability any question appertaining to this branch of our industry.

FACTORY LAD.

PHOTOGRAPHY.

SIR,—I must apologise for not answering "Photo" before this, on the subject of "Toning," but the fact is, I did not receive my ENGLISH MECHANIC, as it went down on board the unfortunate steamer Normandy.

I presume that "Photo" wants to tone a transparent positive, not negative. He may have been partially led to say negative through my saying so in my last. I should have said positive. Now arises another question. Is the querist going to make some transparencies? If so, as they of course will be done at home, he can spare more time, and with that idea, let him develop with pyro, instead of iron, giving about three times the length of exposure. This generally gives a warm tone and pleasing—like a light chocolate. Another way is to develop with iron; do not intensify unless *very* thin, and after fixing pour over a dilute solution of chl. gold. This will tone rapidly and pleasantly. In some cases a grain of bichlor. mercury added to the gold solution is good, but for my own working I dispense with mercury, unless for negatives I only want to use once or twice. "Photo" must remember that in all cases a transparency must be fully exposed, certainly rather over than under, in order to get full detail. I suppose that he knows how to mount them either for the stereoscope or screen? If not I will tell him at a future time.

May I ask "Photo" to be a little more explicit. What sort of house does he mean? Dark room, or studio, or workshop?

Then he says, "He sometimes finds a ring, or more than one solarised place." Ah! I know what that is. I've had it all before now. Listen. These rings (transparent spots of course) are caused by pouring the developer on that portion of the plate where these spots are afterwards produced.

Do not *pour* the developer on one spot. Sweep it gently over the plate, at the same time tilting the plate by a twist of the wrist so that the developer may pass over the whole. Solarised spots must of course be caused by actinic light (white light) touching the negative. Perhaps a small hole in the back or in the camera itself, or it may be some organic substance fallen and so piled up, and reduced the silver during exposure. In all such cases care must be taken to try and ascertain where the fault lies. First look at your back (dark slide). If that is light-tight try the camera. If all right, look to the windows of your dark room, put out of the way all organic matter, well clean your glasses (away from the dark room), and also see that your dark slide is clean and works freely. As it is very unlikely that it is caused by the lens unless that is struck direct by the sun, why he need not trouble himself about that part of the furniture. However, the best shade for the lens is an instantaneous shutter. If he wants to know how to make one, with your permission, Mr. Editor, I will show him how I made mine.

The want of silver deposit on the lower parts of the face I think I can explain in a few words. "Photo" gets all his light to strike *down* on the sitter. Is it not so? If so, let him get a board and cover it with pure white paper, and place it at such an angle as to reflect the light on to the lower part of the sitter's face. I think he will find it all right then.

"Photo," and others, are welcome to what I can tell them, for I would not give a "fig" for a man who "hoards up" what he knows without telling others, *i.e.*, of course, if it's worth knowing. At the same time I hold with one of our correspondents, who says that people should write what they know, not what they think.

MUS.

CASE HARDENING

SIR,—There is an application for letters patent for case-hardening from a Mr. Armitage, of Kirkstall, near Leeds. The following is something like the process:—A quantity of pulverised prussiate of potass is put into a wrought iron retort open at one end. The retort is put on the fire, and as soon as there is heat enough communicated to make the mixture boil, the article to be hardened is plunged into the boiling mixture, and after it becomes red-hot it is taken out and immersed in cold water, and the process is finished. What I want to know is, whether this is an old or a new process. If the former, then it would be an injustice to every manufacturer that has to case-harden his iron by the prussiate of potass process; if new, then the gentleman has a right to his invention.

I for one recollect to have case-hardened by this process 26 years ago, with this exception, that the open end of the retort was sealed up with a luting of clay; and I have often practised this same process since that time. I should take it as a favour if those of your readers who are interested in case-hardening would give an opinion.

I was going to compliment you on the improved form of our MECHANIC, but it would be folly to do so on my part. The recent issue speaks volumes of itself, and will carry with it its own recommendation.

ST. GEORGE.

STEVENS'S IMPROVEMENTS IN COOKING.

FIG. 1

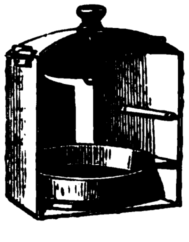


FIG. 2

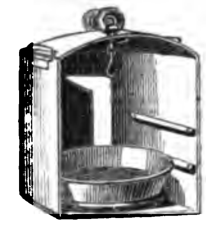


FIG. 3

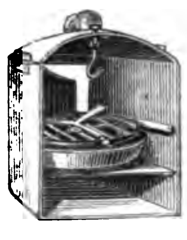


FIG. 4

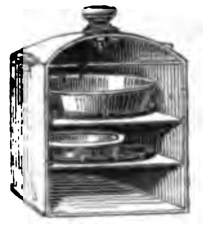


FIG. 5

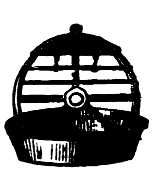


FIG. 6

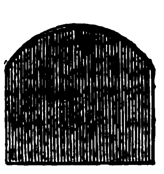


FIG. 7

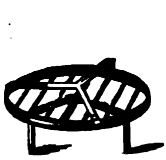


FIG. 8

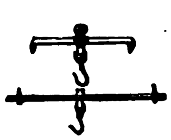


FIG. 9

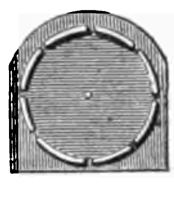


FIG. 10

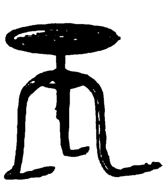


FIG. 11

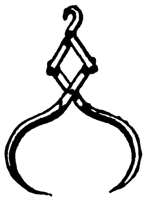


FIG. 12

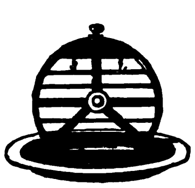


FIG. 13

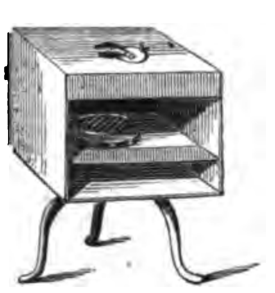


FIG. 14

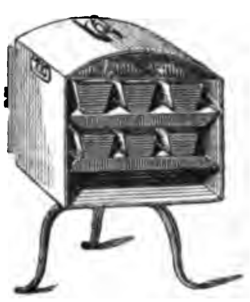


FIG. 15

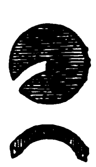


FIG. 16

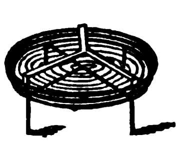


FIG. 17

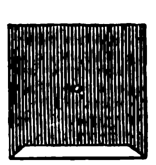


FIG. 18

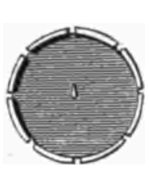


FIG. 19

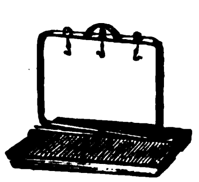
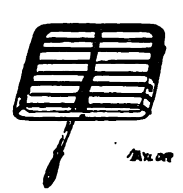


FIG. 20



STEVENS'S IMPROVEMENTS IN COOKING.

Sir,—In No. 248 you illustrated an improved kitchen range. I send you herewith drawings and description of a new oven, lately patented by Mr. Ebenezer Stevens, of Margate, which seems capable of cooking almost anything. Fig. 1 represents the oven as arranged for roasting, if all the space of the oven is required for that purpose, with the revolving baking plate and dish upon the bottom, showing the door at the back partly opened for basting or other purposes. The hook is turned as required by the knob which is made to turn round for turning the meat on the hook. An ordinary hook or hooks are used, or the hook or hooks shown in Fig. 11. Fig. 2 represents the oven also arranged for roasting, but with the knob or coned or flat cover, top or lid with a hole, circle, or slot formed in the cover thrown back, similar to the lid of a teapot, to enable the cook to observe more easily the progress of the cooking; this knob, cover, or lid in some cases is made as shown in Fig. 1, but in this case a straight or arched band, rod, or other support, is fixed across an opening at the top of the oven, having in the centre a hole or otherwise to which are attached hooks to revolve, so that the hollow cap, lid, or cover will lift up on a hinge or hinges to watch the roasting of the meat without being suspended to the bottom of the knob itself, and in other cases a slide cover is used instead of a cap or cover to place over the hook or hooks without any hinge, and in other cases a cap or cover without any hinge. Fig. 3 represents the oven as best arranged for baking meat with or without pudding and potatoes; the revolving baking plate is now upon the bottom side rims or flanges of the oven, and the baking dish upon the baking plate, and the revolving baking dish stand in the dish, showing the door of the oven partly opened for turning the dish, and the knob or cover thrown back for looking into the oven to see the progress of the baking. Fig. 4 represents the oven as arranged for baking pies, puddings, pastry, bread, cakes, or any food required, with two revolving baking plates upon the side rims or flanges of the oven, and if it is required with a large oven, more than two shelves can be used, and each shelf or shelves can be used to suit the fire or the food to be baked. The cover or knob and door in this Fig. are both shut. Fig. 5 represents the oven baking dish with the revolving gridironed baking dish stand placed in the dish in an inclined position; it stands upon the rim, and the legs sideways, forming a small toaster without using the oven for chops and small articles of food. The small cap piece at the top with two hooks drops on and holds fast, and is added if required when the stand is used as a toaster, or an ordinary pot hook or pot hooks double at one end may be used with this stand without this cap, or even without any hook or hooks at all. Fig. 6 represents a piece of sheet iron, the top or circle part with the edge turned down to hang on the front of the oven about half the way down or more if required, when the oven is used for baking bread or pastry, to keep the direct heat of the fire from scorching the bread. Fig. 7 represents the revolving gridironed baking dish stand for the oven on its feet or legs as used for baking purposes. Fig. 8 represents the removable rods or cross bars with the hook, which goes across the hole or opening at the top of the oven, by which the meat is suspended and turned round as required. This figure belongs to the oven shown in Fig. 2, the lid, cap, or cover of which has a hole or opening in the centre, so that it covers up close all round the knob and the hook, and thus the meat can be turned whether the cover is up or down, whether open or shut. These supports for the meat can be arranged to fit outside or inside of the top of the oven. Fig. 9 represents the baking plate of the oven with revolving plate working on the bottom plate. Fig. 10 represents the revolving adjusting oven stand, working on one centre screw, or they may be made to slip up and down in a socket or hollow tube, and fixed by a thumbscrew at the side of the socket or tube, or by a centre pin and hollow tube with a hole through each at desired distances, and kept in its place by a pin. Fig. 11 represents a roasting hook or hooks that can be used with or without the oven if desired. Fig. 12 represents the revolving gridironed oven baking dish stand in an upright or inclined position as it stands in an ordinary plate. Fig. 13 represents the oven in a square or nearly square form on a stand, but not adjusting. In this shape the same kind of hole in the centre at the top with a knob or a bar across and hook, are used, as in Figs. 1 and 2, but instead of a cap or cover, as in Fig. 2, the hole is opened and closed by a sliding cover working on a pivot, having a slotch or opening therein, so shaped as to clear the knob, handle, or ring of the hook in or on the cross bar, and effectually close the opening on the top of the oven when required. Instead of a revolving baking dish stand, in this oven the inventor sometimes makes a wire, or other gridironed baking stand, with three or four projections, legs, or catches, either to rest on the rim of the dish, or to stand in the dish; this Fig. shows the arrangement for baking. The baking plate or plates revolve as in the D-shaped ovens, the only difference being in the shape of the ovens. Sometimes these square, or nearly square ovens, are made with arched tops, and the sliding cap, cover, or knob, is arranged accordingly; and in some cases, according to the size of the oven, the whole, or nearly the whole, of the top of the oven is made to lift up. Fig. 14 represents the same oven as Fig. 13, but with the baking stand and baking dish out, and arranged for baking bread and pastry. This oven is shown without the stand and with an arched top. Fig. 15 represents the sliding cap or cover for oven 13 and 14, with the bar, knob, and hook. Fig. 16 represents the wire baking dish stand for ovens 13 and 14, standing on its legs as for baking, placed in a dish or plate; it will stand upright or in an inclined position, similar to baking dish stand Fig. 12. Fig. 17 represents the baking plate for ovens, Figs. 13 and 14. Fig. 18 represents the circular baking plate with pivot, to work in the centre hole of the baking plate, Fig. 17. Fig. 19 represents the toaster for chops or steaks before the fire; the band or bridge across the dish may be a fixture or made to slide on the dish. The hooks turn round separately, and the frame works round on a pivot. Fig. 20 represents the revolving gridiron, the reservoir is all round below the bars, and the bars are slightly arched and fluted, or otherwise; the bars may be properly formed and attached to the reservoir itself, singly or otherwise, as a fixture, or fastened to end pieces and clipped fast to the reservoir by the two ends turned up and over of the under cross band or bar, into or upon which the handle is made to work the gridiron round upon. Bon Vivant.

WATER GAUGE AND GAUGE COCK.

Sir,—Fig. 1 is a sketch of water gauge for steam boilers which I suggest as an improvement that, in my estimation, will please many of my brother readers, and Fig. 2 is a sketch of gauge cock which cannot fail to prove a cure to leakage and broken cocks.

The water gauge, as may be seen by the declivity given in the bottom part of the gauge, obviates the lodging of sand. Section 1 represents the internal appearance; *a a* is a plug valve and seat in the bottom part, which is provided with a flange to bolt it to the boiler with four pins; this plug valve is fixed as seen on the end of a smooth 3-16th inch rod, which passes through a gland *g*, which can be packed at any time by drawing up the plug, which the pressure will keep up tightly providing the cock *n* be shut, which cock is provided with a gland, as seen, and the working pin has its tightening surface broken by one passage hole, the course being in through the bottom, and out at the side; it is evident no sand can find rest in this gauge, but should there be any oily or other matter floating on the water, it may be blown out by turning the pin of the cock *n* until its course is equal with the vent hole *s*, thus, by the pressure from the bottom, the glass is cleared; it may also be seen that the gauge glass is protected and made tight by a shield, the same as the "Aston" gauge, differing only by being lightened by the box nut *m*, which, when screwed down tight, is followed down on a little hemp and red lead, tight to prevent escape through the threads

FIG. 1

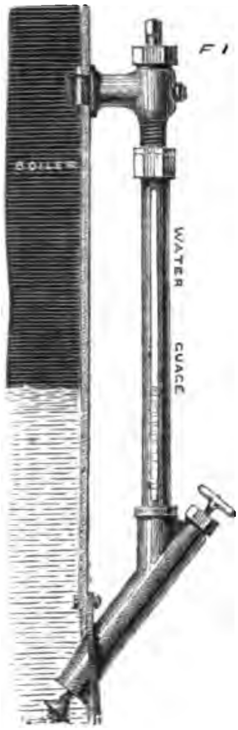
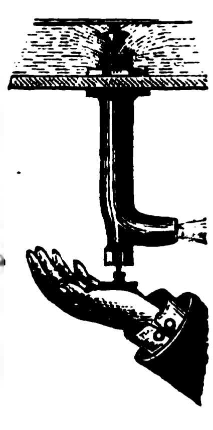


FIG. 2

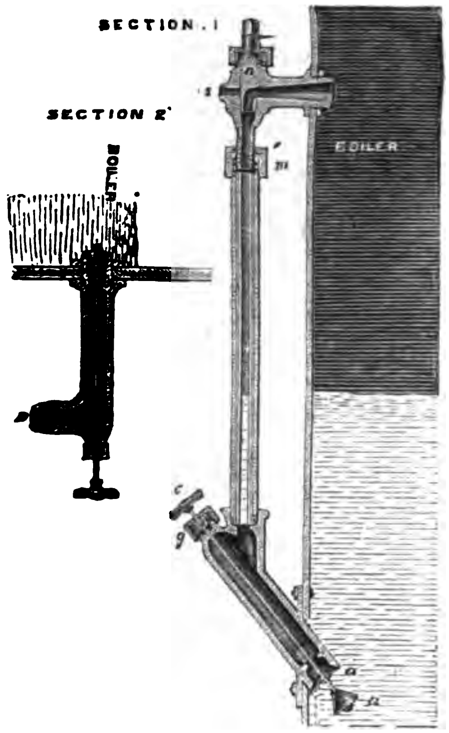


with back nut. By drawing up the plug valve occasionally by the handle *c* and turning it as you pull, you rub off the, crustration; thus the engineer is provided with a water gauge that will tell no untruth through leakage and stoppage, because such cannot well exist, and the durability is more than doubled.

Much trouble has been experienced by the leakage and breaking of the gauge cocks as well as the leaking and breaking of the bottom cocks of the glass water gauge, but such is entirely prevented by my construction, as seen, Fig. 2, and by section 2 of its internal appearance, which is simply the bottom part of the water gauge, horizontally fixed by a back nut

SECTION . I

SECTION 2



inside of the boiler instead of pins, with nozzle *n* to shut downwards; this is really a simple affair, and should it or the glass water gauge leak in any part, it would be entirely the engine or boiler-tenter's own fault.

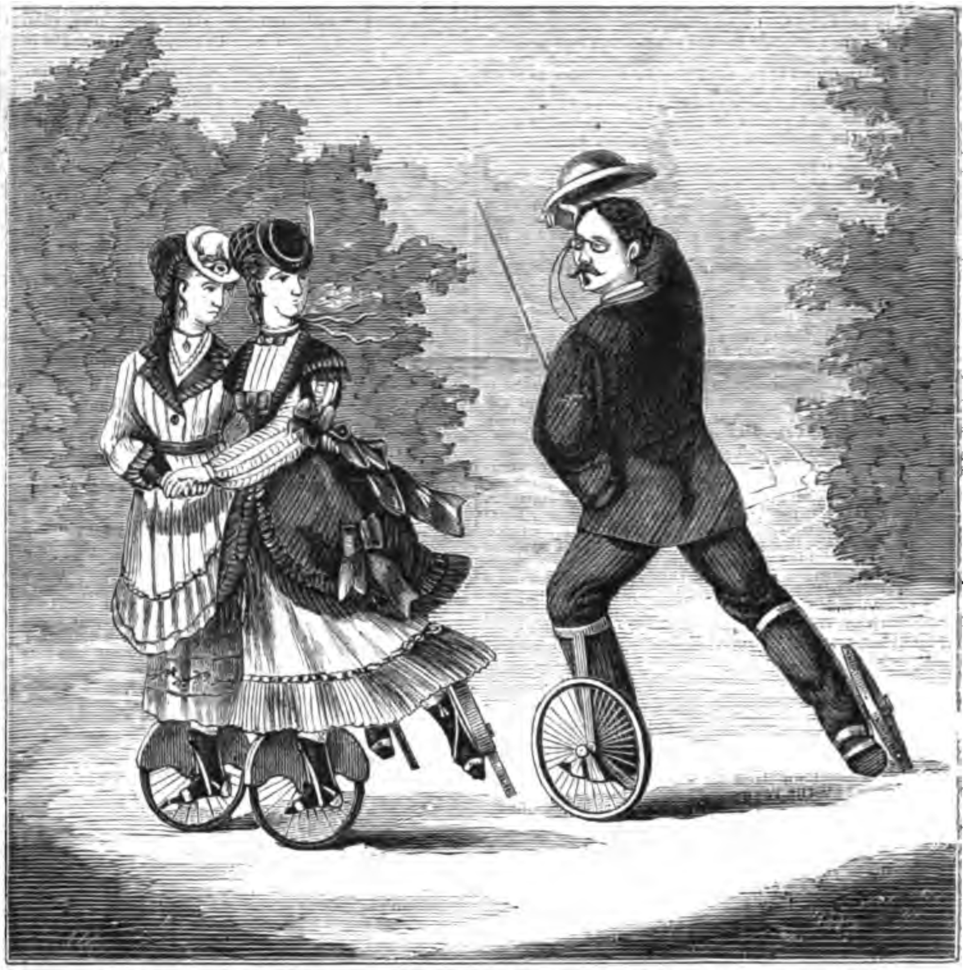
J. C. Shewan, Pitchcombe Works, near Stroud, Gloucestershire.

A NEW PAINT.

Sir,—I wish to draw the attention of our correspondents to the fact that some hundreds of tons of black iron oxide are yearly produced in London alone by the manufacture of a new chemical. It can be ground and used as paint, but the demand for this purpose is very small; melting will not pay. No doubt some of our correspondents can suggest a mode of utilising it in quantity. Barnacles, &c., will not adhere to ships' bottoms if painted with this oxide, as it contains traces of sundry chemicals.

R. G. Bennett.

THE PEDESPEED.—(Described on page 53.)



SWINGING GATE LATCH.

Sir,—Some little time ago I was erecting a new front gate, and laboured under the following requirements:—1st, that the gate should swing free until coming to rest; 2ndly, that it should only open one way. After some little trouble I hit upon the invention I herewith send you a drawing of. It is just possible that some of your readers may find themselves at some time or other under similar requirements, and by the use of this arrangement receive similar relief. In the drawings one is supposed to be standing in the gateway facing the post, the black spot representing the swinging pin fixed on the gate—Fig. 1. The gate is at rest; the pin of course can neither pass to the right or the left. Fig. 2. On the handle being lifted up or pressed down, according as the side happens to come, the lefthand jaw is depressed, and the stud or gate pin can only pass out to the left. On the handle being released it falls back upon the stud underneath, which both supports it and prevents the right-hand jaw from being depressed, and the latch assumes the position in Fig. 1. The gate now being left to swing, the pin, on approaching the jaws, strikes whichever one it first meets, depresses it as it falls under the blow, the connecting link passes down the slot in the handle, carrying with it the other jaw, the connecting links being joined on either side by the slot, the weight on the end of the right jaw bringing both jaws immediately back into their former position; the same thing is repeated on each swing of the gate, until finally it comes to rest with its pin between the jaws, as in Fig. 1.

FIG. 1

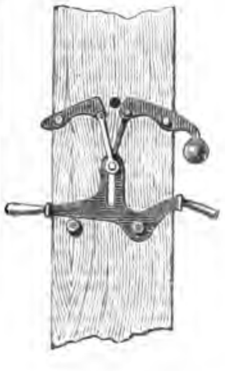
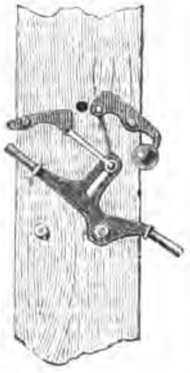


FIG. 2



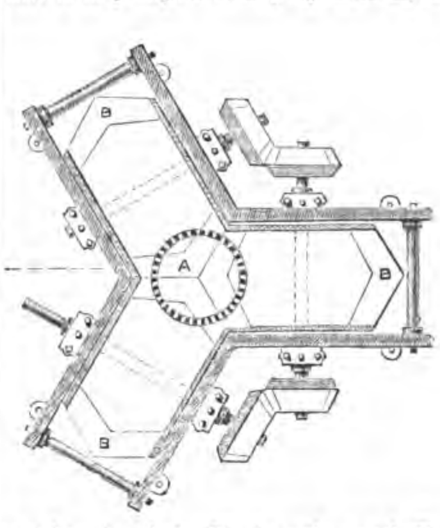
I think, even supposing the particular requirements were out of the case, that this is a good kind of swing latch, chiefly for this reason—that the weight on the right jaw can be so adjusted as to bring the blow of the passing gate pin down to a minimum. The handle also remains at rest during the whole time of the gate's swinging, and from these two reasons wear and tear—which are always heavy items against swinging latches—are very greatly reduced.

I may add that mine, which is quite a success, was forged by my village blacksmith, and finished by myself, so that it is quite a simple affair.

Percival A. Fothergill, B.A., F.R.A.S., Watford, Rugby.

ROTATORY ENGINE.

Sir,—I am pleased to see your attention called once more to the principle of rotatory engines, as they are



great favourites of mine, I having made several. The first one was made about 10 years ago, very similar to the engraving sent by Edwin E. Hill, page 656, Vol. X. Subsequently I made a triangular one, with three wheels revolving together, of which I send sketch. The same amount of driving force acting on all the three buckets together make it altogether a powerful machine and much superior to the couple of wheels. A = a tub on the top of the machine, into which the driving medium is admitted, acting against the buckets (B) of the three wheels revolving together, bucket to bucket and allowing of no escape between till forced asunder by the steam or water. The whole is in an air-tight box, and the three wheels geared together with a pair of mitre wheels fixed on the main shaft outside the case. I enclose a horizontal plan of the machine

John Musgrove, Kendal.

BOILER INCRUSTATION.

Sir,—I some three weeks ago sent a note for insertion in our valuable journal, requiring information in reference to a method for the eradication and prevention of incrustation in a multitubular boiler, but as yet I have failed to see anything in reference to it in print, whilst I see numbers of questions of far less moment to your varied subscribers, such as Astronomy, Equations, and others of very little interest to one-half of the workmen such, as I opine, support our journal.

I see one, "Vivus Sperandum," mentions Irish moss. That I have tried, but it has not answered. I thought of trying sulphuric acid mixed with it. Perhaps if the question is thoroughly ventilated, some of our brother correspondents may be able to give me the desired information.

Flood, Charles-street, Hanley, Staffordshire.

VIOLIN VARNISH.

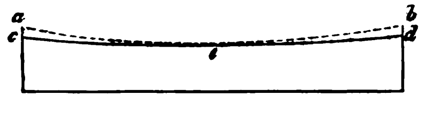
Sir,—I am glad to see a letter in the English Mechanic on the subject of "Violin Varnish." I almost despair of the secret of the old varnish being discovered. I, like many others, till lately thought it was made with oil, but now I am of opinion that the gum, whatever it was, was dissolved in spirits of some kind. No doubt the Italian makers paid the greatest attention to everything connected with the manufacture of violins, and that is the reason why their instruments surpass all others. In these days everything gives way to cheapness, and it does not pay a maker to construct instruments of accurate proportions. Most of the French copies have the back and belly of the same thickness throughout: of course a violin so made is cheaper, and takes less time to finish than an accurately-proportioned one, and then it is covered with a varnish that looks tolerably well, but injures the tone. I believe that very few violins are made in England now, as the cost of labour is so much less on the Continent, consequently English makers do not trouble themselves about varnish.

B.

SPECULUM GRINDING.

Sir,—I am sorry that Mr. Purkiss is at a loss to know what I meant by the question I asked him (page 606, Vol. X.) I will, however, try to put it as plain as I can.

It has been found that a truly spherical mirror does not reflect all the rays which strike its surface to one focal point; the rays from those parts of the mirror near the circumference being reflected to points nearer the mirror than the rays from the more central part, consequently to make a mirror which shall reflect to one focus, the surface near the circumference must be rubbed away or depressed. Sir W. Herschel says, "That the total thickness to be abraded from the edge of a spherical speculum 48in. in diameter, and 40ft. focus, to convert it into a paraboloid, is only 1-21333rd part of an inch." I copy this diagram from Mr. Browning's "Plea for Reflectors." The dotted line represents the spherical curve of the mirror when the polishing is begun, and the continuous line the parabolic curve it assumes when the polishing process



is finished. It will be, of course, understood that in the diagram these curves are enormously exaggerated. Now, it will easily be seen that to convert the spherical surface *a b*, into the parabolic one *c d*, the mirror must be rubbed away more at the circumference *a c* and *b d*, and gradually less as the centre *e* is approached. At page 358, Mr. Purkiss says, "The parabolising is effected *not* by depressing or rubbing away the edges of the disc, as in the old method, *but by depressing the centre.*

I suppose by the word disc, Mr. Purkiss means the mirror. Now, I cannot understand how the parabolic curve is formed by depressing the centre; if it had been the opposite, that is, by depressing the parts away from the centre or towards the circumference, I could have understood it. I am sorry indeed to give Mr. Purkiss trouble, but I hope he will forgive me for doing so, and putting me right on this point, I shall feel obliged.

Novice.

ARTIFICIAL ICE.

Sir,—Your readers may perhaps like a fuller description of Carre's ice machine than is given by Mr. Yonge, in No. 261, March 25th.

The "Domestic" machine is made of best iron boiler tubes, procured from England, and tested to 200lb. pressure. It consists of an upright boiler partly filled with very strong ammoniacal solution, so strong that a glass bottle of it held in the hand at once gives off bubbles or gas. From the top of this rises a tube to about the same height as the boiler. This tube ends in a smaller one, which bends down to level of top of the boiler, and is inserted into a cylindrical vessel kept at a distance of about a foot and a half from the boiler. This cylinder has a smaller one rivetted into it, in which the tin containing the water to be frozen is inserted.

The whole of the machine is hermetically closed, so as to allow no escape of the gas. The boiler is put on a charcoal fire, and when a thermometer shows the temperature to have risen to the proper point the solution is converted into gas at a great pressure. The boiler is removed from the fire, and placed in a tub of cold water; the tin of liquid to be frozen is placed in the cylinder, and the gas begins to condense. In a certain time, according to the coolness of the water in the tub, such a great degree of cold is produced by the condensation that the contents of the tin are frozen solid.

In hot countries the water in the tub must be changed two or three times as it gets warm. Instead of water, cream, or bottles of beer or wine may be placed in the cylinder. The wine, not requiring to be frozen, may remain only a short time, and then be replaced by a second or third edition, till the gas is completely condensed.

It is best to use the stove supplied with the machine, as it prevents the boiler getting burnt.

I have only heard of one accident, and that was from carelessness. A person in Australia had let the machine lie for some time in the hot sun, and then placed it on the fire; of course, the "steam," so to speak, was already up, and the consequence was a blow up.

The solution lasts, theoretically, for ever—in practice it lasts many years. The boiler can be filled again, but it is a very troublesome operation, as the moment a soldering iron is brought near the aperture, the gas begins to escape; still it has been often done.

These machines are not so expensive as Mr. Yonge says, but still they are too dear, and in consequence are almost exclusively used in hot countries.

They afford the easiest and cheapest way of making ice, leaving the first cost out of consideration, as no chemicals whatever are required, only a charcoal or coke fire; other fuel will do, but is said not to be so good.

There is an agent in London, but the machines are only advertised in the particular papers which go to hot countries.

I have unfortunately lost the drawings, or would send one for you to engrave.

W. B. Shanley, 142, Hackney-road.

"HOW TO KEEP THE CLOCK RIGHT."

Sir,—Such is the title of a book recently published, and referred to by "F.R.A.S." in his article on "Transits," in your journal of last week. "F.R.A.S." says he has never seen the book. I have, and shall be glad to give him and your readers in general some information about it, so that in stating my opinion I may compare notes with any other of your readers who, like myself, have been captivated by its title and become the possessor of a copy. The result of a diligent study of it has been to me one of disappointment. In theory the plan suggested is a capital one, but beyond theory, impracticable. No doubt the labour of the author in producing tables of the places of 350 stars has been very great, and in this respect great credit is due to him. His plan is to fix a small telescope permanently, so that it shall *always* point to a zone of the Heavens extending from 50° to 53° N.P.D., and of course pointing as near as possible to the meridian. So far, so good. By this means the telescope, pointing so near to the zenith, the chance of error is reduced almost to a minimum, and the error when once discovered will be the same for every observation and always, and the observation corrected with the greatest ease. But now comes the funniest part of the affair. The author says in his title page that his "tables are arranged to show, by the use of a little arithmetic, the mean solar time," &c., and at p. 8, he says, "The tables have been so arranged so as to be *readily used by those who are not astronomers*, and whose acquaintance with mathematics is limited to the knowledge of a little arithmetic." Will it be believed, after such a statement, that the 350 stars whose places are given are most of them stars not visible to the naked eye, being stars of the 7th and 8th magnitudes, some of the 6th, a few of the 3rd and 4th, and only one of the first? Even if these 350 were all the stars known in that zone of the Heavens to pass the meridian in the course of 24 hours, when two or three happen to cross the wire within one or two minutes of each other, how can it be known which is each star, especially if, owing to the state of the sky, a glimpse of the transit of one only is obtained? For instance, under 23h. R.A., I find one star's place given as 43m. 29s.; the next, 47m. 45s.; the next, 48m. 15s.; and the next, 49m. 22s. If your clock were accurate, you might argue from the clock to the star, and know what particular star was on the wire; but you could not argue from the star to the clock as to its correctness. But instead of the number of stars included in that zone being limited to 350, it contains more than 12000, at least 2000 of which are visible in a small telescope. How, then, can even an astronomer know what particular star is on the wire at any instant, unless he argues from his clock to the star? whereas the design of this book is to enable anyone "not an astronomer" to argue from the star to the clock! I cannot see how the book can be very useful for transit purposes, even to accomplished astronomers. As to persons who are not astronomers, the idea is out of the question. I beg respectfully to enter my protest against the misleading statement I have quoted.

Luke the Labourer.

BRONCHITIS.

Sir,—I wish, with your permission, to offer a few remarks to "A Three Years' Sufferer" from this distressing disease. In the first place he should at once change his diet, avoiding much animal food, and living principally upon eggs and farinaceous food. He should partake largely of pearl barley and groats well boiled in chicken broth or in mutton broth, skimming the latter carefully, and taking it *entirely free from fat.* Gruel, carefully made, and sweetened with honey, should be taken every evening instead of supper. This may be occasionally varied by eating *roasted* apples, of good quality, slightly sweetened. Drink three times every day and three hours after every meal, a teacupful of the infusion of the common horehound. Keep warmly clad, and shun late hours and dissipation. Above all, keep the feet warm and dry, and wear next to the skin a flannel shirt. Do not wear mufflers, but gradually leave them off, and keep the chest warm by buttoning the coat up to the neck. This should always be done in severe weather. Ventilation should be particularly attended to, especially that of the bed-room. There are many ways of doing this without causing any draught, and it is as well to observe that if this important matter be not attended to, any other remedies will be almost useless, since it is through the afflicted organs (the bronchi) that the air is carried on to the lungs. In some diseases, including bronchitis, it is well known that medicines are of very little use, being merely palliatives. There is usually something wrong in the style of living or in the air that is breathed. By carrying out the above instructions our suffering friend might derive considerable relief; but if, unfortunately, that should not be the case, he may pursue the following plan:—Take of pure croton oil *one drop only*, and apply it to the surface of the throat, rubbing it against the organ affected. Do this every day, and the oil, which is very powerful, will soon produce an eruption, which, as it progresses, will, in all probability, restore the voice to its full tone and vigour.

Tautau.

HOW TO MAKE A DECLINING RECLINING SUN-DIAL.

Sir,—The last kind of sun-dial necessary to be noticed is that known by the name of reclining dial, and it is such as may be made upon a plane which reclines or leans back, like, for instance, the roof of a house or church. If the plane exactly faces the S., and merely reclines from the zenith, the calculation is easy, as well as the structure; the only thing necessary to do is to find how many degrees it reclines from the zenith, and to make it like a vertical dial of a different latitude. So many degrees as the plane reclines must be added to the latitude, and then the dial made for that latitude. Thus, supposing the plane reclines 10° from the zenith, the latitude must be reckoned as 10° more—namely, 61° 30'—and then the dial made like a vertical south dial; but if the plane declines as well as reclines, the calculation and the structure require more care, and for this reason we seldom if ever see a dial of this kind. It may, however, be of service to know how to make one. The first thing to do is to find the reclination of the plane, roof, or slanting wall, and this may be done by applying a carpenter's rule to the slant, and opening it till the other leg is on a level with the horizon, which may be known by a common level. The angle may then be easily measured. The declination may be found by a magnetic needle, as directed page 460. We will suppose, for the sake of showing how the problem may be solved, that the reclination from the zenith is 20°, and the declination to be from the S. towards the E. 30°. Our object must be to find five things: (1) the latitude and longitude of the place where it would be a horizontal dial, (2) the distance of our 12 o'clock line from the perpendicular, (3) the distance of the meridian of the plane from our 12 o'clock line, (4) the elevation of the style, (5) the hour-arcs. We may find the latitude and longitude of the place by the terrestrial globe. If we elevate the N. pole to our latitude 51½°, we must then screw the quadrant of altitude over the zenith 38½° from the pole, and bring the end of it to the degree of the plane's declination, which in this case is 30° from the S. towards the E. We must then bring the meridian of Greenwich to the brazen meridian, and count upwards from the wooden horizon on the quadrant of altitude 20°, which is the reclination of the plane from the zenith. Having made a mark on this part of the globe, we must bring it to the brazen meridian. We shall then know the latitude and longitude, which is 14° S. and 30° E. Now, since the elevation of the style must always be equal to the latitude, we shall by this means know to what height to raise it. We shall also know the difference of time between this place and London—namely, 2 hours—which we shall afterwards make use of in finding the width of the hour-arcs. Again, since the plane on which we suppose our dial to be made reclines from the zenith, the 12 o'clock line will not be the perpendicular, as in declining dials, but a little distance from it; and in order to ascertain this distance, we shall find it convenient to work it out by the formula in Spherical Trigonometry. In Fig. 1 let A be 90°, C = 30°, the declination, A C = 20°, the reclination. Here, then, we have two angles and a side, and we can find A B, the distance of the 12 o'clock line from the perpendicular:—Thus, R : sin. A C : : tan. C : tan. A B which is 11° 10'. Again, by the globe we find that the place where the dial would be a horizontal one is in Africa, 14° S. and 30° E. This, converted into time by dividing by 15, gives 2 hours' difference; and we may therefore find the distance of the meridian of the plane from our 12 o'clock line by the same formula—namely, R : sin. lat. 14° : : tan. 30° : tan. dist., which is equal to 7° 57'; and this, added to the former 11° 10' = 19° 7', is the distance of the substiler line from the perpendicular. The last thing to do is to find the hour-arcs; and the simplest way of doing this is to use the same formula as the preceding, which we also use to compute the hour-arcs on a horizontal dial; and where the time is an aliquot part of 12, the process is easy. We must take the meridian or substiler line as the beginning of the reckoning, and having marked all the distances on the dial, we can then number them; but we must be cautious to number with the right figures. In the case supposed, the meridian line must be numbered X., the next line towards the right hand XI., and so on; but on the left hand of the substiler line we must number them IX., VIII., &c. If, however the longitude does not

FIG. 1

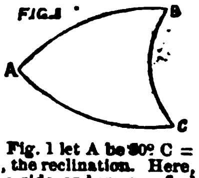
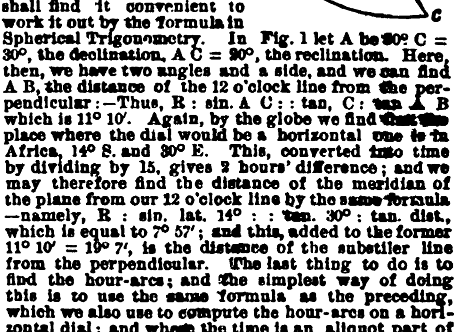


FIG. 2



form an aliquot part of 12, we must make an allowance for it. Suppose, for instance, that the substiler line should not be on the line of X., but between IX. and X., we must find how much to allow for it before commencing our reckoning. For the sake of example, suppose the longitude should be 2h. 20min. This, converted into degrees, will be 35°, and using the same formula—namely, R : sin. 14 : : tan. 5 : tan. dist. —we shall have 1° 13′. Having measured this distance from the substiler line, we must compute the hour-arcs by taking it in, and instead of taking tan. 15°, tan. 30°, &c., we must take tan. 20°, tan. 35°, &c., adding 5° to each; but in the morning hours, by the same process, we find we must allow 2h 20′ from the substiler line to the hour of IX., and instead of tan. 15°, tan. 30°, &c., we must add 10°, and compute by tan. 25°, tan. 40°, &c.; and by working them out in this way we shall obtain all the hour-arcs. In conclusion, we must remember in all these kinds of dials to place the gnomon parallel with the axis of the world, or point to the poles, and to apply the equation of time when we set our clocks and watches by them, and then, like the great sun of the universe, we may always depend upon an unerring guide to direct us to our several duties. T. S. H.

P.S. — Your highly-instructive correspondent "F.R.A.S.," whose papers it is a pleasure to peruse, recommends "Heather on Mathematical Instruments and Dialling Scales," but I venture to say that although its contents are most valuable, and its directions on dialling quite sufficient for those to whom the art is like A B C, yet it is not full enough for others, nor does it give any directions whatever for the construction of declining and reclining dials. The hour-arcs may also be found by that useful rule, the sector, but with much more trouble and far less accuracy than by the method prescribed, which is nothing more than addition and subtraction. In last letter, page 15, in the diagram, for "60°" read "63°;" and for the "angle A C B 30° + 90°" read "angle A C B 27° + 90°."

EXPLANATORY.

SIR,—I cannot see anything in my letters entitling "F.R.A.S." to suppose I had him in my thoughts when I referred to what the German poet has said about "strong men." All the same, I would submit to him my doubts whether it befits a real lover of science, as he undoubtedly is, to "eschew discussion *ab initio* on every moot point whatever;" nor can I think that the abandonment of "a winning cause" (in itself hardly a commendable thing) would justify the course of dropping an argument when one finds one has made a mistake.

I have brought no charge of either sort, however, against "F.R.A.S.," for whose scientific attainments and surprising general accuracy (when one considers the wide range of objects he treats of) I have the highest possible respect. If I were disposed to do so, I should be far more inclined to dwell on his spectrum analysis illustration than on his theory respecting object glasses. The latter is a matter of opinion, the former a question of fact; and any one who is desirous, as I confess I am, of seeing the truth laid as clearly as possible before people, might fairly object *to a statement which is opposed, I submit, to the very principles on which spectroscopic analysis depends.*

But in praising (as was just) our contributor "T. A.," I was not "*making a cap;*" so that I need dwell no farther on a discussion which I also have desired to drop.' RICHARD A. PROCTOR.

CRIMINAL LITERATURE.

SIR,—A clergyman, on the 31st ultimo, wrote under the above heading thus to the *Times*:—

"Sir,—A short time ago you recorded the conviction of several venders of immoral prints, not on the prosecution of the Government, but of a society whose successful operations have made them insolvent. To-day you record the words of Mobbs, the murderer:—'I had seen a picture of the man Baker murdering the girl in the hop-gardens.' Week after week the illustrated records of crime are circulated over the length and breadth of the land. In my country parish the *Illustrated Police News* has a large circulation. Its pictures represent crime in varied phases; its letter-press is explanatory; but its most damaging part is to be found in its advertisements. And yet as the law stands I much question if it can touch this publication. Has no M.P. time to consider first and give notice next of a motion upon this subject? Surely crime in England should have its share of consideration with crime in Ireland, and it strikes me that it is somewhat important to protect innocence as we spread education; but it unhappily appears that while we are squabbling as to whether religion may be taught in our schools, we are permitting vice to be taught everywhere."

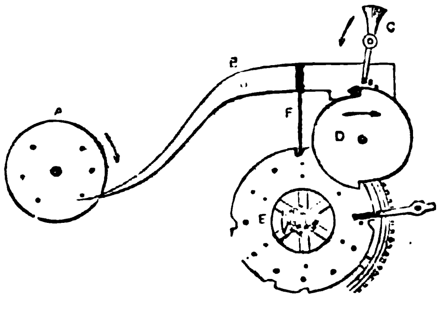
If such men as Mr. Edward Henri Todé (who started, and for some time edited that journal), and who afterwards started and edited the *Fenian*), and others like him, cannot be induced on moral grounds to forbear from publishing their filthy broadsheets, it is time for the law to interfere. I trust therefore you will allow these few lines to appear, that now, when there seems a chance of the matter being agitated, we, who are represented by you, may not incur the reproach of having remained silent. KAPPA.

TEST OBJECTS.

SIR,—I send you a few of the tests that have been put upon a telescope in my possession. It is 3in. aperture, 4ft. focus, 3 eye-pieces of 35, 60, and 96 diameters. With the lowest power I can discern Jupiter's satellites before sunset, and with the highest power I have observed the transit of the satellites. It shows distinctly 4 stars in the trapezium of Orion, it splits Castor easily, shows the companion of Sirius, also Rigel; Cor Caroli it shows beautifully with the lowest power; Mizar also. I have seen the trapezium through a 3½in. and 4½in., and see 5 stars in one, and 6 in the other. The 3in. shows the belts of Jupiter more distinctly than a 7½in. silvered glass reflector. If "F.R.A.S." can give me further test objects, I shall be greatly obliged. WILLIAM BAGULEY.

TURRET CLOCKS.

SIR,—Several correspondents in the last number of the MECHANIC ask for more information about the clock I described in your pages a short time ago; I will, with your permission, afford them it. Enclosed is a drawing, showing how the quarter train is discharged and stopped. A is the pin wheel. Three times in the hour a pin presses down the lifting piece B, which has two bits of steel rivetted in it. The locking arm C has also a bit of steel, which comes against the stop on the lifting piece, when it is allowed to fall by the wedge of hard steel rivetted in it dropping into the notch in the cam wheel D, and the detent F into the notch in the locking plate E. When the end of the lifting piece is pressed by one of the pins, the heavy end rises, and lets one of its stops slip past the stop on the locking arm C, which moves forward in the direction of the arrow, and comes against the warning stop two or three minutes before the quarter is to be struck. When the end is free of the pin, the heavy part falls back into its former place, the cam wheel revolves and raises the stops on the lifting piece out of the way of the locking arm, and the number of strokes is determined by the distance of the notches in the locking plate, which, in this case, is also the pin plate, and works two levers. The lifting piece B must fall quite dead, or it may fail to stop the train, and therefore the detent F must not touch the bottom of the notch. The hour-discharging mechanism is the same, only then the locking plate does not work the hammer lever, and the lifting piece end is not pressed down, but raised by the pin in the going part. I said nothing about the dial work, or the way the pointers are driven, because it is not done in the usual way.



There was an old thirty hour clock, which had been going for nearly two hundred years, and was about worn out, already in the tower; it had only one hand, showing the hours. About three years ago I put machinery to it for striking the quarters. Change wheels were used, and I sent a description, which was published in the ENGLISH MECHANIC. I also put another hand to the clock, showing the minutes. The method was simple, but objectionable, as the minute hand was next the dial, fastened on a tube. I should prefer to use dial wheels in the usual way; they would be much more costly than change wheels. When I removed the old clock, I found the wheels none the worse for their nearly three years' work. The quarters had been striking at their regular intervals, and I had been well repaid for my labours by hearing their musical sound.

A correspondent asks why I use cast iron wheels in preference to brass ones. Simply because iron wheels cost only about a quarter of the price of brass ones. No doubt the train is a coarse one, but with weight enough on the barrel it will do its work well. For the going part, 150lb. is hung on a 6in. diam. barrel; that is a great deal, but with a gravity escapement it does not interfere with the time-keeping property of the clock. I believe, from what I have seen of the performance of the clock—and I kept it going in my workshop during the time the hour and quarter parts were being done—that it will not vary more than a minute in a month from mean time, when the pendulum, of varnished steel, is regulated. It takes about half a minute to wind the going part up, and by lifting up a ratchet lever, geared to the third spindle, from below, a maintaining power is kept up. The weight on the barrel of the hour part is 350lb., and lifts a hammer high enough to bring out the sound well from the tenor bell, weighing, I should say, 16 or 17 cwt. The quarter bells in proportion. I obtained the change wheels of J. Buck, Newgate-street, but Mr. Lloyd, 135, Steelhouse-lane, Birmingham, has sent me his supplementary wheel list, and it appears he can supply many other numbers of teeth besides those I mentioned, amongst others, the 130 tooth wheel I wanted.

There is no reason why every village church, if it has a bell, should not have a good public clock. A clever blacksmith, with a lathe and slide rest, could put such a clock as I have described, up in almost any town, for £25, if it only struck the hour, and make very good wages. The bearings for the spindles, I forgot to mention, were flat bars of iron, screwed to the wooden frames. The pivots work in brasses, rivotted in the bars. The pallets are made of sheet brass, and the 'scape wheel of steel. The pendulum bob is a cylinder of lead, weighing 15lb.

Allow me, Sir, in conclusion, to say I like the new shape the ENGLISH MECHANIC has taken, and that I hope it will continue to be successful! I have subscribed from the first, and have always endeavoured to make it known to my mechanical friends.

SYDNEY MADDISON, Hastings.

P.S.—I have no objection to indicating the place where the clock may be seen; Partney, near Spilsby, is the village, and the blacksmith who has charge of the clock would no doubt be glad to show it to any one who found it worth his while to go there.

I was engaged previously in putting up, in the tower of a friend's church machinery to strike the quarters on four bells, as at Westminster. It can be done very well with six bells, if they are in the key of E flat. I should be happy to describe the machinery, together with a novel method of fixing the hammers to the bells, if it would be of interest to your readers.

THE ILLUMINATED PORTION OF THE MOON'S DISC.

SIR,—I think Mr. Beardsley is right in not accepting the explanations already given as exhaustive; for if, when the moon is only two days old, an imaginary line be drawn from its centre, and made to pass through its surface in the centre of the edge of the illuminated arc and prolonged, it would not cut through the sun at all, but would be almost at right angles with that luminary; but a line drawn from the centre of the moon through that part of the surface which is in the centre of the illuminated half (for we all know that one-half of the moon is always to the sun) was prolonged, it would cut through the centre of the sun.

Now, Sir, when the moon is about the end of the first or third quarter, one-half of the illuminated portion is turned towards the earth, the other half of the illuminated portion is turned away; therefore, in this case, the centre of the whole illuminated moon, and the centre of the illuminated edge as seen from the earth, coincide; so that in this part of its orbit the illuminated portion of the moon's disc is fairly directed to the sun, allowance being made for optical effects. W. F. SWALLOW.

BREAD-MAKING.

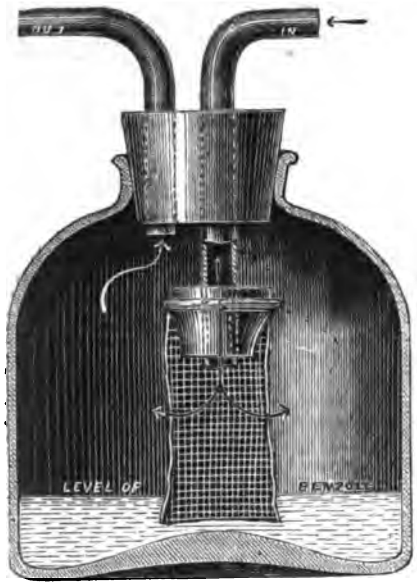
SIR,—I cannot pass over "T. Estee's" letter without a few words of comment upon it, as I certainly think your correspondent has never tasted good unfermented bread. We have used it for 21 years, and scarcely ever failed in having excellent, sweet, moist bread. As to its being injurious to the system, I think it must be far otherwise, as I am myself an invalid of many years' standing, and attribute my present state of health entirely to the use of this bread. As regards the recipe for baking powder given by "T. E.," I think the quantity of rice so large, that any one would fail to make good cakes or pastry with it. Our proportions for baking powder are as follows—viz., tartaric acid, 3oz.; bicarbonate of soda, 4 do.; ground rice, 1 do. As I cannot give the mode of operation of making our bread in the space of a letter, I must refer "T. E." to the *Family Friend* of 1850, vol. 2, page 176, where he will find the full particulars.

THE AUTHOR OF THE ARTICLE ON UNFERMENTED BREAD IN VOL. 2 OF "FAMILY FRIEND," 1ST SERIES.

"SIR,—"T. Estee" makes a vital mistake in confounding fermented with unfermented bread. The latter may be kneaded into a kind of raw paste with a little water, while no amount of kneading will effect this change in the former, which, for this reason, sits more lightly on the stomach. Many persons, including the writer, cannot eat unfermented bread. Yeast acts chemically on flour, "powders" act mechanically. Buy a shilling treatise on baking of any bookseller for theory, and when you have spoiled a few bakings and brewings you will find out how *good sweet bread* is made. If you value this commodity your trouble will not be lost. Don't try to make good bread out of bad flour. Don't let rice come in contact with yeast. NEW SUBSCRIBER.

CARBURETTING GAS.

SIR,—"Adolescens" asks, at p. 645, Vol. X., if he can fit gas burners to his 4in. condenser lanterns? and as I have done this for some years past, I am happy to tell him how I fitted them, as "V. W.," page 659, proposes a method which I think would prove a very dangerous one, and I should like to know if he has actually used the arrangement he describes. "Adolescens" will have to select very fine hole argand burners (32 will be required for such powerful lanterns as he has), and they must be fitted with a conical ring round the outside of the burner, to cause a current of air to impinge upon the outside of the flame, and thus compress the flame to a smaller diameter. I have found with such burners that a common straight chimney gives the best light, but he must fit fine wire gauze under the centre of the burners to obtain a perfectly steady flame. Ordinary coal-gas will not give a sufficiently powerful or white light for lanterns, and must be carburetted, as described by "V. W.;" but I advise "Adolescens" not to attempt to make a vessel *inside* the lanterns, as, unless he is an experienced hand, he will be very likely to have a dangerous explosion, as the heat of the lanterns in use would soon cause the naphtha in the tin vessel to volatilise too rapidly and burst the vessel, or make a smoky flame from excess of hydrogen vapour. A simpler and cheaper plan is to use a common glass round pickle bottle, which can stand on the floor or table, on one side of the lanterns, out of the way, and the whole affair will not cost 6d., and yet answers the purpose admirably. Two pieces of compo. pipe, each 6in. long, must be fitted through a good bung in the mouth of the bottle, the inner end of one being flush with the bottom of the bung, and then curved to an elbow. The other must be thrust through the bung about half way down the inside of the bottle, and the outer end also curved to an elbow. This will be for the inlet for the gas. Now tie a sponge or large-sized argand cotton wick to the inner end of the pipe, on which a plug of wood or a cork with a hole through it is fitted tightly, so as to keep the wick distended, which will then hang down to the bottom of the bottle. Pour in about half a pint of benzole, *not* rectified, but what is sold as ordinary benzole by chemists, at about 1s. 6d. a pint. Then close the bottle, and connect the inlet pipe to a gas branch (after taking off the burner), and connect the end of the outlet pipe with the pipe leading to both lanterns. This latter connection must not be of india-rubber tubing, but either compo. or flexible tubing (to be got at all gasfitters), as the india-rubber



tube absorbs the benzole vapour very rapidly, and would spoil the effect. The action of this simple apparatus will be evident, for the capillary action will saturate the whole of the cotton wick or sponge, and as the gas passes from the end of the pipe the pressure will force it through the sponge or wick, and in doing so it will take up the vapour of the benzole, for which it has great affinity, and, passing out of the bottle by the outlet, will burn in the lanterns with a very fine white light, far superior to any oil flame, and also very steady; but this must be the result of careful experiment, and will depend on the relative length of chimney and pressure on the gas main. I need hardly add that every joint must be made perfectly tight by cement or sealing-wax, and when done with, the remaining benzole must be emptied into a good stoppered bottle, as it is very volatile. Nothing but *very* fine hole burners can be used with advantage with such rich gas; and if "Adolescens" fits taps to each burner, he can dissolve without using the ordinary shutter or comb, leaving one burner just alight, while the other is turned full up. A small hole in each lantern door with a coloured glass in it will enable him to turn on the gas to the proper height; otherwise, he will find a great waste of gas and bad light.

"V. W." may have used his plan by careful attention, but I am confident he would not get a brighter light and better or more convenient arrangment than what I have described, as I have tested it frequently, and used it constantly in giving lectures, &c., for the last six years.

Above is a rough drawing of the bottle, but fear that I have already taken up too much of your valuable space. C. D C.

BARIC CHLORATE.

Sir,—As your correspondents "Taffy" and "Pyro" may wish to have some idea as to the sort of baric chlorate they will obtain, by strictly carrying out Mr. Davis's instructions on page 10, I append the probable per centage composition of the crystals it will yield. If allowed to cool to 80° C., and then the crystals collected:—Baric chlorate, 53 per cent.: baric chloride, 47 per cent. If allowed to cool down to 60 Centigrade:—Baric chlorate, 47 per cent.; baric chloride, 53 per cent. If allowed to cool to as low as 40 C.:—Baric chlorate, 41 per cent.; baric chloride, 59 per cent. If allowed to cool down as low as 20 C:—Baric chlorate, 33 per cent.; baric chloride, 67 per cent. Finally, if allowed to, as most probable, cool to 10 Centigrade (50 F.):—Baric chlorate, 27 per cent.; baric chloride, 73 per cent. Therefore, most likely, the salt obtained, supposed to be "pure" (?) baric chlorate would consist of a mixture of 1 part of baric chlorate, and nearly 3 parts of baric chloride; while, if collected so as to yield the purest salt (*i.e.*, containing *only* about 50 per cent. of impurities), over 60 per cent of the baric chlorate would be wasted and lost, as the mother liquid would contain from 15 to 70 per cent. of the baric chlorate formed, the exact amount depending on the temperature.

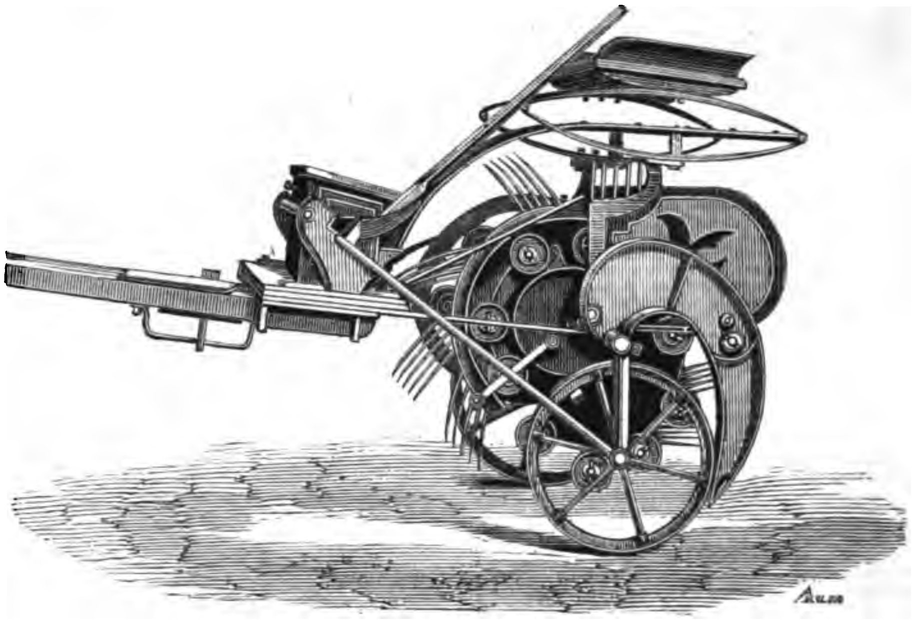
With reference to the three apparently contradictory replies furnished by Mr. Heard, Mr. G. E. Davis, and "Ernest," concerning hypochloric acid, they are "all right and all wrong." U.

AGRICULTURAL IMPLEMENTS.—COMSTOCK'S ROTARY SPADER.

Sir,—I am glad to see that our old friend the English Mechanic is so strong and vigorous. As you have lately given the millers a fair portion of your time and attention, perhaps you will be kind enough to pay the like compliment to their brothers the farmers. In looking over some papers a few days ago which I brought from the Paris Exhibition, I found the enclosed, and the thought struck me that perhaps it might be useful to some of your subscribers; it might give some of them a hint which would set their thoughts in the right direction with regard to the improvement of agricultural implements. If you think the spader worth insertion in your valuable pages you will greatly oblige.

S. Kent, Hastings.

COMSTOCK'S PATENT ROTARY SPADER.



The spader is designed as a substitute for the plough in preparing the ground for seed in fields that have been once broken and the sod rotted. It is not adapted to breaking prairie or meadow land, nor for land that is not comparatively free from stones, stumps, and roots.

By means of the lever on the foot board, it is readily put into position to work or travel, on the farm or road, and is easily controlled by any one capable of driving a team.

The teeth or tines on the fork-bars are about 7½in. apart, and when on the bar constitute what is called "a fork."

The teeth or tines of the fork are cast steel, *self-sharpeners*, of the simplest possible form, 8in. in length, and are secured to the bar by a clamp, or stirrup, and wedge, and can be taken off or put on in the field by any person, as each tine and stirrup will fit the fork-bar of any sized spader. Great care has been exercised in determining the strength necessary in these parts; but if broken, and no extras are at hand, may be replaced by any good blacksmith.

A team in ploughing a furrow one foot in width travels 8¼ miles to each acre (besides turning corners), or 16½ miles in ploughing two acres, which is a good day's work for both team and man, and is not always well done with a furrow of that width; if a narrower one is turned, the travel is increased. The five tine spader works three feet in width; therefore six acres are spaded to 16½ miles travelled, or as much as three pair of horses, three ploughs, and three men will do; and but 275 miles of the team is required to spade 100 acres; making a garden bed of the grain-field at less than half the cost of ploughing; and this may be done by any one able to sit on an easy seat and drive the team—no walking or other labour required.

The saving in expense of teams and manual labour alone soon pays the cost of a spader, even to smaller farmers.

Other advantages may be enumerated as of equal, if not greater, importance than the saving of labour and cost.

As the ground can be prepared in much less time, it may be done at the right time—and less time is given for the soil to settle and pack, and for seeds of weeds to germinate and take root before planting.

The attention of nursery men and market gardeners is invited to the fact that by twice going over lumpy ground with the spader the soil is better and more cheaply pulverised than can be done by any other process.

It will pulverise the soil and leave it light and mellow when too wet to be worked, without damage by the plough. And on sticky soils, where the plough will not scour, it will do its work perfectly.

THE ADVANTAGE OF USING CRUSHED OATS.

Sir,—The advantage of using oats, beans, peas, &c., which have been previously crushed and partially ground into a coarse powder, is not as generally known as it should be; I therefore take this opportunity of drawing the attention of those of your readers who are interested in such matters to the following practical illustration of an important fact, namely, that but little good can be expected from the best descriptions of food unless its mechanical condition is also attended to.

Some days ago I procured a small load of horse dung, which, being taken from the streets of London, was perfectly free from any loose particle of hay or straw. This manure was put in a heap in my garden, and covered over with a thin layer of earth.

In about a week afterwards I was much surprised to see quite a crop of green shoots coming up on the surface soil, and on making a careful examination at the rootlets, I found that in each case these shoots proceeded from what had originally been a sound grain of oats.

It would be interesting to know to what extent, and under what special circumstances, oats and similar cereals are passed off unaffected by the ordinary process of digestion, &c.

It certainly appears to me very desirable, in order to feed animals with the greatest advantage and profit, that the different kinds of food should be carefully reduced to a fine state of division, then steamed, or at least moistened, after which chaff or similar coarse material may be mixed in proportion, as we may wish to make a more or less bulky kind of fodder.

John Hughes, Analyst, 16, Penn-road-villas,
Holloway, N.

NEW CARRIAGE BRAKE.

Sir,—In your excellent journal of the 28th of January last there appears a notice of a new carriage brake. On reading the description of it, I was much surprised to find that a carriage or cart brake exactly similar in every way to that now patented by Messrs. Parry and McHardy was exhibited at the show of the Highland and Agricultural Society of Scotland held at Dumfries in the summer of 1860, and that to it was awarded a premium of £10. It attracted great attention, and was universally approved of. It was made and shown by Mr. Thos. M'Cririck, agricultural implement maker, Old Cumnock, Ayrshire, who has long been well and widely known in the south and west of Scotland for his many useful improvements and ingenious and original inventions in connection with agricultural machinery, but whose diffidence of disposition (which is so frequently found allied to true and original genius) has hitherto kept him from patenting any of his many inventions; and as he has now considerably passed the allotted span of threescore years and ten his career as an inventor may be said to be over. Still it is right that he should not be robbed of any honour which justly belongs to him; and undoubtedly he is the *original* inventor of "the new carriage brake" described in your journal of the above date. Messrs. Parry and McHardy may not have seen Mr. M'Cririck's brake, and they may have been original inventors also; but even if such has been the case, they have been forestalled in it by Mr. M'Cririck by nearly ten years.

A photograph of the brake, and of the cart to which it was attached was taken at the time. Could we have obtained a spare one, we would have enclosed it; and we may do so yet, when more of them are taken.

A. B. Todd, Old Cumnock, Ayrshire.

THE SUN.

Sir,—The English Mechanic of the 1st April, 1870, has just come to hand, in which I have noticed a letter that bears the initials of "S. B.," who says he was in hopes that some of your "qualified" correspondents would have answered "Veritas."

"The 1·005998 is a fraction." This is not the case, because a fraction is a part only of a whole. If "S. B." had stated that 1·005998 was the proportion, ratio, or quotient of two distances or values, he would have been nearer the truth.

Mr. "S. B." has one fundamental error in his calculation of the mean diameter of the sun—namely, he employs the equatorial semi-diameter of the earth, whereas, he ought to have used the *mean* semi-diameter in order to arrive at a mean value of the sun's diameter.

I beg to submit the following facts as given by

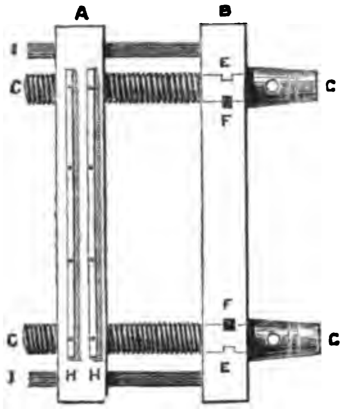
	"F.R.A.S." and	"S. B."
	Miles.	Miles.
Sun's diameter =	845947	853650
" distance =	90854708	91516000
M. H. parallax	8″·91	8″·932

It will thus appear that the values of "F.R.A.S." and "S. B." are wide apart.

Perhaps the best that could be done under the circumstances of the case is to appoint a scientific pope for the purpose of a final settlement of our scientific differences. Veritas.

BOOKBINDER'S CUTTING PRESS.

Sir,—I send a sketch of a bookbinder's cutting press, although I firmly believe it will be "Love's labour lost," for those whose *trade* it is to provide bookbinders with cutting presses do not always turn out a good press; but as "Maschil" and others have inquired about the apparatus, I thought it would perhaps be best for the interests of "our" Mechanic to comply with their wishes. Persons out of the trade seem to form the most erroneous ideas of bookbinding, gilding leather, &c. I should much like to see some of "Maschil's" first-rate binding. The sketch is drawn to a scale of 1-20th of an inch to the foot. A B are two pieces of well-seasoned beech, about 40in. long, 5¾in. wide on the upper side, as shown in the sketch, by 4½ deep. C C are two beech screws, of 3in. diam., with a groove in the plain part of each screw, E E, through which groove a garter pin, ⅝ square, F F, is tightly fixed, which causes the cheek A to recede from or approach to the cheek B. G G are the heads of the two screws, through which are two holes, about ⅝ of an inch in diam., in which the press-pin, or lever, which is about 20in. long, is inserted. H H are two strips of hard wood, placed about 1¾in. apart, for the plough to traverse in. The cutting press here shown, is 2ft. between the screws. I I are two guide rods, firmly fastened in the cheek B, which keep the cheek A in its proper position. AB INITIO.

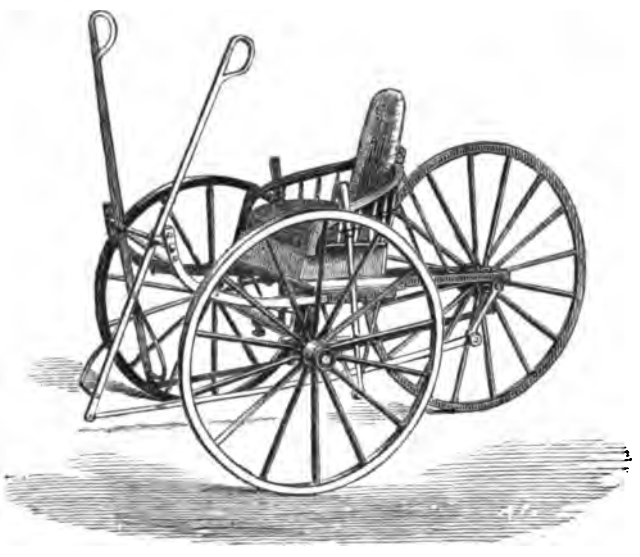


THE "ENGLISH" VELOCIPEDE ON A NEW PRINCIPLE, AND OUR ENGLISH ROADS.

SIR,—For many years my attention has been directed to the subject of velocipedes, both theoretically and practically; and when your third volume was coming out I saw it was treated of therein, since which time I have been a subscriber.

I will be as brief and as plain as I can in what I am about to say, for my aim is the diffusion of clear views of the correct principles of velocipede construction, and to assist in its inauguration as a really useful machine. I have had several machines made on different principles and designs. One, a three-wheeler, had two driving wheels, between which the rider sat. It could be worked up hill pretty well. Afterwards—thinking that if one were made for two to work, sitting back to back, it would be easier to get up hill, I had one made for two; and what was the result? Why, the very reverse anticipated! Two could not possibly work it up anything like a hill, and, strange to say, one could! This was about two years ago, since which time I have endeavoured to trace the reason of this; and about twelve months since I succeeded in what I thought might be some explanation of it. Suppose a man had to take two sack-loads of potatoes (weighing, say 5cwt.) a mile, and he had before him the choice of a wheelbarrow and a truck (a two-wheel handcart) to take them with; and granting that the truck weighs as light as the wheelbarrow, which should we suppose he would choose? Common sense would say the truck, because he could balance the load on it, and all he would have to do would be to roll or wheel it along. In the case of a wheelbarrow, he would have to lift half the load before he could wheel the other half. Now, as wheeling a load is easier than carrying a load, it is evident that the wheelbarrow is a foolish vehicle where a truck can be used. Let us look again at the above velocipede. We see that the spokes of the driving wheels act similarly to a man's legs in a wheelbarrow, with this difference, that whereas in a wheelbarrow a man's legs have only to overcome the friction of half the load, in this machine the wheels have to be made to overcome the friction of nearly the whole of the load before it can be moved. Again, let us now look at the truck. Its two wheels act as guiding wheels, at the same time bearing the load, and the man's legs act as the spokes of a driving wheel. Now, if a velocipede were made on this principle, the question would be, Would it be easier to propel than the other? I was soon convinced that it would; and having proved it to my own satisfaction, I have laid down this maxim or principle as being the correct one in the construction of all velocipedes—viz., that no more weight should be placed on the driving wheel than is actually necessary for driving purposes.

To illustrate this still further, take the case of a luggage train. Suppose that instead of the locomotive drawing its load of 200 tons behind it, the whole of the 200 tons were to be placed right over and upon the driving wheels of the engine, what would be the consequence? Why, the power of any ordinary locomotive would most probably fail in endeavouring to overcome the enormous friction caused by the load above. Observing the above principle, I designed the following velocipede, which at a glance will be perceived to be self-adjusting as regards the load on the driving wheel. It also meets every other requirement that is looked for in the velocipede—viz.: 1st. It is light and simple in construction and working. 2nd. It is perfectly safe, easy to work, and comfortable to ride. 3rd. It is easy to guide, and with all the wheels being free of each other, it turns sharp corners. 4th. It has a minimum of friction consistent with a maximum of power, as both hands and feet would be used; but I never found it to require more than the use of one hand with the feet up the steepest hill, the driving wheels not slipping.



The wheels, as will be seen in the drawing, are rather small, the driving wheel being only 2ft. 8in., and the others 2ft. 4in. Some will very likely think they are too small; but those who have made great use of the velocipeds on all kinds of roads will never prefer them much larger.

The frame of this velocipede consists of angle iron bent in the forepart to a curve, as shown. It is filled in with wood. They are in four parts. One end of each goes right across a strong board, to the under part of which it is bolted by two bolts. Above this board is the seat, between which is the box, secured by a lock and key. There are no springs, but a good cushion on the seat, and I can affirm that I have not experienced the slightest unpleasantness as regards jolting, jogging, or shaking (I have gone over rough roads); indeed, it is rather otherwise, for it is truly comfortable to ride, as I have said above. Another noticeable feature in this machine is the guiding handles being placed at the sides of the seat. This allows the chest more play, and gives greater opportunities of development than when the hand has to reach forward to guide.

This latter remark leads me to refer to the worker of the velocipede. It may be said that the velocipede will never compete with the railway train as an economiser of time. It may be so; but it can also be said that the railway train will never compete with the velocipede as a promoter of health. So the velocipede question, in this respect, resolves itself into these two points, time or health, not considering the saving of railway fares. Time is no doubt valuable, but health is still more so—it is invaluable; it is a fortune in itself. What truly wise man would, for the sake of saving time, always avoid opportunities of promoting his health? As vigorous health means greater capabilities for business, it is questionable whether the right use of the velocipede is not more favourable to the attainment of wealth than otherwise.

I will conclude what I have to say on the question in another letter, next week. A THINKER.

EXTRACTS FROM CORRESPONDENCE.

INTERESTING FACTS.—"Pneuma" writes as follows:—"In your number for March 25, page 23, is a small paragraph headed 'Interesting Facts,' among which are two or three statements which perhaps you will allow me to correct. The German mile is much more than 1800 yards. The German short mile is 6859 English yards, and the German long mile 10126 English yards, and the Hanoverian mile 11559 yards (see Kelly's 'Cambist'). The greatest depth of the sea is more than 4 miles. On the 15th November, 1849, Lieutenant (now Captain) Maury, in the 'Fancy,' let out 5700 fathoms of line (about 6½ miles) without finding a bottom. This was in lat. 31° 59′ N. and long. 58° 43′ W. This depth exceeds the height of Mount Everest, in the Himalaya, by a mile. The statement respecting the English acre is evidently wrong. It should read 4840 square yards, being 69yds. 1ft. 10in. each way."

"J. K. P." also writes:—"Under the above heading, on page 23, you state a German mile at 1806 yards. Now a German mile is what they call a 'stunde' or 'hour,' i.e., an hour's walk, and 'Adcock's Pocket Book' gives 10126 yards, which agrees with 'Chambers' Encyclopædia.' Adcock states the Turkish mile at 1826, while you give 1626, and I have no means of telling which is right. A German 'short mile' is 6859 yards according to the 'Imperial Dictionary,' and is quite enough for an hour's walk for me."

DR. USSHER'S ADVICE.—Hy. Good sends us the following.—"Will you allow me to point out one or two errors in 'Dr. Ussher's Advice?' First of all, it is not Dr. Ussher's, for I have now before me Cowper's Poems, in which I pasted a label more than thirty years since, a copy of which I enclose. I am quite sure that it is an oversight of the doctor to say—

'For oft-imparted knowledge doth
Diminish learning's store.'

You will also observe that the words 'I often lent' should be 'it often lent.' If some of your subscribers would get up a neat label of the above, either in lithography or photography, leaving a space for name, I think they could find a sale for them."

VARNISHING THE VIOLIN.—"St. George" writes:—"I find amber varnish to injure the tone of the violin the least of any that I have tried."

THE ENGLISH MECHANIC.—"An Old Subscriber" writes:—"Allow me to congratulate you on the decided improvements recently made in the ENGLISH MECHANIC. Issuing the index with one of the numbers, separating the advertisement sheets from the body of the work, giving the contents on the outside page, increasing the size and at the same time improving the form of the publication, giving a list of the new patents—these, with what we have had before, combined with a greater variety of contents, and, I think, a certain sifting of the Notes and Queries department, make the ENGLISH MECHANIC AND MIRROR OF SCIENCE the principal scientific journal published. You need not stoop to the miserable and deceptive manœuvre of offering to give away prizes 'for nothing,' in order to bolster up an artificial circulation; you can stand on your merits."

BENNETT'S DIE CHUCK—Edwin Baker writes:—"Will you allow me to correct an error in last week's number, with respect to Bennett's die chuck? Mr. Bennett invented and made that chuck while he was in the employ of the Messrs. Holtzapffel, and not Mr. Evans's, as it was given us to understand. I question if Mr. Bennett ever was in the employ of Mr. Evans at all."

A GOOD RECIPE FOR HOME-MADE YEAST OR BARM.—Place a quart of malt in some wooden vessel, boil one ounce of hops in three quarts of water one hour; when clear from the vapour arising therefrom your over the malt so as just to scald it. Cover over with thick flannel or baize till morning, when it should have a frothy head on; strain. Put half-a-pint of this liquid to 7lb. flour, set your sponge over night, in the morning mix and bake in the ordinary way. This is an excellent recipe, and was given me by the late Sir Charles Napier's cook. Nothing can equal the sweetness of bread made from this.—W. I.

MEDICAL OPINION—Dr. Burdwenll in a letter says:—"I love your MECHANIC, but I dislike to see medical questions, and often very absurd ones, asked through it. It is almost impossible to give an opinion without seeing the patient, and in most cases it would be dangerous to act on good avice given under such circumstances."

NAME OF STAR.—"Conjecto" writes:—"Allow me to thank 'Omicron' (page 656; for the (probable) name of the star which I saw in conjunction with Venus on the evening of the 3rd Jan. I am somewhat surprised that no other mention has been made of this (to me) most interesting sight. I have watched many occultations of stars by the moon, but have never been so pleased as with the beautiful appearance presented by Venus and this star, which I watched from the early evening until they disappeared together behind the distant tree-tops. The star was at least as bright as Jupiter's 3rd satellite, and shone with a steadiness quite remarkable for a fixed star."

TO MAKE GOOD BARM.—"T. S. T." says:—"Boil 1oz. of good hops in 2 quarts of water ½ an hour. When strained and milkwarm, add ½lb. of brown sugar and ½lb. of good mealy potatoes previously boiled and squeezed stone jar, and place by the fireside for one day and two nights. When it has done working put in a handful of salt, and cork the jar tight and place it in a cool place. This you may use immediately. Keep it closely corked after pouring any out. It is well to add a fresh quantity before the whole is used. It will keep as well for use when made six months. At about four o'clock set your barm—that is, get two or three potatoes (or one good large one), mash them up very fine, put them in a sieve and strain about three pints of lukewarm water over them into a crock (throw away the remainder), then throw the barm down on the top of this, then shake a couple of handfuls of flour on the top of this, and cover with a cloth and let stand before the fire till about 9 o'clock—by this time it will have risen, and fallen a little again. A regular quiet heat must be kept to it. At that hour throw a little salt through the flour, mix the barm well through the flour, and if too dry add a little warm water. Work it up until quite fit to put into the oven. Next morning, when well risen, divide into loaves (two quarts of flour to a loaf). After making the loaves, lay them on the board and cover with a cloth for about twenty minutes. Do not shake any flour on them at night after mixing the barm in the evening. About fourteen quarts of flour to this much barm (three pints of made barm)—Buns for breakfast: 1lb. of flour, whites of two eggs, 2oz. butter, two spoonsful of barm; mix together with milk to a light dough, put at the fire for one hour to rise—five minutes will bake them. Mix as for a cake.'

FREE SCHOOLS OF INDUSTRIAL ART.—A plan is now before the Massachussets State Legislature, U.S., by which every town of a certain size will be compelled to maintain, in connection with its town school system, an evening school for education in "the industrial arts." These evening schools will be open two hours on five evenings in the week, with a competent master or mistress for every 25 pupils. Travelling loan collections of models and casts of works of art and design are to be formed, the expense of which be borne by the commonwealth. A monthly sy examinations is also proposed, with the exhib meritorious works.

REPLIES TO QUERIES.

◆

ZINC PLANT. — In reply to "Saul Rymea's" question to me, his idea of the *rationale* is correct. All the descriptions given relate to the lead tree, and of course the more lead salt there is in the water the more vigorous will be the growth of this specimen of metallic growth. A true zinc tree would require the use of a more oxidisable metal in a zinc solution, and as the action of such metals as magnesium, sodium, &c., would probably be too rapid, the metal would be more likely to be thrown down as a non-adherent powder than as coherent crystals. The process is a true electric one when the "plant" is formed, the electricity acting at the extremities of each deposited particle, and producing there the crystalline deposit. Other metals may be thus deposited also, and the nearer alike the affinities of the two metals are for the acid holding the one in solution the slower and more perfect the action.—Sigma.

[1708.]—HEATING GREENHOUSES BY GAS.—In reply to "Professional," p. 637, I beg to say that I shall be glad indeed if he can point out a plan by which gas may be used in the heating of greenhouses, so that it may be done with some degree of economy. He has, however, a much better chance of doing so than I have, as with him gas is charged 3s. 6d. per 1000ft., but with me it is 6s. 3d., in itself a mighty difference. I have long thought that our gas company is extortionate, but they maintain that the superior quality of their gas, made from Cannel coal, makes it as cheap to the consumer as gas from other coal at half the price. This reasoning may suit their dividend of 10 per cent. per annum and a bonus besides, but I must acknowledge I don't believe in it. "Professional" suggests that it may be the arrangement, and not the material, which causes the failure with me. I shall endeavour as briefly as I can to explain my apparatus, and then he may judge for himself. It consists of a small copper boiler connected to about 64ft. of 3in. iron pipe. The boiler is a cylinder, the under end, as it were, pressed in to form a concave for the flames to play upon. Enveloping the boiler is an iron jacket allowing a space of about 2in. between it and boiler. From the top of the iron jacket a 3in. iron flue is carried away so as to take off the fumes of the burnt gas, and also to radiate as much heat as possible. This flue is carried the whole length of the house, and then passed outside. The gas is applied at the bottom of the boiler by three of Bunsen's burners, so arranged that either one, two, or three may be lighted at one time. I find that in severe weather it required the whole to be lighted, and on these occasions, supposing they were lighted at at 4 o'clock in the afternoon, and were kept burning until 8 o'clock next morning—16 hours—it consumed about 460ft. of gas, which cost me 2s. 6d. The apparatus worked well and gave little or no trouble; the only drawbacks were want of heating power, except a very large quantity of gas was consumed, and the injurious effects the fumes had upon the plants. This latter objection could be remedied by keeping the gas entirely out of the house, but this would necessarily entail a certain amount of loss of heat, which could only be made up by a greater consumption of gas. I suspect others have come to the same conclusion as I have done (I notice the reply of "J. B.," p. 12, vol II., &c.), but if "Professional" can produce a plan by which gas may be used with a reasonable cost, and at the same time to give a sufficiency of heat, I am sure he would confer a favour on several of us amateurs, as there is no doubt that the little attention gas requires gives it in that respect a great advantage over other modes of heating.—Amateur.

[1820.]—HOW GLASS FOR CHURCH WINDOWS IS FIRED.—When the windows are painted with the requisite colours, they are placed in an oven much resembling the ordinary bakehouse oven. Around this oven are iron shelves, upon which are placed large iron plates very level; on these plates the glass from the windows is placed; the oven is then very gradually heated. The heat is adapted to the nature of the colour required; if the flux is hard the heat is much greater than when soft. This requires great nicety, and perfection can only result from much practice. It sometimes happens that one or two moments of too prolonged an heat, will spoil an entire batch of window panes, turning the colour from what was intended as a bright yellow, to a dirty brown. When the oven is got to the required heat, the calculation is made by the man who has charge of it as to the duration of the heat; this is very carefully watched, then when the glass has had sufficient fire, the oven is stopped up, the bars from the grate drawn out, and the whole is left to cool gradually to prevent cracking. When cool they are then washed with water, the ochre comes off, the beautiful stain remains. The heat required is a little over that of redness, just approaching a white heat, but modified according to the nature of the colouring materials.—Joseph Leicester.

[1871.]—BLOTCHY FACE.—I have just perused Mr. Johnson's reply as above, in answer to a "Sufferer from Blotchy Face." It is certainly good sound advice, but not a remedy for this disagreeable ailment. Four years back, having been troubled with it in a violent form, I was induced to pay a visit to the late Dr. James Seaton Smith, of Liverpool, surgeon of the Skin and Cancer Hospital in that town, for the purpose of getting a remedy for it. His remedy was the enclosed, coupled with good and plain diet, which put me to rights in two months. The recipe was dear (£2 2s.), but it was effectual. Let the gentleman interested give it a trial, and kindly let me know the results through your columns. Sol. arsenic chlorid, 1dr.; tinct. ferri perchlorid. 1dr.; tinct. rhu. 2dr.; lig. zarafar 4dr.; aq. pur. 12oz. Ointment—Megt. plumb. iodid. 11dr.; to be applied outwardly.—Fortunatus.—[A friend of ours, many years since, was troubled with pimples on his face, and particularly under his eyebrows and moustaches. He consulted several country doctors without deriving any benefit. He tried the hydropathic treatment, with the same result. He came to London, and consulted one of the physicians of the Cutaneous Hospital, Bridge-street, Blackfriars, and was cured in about a fortnight; and has not suffered from the malady from that day to this.—Ed. E. M.]

[1908.]—ETCHING RAZORS. — For H_2SO_3 read H_2SO_4.—F. B. Knox.

[1967.]—PESTLE AND MORTAR.—Sulphuric acid is the best thing he can use.—A Mechanic.

[1970.]—VARNISH FOR IRON PATTERNS.—"N. L." gives an excellent reply to this query, but he forgot to say that it was raw linseed oil that should be used, brushed on like paint. Should the pattern be required for almost immediate use, coal tar naphtha is very good, and it dries quickly without heat.—Metal Head.

[2007.]—TEMPERING DRILLS.—Surely your printer must have misread "S. T.'s" answer, which is exactly the opposite to what he must have meant to state, and which, so far from hardening drills, would anneal and soften them. Let me add to my former reply to this query: That for small drills, say to $\frac{3}{16}$in. diameter, a candle is the most convenient means of letting down the temper, as the mild heat causes the colour to change so gradually that the exact tint can be obtained with certainty.—J. B.

[2013.]—MULTITUBULAR BOILERS.—Tubes in boilers of this kind should have a ring on one end, say ¼in. thick; the ring may be put in the end of the boiler first, and caulked. In ordering the tubes, he could order them bulged at the factory, about 1-16in. The advantage of the ring is that if the tubes should scale they can be knocked out from one end.—Milly.

[2043.]—PILLS.—Not only pills, but (that most nauseous form of medicine) powders may be taken by any one without the least difficulty. Buy at any confectioner's a sheet of the wafer that they use for ratifees, costing one halfpenny. This is 8 or 9in. sq., and is to be broken up into squares of an inch and half or two inches. Take one of these, dip it in water, and lay it on the palm of the hand, where it instantly becomes as limp as a rag and as slippery as an oyster. Lay your one or more pills, or your powders, in the centre, and fold the wafer over it, put it on the tongue where it lies flat, like an oyster, and a sup of water takes it down without taste or trouble. This method is always practised in Germany, and has been in use in my house for twenty years, and, strange to say, I have never met any person, medical man, or druggist in England who seemed to have ever heard of it. It is perfectly effective, within reach of the poorest, and ought to be more generally known.—G. Nash, S. Michael's Vicarage, Louth.

[2044.]—REPOLISHING STEEL WATCH CHAIN.—"H. B. M." should rub his chain between his hands, dusting them with fine flour of emery from time to time; he will soon get it tolerably bright, then fasten it to his bunch of keys which he carries in his pocket, and the chain will soon become burnished. Proved.—F. H.

[2055.]—COIN OR COUNTER.—My statement on p. 20 is incorrect; as stated by Mr. Batty, the pieces referred to are certainly weights.—Henry W. Hemfrey, M.N S., &c., &c.

[2059.]—CEMENT FOR AQUARIUM.—1 India-rubber, 12 mineral naphtha or coal tar heated together, add 20 of pounded shellac. When required to be used heat to about 260°.—Blue Ruin.

[2062.]—SODA WATER BOTTLING MACHINE.—Seeing no one answer T Harding, I will endeavour to do so myself. In the first place his leathers are too thin, and the hole in the washer should not be smaller than the cone where the corks are put in; again, have them screwed up tight. I have been in the habit of buying a soldier's belt (an old one), and making them myself. One lasts me nearly two years. Since I have used them, now nearly ten years, I have never had the bother T. H. complains of. If he wants any further information, I shall be glad to give it.—J. T. Bailey.

[2038.]—CONTENT OF IRON PANS.—In answer to "J. R. W.," taking the depth of the pan as h, diameter as d, and V as cubical content of pan, $\pi = 3{\cdot}1416$.

$$\therefore V = \frac{\pi}{6}(3d - 2h)\,h^2$$

Again, cubical content of globe, taking d = diameter V = cubical content

$$\therefore V = \frac{\pi}{6} \times d^3$$

Blue Ruin.

[2084.]—GRANITIC PAINT.—"S. T.," in his reply in your last week's number, is in error as to this paint. He states that the menstruum employed in it is silicate of potash, to harden and combine it with the pigment with which it is admixed. The granitic paint of the Silicate Zopissa Composition and Granitic Paint Company, of 39A, King William-street, City, contains no silicate of potash, and is well known to dry and harden in a manner superior to any paint yet manufactured. The statement of "S. T.," if uncontradicted, might do us great injury.—Thomas Child, Manager.

[2093.]—BRAZING CAST IRON.—The only method of brazing cast iron is to fit the broken parts exactly together in moulding sand, then pour melted iron over the parts to be joined, and when cool chip off the superfluous iron. If properly done the joints will be difficult to detect.—Blue Ruin.

[2094.]—SUBMARINE LAMP, &c.—I send the following reply to the second question of "A Diver," under this heading, viz., to find the solid contents of a vessel with semicircular ends:—

Let l = Full length of vessel
„ d = Diameter „ „
„ s = Solidity „ „

Then

$$s = d^2 \times {\cdot}2618\,(3\,l - d),$$

Or, in words:

From three times the total length of vessel subtract its diameter, multiply the result by the square of the diameter and by ·2618 for the solidity.

If l = 10ft., and d = 4ft., we have

$$\begin{aligned} s &= 16 \times {\cdot}2618\,(30 - 4) \\ &= 16 \times {\cdot}2618 \times 26 \\ &= 108{\cdot}9088 \text{ cubic feet.} \end{aligned}$$

The content may also be found by obtaining the solidity of the middle cylindrical part, then that of the semicircular ends, and adding the two results together; but I think "A Diver" will find the rule given above more concise.—William Moor, Jun., Hetton Colliery.

[2097.]—STAINING WOOD BLACK.—Boil ½lb. of chip logwood in 2 quarts of water, add 1oz. of pearl-ash, and apply it hot to the work with a brush. Then take ½lb. of logwood, boil it as before in 2 quarts of water, and add ¼oz. of verdigris, and ¼oz. of copperas; strain it off, put in ½lb. of rusty steel filings, with this go over the work a second time. Oil of vitriol diluted with water and applied with a brush makes a good black stain.—Guillaume.

[2098.]—DISCONNECTING STEAM PIPES.—Putting brown paper between the flanges and the india-rubber washer will keep it from adhering to the iron. I have found this to answer well.—Aberdeen Mechanic.

[2098.]—DISCONNECTING STEAM PIPES.—Canvas steeped in red lead is frequently used instead of india rubber; or if the flanges have been faced, a little plain red lead will do. Another way.—Steep plaited gasket in whitelead, and by working it in the hand it may be used several times; or, instead of whitelead mix blacklead with boiling oil into a paste and work well into the gasket; if the flanges are rough or uneven, equal parts of redlead and whitelead with fine metal borings. In using gasket, canvas, &c., care should be taken that the ends do not overlap, but meet nicely.—Blue Ruin.

[2110.]—TO REMOVE RUST.—Plunge the hooks into a bath of diluted hydrochloric (muriatic) acid, say 1 pint of acid to 1 quart of water. Leave them there for twenty-four hours, then take them out and rub them well with a scrubbing brush. The oxide will come off like dirt under the action of soap. Should any rust still remain, as it is likely in the corroded parts, return the hooks to the bath a few hours more, and repeat scrubbing. Afterwards well wash in plain water several times and thoroughly dry before a fire. Lastly, a little rubbing with oil and fine emery powder will restore the polish. Should grease have mingled with the rust, it is necessary to remove it with a hot solution of soda, before submitting the metal to the acid.—Guillaume.

[2116.]—WATER POWER.—I find that my answer to this question last week had reference to 200 cubic feet of water per minute falling from a height of 30ft., whereas the question was: What would be the power of 200 gallons per minute falling from that height? The answer should have been 1¾ h.p., reduced to a useful effect of $1\frac{1}{6}$ h.p.—C. S.

[2117.]—CEMENT FOR IRON ROOM.—"T. S. H." will find the following to answer his purpose: 1 bushel of sand, 4lb. of red lead, 1lb. of whiting; mix up with boiled linseed oil and a little boiling water.—Sweep Ho.

[2119.]—CLEANING PIANO KEYS AND TEETH.—If the discolouration does not extend much below the surface, the ivory may be scraped till something like its original condition is obtained, then smoothed with very fine glass paper, and finally polished with a leather buff and whiting. As to teeth, if "Ilex" means natural ones, which have simply obeyed the laws of nature, I with him should be glad to know of any means to restore their pristine whiteness without injury to their present or future usefulness, but such a remedy I fear, will be as easily obtained as a mill for grinding old age into youth.—F. F. C.

[2121.]—BOILER TAP.—Had "Gilder" followed the suggestion of some of our correspondents, adding "proved," he could not have recommended emery and oil. It will not stop the leaking, but make the tap useless. Let "R. A." pound a piece of freestone, and sift it through a piece of coarse packsheet. Mix this with water and grind it, adding no sand, but keeping the plug wet for five minutes before drying the plug and bill. This, if properly done, will make the tap perfectly tight. Proved—Conical Plug.

[2121.]—BOILER TAP.—I should advise "R. A." to take his tap out—he may do so with a hammer and chisel—and apply to J. Blakeborough for a patent tap, which he may fix himself. It will not leak for years; and then it can be made good without taking it off. Address J. Blakeborough, Commercial Brassworks, Brighouse. Yorkshire.—Sweep Ho.

[2126.]—JOINING WIRE.—"E. H. B." will make the best connection by first cleaning or scraping with an old knife three or four inches of the wire ends; cross them at right angles, hold firm with a pair of pliers, and twist the ends tight around each other; then solder with rosin.—Sweep Ho.

[2131.]—PUMPS.—In reply to "Plumber," although this does not seem to me to be plumber's work, a turbine may be made to receive a supply of from 40 to 50 gallons per minute (say 45) with a fall of 8ft, and to deliver water at a height of 70ft. above it at the rate of 3 gallons per minute. This is a small quantity, but it is as much as can be done with the power and under the circumstances named, A water ram would be a more suitable appliance, and would cost less. It would deliver about the same quantity.—C. S.

[2139.]—BOILER.—If John Jones will state, through the Mechanic, the length and diameter of the boiler he intends to put down, and what is the greatest height he can put his water-tank from his steam boiler, and the pressure of steam at its highest point, I will send him a rough sketch of a self-acting feed that I have at work at present on two boilers working at 15lb. per square inch.—Anti-Egyptian.

[2143.]—SOFTENING CAST IRON.—"G. B. K. cannot soften cast iron. But by chipping off the surface or skin with a chisel he will find it easier to cut—Blue Ruin.

[2152.]—PAINT ON BICYCLES.—Grind the dry colour; thicken with good pale copal varnish, then thin with turpentine; lay on evenly with common paint brush. This should have very dull appearance, and dry very hard. When thoroughly dry, varnish with good pale copal (or carriage) varnish; put in a warm place, and away from dust (after varnishing), until thoroughly dry.—W. H.

[2160.]—PRESSURE ON COLUMNS.—If "W. R. E." will give the length of columns, and state whether they are composed of cast or wrought iron, I shall be happy to answer him.—BLUE RUIN.

[2160.]—PRESSURE ON COLUMNS.—This question cannot be completely answered in its present form, as the weight of the columns is not given. The following figures, from the "Engineer's Pocket Book," may, perhaps, suffice:—Solid cast-iron columns, 3¼in. diameter, will each bear—

Height in feet	6	8	10	12	14	16
Load in cwts.	282	214	191	173	156	136

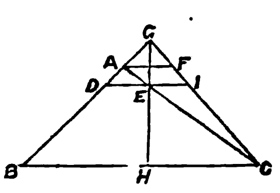
—J. B.

[2160.]—PRESSURE ON COLUMNS.—According to Molesworth, the breaking-load distributed equally on all four columns $= 59{\cdot}6\,\frac{3\frac{1}{4}^{3{\cdot}76}}{L^{1{\cdot}7}}$ whereby L is the length of a column, assuming L to be greater than 15 times the diameter of the column. The calculation is easily carried out by means of logarithms.—A. TOLHAUSEN.

[2162.]—SEAMS OF MACKINTOSH.—If "G. W. D." will refer to reply 1777, page 613, Vol. X., he will find that I there stated that I found "Kay's Coaguline" (Kay, Bros., Stockport, 6d. per bottle) answer my purpose in mending the seams of my mackintosh, which statement I confirm.—W. H. I. P.

[2162.]—SEAMS OF MACINTOSH.—Nothing is better than india rubber dissolved in naphtha.—J. B.

[2169.]—PROBLEM.—Through A draw A F parallel to B C, and equal to the difference between A C and A B. Join C and F, and produce C F and A B to meet in G. Bisect B C in H, and join G H by a line cutting A C in E. Through E draw D E I parallel to B C, and D F is the required line. For since A F = A C − A B, and the triangles A C F and E C I are similar, as also A D E and A B C, E I = E C − D B. But since B H = H C, and D I is parallel to B C ∴ D E = E I. Then D E = E C − D B as required.—T. BROWN.



[2170.]—AN UNANSWERED QUERY.—I beg to inform "Gitche Manito" that I replied to this question some time ago. It is the opinion of the best numismatists that copper coins should be left alone, or at most simply washed with soap and water. Cleaned or coloured copper coins are quite worthless.—HENRY W. HENFREY, M.N.S., &c., &c., Markham House, Brighton.

[2170.]—UNANSWERED QUERY.—Dissolve small quantity of corrosive sublimate in vinegar; dip or place copper coins therein; wipe dry, and finish with blacklead, using common stove brush.—W. H.

[2176.]—BLAST FAN.—The proportions I sent "Fan Blast" (p. 563, Vol. X.) are suitable for a smith's forge. Let "C. T." look at them, and if he cannot get on with them I shall be very glad to help him all that I can.—JOHN W. BEDFORD.

[2178.]—CIRCULAR DISC.—Areas of circles vary as the squares of their radii: as, therefore, 36 is the square of 6in. (the radius of the given circle), the radius of the disc which is to cover half the area must be the square root of 18, or 4·2426407in.—J. B.

[2178.]—CIRCULAR DISC.—If "Indagator" will inscribe a square in a circle of the diameter of the orifice—viz., 1ft., the side of the square will be the diameter of the required discs = 8·4853in. Or, if he will square the diameter of the orifice, 12in. × 12in = 144; take half the product 72in., extract its square root = 8·4853in. because the areas of circles are to each other as the squares of their diameter.—S. B.

[2180.]—ENGINEERING IN GERMANY.—There are several engineering colleges—Polytechnische Schulen—on the Continent that have attained a world-wide fame. In these colleges very little knowledge of mathematics is required to pass the examination in the preliminary course—Vorschule—and in four or five years' study the student can have gone through the various branches of engineering, theoretically and practically, the latter shown by excursions, if steady and diligent. Age required, 17; and yearly school-fee, £4. Establishments of this kind exist in Berlin, Karlsruhe, Hanover, Munich, Stuttgart, Vienna, Zurich, &c. Should any young gentleman entertain the idea of studying there, I can give him further information. Lastly, the × area of the sector is = 450 square feet.—A. TOLHAUSEN, 18, Waterloo-road, Manchester.

[2182.]—CONSTRUCTING COILS.—"Nemo" will require about 40 yards of No. 16 primary wire; but for a coil the size he purposes making it would be better to use No. 12. The number of sheets of foil to the pound of course depends upon its thickness; the best foil, however, runs about 60 sheets 1ft. square to the pound. If the coil is well constructed the maximum spark will be about 6in. long. The number of bottle batteries requisite will depend on the surface of carbon exposed: he will probably require five or six cells. The secondary wire should be first covered with silk and have some insulating material, in a fluid state, brushed over each layer as it is wound on the coil. Thin paper saturated with paraffin wax may be substituted for gutta-percha tissue. The silk used for covering wire differs from ordinary silk in not being twisted.—J. D. M.

[2183.]—TAXIDERMY.—The Taxidermist's Manual," &c., by Capt. Thomas Brown, F.L.S., published by A. Fullarton and Co., London. Price 3s. 6d. ?).—WILLING.

[2183.]—TAXIDERMY.—There are a few chapters on the above, as well as on skinning and preserving birds, reptiles, fishes, &c., at the end of "Beeton's Book of Birds," which may be ordered through any bookseller.—VIVIS SPERANDUM.

[2184.]—SULPHATE OF LEAD BATTERY.—Some time ago I decided to fit up my house with some half a dozen electric bells. I got all the apparatus I required from a firm at Halifax, except the battery, but took some time to consider this matter, as I wanted one which would fulfil two conditions—cheapness and constancy. I at last decided upon a sulphate of lead, one which I must say has answered perfectly both. I made it up myself as follows:—I obtained 6 glass pickle jars and 6 porous cells, I then made 6 cylinders of thick sheet zinc to go easily into the glass cells. I got some No. 8 copper wire and wound into spirals to fit loosely into the porous pots. After placing them all in their proper places I mixed up some sulphate of lead with water and nearly filled each porous pot. I then filled each glass cell within an inch and a half of the top with clean water, adding some crystals of Tidman's sea salt, and after connecting the copper spirals of the one cell to the zinc cylinders of the next all through the series, leaving a zinc unconnected at one end and a copper unconnected at the other end, it was all ready for use. I placed it upon a shelf at the top of my cellar and connected the wires communicating with my six rooms and bells. It is now nine months since it was set going and appears as good now as at first. It cost me for material about 15s., the cells are quart size, I am very proud of my handiwork, and believe it quite as good and far cheaper than the trade would have supplied me.—A GOOD BOY.

[2188.]—VELOCIPEDES, &c.—In every case a driving wheel above 36in. becomes a disadvantage; the greater the diameter of the wheel above 36in. the greater the disadvantage. Treading is the best mode of driving, for when the foot is pressed on the treadle the weight of body then ceases to be the load and becomes the propelling power. As a crank 6in. in depth is quite sufficient for working the foot, so a driving wheel more than 36in. will be too great a leverage for that crank; and what is gained by a larger wheel down an incline is lost with more when on a bad road or ascending a hill. Sit as close to the driving wheel as possible, that the pressure may be on it; enough pressure on the guiding wheel to steady it is sufficient. Regulate the height of your seat according to the depth of your treadle, so that when you are on your seat, and your legs straightened down, the foot may just fairly reach the treadle when it is at its extreme downwards. I would use two connecting rods—one on each side. Let them be your treadles, pivot them to the crank of the driving wheel (the hind one), also to the crank through the frame between the wheels. Let each crank be of equal length that the treadles may work in unison—one handle to guide with, another for the brake; also a projecting bit close by the brake handle to steady yourself with (this is for driving the hind wheel). Perhaps you may glean something from these suggestions. I think we may yet improve the veloce. I have been a velocipedist more than 20 years, and I consider as yet it has been altered and not improved. The bicycle is fit for none but those who are fond of dangerous sports. Driving the front wheel of a tricycle, sitting so far from it, and dragging two behind, it is a mistake. Driving by levers pivoted near the front wheel is a mistake. A four-wheeled veloce is the best.—N. G. LAMBORNE.

[2195.]—SMOKELESS LAMPS.—I beg to inform "Practical" that the cone must be made to fit the lamp; that is to say, it is to stand upon the gallery and reach up to that part of the wick just going to burn, leaving an air passage at top about ¼ free, as shown in my section, page 459. It must, moreover, be adjusted to each lamp so as to produce the best effect. The ball should be about the diameter of the round wick, also adjustable as to height for best effect. Hollow balls of brass or iron may be got of the proper size at any metal shop. The cone prevents the air passing through the pierced bottom of the gallery getting into the glass globe, and must not therefore be pierced. For raising and lowering the wick, "Practical" must look at any well make round wick colza lamp, or, argand burner. Upon the whole, as "Practical" does not seem to be well acquainted with this subject, I should advise him to apply to a practical lamp manufacturer who will at once understand my section.—HENRY W. REVELEY, Reading.

[2200.]—STEAM LAUNCH.—An engine working up to 8-horse would be about the power required for the boat mentioned by "Solicitor." I should recommend a vertical boiler for two reasons. Firstly, they are much more convenient to get at for cleaning and repairs—a most important point where salt water only is used; and, secondly, the tubes are not so likely to be uncovered by the water in consequence of the pitching of the boat in a rough sea. The boiler should be made of the best material and capable of standing at least 80lb. working pressure. The engines should have double cylinders and be fitted with reversing gear. Is not 9ft. beam rather to much for a boat only 30ft. long? About 7ft., I should say, would be a better proposition. I shall be happy to give "Solicitor" any further information should he require it.—CANON.

[2204.]—PROBLEM.—If "W. B. S." considers his problem, he will see that it resolves itself into finding the height of a cylinder of water weighing 25 lb., and standing on a circular base 12in. diameter. I think he can work this. With regard to his second question (2205), the atmospheric pressure per inch which sustains 30in. of mercury in the barometer is the weight of 30 cubic inches of mercury. A table of specific gravities will inform him that a cubic foot of mercury weighs about 13600oz. From this he can calculate the pressure required.—PNEUMA.

[2208.]—CERAMIC MANUFACTURE.—The treatise on porcelain in Lardner's "Cyclopædia," which may generally be bought at bookstalls for about 2s. 6d., contains an account of the colours used in painting and printing. There are several editions of Brongniart, but no cheap one. The way I pick up my books at a low price is by reading the catalogues of dealers in secondhand books, or sale catalogues; although I have sometimes to wait a considerable time, I generally manage to get what I am in search of.—H. B. MILLER.

[2215.]—BRONZING BRASS.—Some time since, I asked through these columns how to bronze the ferrules of fishing rods, without eliciting any reply. I fortunately found a tradesman who kindly told me, and I succeeded perfectly in giving the brass an appearance of real bronze. The recipe is, 1d. of oxide of iron (rust), 1d. of arsenic, mixed in ½ a pint of hydrochloric acid. Clean the brass well to get rid of lacquer or grease, and apply with a brush until the desired colour is obtained. Stop the process by oiling well, when it may be varnished or clear lacquered.—VIVIS SPERANDUM.

[2218.]—GEOMETRY.—Theor.: three circles being given, the lines respectively tangent to 2 of them have their intersections on the same straight line. "X. X." asks a geometrical proof; perhaps the following might satisfy him. Draw a plane through the 2 centres; on each side of this plane we can construct one tangent to the 3 spheres constructed on the circles; these 2 symmetrical planes will cut the plane of the centres on the same line. Now, supposing 3 cones respectively tangent to 2 spheres, those 3 cones will be tangent to the 2 planes, and have their vertices on their line of intersection, and those vertices are the intersections of the tangents to the circles. Other demonstration, Analytic, v. Salmon, "Conic Sections," No. 117.—BERNARDIN.

[2220.]—SOLDERING.—File the end of the iron pipe bright, then see that the soldering iron (which should be as large a one as can be got, so that it may carry a great amount of heat) is well tinned; this is important in all soldering operations. When the iron has been in use some time after tinning, or when it has been made too hot, the solder and the copper become melted together and the solder seems to eat holes in the copper. In this state the iron is not fit for use, but must be filed down smooth and re-tinned. Having the iron ready, and as hot as it will bear, take and wet the part to be tinned with a little spirits of salt that has had as much zinc chippings put in it as it will dissolve, then apply the solder with the iron, bearing in mind that the pipe will have to be very hot with the iron before it will tin; it would be as well to tin the iron pipe with a little block tin or pewter, if available. If any difficulty is found in tinning the iron pipe a little powdered salammoniac might be sprinkled over it when very hot, which would assist the tinning; this done, the lead pipe must be widened out so as to form a lip all round the iron pipe, and soldered round with fine solder, taking care to keep the heat of the iron on the iron pipe rather than the lead, or what is called a plumber's joint may be made by pouring on a quantity of plumbers' solder from a ladle, and wiping off the superfluous solder with a greased cloth. For an amateur the first plan will be the most simple.—SIGISMUND.

[2224.]—BOILER.—In reply to inquiries from "One in a Fix" respecting the use of Carrigeen moss to prevent the incrustation of boilers, I was recommended to use it by an inspector of boilers. I do not see any reason why it should not be put in feed cistern and drawn directly to boiler, provided there is no overflow from cistern that would carry off the moss as waste. The quantity I would recommend for 50-horse boiler would be a stone weight per week (the present cost of the moss is about £10 per ton here in Ireland). I cannot speak of its merits as a purgative of a very foul boiler, as I never allow a scale to get on mine; but I do think from using it that it prevents the formation, and I am certain that it is a very harmless article.—VIVIS SPERANDUM.

[2225.]—VACUUM IN CYLINDER.—The exhaust steam leaving a high pressure cylinder causes no vacuum, but, on the contrary, should the passage be too small it often causes back pressure and compression on the return stroke by not *fully* and *easily* exhausting.—H. SUMNER.

[2227.]—LIFE PRESERVERS.—The life preservers found on all sea-going vessels are composed of slices of cork, neatly arranged and compressed together so as to form a zone 30″ in diameter, 6″ in width, and 4″ in thickness; it contains about 12lb. of cork, is generally covered with painted canvas, and will support 6 persons. Inflated belts are liable to get punctured, and so tendered useless.—VIVIS SPERANDUM.

[2227.]—LIFE-BELT.—"Avalonensis" would find "the buoyant waistcoat" made by the "Aquatic Safety Company" better for boating than any of the ordinary life belts. My friends say they are the best and most portable things of the kind yet out.—W. H. I. P.

[2228.]—ADDRESSES WANTED.—If "Foreign Correspondent" will get the "Mineral Statistics of Great Britain and Ireland," by Robert Hunt, F.R.S., published by Longmans, Green, Reader, and Dyer, and by Stanford, Charing-cross, price 2s., he will find the name of every colliery in the United Kingdom and where situated, and owner's name, besides a quantity of other useful information.—S. W. T.

[2233.]—STAINED GLASS.—A small treatise on "Glass" is contained in Vol. 115 of Lardner's "Cabinet Cyclopædia:" after this, study the works of the late Charles Winston, to whom every glass painter is deeply indebted for the untiring attention bestowed on this art, from 1830 until his lamented death in 1864. They principally consist of "An Introduction to the Study of Painted Glass, with Remarks on Modern Glass Painting," 1849, Parker; "Memoirs Illustrative of the Art of Glass Painting," 1865, Murray; "An Inquiry into the Difference of Style Observable in Ancient Glass Paintings, especially in England, with Hints on Glass Painting," 2nd edition, 2 parts, 1867, Parker and Co. "Proba est materia, si probum adhibeas artificem."—Erasmus. I trust this reply may not prevent Mr. Leicester from rendering his highly-valued assistance.—H. B. MILLER.

[2234.]—FROM "JUPITER."—My 3in. glass was got from S. and B. Solomon's, 39, Albemarle-street, London; price, on pillar and claw-stand, £5. It has one day eyepiece about 40 power, and one night-power 100, but I have added several others since—20, 60, 75 (100 day eye piece), 150 and 275. The latter works well indeed without any shade of colour appearing. The planet Jupiter, would, I think, appear nearly the same size as in the 4in. Gregorian, but then the defining power and brightness of Gregorians as compared with refractors is stated by Dawes as 8 : 5, that is the proportion of aperture, both telescopes being alike in brightness. As a light test, I am able with 75 to pick up the 7 mag. companion to Antares ; Warner with the finest instruments could only do so with 2¾in. distant 3½″. I am also able to see two of Saturn's moons, and the ring very fine. When Venus was an evening star, I could observe her with the 150 power without the slightest trace of colour, and to those who know the difficult object she is in the telescope, that is a testimonial of the performance of the glass. The Messrs. Solomon supply the 3in. glass separate by itself, price £2 2s., and any power eyepiece 14s. For the information of all your readers, I have found by trial during the last few weeks, that the sun had so many spots on his disc that green and red glass combined made the best shade, much better than either above. To those who have not got the "Nautical Almanac," to see the sidereal time time at noon, I may tell them that they can get it by applying the equation of time to the Sun's R.A., the reverse of that directed in the almanac pages.

[2236.]—DIRTY CEILING.—All common plaster is pervious to air, which, in passing through it, is, as it were, filtered from the dust which floats in it. Where most air passes most dust is left, and so those portions of a ceiling where the passage of air is not impeded by joists, &c., collect most dust and are most discoloured. —J. B.

[2237.]—SALERATUS.—"A carbonate of potass, containing a greater quantity of carbonic acid than pearl ash ; used in cookery."—"Ogilvie, Imper. Dict."—H. B. M.

[2239.]—PROTRACTOR.—The fault lies in the protractor, and not in "R. W. R." A protractor, properly constructed, should have a mark, either on the upper or the lower edge of the cross-piece; which, of course, depends on the construction of the instrument. On his instrument, the mark should be on the lower edge of the cross-piece; also the mark for 1°, and that for 180°, should be in the same straight line with the centre mark, otherwise the protractor is not properly divided. Any mathematical instrument maker will put a centre mark on it for him.—Thomas J. O'Connor.

[2248.]—SPEED OF AIR AND STEAM.—To calculate the velocity of air or steam rushing into a vacuum, we must first find the height of a column of air or steam corresponding to the given pressure. Then from the rule for falling bodies we must obtain the speed due to that height, which will be the theoretical velocity of the gas on vapour. When the steam issues from an orifice into the open air, we must deduct the pressure of the atmosphere from that of the steam, and then find the height of a column of steam corresponding to the resulting pressure, and proceed as before For instance, the velocity of steam at 15lb. pressure rushing into a vacuum, would be same as that of steam of 30lb. pressure rushing into the atmosphere.—Machinator.

[2251.]—DISPENSING QUERY.—By filtering the mixture it can be made perfectly clear, not without.—Guillaume.

[2258.]—EQUATIONS.—Mr. Williams will find a solution by "Senior Op." of the treble equation in last number. The following solutions of his other equations are suggested :

$$\frac{x-a}{b} + \frac{y-b}{a} = o \quad .. \quad .. \quad .. \quad (1)$$

$$\frac{x+y-b}{a} + \frac{x-y-a}{b} = o \quad .. \quad (2)$$

Here

$$x = a, \; y = b$$

evidently satisfy (1), and by trial they are found to satisfy (2).

The other pair thus :

$$(a + h)\,x + (b - h)\,y = c$$
$$(b + k)\,x + (a - k)\,y = c$$

Subtracting

$$(a + h - b - k)\,x + (b - h - a + k)\,y = o$$

Dividing by the coefficient of x and $x - y = o$

$$\therefore x = y$$

Substituting x for y in either equation, we get

$$x = \frac{c}{a + b} = y$$

—Pneuma.

[2262.]—RHUMKORFF'S COIL.—I cannot do better than refer "T. J. O'C." to "T. S. C.'s" reply to "Nemo," p. 44. Rhumkorff was simply the originator of the induction coil, by making one with very perfect insulation, which the application afterwards of the condenser converted into the now common instrument. —Sigma.

[2262.]—RHUMKORF'S COIL.—Having provided a bobbin of paper, wood, or vulcanite, with (by preference) vulcanite ends, drill two holes in one of the ends, each about ¼in. diameter, and at a short distance from the centre. These should be in a line with the horizontal diameter of the bobbin tube. In the opposite end drill a small hole—say $\frac{1}{16}$in. diameter, at a rather greater distance from the tube than the others, but this time over the tube. Next take your primary wire and pass one of the ends through one of the first-named holes, and wind it over the tube in a close spiral quite up to the other end, continuing to wind it back again over the first layer to the end at which you first commenced, and passing the other end of the wire out through the remaining large hole first-mentioned. When this primary coil is completed, give two or three coats of shellac dissolved in methylated spirits, and allow it to dry thoroughly. Next take a strip of cartridge paper the exact width of the bobbin between the ends, and wind it on tightly until you have formed a strong tube at least $\frac{1}{16}$in. thick, and then thoroughly coat with the shellac several times, and allow it to dry. To shut out all communication between the primary and secondary coils, it will be as well to secure the edges of the paper to the vulcanite ends by means of several thicknesses of gutta percha tissue cemented by a hot knife, as the insulation is all important. This done, take the secondary wire and test it on the reel by means of a galvanometer, and if the needle shows that the wire is unbroken, you may take one end, and, passing it through the small hole before-mentioned, commence winding it on carefully and closely to nearly the other end. When one row is finished, carefully varnish it with the shellac and spirit three or four times, and allow it to dry thoroughly, then wrap round several thicknesses of gutta percha tissue, and one thickness of paper soaked either in the aforesaid shellac mixture, or a warm mixture of gutta percha, benzole, and paraffin. You can then proceed with the next row, and so on, till you have filled your reel and bobbin to the edge, or nearly so. The one great thing to guard is the insulation, and of that it is better to have too much than too little.—T. S. Conisbee.

[2267.]—WORK ON ELECTRICITY.—I would recommend the work on electricity published by Messrs. W. and R. Chambers, Paternoster-row, price, I think, about 6s., as a very good and comprehensive work on electricity, both theoretical and practical.—T. S. Conisbee.

[2267.]—ELECTRICAL BOOKS.—"S. T. P." might get Dyer's "Induction Coil," price 1s., or Noad's "Inductorium," 3s., I think, on that special subject. For general details in electricity, "The Student's Text Book," though a rather slip-slop compilation, is a useful book at 12s. 6d. ; but for simplicity and scientific accuracy there is no work superior in a small way to Ferguson's "Electricity," at 3s. 6d., but it does not go fully into any branch.—Sigma.

[2268.]—POLES OF MAGNETS.—"H.'s" question arises from a common misapprehension. The poles are not the points of strongest action merely, but the points at which are united the actions of the half magnet as a whole, and from which the relations of the force to distance are to be considered ; they bear thus a sort of analogy to the centre of gravity of a body ; which is not necessarily the heaviest part : form and arrangement influence the position, as also does the presence of another magnet. The points of maximum attraction are at the extremities, because each section of the magnet has its own power, and transmits it to that beyond ; but the action on a body separated from it will vary according to its distance, not from the extremity, but from the pole, which explains the by no means quite clear law of the square of the distance. Thus, at 1in., the force may be very much greater than one-fourth that at ½in.. and if the pole were 1in. within the magnet, the body would have to be removed to 3in. to reduce the force to one-fourth that at ½in. distance.—Sigma.

[2272.] — GALVANOMETER FOR INDUCED CURRENTS.—An ordinary fine wire instrument, well insulated, will do, but it must be used differently from usual, as the induced current is instantaneous only, and attended with a reverse current at each contact; hence only the utmost swing of the needle produced by a single make or break of contact can be used, and as the intensity and not quantity is the characteristic of these currents, to get any valuable information would require a series of resistances as well as a galvanometer. Of course, if great care be not taken in the insulation of the instruments while making, they would be apt to be destroyed by a spark of high tension.—Sigma.

[2283.]—PAINTING THEATRICAL SCENES.—"H. N. H." asks how to paint theatrical scenes on coarse calico with water colours. The thing is easy enough. The calico must be stretched on a frame, and coated once with clean size. When it is dry, the scene must be sketched with a soft crayon or blacklead pencil. The colours to be used are all earths, and they can be obtained at any oil and colour shop. They must be mixed with warm size, and, when first put on the canvas, should appear much darker than the tint that is required. Different from painting in oil, the first coat of colour must be the final one ; the size will then not peel off when the canvas is rolled up. No varnish is required.—Hipparchus.

[2284.]—MEDICAL COIL.—Of course the screws belonging to the primary and secondary circuits should be marked when the coil is made, though their positions will serve as a guide. The primary screws should be near the contact-breaking arrangement, and the secondary screws for receiving the handles at the other end.—Sigma.

[2288.]—CHARCOAL for rubbing down silver circles may be obtained at most of the good tool shops; it should be carefully tried first on an old plate ; to prevent the risk of scratching good new work.—Engraver.

[2291.]—ENGRAVING ON METAL.—The point is used for tracing the outline, the scraper for removing the rough burr made by the graver. I really do not know any rule for tempering the graver ; metals vary so much in toughness and hardness that practice alone is the sure guide.—Engraver.

[2296.]—MONOGRAM DIE.—If a copper counterpart be necessary, take a cast and copper it by the electro process. To touch up any imperfections, a graver and a seal engraver's lathe are the tools.—Engraver.

[2299.]—GENERATION OF ELECTRICITY.—I can scarcely give "Lancashire Lad" the information he asks, not being sufficiently acquainted with the arrangement of the machinery. I suspect that the threads must rub against some dry surface of wood, or other insulating substance, or, possibly, gutta-percha belting is used, and works on a wooden pulley. The best suggestion I can give is to fix pointed wires near to the parts at which sparks are apt to be given off, and as close as possible, and connect them to the nearest gas and water pipes. One wire will serve to connect many points. If gutta-percha is used present a comb of points thus to it at the part at which it leaves the pulleys. Will the querist, if he tries this, say if it succeeds?—Sigma.

[2302.]—POLISHING SCOTCH PEBBLES.—Lapidary mills, &c., on a small scale, for amateurs, may be had in and about Clerkenwell, either new or second-hand. Advertise in the English Mechanic, or consult Vols. VIII., IX., and X., for directions how to make the tools.—Engraver.

[2309.]—ETCHING ON GLASS has been so frequently described in the English Mechanic that I should not like to occupy valuable space with it ; besides, it is an unhealthy business. Draw your design as you would on metal, and give the plate to a professed dipper, who will use the hydrofluoric acid instead of the fluor spar. But after all, the effects are not to be compared to those produced by the diamond point, or the engraving lathe.—Engraver.

[2312.]—HISTORY OF IRELAND.—"History of Ireland, from the Earliest Times to its Last Chief," by Thomas Moore, 4 vols, 8vo, 24s., is contained in Lardner's "Cyclopædia."—Pater.

[2318.]—ETHERIAL SOLUTION OF GOLD.—B. S. Burden could get this prepared by any chemist, as druggists are usually called ; or prepare it by dissolving chloride of gold in ether. The chloride he would obtain of any photographic apparatus dealer, or make by dissolving gold in aqua regia, or hydrochloric and nitric acids, evaporating to perfect dryness and redissolving in water, and again evaporating till all the water is driven off.—Sigma.

[2323.]—WATER POWER.—If "G. P." can dam up the stream of 200 cubic feet per minute, so as to obtain 8ft. clear fall, the power obtained will be 3 h.p. ; and deducting one-third for friction and loss, there will remain a useful power of 2 h.p.—C. S.

[2333.]—BRILLANTINE. — Glycerine, 1oz. : oil of almonds, 2oz. ; oil of jasamin, 1oz. ; mix, and shake well.—W. C.

[2348.]—ELECTROTYPE.—If "E. R. H.'s" objects are sufficiently large he would get a better result by using hollow moulds and depositing within them, but this might be very troublesome, as the moulds might have to be made in several parts in order to remove them from the model : moderately small objects may be thus copied by careful arrangement of pieces of copper within the mould, but of course not in contact with it.—Sigma.

[2352.]—OVALS.—The best directions I ever met with for describing ovoid figures are contained in a work by D. R. Hay, "On Symmetrical Beauty," 8vo., Blackwood and Co., 6s., to whose writings I acknowledge my great indebtedness. Illustrated directions for drawing ovals have been given repeatedly in the English Mechanic. Why does not every subscriber purchase the indexes to back volumes ?—Engraver.

[2356.]—GOLD.—"Rudis" may use either of the following processes to recover his gold :—First mix about 1oz. of mercury (common quicksilver) with the mixture, and well shake for some time ; allow it to settle, remove the sand and drive off the mercury by heat in a crucible; the gold will be left behind. Or he may add a mixture of nitric and hydrochloric acids, boil the whole till the gold has entirely disappeared, and allow the whole to stand ; he will then have a solution of chloride of gold, which can be poured off, leaving the sand as a sediment. By mixing the solution with water and mixing with a solution of sulphate of iron, the gold will be recovered in the metallic state as an impalpable power, which, from its fineness, will appear as a fine chocolate brown. The latter way, although very troublesome, will yield the gold chemically pure.—T. S. Conisbee.

NOTES AND QUERIES.

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[2360.]—ALUM.—Will someone kindly afford me some information on the extraction of alum from alum shale—the said shale being a parting of one of our Yorkshire beds of coal ? I know it to be rich in alum, but am ignorant as to the method of extraction. —Tuebor.

[2361.]—SOFT SOAP MAKING.—In 1441 "Thackeley Lad" gives a recipe : 10lb. of potash in warm water over night, in the morning boil it, adding 6lb. of grease, then 15 gallons of warm water. I used the best tallow and have failed in soap making, so if "Thackeley Lad" or any other reader will give more information it will be thankfully received.—A Constant Reader.

[2362.]—METALLURGY OF COPPER.—Mr. Joseph Roskell's articles on the metallurgy of copper interested me much. Is there in London any metallurgic establishment where I should be admitted to assist at the operations he has so well described ?—E. V. D. S.

[2363.]—SILVERING CLOCK DIALS. — I know there have been many recipes given for silvering brass, some I have tried, but ineffectually. Surely some of our London or Birmingham readers could give me a cheap and simple recipe that I should succeed with. It is waste of time, money, and patience to keep trying recipes and fail.—Poor Clockjobber. [Has it ever occurred to "Poor Clockjobber" that possibly the fault might not be in the recipe, but in the way he applied it ?—Ed. E. M.]

[2364.] —TIME. — In the article on "Time," by "F.R.A.S.," No. 260, p. 648, Vol. X., he says if we bisect the interval S S′ thus measured on our meridian line at E, we shall only have to wait until the shadow of the top of our rod G just touches this point E of bisection to ascertain the days of the two Equinoxes, because, to cast a shadow of this precise length, the sun must be on the equator. It is not so, for the shadow of the rod G at the days of the Equinoxes does not cover half of the above-measured meridian line. Will "F.R.A.S." explain this ?—W. F. Swallow.

[2365.]—GREASE.—Will "Patience and Perseverance" be kind enough to explain more fully what is meant by caustic or milk lime, and how made, and what quantity he would use of one to the other, as I have tried many ways, but failed to make the grease hard enough ? I find the recipe on p. 589, Vol. X., Feb. 25.—A Long Looker.

[2366.]—COPPER BOILER.—I purpose having a small boiler made out of sheet copper $\frac{3}{32}$in. thick, it has to be 2ft. long and 1ft. diameter. Will some of my brother readers kindly inform me as to what pressure it will be safe to work it, and what power it will drive?—Caution.

[2367.]—ANILINE COLOURS FADING.—I wish to colour the windows in my stock room to prevent goods which are made from cotton and woollen yarns dyed with aniline colours, fading. Can any brother reader say from practical experience which is the best colour for the purpose? It must be rather transparent, allowing a moderate amount of light to pass through.—W. H. F.

[2368.]—CUTTING AND POLISHING STONES.—If you or any of your numerous readers could give a description of the process from first to last, I think it would be greatly beneficial to many of our lapidist friends—it would be to me, at least.—Lapidist.

[2369.]—COLLEGE OF PRECEPTORS.—Will someone give me some information respecting the College of Preceptors?—when was it established? what are it objects? and how can anyone become a member?—S. Kent.

[2370.]—UNSOLVED PROBLEMS.—Would the author of "Unsolved Problems" kindly assist me in the following?—If the piston rod of a steam engine, say 1-horse power, was suitably connected to the rim of the fly-wheel, what saving of power would result? Would it increase the power of the engine? I have invented the means of doing so; have made a rough model in wood of a horizontal engine about 4in. to 1ft., and it works very smoothly by pressure of the hand on piston rod; it appears to me to be equal to a crank of half the diameter of wheel of a stationary engine.—J. Bannell.

[2371.]—HEATING OF JOURNALS.—I am very much annoyed with a bell (or double) crank and other journals heating, although lubricated with the best sperm oil. Is there anything which I can apply to keep them cold, or cool them whilst running, without having to stop the engines to do so?—Relwot.

[2372.]—WIND INSTRUMENTS.—Can any of your numerous correspondents enlighten me in the theory of making wind instruments, such as fifes, &c.? What rules have they for the places, and sizes of the holes for the finger and keys?—Sigismond.

[2373.]—STENCILLING ON GLASS.—I shall feel much obliged by instructions as to the best method to be pursued for stencilling large numbers of sheets of glass about 18in. by 8in., with explanation of the best kind of utensils, &c.; also the address of a maker who supplies the necessary apparatus and tools for the above process, and who supplies the stone and metal wheels used for putting patterns or lines on glass. Does any correspondent know the process used in Germany for the manufacture of paper table napkins, toilet covers, and cloths? It is not an ordinary paper mill, as the material is so treated that it can be rolled out either by itself or on to linen, and is, when dry, quite tough. Any information I shall be glad of.—S. D. T., 6, Mildmay Park, N.

[2374.]—*BREWING.—Where can I get a good treatise on brewing?*—New Subscriber.

[2375.]—*LIFTING SACKS.—I shall feel greatly obliged to any of your readers or correspondents who will give me a practical idea for enabling sacks of corn to be lifted from the ground to a height of 3ft or 4ft.* by one man's labour. In the course of the year we have to move from our barn floor into a cart or waggon some seven or eight hundred sacks, and I wish to do this with two men only—one to lift the sacks, and one in the cart. Our present mode is to back the cart to the barn door, and then for the men to lift the sack by main force into the cart to the third man. But I imagine some simple mechanical contrivance would enable one man to do this. At first I thought of fixing a pulley to the beam above the barn door, and running a rope through by which to hoist the sacks, but as the sacks weigh 250lb., and a man about 170lb., it would obviously require a system of pulleys to effect the required lift. It has also occurred to me that an inclined plane from the barn floor to the cart might be made effectual, but as I am not mechanic enough to carry this out, I think it better to state my difficulty, and trust to the ingenuity of your correspondents to offer a solution. Economy, both of labour and material, is indispensably necessary.—Rusticus.

[2376.]—GEOMETRY.—Represent three planes, each perpendicular to the other two, when two of them are inclined at 50° to 70° to the paper. Show the inclination of the third plane.—A Teacher.

[2377.]—GOVERNORS.—Which governor for controlling engines may be relied on as the most sensitive?—Claude.

[2378.]—SILVER FROM LEAD.—Will any reader give some information about the extracting of silver from lead, more particularly as regards the cupellation, and what is the best kind of furnace? I understand the melting of the lead, but not the cupellation of it.—Silver Ore.

[2379.]—CLARIONET.—Will Dr. Ussher or some other correspondent that possesses a clarionet kindly give me information on the following points in an instrument in the most useful key for use, say, with the pianoforte?—1. The exact length and inside diameter of each joint, including the bell, of which latter I require the length and diameter of each end? (This, of course, must not include the parts with the thread round, as they, obviously, do not contribute to the length.) 2. The exact distance from the extremity of the reed to each finger hole? 3. The number of keys necessary, and the position of all except those which are between the finger holes, of which I only require the names, unless he is able and willing to supply these also which would, perhaps, be as well?—Reed Fancier.

[2380.]—FOUCAULT'S MERCURIAL CONTACT BREAKER FOR RHUMKORF COILS.—Will someone describe the above, and also state whether or not it possesses any advantages over the vibrating contact breaker?—R. S.

[2381.]—COMPOSITION FOR RUNNING IRON WORK INTO STONE.—Will someone explain what the above substitute for lead is made of?—R. S.

[2382.]—STARTING VALVE.—Can any reader give a drawing and short description of a starting valve for a model horizontal engine with oscillating cylinder?—A. W. T.

[2383.]—INSULATING POWER OF GUTTA PERCHA.—Can anyone inform me what is the insulating power of gutta percha compared with air?—S. T. P.

[2384.]—WORK ON ELECTRICITY.—Will someone of your readers (perhaps "Sigma") be so good as to recommend me a good modern work on electricity (giving price) describing the theory of the induction coil? If not in English, a work in German or French would suit.—S. T. P.

[2385.]—HARMONIUM TONGUE-RIVETS.—Can some of our provincial friends state where these said rivets can be procured? Application has been made to several houses in the metropolis to know if they can supply them, but the reply is no. You may purchase any amount of tongues, but not rivets in London.—I. H.

[2386.]—TUNING HARMONIUM REEDS.—I am very glad to see the renewal of Mr. Hermann Smith's papers on harmoniums, and will be obliged to him if he will state whether in tuning harmonium reeds the action has to be opened and shut every time a reed is scraped? Is there no other method of trying whether they are in tune?—Vibrator.

[2387.]—SHOWER BATH.—Could any subscriber inform me how to make a shower bath at a trifling expense, as I cannot afford to buy one?—T. A.

[2388.]—UNANSWERED QUERY.—Will some kind friend favour me by describing the material used in solution to deposit a blue and red surface on tinsel plate or flattened wire—such as is used for fire stove ornaments, and by fishing tackle makers, and if it is deposited by a battery, and if used hot or cold?—Inquiring Workman.

[2389.]—VARNISHING GILT MOULDINGS.—I have heard that there is a process or means of varnishing gilt mouldings so as to prevent the gilt from rubbing off when cleaned or dusted; if such be the case, I shall feel extremely obliged to any of your numerous intelligent correspondents for information on the subject.—Desideratum.

[2390.]—INDUCTION COIL.—Will some brother reader kindly tell me what battery power I can safely use with a coil of the following dimensions?—Primary wire, 54ft., wound on in four layers; secondary wire, 3168ft., wound on in thirteen layers? The large wire weighs 1lb., and the small (No. 39), ¼lb.—Thomas J. O'Connor.

[2391.]—GAS STOVE.—Would "J. B.," or any reader of our valuable paper, kindly tell me the best form of gas stove and burner for heating the water to nearly boiling in a coil of ⅜in. iron pipe 36ft. long, and the time it would take to heat the water?—Robt.

[2392.]—WRITING ON GLASS.—Would any of our scientific contributors oblige by giving the process for embossing the name, &c., on glass bottles—such as you see on publicans' bottles in the form of a lable, the letters being clear, and the ground embossed?—Je ne Sai Pas.

[2293.]—NICOTINE.—I should be glad if someone could inform me if there is any non-poisonous liquor that will absorb nicotine.—Mauks.

[2394.]—WINDMILL.—Would Mr. H. Algar be kind enough to explain the plan (described on p. 560, Vol. X.) he has for regulating the mill in accordance with the power of the wind, and if the sails be wood or sheet iron, and what length the arms would require to be to have power to drive a thrashing machine?—C. C. J.

[2395.]—CANARY CAGE.—Can any correspondent inform me how to give the wire of a cage a silvery appearance?—Aviary.

[2396.]—CHAMBER MUSIC.—As we cut the leaves of the Mechanic and stitch it for dad's perusal, we always get a peep at the contents, and are much pleased with the drawing lessons now publishing. We should be thankful if Dr. Ussher, the "Harmonious Blacksmith," or any of your musical readers would recommend some good trios for violin, English concertina, and cello. Also a few slow movements as quartetts for the piano, and the above-named instruments.—Ophelia and Alma.

[2397.]—HARMONIUM.—I have an excellent harmonium by Alexandre, with two rows of vibrators—one of 8ft., the other 16ft., it has this defect, viz., when I pull out the stop grandjeu, the wind seems to run, and it is with difficulty I can sufficiently supply it, even by hard blowing, otherwise it is in excellent order. Will some kind subscriber point out the cause, and how to remedy the defect?—J. H. C.

[2398.]—BOOK-KEEPING.—Will someone tell me of a good treatise on book-keeping suitable for a manufacturing concern—such as an iron works?—T. W.

[2399.]—DIE FROM MEDAL.—I have a beautifully-worked medal. What would be the best way to make a die, or stamp the same pattern, and what is the best material?—Medal.

[2400.]—CLEANING BLUE TILES.—Would any of your readers kindly tell me the best way to clean blue Staffordshire bricks from lime which has fallen upon them in white-washing? Perhaps you could suggest some method either by a cheap acid, or otherwise.—E. D. B.

[2401.]—BREAKING WEIGHT OF OAK BEAM.—Allow me to ask Robert Pickwell the method of finding the strain and breaking weight of an oak or any other wood beam—say of the following dimensions: 18ft. long and 12in. square, supported at each end?—John Kyle.

[2402.]—ELECTRIC BELL AND BATTERIES.—Will Mr. W. H. Stone, who has lately given us a description of the manganese battery, answer me a few questions concerning it? In the first place, then, how many cells should be required to ring a bell that rings well with two-pint Smee cells? I have tried it with eight Minotto's cells, and it would not ring at all. I then tried one three-pint cell of the manganese battery and that also took no effect. Will W. H. S. tell me the number of cells I should require to make it equivalent to two cells of Smee, and what is the best size wire to use in the construction of bells? Any information I shall be glad of.—A. Spencer.

[2403.]—FLUXES.—Will Mr. Roskell or Mr. Davis kindly inform me where to obtain fluor spar, and can it be obtained in a powdered state? Also what is white argol, as I cannot find in Park's "Treatise on Chemistry," any mention of it? I presume it to be a mineral substance to be used as a flux.—Dorset.

[2404.]—TELESCOPE QUERIES.—Would Mr. Blacklock kindly say if he can use a power of 500 or 600—which his 6½in. speculum ought to bear under favourable circumstances—without screw motion in azimuth? Mr. Peters would also oblige very much by a description of his fine screw motion in azimuth. I am thinking about setting up a reflector, and like the plans of both the above gentlemen, especially Mr. Peters'—chiefly through his stand having screw motions in each direction. Have any of your readers compared or tested Mr. Purkiss's specula against Mr. With's? The prices of the former are so gloriously low compared with the latter, that I hardly dare hope for results so good as those obtained from the With-Browning specula.—C. S.

[2405.]—MANGANESE BATTERY.—TO MR. STONE.—I duly appreciate the valuable service Mr. Stone has rendered to your readers in bringing the manganese battery so comprehensively before them. I am sorry he should feel it necessary to deprecate the information I have given, but my object in doing so was to describe a cell which acted so perfectly. I use uncovered copper wire (No. 17 gauge) insulated at the supports through a piece of india-rubber piping, and the thickness of the wire is, I am told, rather a disadvantage. I have, since Mr. Stone's last communication, fitted up a quart cell according to the dimensions he there gives, but I exceeded his estimate of 2s. 8d. for a quart cell, as I had to buy binding screw and platinum foil. This sized cell works my bell very well, but the ring is not quite so powerful. I intend to use the cells alternately—a week each. Will Mr. Stone kindly say whether they will gain much in power by this interval of rest? I should also feel obliged if Mr. Stone would state how the binding screws and platinum can be dispensed with, as they form no inconsiderable item in fitting up three or four cells.—E. H. B.

[2406.]—MANGANESE BATTERIES.—I am about to construct some manganese batteries, but before commencing, would like to know what surface of zinc should be exposed to the carbon, so as to obtain the greatest power? Of course the more zinc the longer it will last but is there any method of getting at the proper proportion that should be exposed of each. I also thought of constructing a single fluid battery of carbon and zinc, to be charged with a saturated solution of salt and water. Has such a battery been tried, if so, what are its merits? Will "Sigma" kindly answer the above?—E. C. Murray.

[2407.]—COLOURS.—Could any fellow reader inform me of a book showing how to obtain different shades of colours from chemical dyes—as fustic, prussiate, potash, &c.?—Mordant.

[2408.]—METRONOME.—Would some reader give illustrations and description of a clock metronome?—Metronome.

[2409.]—MENDING TORTOISESHELL.—Will someone explain the process of mending tortoiseshell ornaments?—A. S. C.

[2410.]—PEDAL PIPES.—I am building a chamber organ (6 stops), the stopped diapason is the only one I am carrying through, the others only extending to tenor C. As I intend having a separate pedal organ, would any of your readers inform me what scale of pipes they would advise for the pedals—whether a bourdon or a 4ft. stopped (large scale), or a principal? Perhaps "An Adept" would kindly answer my query. The organ is to be more particularly for fugue playing, to contain the following stops:—Open diapason, 42 notes; stopped diapason, 54; dulciana, 42; principal, 42; twelfth, 42; fifteenth, 42.—Geo. M. Little.

[2411.]—GRINDING LENSES.—Will any kind reader inform me where I can buy the gauges and counter-gauges used in grinding the lenses of microscope objective?—Hipparchus.

[2412.]—MANGANESE BATTERY.—Will Mr. A. J. Jarman, of Ramsgate, oblige with a description of his manganese battery, its construction and arrangements, in our next number, for a fellow-subscriber?—Electro.

[2413.]—DOMESTIC TELEGRAPH.—Will some practical reader answer query 2099, p. 661, of the last volume?—J. O.

[2414.]—ALGEBRAIC EQUATION.—What are those two numbers whose difference is 2, and product multiplied by their sum is 12? Please work out at length.—Pater.

[2415.]—SARSAPARILLA.—Could any reader inform me how I could make a decoction of sarsaparilla? I want to make it so that it shall be strong enough so as not to use more than one or two tablespoonfuls in a wineglass of water.—Sarsaparilla.

[2416.]—ADHESIVE MATERIAL.—Would any reader inform me what is the best adhesive material for affixing ordinary paper labels on brown paper parcels, how it is made, what it is made of?—Beta.

[2417.]—FERNS.—Will any reader inform me how to construct a fern case, medium size, and the best species of ferns to stock it with? I do not want costly ones. A few hints on their cultivation would be very welcome.—Ignorant.

[2418.]—OXFORD AGRICULTURAL EXHIBITION.—Can any reader inform me what class of implements will contest for the prizes at the Agricultural Society's meeting at Oxford?—Geo. Holdon.

[2419.]—GALVANIC BATTERY.—Is it necessary to amalgamate zinc wire for a salt-water battery? If so, which is the best way to put the mercury on?—Voltaic.

[2420.]—SPRING BOW.—Can I weaken the spring of a spring-bow without making it thinner? It cannot be made longer, being in one piece.—Voltaic.

[2421.]—MEDICAL WORKS.—Can any brother reader inform me of the publishers' names and addresses of the following books:—"Culpepper's Translation of the London Dispensatory;" Culpepper's "Ephemeris," 1651; and Galen's "Art of Physic" (herbal works); or where they can be obtained?—George Gregory.

[2422.]—MORTISING.—Can any fellow-subscriber inform me how to make a machine for mortising small stocks of wheels?—Subscriber.

[2423.]—AQUARIUM EXPERIENCE.—Will water, in passing through about 6ft. of gutta-percha tubing from a reservoir to an aquarium, be impregnated with anything at all injurious to the health of the fish or other inhabitants thereof? Where can I procure, in a small quantity, cement (what name?) suitable for sticking artificial rock-work together, and capable of withstanding the action of the water?—Chas. Aubrey.

[2424.]—MICROSCOPICAL.—What are the advantages offered by the Quekett Club to persons so situated as to time and circumstances as to render attendance at their meetings impossible? Where is "Cox's gelatine" to be procured? Will isinglass answer the purpose (preserving microscopic objects) equally well?—J. Cherry.

[2425.]—TO F.R.A.S.—Will you kindly supplement your interesting articles on "Time" by saying what is the right way of calculating Greenwich mean time from local sidereal time (and *vice versa*) at a place not on the meridian of Greenwich—for example, in 8min. 7sec. West long.? In the "Nautical Almanac" the "explanation" on p. ii. says that if the place be not on G meridian, the sidereal time must be "corrected by the addition of 9·8565sec. for each hour of long., if to the west;" that is to say by the addition of 1·33sec. in the supposed long. of 8min. 7sec., but the result seems not correct.—Not a F.R.A.S.

[2426.]—UNANSWERED QUERY.—PIG IRON.—Could some reader of your valuable and widely-circulated journal tell me the reason why pig iron that has been stocked some six, nine, or twelve months' exposed to atmospheric influences, almost invariably works better in every respect in the forges, and its products in the mills are more satisfactory than iron that is newly made at the blast furnaces?—An Iron Worker.

[2427.]—VARNISHING CASTINGS.—Will any reader kindly inform me of some method of varnishing (black) small castings to make them perfectly smooth, so that dust and small fibres will not adhere to them?—W. H. B.

[2428.]—HORSEHAIR AND FEATHERS.—Could any reader inform me how horsehair is cured and curled?—also how feather are steamed and purified? Any information will be kindly received.—An Old Sub.

[2429.]—PROTECTING WOOD AND IRON FROM STEAM.—Will you permit me to ask some of your correspondents how to protect the surface of cast or wrought iron so as to withstand the heat of steam, and not be affected by grease or moisture? A substance similar to that used for lining saucepans, &c., would answer well if it can be readily applied to large surfaces?—Thomas Baxter.

[2430.]—TO MR. GEORGE BATES.—I should be much obliged to Mr. George Bates, agent for Hopkinson's valve, if he would give me the rule by which the calculation is made as regards loading the valves, one valve being smaller than the other, and one being without a lever and likewise the float; what weight it would take to lift the small valve at a pressure of, say, 25lb. to the square inch? I should like to correspond a little more with Mr. Bates on the mechanical improvement he sees in his daily travels (through the medium of the Mechanic), which will benefit me and others also to insert his address. His last information corresponded exactly with my views on the compound safety valve.—A. F., Leamside.

[2431.]—WEDGWOOD PLAQUES.—Where can I procure the above, of small medallion size for enlaying, and about what would be the cost?—F. S.

[2432.]—STONE CARVING ON SCULPTURE.—Would someone of experience tell me a little about the tools and mode of procedure, and working? I can work at wood carving.—F. S.

[2433.]—KEYLESS WATCH BUTTONS.—Will some reader tell me how the gold is put on the iron or steel in the buttons of keyless watches?—J. Holt.

[2434.]—MEASURING LABOURER'S WORK.—Will any brother reader inform me how to measure land, &c.—such as is required upon a farm—as I wish to be able to measure the work done by the labourer?—A Young Farmer.

[2435.]—PROJECTION.—I will be obliged if Mr Quilosa or any other subscriber will give an explanation of the following problem:—A cube of 1in. edge is to be represented by its plan and elevation when the planes of two faces are inclined at 50° and 70° to H. P.—T. Cornforth.

[2436.]—TO "F.R.A.S."—I am much obliged to our learned friend "F.R.A.S." for his courteous reply, but regret that my letter was not fully understood. I stated that I proposed grinding an object glass of 18ft. 3in. focal, and that the glass I intended using would require the crown lens to be 6ft. 10in. focal length to correct the chromatic aberration. I know for certain this will do it, so that the focal lengths are settled. But what I wish to know is, what would be the best curves to correct the spherical aberation, the outer curve of the crown, and the inner curve, also the outer and inner curve of the flint lens? I know that our learned friend could do this in a few lines. I should like to grind them according to his formula, if he will favour me with one.—Neptune.

The Imperial Academy of Science, Agriculture and Art, of Lille, offers two prizes of a thousand francs each; one for the best work on some branch of experimental physics, the other for the best work on the use of the thermometer in medicine.

USEFUL AND SCIENTIFIC NOTES.

THE GULF STREAM.—Professor Maury has recently delivered a lecture in New York on the Gulf Stream, which shows that he does not share the scepticism which has arisen concerning it. He declares that it is in volume nearly equal to the great equatorial current itself, and 1000 times larger than the Mississippi river; that it moves across the Atlantic on the tract of a great circle of the earth, and in obedience to its diurnal rotations; that it unites with the waters of the Mississipi beyond the Bahamas. With touching enthusiasm he compared the Gulf Stream to the Milky Way, because its warmer water was sought by myriads of phosphorescent insects, which make it sparkle and glow like a sea of fire.

THE PANNIER RAILWAY SYSTEM.—A new arrangement for railways will shortly come before the public under the title of the Pannier system. A single row of piles carries a continuous girder on, which the train runs, the carriages hanging down on each side to within a short distance of the ground. The carriages are so arranged that inequality of weight on one side to the extent of a ton will not affect the action. The small quantity of land required, cheapness of construction, and speed are advantages claimed for it. Mr. Samuel, C.E., has taken the invention in hand, and we shall doubtless soon hear more of it.

THE ROYAL DUBLIN SOCIETY has commenced its session for the delivery of popular scientific lectures. Some of last year's courses, were of the deepest interest. Mr. Huggins has already given one of the present course of lectures "On Recent Solar and Stellar Discoveries." Amongst others it is announced that Dr. R. M'Donnell will give a lecture "On Phosphorescence and Fluorescence;" Professor Hull, "On the Coal-fields of Great Britain;" Dr. Wyville Thomson, "On the Deep-sea Soundings during the Cruise of the Porcupine;" Dr. Humphrey Minchin, "On Some interesting Phenomena of Sound;" and Dr. J. Emerson Reynolds, "On Ozone, its Nature, Properties, and Uses."

DIAMONDS.—Professor Tyndall has just succeeded in igniting a diamond in oxygen by the concentrated rays of the electric light. He has no doubt of his ability to ignite it by the purely invisible rays from the same source. It is interesting to know that a new locality for diamonds is reported by Herr Gustav Rose, of Berlin, which may be considered the first in Europe, if the western slope of the Ural is placed out of the question. The stone referred to was found in the granite quarries of Count Schonborn in Bohemia, and has been unquestionably identified as a diamond, both by the combustion of a splinter into pure carbonic acid, and by its physical and mineralogical properties. Its weight is 57 milligrammes; it is cubical in shape, and is of light yellow colour, and is probably not the only one to be discovered. Prof. Wohler, of Gottingen, has also discovered minute diamonds in a piece of platinum from Oregon.

SUGAR FROM BEET-ROOT.—Now let us see (keeping as clear as possible from technical terms) what happens to the beet-root when it is brought to the factory. The usual plan of operation is to wash the roots well, so as to free them from clay and dirt, and then to place them within the clutches of circular saws making over 1000 revolutions a minute, by which they are torn to pieces and reduced to pulp. This latter it then packed in linen bags, and subjected to the action of an hydraulic press, by which the juice is all squeezed out, and the pulp becomes a cake. This not only forms the beet-bread so valuable for feeding purposes, but, if not required for that purpose, can also be used for making brandy and vinegar; or, what is still more remarkable—paper, it being found by paper manufacturers to be superior to rag pulp. So that whatever may be the defects in the beet process, incapability of utilisation is not one of them.—*Food Journal.*

SOLID BEER.—The age produces some queer paradoxes, and none more so than in the results of manufacturing science. In former days it was the custom to buy bread and even beef by the yard; but we believe that it is only in the present day that we can get our beer by the pound. By a very simple process, introduced by Mr. Mertens, the wort, after being made in the mash-tub of malt and hops in the usual manner, is sucked up by a pipe into a large vacuum (exhausted by an air-pump), and then persistently worked round and round, while the moisture is evaporated. The wort emerges from its tribulations with a pasty consistence, and is allowed to fall from a considerable height into air-tight boxes, in which it reposes, like hard-bake. It soon gets so exceedingly tough that it has to be broken up with a chisel and mallet, and in that condition is easily sent abroad, or to any part of the world, for people to brew their own malt liquor. We have had the wort subjected to analysis, the results of which, in 100 parts, show that there is almost absolute purity:—Gum, 64·219; sugar, 20·664; lupulin (the active principle of hops), 2·0 0; albumenous matter, 0·600; mineral matter, 1·500; moisture, 11·017.—*Food Journal.*

THE USE OF SALT IN AGRICULTURE.—Whether common salt is of any value to plants, is still a mooted question, and one that finds advocates on both sides. The luxuriant growth of marsh meadow grass is taken as a proof that salt water must be favourable, and farmers attempt to imitate this state of things by putting salt on the grass without reflecting that all other conditions are omitted in the experiment. They are generally astonished to find that the grass is killed, instead of being promoted in its growth. It is a remarkable fact that this same salt marsh grass, on analysis, is found to contain very little soda, but to have its full complement of potash. This would seem to indicate that it had grown in spite of the salt, rather than in consequence of it. According to some recent researches, made in France, potash is a hundred times more valuable to plants than soda. It is true that small quantities of soda have been found in plants, but generally under circumstances that seem to point to its accidental rather than essential presence. Direct experiments have shewn that salt is injurious to tobacco and to the sugar beet. An examination of the plants growing near salt springs and salt marshes shows that the vegetation is of a limited and peculiar character. All of these observations point to the conclusion that the direct use of salt, as an artificial fertiliser, is only applicable to such plants as grow on the sea shore, or near salt springs, and not at all to the usual grass and cereals of our farms. The whole system of manuring farms is based upon the principle to restore to the soil the constituents that are removed by the crops. As the crops carry away no soda, it follows that none is necessary to their growth. There is another objection to the use of common salt, and that is the chlorine contained in it. This element is decidedly injurious, as has been shown by the experiments of Wolf and others. Public opinion in Germany has set so strongly against the use of salt, that in the famous mines of Stassfurt, where vast quantities of artificial fertilisers are manufactured, the exclusion of chloride of sodium, or common salt, is now considered necessary, and the value of a manure is made to depend upon its percentage of potash.

SPURIOUS TEA.—The discovery of spurious tea, by Dr. Letheby, is a very serious matter, looking at the enormous quantity already brought over to this country, and the still larger supplies, said to be 7,000,000lb., which are reported to be on the way. This tea, which is described as "Fine Moning Congou," is really nothing but the re-dried leaves of the exhausted tea, the peculiar piquancy of which is increased by the fact that, in Shanghai, the pigs and dogs freely promenade amongst the rotting heaps in the streets. "The leaves are for the most part quite rotten from the putrefactive decomposition, and do not contain more than a trace of the active principle of tea. The odour of them is very offensive; and, when infused in boiling water, they produce a nauseous, unwholesome liquid." The value of this precious article is from 1½d. to 2½d. per lb., though for purposes of adulteration it has already been sold for from 5½d. to 7½d. per lb. We regret to learn that the prosecution of the guilty parties has been to a great extent rendered abortive, by the action necessarily taken by the Custom House authorities. If nothing else, however, results from the discovery, it will put an end to the fraud—at all events for a time—and in this particular guise.

FARADAY ON OPTICAL GLASS.—In 1829, Faraday gave the Bakerian Lecture at the Royal Society on the Manufacture of Glass for Optical purposes. This most laborious investigation did not end in the desired improvement in telescopes; but the glass thus manufactured became of the utmost importance in his diamagnetic and magneto-optical researches. He says, "When the philosopher desires to apply glass in the construction of perfect instruments, and especially the achromatic telescope, its manufacture is found liable to imperfections so important and so difficult to avoid, that science is frequently stopped in her progress by them—a fact fully proved by the circumstance that Mr. Dolland, one of our first opticians, has not been able to obtain a disc of flint glass 4½in. in diameter, fit for a telescope, within the last five years; or a similar disc, of 5in., within the last ten years. This led to the appointment by Sir H. Davy, of the Royal Society Committee, and the Government removed the Excise restriction and undertook to bear all the expenses, so long as the investigation offered a reasonable hope of success. The experiments were begun at the Falcon Glass Works, three miles from the Royal Institution, and continued there in 1825, 1826, and to September 1827, when a room was build at the Institution. At first the inquiry was pursued principally as related to flint and ground glass; but in September 1828 it was directed exclusively to the preparation and perfection of peculiar heavy and fusible glasses, from which time, continued progress has been made." The paper than proceeds with an exact description of this heavy optical glass: "its great use being to give efficient instructions to the few who may desire to manufacture optical glass." In 1830, the experiments on glass making were stopped. In 1831, the Committee for the Improvement of Glass for Optical Purposes reported to the Royal Society Council that "the telescope made with Mr. Faraday's glass has been examined by Captain Kater and Mr. Pond. It bears as great a power as can reasonably be expected, and is very achromatic. The Committee therefore recommend that Mr. Faraday be requested to make a perfect piece of glass of the largest size that his present apparatus will admit, and also to teach some person to manufacture the glass for general sale." Faraday declined to continue the investigation at the time; and in 1845 he says: "I consider our results as negative, except as regards any good that may have resulted from my heavy glass in the hands of Amici (who applied it to microscopes), and in my late experiments on light."—"Life of Faraday," by Bence Jones, Vol. I.

HAMPDEN'S CHALLENGE.—Our readers probably remember the challenge boldly given to the "lying astronomers" some weeks since by Mr Hampden, and in which he offered to stake £500 against any astronomer's proof of the "convexity of a river, canal, or lake." Mr. L. A. Scott, of St. Neots, Hunts, has kindly forwarded an account of the proof which was undertaken by Mr. Alfred R. Wallace, who engaged to demonstrate that the middle point of the surface of six miles of still water would be found about 5ft more or less, *above* an imaginary straight line drawn between the surface points of the water at the end of that distance. The experiment has been made on a suitable piece of water called the Old Bedford river, a large fen drain in the north of Cambridgeshire, and the result is, as a matter of course, that Mr. Hampden's £500 is about to change hands. We trust his loss may render him less pragmatical, and a little more inclined to give due credit to the results of the disinterested labours of astronomers.

ARMOUR PLATE TESTING.—A new method of testing thick armour for Her Majesty's ships has been introduced during the past week at Portsmouth in the trial of two large plates for the Glatton and the Devastation breastwork monitors. Hitherto, the practice has been to fire at the plate with spherical shot from the smooth bore 8in. gun, but the method now brought into use by the Admiralty substitutes the 7in. muzzle-loading rifle gun with chilled shot for the smooth bore. The powder charge varies according to the thickness of the plate under test in the following degrees: For 12in. plates, 21lb.; for 11in. plates, 18½lb.; for 10in. plates, 16½lb.; for 9in. plates, 14lb. The distance between the gun and the plate is 30ft., and four shots are fired at the plate within an an area of two square feet. The plate for the Glatton was from the rolling mills of Messrs. Charles Cammell and Co., Cyclops Iron and Steel Works, Sheffield, measuring 10ft in length, 3ft. 6in. in breadth, 12in. in thickness, and weighed 7 tons and 2 cwt. The plate for the Devastation was from the rolling mills of Messrs. John Brown and Co., Atlas Iron and Steel Works, Sheffield. Its dimensions were 14ft. in length by 4ft. 6in. in width and 10in. in thickness, and weight 10 tons. The average penetration of the shots in the 12in. plate was 7.2in., and in the 10in. plate the penetrations were 6·3, 6·8, 6·8, and 7·8in. respectively. It is a remarkable feature in the manufacture of these enormous slabs of iron for our new turret ships that they are bent to the required form direct from the rolls, and when at cherry-red heat.

CANDLE STAMP.—It is marvellous, writes the *Scientific Review*, to observe what trifling articles may form the subject of a useful invention; the stamping of candles, for example, would appear to be a very unimportant matter, yet Mr. Schleidner, of Paris, has designed a special machine for the purpose. The candles are placed on an inclined plane, from which they successively slide into the notches of two similar wheels or rings, which, at each revolution of the driving pulley, bring a candle under the stamp. This stamp, suitably engraved, is heated to an unvarying temperature, by steam or otherwise, so that on pressing lightly upon the candle it melts the fatty matter, leaving the candle stamped with a very clean impression, obtained without shock or stain. The candle then leaves the notches, falls upon another inclined plane, and passes thence into a box.

NEW METHOD OF EXTRACTING GELATINE, &c.—*It* is announced that a mode of obtaining gelatine from all animal substances capable of yielding glue has been discovered. The oils and grease are separated from the gelatine by means of benzine, coal-oil, or other hydrocarbons. In some cases it is found advantageous to treat the material with lime, before the hydrocarbons are employed; but these are exceptional. After the substances treated have lain for a considerable time in benzine, or other agent employed, the fatty matters are dissolved, and the pure gelatine is found at the bottom of the vessel; they are, therefore, easily separated in order to be treated in the usual manner. The hydrocarbons are recovered by evaporation, by means of steam and condensation, and both the gelatine and the fatty matters are afterwards purified by the ordinary processes.

THE WATER TYPE.—*Mr. Wanklyn has recently published an important paper that will probably give rise to much controversy. It does not admit of brief* abstraction. The author denies the analogy between the acids and metallic salts; that the acids are built on the water type he is indeed not prepared to deny, but he maintains that the acids and the metallic salts are built on totally different types. The alkalies, instead of being waters, and like the acids in structure, are like metallic salts. Thus caustic soda is

$$\mathrm{Na}''\left\{\begin{matrix}\mathrm{O}''\\ \mathrm{H}\end{matrix}\right.$$

It may be briefly stated that the accuracy of the mode of representation proposed by this distinguished chemist entirely depends on the question, is there, as a matter of fact, a fundamental analogy, or fundamental want of analogy, between hydrogen and the metals? In Mr. Wanklyn's opinion, in favour of which he gives strong reasons, there is a fundamental dissimilarity between hydrogen and the metals.

DETECTION OF ARSENIC IN FUSCHINE.—Dr. Riecker finds that the pigment Fuschine contains arsenious acid, the amount in some samples being 2·07 per cent.; he therefore recommends that there should be legal prohibition to the employment of this pigment as a colouring for sweetmeats.

CONVERSION OF CRYSTALLINE SULPHUR INTO THE AMORPHOUS MODIFICATION.—M. Lallemand finds that the direct action of sunlight converts crystalline sulphur into sulphur insoluble in sulphide of carbon. By placing a solution of sulphur in sunlight concentrated by a lens, the author states that the sulphur is rendered insoluble and deposited in the amorphous form.

CHIPS.

M. Sommer propounds a new theory of sleep: his idea is that sleep is simply a result of the deoxygenation of the system, and he believes that sleepiness comes on as soon as the oxygen stored in the blood is exhausted.

"*Cosmos*" asserts that it has recently been demonstrated by reference to authentic documents that Guernsey and Jersey have sunk more than fifteen yards during the last five centuries.

On Saturday the 26th ult., Mr. Green, the celebrated aeronaut, died suddenly at his residence, Tuffnell Park, in the 84th year of his age.

Dr. Hooker has been elected an honorary member of the French Acclimatisation Society, on account of his exertions in regard to the Cinchona plant.

There are in America and Europe more than 250 manufactories of rubber articles, employing some 500 operatives each, and consuming more than 20,000,000lb. of gum per year.

It is reported, on the authority of the late Major-General Davis, of the Royal Artillery, that the *Reduvius serratus*, commonly known in the West Indies as the "wheel bug," can, like the *Gymnotus electricus*, communicate an electric shock to the person whose flesh it touches.

M. Hesling states, in the *Journal de Pharmacie et de Chimie*, that even long before milk becomes sour there are generated in it very small organised spores of an Ascophora species.

The exports of railway iron from the United Kingdom attained a heavy total last year, having risen to 895,848 tons, while the corresponding total for 1867 was only 583,488 tons.

M. Alphonse Milne-Edwards shows that at the time of the deposition of the tertiary beds of Bourbonnais its Fauna represented that now existing in Africa.

M. Hurtault has patented a process for rendering petroleum inexplosive by the addition of a certain proportion of amyl alcohol.

A process for the manufacture of artificial butter has been patented in France.

M. Oudemons has succeeded in making an alloy of zinc and iron. The new metal, which contains 40 per cent. of iron, is remarkable for its whiteness and tenacity.

DOMESTIC RECIPES.

(From the Food Journal.)

The Vocalist's Soup.—Take three ounces of sago, and, after washing it in boiling water, add it gradually to about two quarts of medium stock, which should be almost boiling. After half-an-hour's simmering, it will be well dissolved. Beat up the yolks of three eggs, add half a pint of boiling cream, and stir them all quickly in the soup, not allowing the latter to boil, lest the eggs should curdle. These materials will make sufficient soup for eight people, so that it can be recommended for dinner before an amateur concert.

Potted Pigeons.—Stew the gizzards and livers of the pigeons, chopped fine, and add grated ham, bread crumbs, and herbs. This is to be made into a force-meat, with the yolk of a hard-boiled egg, and the pigeons are to be stuffed with it. Put them into a stewpan, with water and a little butter; add the gravy from the gizzards, some flour, and an onion, with the addition of a glass of wine, and stew gently until done.

Veal Soup.—Boil the veal with two-thirds of a cup of rice, and add sweet herbs or celery, and the usual seasoning. This makes a plain, wholesome soup.

The Preservation of Milk.—The following recipe appeared in *Cosmos*:—"To every litre (= 1¾ pints, 5 oz.) of unskimmed milk, previously poured into a well-annealed glass bottle, add 40 centigrammes (about 6 grains) of bicarbonate of soda. Place the bottle (which must be well corked) containing the milk for about four hours in a water-bath, heated to 90° (194° Fahr.). On being taken out, the bottle is varnished over with tar; and in that state the milk contained in it will keep sound and sweet for several weeks."

Potatoes a la Maitre d'Hotel.—Peel the potatoes, when boiled, and, after trimming them into the shape of large corks, cut them into slices ¼in. thick; then place them in a stewpan, with sliced green onions and minced parsley, pepper, salt, and butter. Moisten them with stock, and let them be well tossed, until the parsley is cooked.

Hare a la St. Hubert.—Persons who object to "high" game will find the following recipe most useful:—The dish is called *Hare a la St. Hubert*. The hare must first be skinned soon after death, put into a copper, and great care taken to save as much blood as possible; secondly, 4oz. of bacon fat are to be added, with leeks, parsley, &c.; and, lastly, a pint and a half of good strong, spirituous red wine. The copper is then to be hooked on a pot hanger, and the wine set on fire. While this is flaming, roll six ounces of butter in some flour, and when the wine ceases to burn, add the butter rolls to the stew, which may be allowed to remain on the fire for half-an-hour. A veteran French spinster, whose word on such matters is law, bids us, on eating the dish, bless the memory of the propitious saint. A hare, thus cooked, merits this effusion of gratitude.

How to Cook Tough Poultry.—Madame Miau is, what may be called an Anglo-French authority on culinary operations. At least she was born in England, educated in France, came back to England, studied, talked, cooked, and ate a great deal in both countries. A friend in extremity once asked her, what she could do with "a miserable half-starved chicken that the dogs had killed?" Her answer was prompt and encouraging to those mistrustful people, who are compelled to dine in doubtful eating houses. "Truss it neatly," Madame Miau replied, "stuff it with sausage and bread-crumbs; mix some flour and butter, taking due care it does not colour in the pan, for it must be a white rout; plump your chicken in this, and add a little water, or soup if you have it." We are told besides to put carrots cut in half, tops of celery, chives, bay leaf, parsley, &c., then "cover close, so that all air may be excluded, and keep it simmering two hours and quarter; it will turn out white and plump; place the vegetables round it, stir in an egg to thicken the sauce, off the fire, and your dish will make you blush." Without actually snatching half-starved chickens from the mouths of dogs, might not Madame Miau's instruction render many a tough old bird palatable?

THE *ENGLISH MECHANIC* LIFE-BOAT FUND

Subscriptions to be forwarded to the Editor, at 31, Tavistock-street, Covent-garden, W.C

	£	s.	d.
Amount previously acknowledged	£164	6	1
J. S.	0	1	0
Vibrator	0	1	0
R. G. B.	0	5	0
W. H. Coffin	0	0	3
	164	13	4

ANSWERS TO CORRESPONDENTS.

◆

ANOTHER TESTIMONY.

Sir,—I have great pleasure in adding my testimony to that of the other subscribers, as to our Mechanic being a *first class* advertising medium; in fact, I have found it so good that I have been obliged to very much increase my facilities for the execution of orders. I may also say, I am much pleased with the new arrangement for advertisements to appear outside, and the general improvement of the paper.—F. Perks, Wolverhampton.

Received.—J. G., S. & R., S. S. & Co., James Hunt, W. H. N. J. G. Watts, W. Melroy, J. E. Pearson, G. Woods, J. Hinks & Son, T. Winter, B. & Co., Fred. Walton, W. Butler, H. H. Lloyd, Otley & Nuder, W. H. C., W. Ferrell & Son, W. A. Gibbons, J. E. Holmes, T. J. O'C., Geo. Jackson, C. & H., George Plant, W. M. W., R. W. P., W & T. Pye, Excelsior, J. K. P., F. J. H., J. Kilburn, W. E. Hickling, J. Radcliffe, John Holmes, Procul, M. A. Ennis, W. J. C., R. Rumsey, S. W. & Co., J. C. Scott, W. C. R., Capt. O. Haldane Stokes, R. A. Proctor, Omicron, J. Rattray, Coalbrookdale Co., H. Bradley, C. C., E. S., C. B. A., R. N., J. V., S. S. & Co., J. Rattray, S. & J. F. D., J. W., M. B. A., S. W. & Co., P. Bros., E. S., J. Holt, W. C., J. Kilburn, J. Radcliff, W. P., P. Champs, R. J. Boyall, W. H. Coffin, Caffal and Miller, E. V. S., F. H. B., Hy. Canning, C. S., J. Jennings, C. and D. Jones, C. H. B. H., W. Leary, A. Tolhausen, J. E. Fenney, Edwardian A., Geo. Gregory, A. F. S., W. H. B., Neptune, G. E. Crick, One in a six, A Young Farmer, Ianthe, S. M. J., J. Holt, J. Cornforth, Delineator, H. B. A., G. G. Ventnor, Waherof, Thos. Stanway, J. O. Clark, An Old Sub., A Young Irishman, W. H. Ridgway, Ashhurst Bros., W. R. Bland, H. C.

Wilfred.—Your query, like too many which reach us, is very ambiguously worded. You do not say what *leather* your couch is covered with, therefore no one could advise you how to clean it.

Hypo.—We never pass any correspondent unnoticed.

Sigismond.—State more precisely what instrument you require music for.

Chuck.—Consult indexes.

J. D. M.—Could only say after perusal.

Pesky Cuss.—Replies dealing with such a malady appeared some time back. Why adopt such a signature?

H. G. Hoult.—Communications on mesmerism reached us in such numbers that a general acknowledgment only was made of their receipt.

E. G. Willingly.—Send us the addresses. Our simile was founded on the Biblical account of the fate of the magicians' rods, whose owners attempted to compete with Aaron in miracle-working.

W. J. B.—You write anonymously, and, therefore, to no purpose.

Samuel Forrester.—Only at certain times, which vary in different districts.

A Chemical Man.—If you choose to *describe* your invention our columns are open to you. If you want to push it commercially, we can only help you through our advertisement pages.

Phonography.—Shorthand-writers are divided in opinion to a certain extent as to the merits of the systems you name, but the great majority prefer Pitman's.

George Whitaker.—We know no other address.

Lux.—We think not.

Metronome.—Second query inserted. Reply 2091 will help you to solve the first.

Samuel Wymer.—We cannot advise you.

Gilbert.—You send a query to which replies are even now appearing. Be more considerate.

Amicus Scientiæ.—The information you ask for has been given repeatedly. It is not our fault that you do not possess the back numbers.

T. Bannell.—First query inserted. A search at the Patent Office will give you the desired information.

J. W. Bedford.—The correction *did* appear in this column.

A Brother can only have his query inserted as an advertisement.

Novice thanks Mr. A. W. Blacklock for answering his question on parabolising specula. With the assistance of the diagram "Novice" says he "saw the thing at once."

J. Cherry.—Please send the note on starch.

F.R.G.S.—Thanks for your offer to "supply epitomised accounts of the proceedings of the Royal Geographical Society." We are sorry, however, we cannot give you much space.

Dr. B.—As you say, nothing is perfect. Whilst bestowing praise on most things you ridicule others. We cannot reply to all, but will refer to one as an example—that of "Pills." You have no patience with "Wry Face" for asking such a question, and you are not the only one who has so written. On the other hand, we beg to say that the question was asked by one of our most intelligent correspondents; that it was a fit question to ask, and that it has elicited several valuable suggestions, one of which appears to-day. A question like this, or the answers it elicits, may not be interesting to "Dr. B" and others, but they are interesting because useful to many others.

J. Mills.—See letter "Criminal Literature" on another page. One letter on the disagreeable matter is enough.

Dr. B.—We cannot advise as to the quality of the goods mentioned in advertisements. The house you mention, that of Mr. Cox, Ludgate-hill, London, is a respectable one.

Dr. Ussher.—In printing a large number of copies, and rapidly, some badly-printed sheets occasionally pass through the machine, and we suppose your copy last week was an unfortunate one.

Canute.—You give good reason for using "Terset Deuroy," the name of your residence. "Canute" rolls over the tongue a little more easily. Certainly "Neptune" cannot object to it.

Robert Cossens.—You inclosed no stamps.

W. T.—The drawing you send is not clear; our draughtsman can make a good illustration if he is supplied with a good drawing.

Oxyhydrogen Gas Stove—"Houblon" thanks J. C. Shewan for his interesting communication, p. 41, No. 262 respecting his method of applying heat by means of ordinary coal gas to domestic purposes. He thinks it may be generally adopted, provided a continuous stream of fresh air could be supplied by some simple and cheap apparatus.

A Friend to Improvements.—There is no person or society to give a reward for such an invention; but if it be as you say, any capitalist would co-operate with you, or if you gave the invention to the nation, the Government *might* give some kind of reward. Sir Wm. Armstrong, for instance, was rewarded vastly and made a baronet in the bargain, when he offered his invention to the Government, but the invention was worthless, nevertheless. But Sir William was an adroit and persevering diplomatist. His gun has cost the country at least £3,000,000, and we shall never get in return 3,000,000 farthings.

Argus.—The suggestion, if made, would not, in all probability, be adopted.

Scrutator.—The matter in dispute between you and "Minnehaha," would hardly justify the insertion of more letters on it.

Wm. Turner.—Questions publicly asked, must be publicly answered.

Equation.—No. 2258. Several answers have been received. We give preference in such matters to the shortest.

Heraldry.—W. H. H. says:—"If 'Lincolniensis' has not yet purchased a work upon heraldry, and if, further, money is any particular object to him, I shall be happy to send him 'free gratis" an old, but, I believe, perfectly reliable book, containing, besides the treatise, 'the arms of the nobility of England, Scotland, and Ireland.' If he would like to have it, and will send his address to me at 12, Chapel-street, Bedford-row, W.C., I will despatch it by next book-post."

The Sixpenny Sale Column is the only place in which can appear queries forwarded by E. Spencer (second query), "Vulcanite," J. Benson, "W. G. H.," "Tyne," "Metal Head," "Tackle Maker."

John C. Scott.—Not received.

W. R. Bland.—We intend to give chess problems, but yours is incorrectly stated, and is not a very good one. In the first place the W. R. moves to the Q. B. *4th*, and not to the Q. B. 5th square; next the White Queen moves to Q. 5th, and checkmates, and not as you say, to Q. 4th.

J. W. T.—If the drawing and description were given they would be of no use to anyone but yourself.

W. S. McKay.—Ingenious but impracticable.

Lotteries—Great Prizes, &c.—J. T. Keighley, of 20, Barton-street, Ribbleston-lane, Preston, writes to complain of the non-receipt of a prize drawn by him in a distribution which took place some time back in connection with another journal. He and any others who have similar complaints to make had better apply to the former publisher. We have had nothing to do with "prize distributions," and never will. There is really nothing *given* to the subscribers. When these distributions are honestly conducted, (which we fear is but seldom the case), each subscriber has to forward four or six stamps, which more than defray the cost of a considerable number of "magnificent prizes," which generally consist of bull's-eye lanterns, concertinas, and similar valuable articles.

Kennington Amateur.—Inquire through a bookseller.

W. Roberts.—No.

J. W. Russell.—We are afraid you are hard to please. Such letters only discourage.

Frederick Smithe.—Agreed.

E. Keenan.—With MSS., making four packets in all.

F. D. Hart.—Mispickel is arsenical pyrites.

B. Johnson.—"Hungary" is thus made on a large scale. 10 gallons of rectified alcohol, 60° over proof, 15 oz. of otto of neroli of lemon, 5 oz. otto petit grain of orange, 6 oz. otto of rosemary, 8 oz. otto of citron zeale, 2 oz. of otto neroli of orange.

M. Van B.—Probably rutile (native oxide of titanium, coloured by iron). It has sometimes been met with in specular iron.

B. L.—Vanadium was discovered by Sefström in 1830, in a Swedish iron mine at Jaberg.

THE INVENTOR.

In obedience to the suggestions of a number of readers, we have decided on appropriating a portion of our space to a condensed list of patents as nearly as possible up to the date of our issue.

APPLICATIONS FOR LETTERS PATENT DURING THE WEEK ENDING MARCH 26th, 1870.

840 J. Milne, St. Andrew's, fire grates
841 R. H. Rimes, Bradford, boots and shoes
842 W. H. Clemesha, and T. Roberts, filters
843 W. Gallimore, Leek, machinery for drying thread in the hank
844 D. Joy, Saltburn, increasing efficiency of steam generators
845 W. R. Lake, counteracting pressure on slide valve engines.—A communication
846 S. S. Turner, Westborough, Massachusetts, machines for sewing straw
847 J. H. Johnson, 47, Lincoln's-inn-fields, improvements in locomotion.—A communication
848 D. Gray, Wishaw, wheel tyres
849 T. J. Smith, of Robertson, Brooman, and Co, 166, Fleet-street, treatment of ores.—A communication
850 C. J. Eyre, Westbourne-grove, apparatus for producing motive power
851 J. and J. Bradbury, Denton, machinery for felting hat bodies
852 W. T. Culmer, Hornsey-road, new mode of manufacturing brushes
853 J. B. Colbran, and W. Pollard, Holloway, trap for vermin or animal
854 C. Farrow and R. B. Jackson, Great Tower-street, iron wine bins
855 M. Chapman, Charterhouse-buildings, Goswell-road, improved album
856 W. R. Lake, Southampton-buildings, bars, plates, and sheets of steel.—A communication
857 J. Moore, Dublin, metal bushes for bung holes of casks
858 J. C Cushion, Penrose-street, Walworth, improvements in mill bills or chisels
859 J. H. Miles, Birmingham, velocipedes
860 S. Mawson, Bradford, nitrous oxide gas (or other gas that may be inhaled) indicating the quantity at each and every inhalation
861 T. P. Hawkesley, New Bond-street, clinical thermometers
862 J. Gilchrist, Glasgow, ratchet drill, brace, and grab combined
863 H. R. Fanshawe, 14, Finsbury-place, and W. H. Smith, 12, St Ann's-gardens, Haverstock-hill, treatment of hides and skins in tanning
864 R. H. Kay, and A. T. Richardson, Mobberley, improvements in manufacture of crape.
865 J. Sawyer, Alma-street, New North-road, London, N., and J. Brindley, Sunnyside-house, Chingford, improvements in furnaces
866 S. Bateman, Asnieres, apparatus for measuring card filleting whilst making
867 G. A. Buchholz, Regent's-park, machinery for manufacturing semolina
868 R. Cambridge, Bristol, improvements applicable to steam boilers or generators
869 T Claridge, Bilston, and J. Jeavens, Sheffield, armour plates
870 W. R. Lake, improvements in turbine water-wheels.—A communication
871 L. Watson and J. Hall, Craven-street, Strand, registering goods raised or lowered in breweries, and other buildings
872 W. R. Lake, preparation of ammoniated sulphuric acid.—A communication
873 A. Baumann, Heilbronn, steam engines
874 T. Gibb, and C. Gelstharp, Jarrow-on-Tyne, smelting copper and other metals
875 T. Gibb and C. Geltsharp, Jarrow-on-Tyne; extracting copper from ores
876 T. J. Smith, of Robertson, Brooman, and Co., 166, Fleet-street, new docimastic process for treatment of simple and complex sulphurets and the arsenic sulphurets of lead, antimony, copper, and iron, as well as coppery matts and coppers containing precious metals, to extract silver and gold therefrom.—A communication.
877 W. R. Thomson, Glasgow, improvements in locks, latches, or bolts
878 E. T. Truman, Old Burlington-street, improvements in treating and preparing gutta-percha
879 R. F. M. Harcourt, 9, Essex-street, Forest gate, Essex, improvements in fastening railway carriage doors
880 J. Cross, Bristol, propelling vessels
881 J. Townsend, Glasgow, obtaining and applying iron and manganese protoxides in utilising bye or 'waste' products in the manufacture of chlorine, copper, and alum
882. B. Hunt, 1, Serle-street, Lincoln's-inn, valves.—A communication.
883. A. Dixon, Railway-place, Fenchurch-street, railway or other season tickets
884 C. Jean, Paris, weighing cart
885 W. R. Lake, improvements in valves.—A communication
886 W. Ramsden, J. C. Pearce, and B. Ayrey, Bradford, apparatus for sorting wool
887 A. Angell, Rio de Janeiro, heating and delivering metal bars. —A communication
888 W. H. Grassam, Spalding, improvements in horseshoes
889 C. D. Abel, 20, Southampton-buildings, machinery for grinding and polishing saws.—A communication
890 J. C. and G. Watson, Leeds, machinery for making dip candles
891 T. J. Smith, Robertson, Brooman, and Co., apparatus for regulating driving of millstones.—A communication.
892 A. Dickinson, Hartshill, Stoke-upon-Trent, W. W. De la Rue, Bunhill-row, besique markers
893 J. C. Morgan, H. Macaulay, and F. W. Waide, Rotherham, register stoves.
894 W. Dobson, Stockton-on-Tees, apparatus for cooling liquids
895 W. Bailey, Wolverhampton, brewing
896 J H. Johnson, extracting moisture from peat, clay , and other materials
897 A. M. Clark, 53, Chancery-lane, rotary printing machines
898 J. W. Perkins, Herne-hill-road, fuminating compound
899 R. Smith, Manchester, doubling and winding yarns and threads
900 J. Hopkinson, Lower Town, near Keighley, and R. Newton, Engineer, spinning and twisting fibrous substances
901 J. Sampson, and R. R. Minton, Liverpool, improved varnish paint
902 W. Gray, and T. Biggin, Sheffield, metal bushes for casks or barrels
903 S. P. Baker, Whitton, near Hounslow, locking and unlocking gates on railways
904 J. H. Johnson, 47, Lincoln's-inn-fields, wrenches.—A communication
905 A Nicole, Soho-square, improvements in lever escapements
906 W. R. Lake, improvements in anchors.—A communication
907 W. E. Newton, 66, Chancery-lane, improvements in pumps.—A communication
908. J. S. Davies, and W. E. Yates, Manchester, looms.
909 O. H. Weed, Boston, U.S.A., combined washing machine and ironing table.

PATENTS BEING PROCEEDED WITH.

3297 G. R. Mather, giving form to wood
3306 J. Garrard, buffers
3307 W. Niell, Lancaster, Engineer, blast engines
3312 S. J. Mackie propulsion of vessels
3324 C. Faure, galvanic batteries
3328 H. A. Hammond, improved chimney cowl
3429 G. Petrie, brick and tiles and manure
3334 T. E. Lundy, and J. L. Dunham, improved means of communication between passengers
3340 W. and M. Bayliss, cast-iron earth screws
3343 W. J. and F. W. Edmondson, engraving cylinders used in printing
3346 H. Wilson, lubricating apparatus
3347 B. Giuseppe, boilers
3353 T. R Hetherington, machinery for preparing, spinning and doubling cotton
3354 D. Morgan, lubricating oil or grease
3355 T. F Lynch, bottles for holding poisons
3356 W. R. Lake, distributing type
3360 S. L. Loomis, apparatus for tightening and holding window sashes
3364 R. Wilson, hydraulic presses
3367 J. Bourne, improvements in gauges
3373 J. Thomlinson, cements
3376 H. A. Bonneville steam-boiler supply cock
3377 H. A. Bonneville, improvements in electro-metallurgy
3378 H. A. Bonneville, electric batteries
3380 J. E. Croce-Spinelli, propelling and steering vessels
3381 E. Round, indicator for marking games
3392 W E. Gedge, improved system of hydraulic traction
3397 J. Turnbull, connecting and disconnecting carriages and waggons
3398 S. Chatwood and T. Sturgeon, apparatus for forcing and drawing fluids
3402 P. C. Evans, apparatus for fibrous materials to carding or other machines
3404 T. Richardson, forms, desks, or tables
3410 A. McDougall, blacking
3415 W. E. Gedge, powder for destroying the oidium in vines and other plants
3419 J. and W. Fletcher, mortar mills
3432 A. Barclay, improvements in condensers
3444 S. Fox and J. Refitt, boring, turning, and polishing treenails, bobbins
3517 A. Ripley, pipe wrench
3520 S. Chatwood, escape valve
3562 W R. Lake, improvements in vices
3570 W. E. Gedge, velocipedes
3645 A. M. Clark, manufacture of superphosphate of lime
219 F. Kohn, extracting juices from plants
553 H. Bessemer, lessening or preventing sea-sickness
569 J. Saxby and J. S. Farmer, locking or securing railway points and signals
594 C. W. Siemens, treating iron ores
658 E. Stevens, apparatus used in cooking
696 J. Neilson, hollow cast-iron cooking utensils
711 J. Jeavons, armour plates
725 H. A. Bonneville, machines for setting types
736 J. Polson, treating grain
775 G. Holdsworth, preparing designs on ruled design paper for manufacturing purposes
780 J. T. Walker, horseshoes
782 W. R. Lake, forming trenches or ditches
819 G. W. Fox, treatment of medicinal oils, to render the same palatable

All persons having an interest in opposing any one of such applications are at liberty to leave particulars in writing of their objections to such application at the office of the Commissioners before the ·9th of April, 1870.

PATENTS SEALED.

2612 J. Porteous and H. Gibson, manufacture of tobacco
2805 R. Harlow, improvements in valves
2810 T. R. and T. W. Harding, leather driving bands
2815 J. Taylor, bradawls
2816 W. Whiteley, apparatus for roving and spinning fibrous substances
2823 H. Y. D. Scott, improvements in kilns
2835 H. Hughes, reducing metal rods, bars, or tubes
2837 J. Anderson, improvements in treating maize
2839 H. Woolf, hat brims
2846 J. Dewe, construction of locks and indicating number of times lock has been opened
2849 F. S. Barff, utilising vapours arising from furnaces
2872 F. Grau, improvements in lamp sockets
2880 C. Montagu, improvement in umbrellas
2882 A. Brooman, liquid meters
2886 B. Baugh and B. Walters, ornamenting bricks
2964 W. Bennett and J. Currall, improvements in kitchen ranges
3040 A. V. Newton, a sacking for bedsteads
3131 W. E. Newton, improvements in drawing frames
2856 A. J. Ell and H. Sawahn, apparatus for registering distances travelled by vehicles
2864 C. A. Maugin, silvering looking-glasses
2889 T. W. Bunning, and W. Cochrane, apparatus used in getting minerals
2949 A. Welch, cattle trucks
2967 W. R. Lake, permanent way of railways
2973 J. Smith, timing ships' logs
3005 W. R. Lake, improvements in sewing machines
3036 C. E. Spagnoletti, apparatus for signalling
3039 A. Welch, cattle trucks
3095 J. H. Johnson, adhesive compound for stamps
3163 R. Bianchi, cartridges
3311 A. M. Clark, boring tools
3363 H. F. Shaw, cutters for mowing machines
3497 J. Smith and T. Eastwood, working and reversing valves of engines
3544 J. S. Robertson, improvements in horse-shoes for frosty weather
3680 F. Ellershausen, and T. Wehle, apparatus for utilising the force of the waves
22 C. Wyndham, apparatus connected with bicycles
64 B. Brown, improvement in machinery for spinning fibrous substances
109. J. Cross, frames of umbrellas and parasols
190 W. E. Newton, of Middlesex, Civil Engineer, for an invention of preparation of natural substances, to render them applicable for use in journal boxes
25: W. R. Lake, improvements in lawn-mowing machines
266 C. H. Perham, hinges
268 J. H. Johnson, sewing machines
284 J. H. Johnson, improvements in motive power engines
287 B. Latchford, spur boxes
299 C. Vero, hats, caps, and other coverings
332 A. M. Clark, printing presses
384 G. W. Wigner, purifying sewage

PATENTS ON WHICH THE STAMP DUTY OF £50 HAS BEEN PAID.

806 R. Moreland, constructions of floors and rooms for buildings
834 G. Little, combing fibrous materials
846 J. and A. Gamgee, preservation of animal and vegetable substances
924 P. Shaw, an improved air engine
866 W. Clark, improvements in breech-loading fire-arms and cartridges
892 G. R. Postlethwaite, improvements in the manufacture of screw nuts and washers
901 J. Werndl, fire arms
911 D. Foster and R. Cooke, casting of Bessemer steel hoops for the tyres of railway wheels
859 G. Davies, rotary digging machines
861 J. Johnson, textile materials
863 A. Wyley, breech-loading fire-arms, and bayonets
874 E. O. Greening, iron and continuous fencing
886 G. E. Donisthorpe, getting coal and other minerals
907 W. Crighton, preparation of fibrous materials
922 E. H. Aydon and E. Field, smelting iron and other ores
927 W. Easterbrook, railway points and signals
933 W. Bywater, drawing, spinning, twisting, and laying of hemp, flax, &c
1034 W. P. Butchart, treating and softening jute, hemp, flax, and other fibrous substances
917 G. A. Buchholz, manufacturing semolina
918 J. Howard and E. T. Bousfield, machinery for cutting and spreading grasses
1004 J. H. Barker, improvements in milling machines
1064 J. H. Player, phosphorus
891 E. W. Shirt, plane irons

PATENTS ON WHICH THE STAMP DUTY OF £100 HAS BEEN PAID.

770 G. Davies, improvements in wrappers or papers for needles
769 J. Reilly, lubricating shafting and bearings
779 J. H. Worrall, producing surfaces in imitation of wood
942 J. Smith, furnaces and boilers

The English Mechanic
AND
MIRROR OF SCIENCE AND ART.
FRIDAY, APRIL 15, 1870.

HINTS TO ASTRONOMICAL STUDENTS.

(Continued.)

WE have in the preceding papers discussed various preliminaries with which it seemed desirable that the young astronomer should be acquainted, but we have not yet advanced so far as the actual trial of the instrument; nor indeed are we even now in a position to attempt it fairly; for before we can use satisfactorily even the most suitable tests for the purpose, we ought to be acquainted with the exact nature of telescopic definition. Unless we have formed correct ideas as to this point, so as to know the degree of perfection which we have a right to look for, we may either (as the writer was in his young days) be subjected to disappointment from the unreasonableness of our expectations, or satisfy ourselves too readily with first appearances, which may not be borne out by a further acquaintance with the instrument.

The peculiar character of telescopic vision is *immediately* dependent on the nature of light *itself*, the laws of which, as fixed by the Great Creator, impose an unvarying limit on the degree of perfection to which the finest human workmanship can attain, for it is a demonstrable fact that even if the optician's skill could unerringly realise the formula of the mathematician, the focal image would not be an absolutely perfect optical reproduction of the object from which it is derived.

This may appear strange, but it is a necessary *consequence of the undulatory nature of light, consisting of vibrations of exceeding but still finite* and even measurable minuteness. It might be possible to form an idea of light which would fulfil the condition of perfect telescopic vision, namely, that every point and line in the object should be represented by an exactly corresponding and similar point and line in the focal picture. But this would not be in accordance with the actual law by which He who said "Let there be light, and there was light," has seen fit to govern *its* emission and propagation. In consequence of that law, as was very ably pointed out many years ago in the "Cambridge Philosophical Transactions" by the present Astronomer Royal, every pencil of light transmitted by a lens or reflected by a mirror is affected in converging to a focus by what is called the "interference" of its undulations. This interference is the necessary result of its having an external boundary, whatever the form or dimensions of that boundary may be. In practice it arises at the edge of the brass cell, but if the cell were removed, it would be equally produced at the edge of the lens or speculum, and cannot possibly be prevented or avoided, being the direct result of the employment of a limit in any way to the pencil of rays. Hence it follows that every focal image, no matter how it may be obtained, must exhibit the effect of the interference of undulations. This effect, though very minute, is not beyond the reach of investigation by modern analysis, and the inquiry, as conducted by Professor Airy, has led to the following result.

The image, whether reflected or refracted, of a luminous point—we will say the image of a star, for it is well ascertained that this possesses no sensible magnitude—is not a point, but a circular luminous disc of a certain calculable diameter, surrounded by a number of bright rings. The angular dimensions of the whole will depend on nothing but the aperture of the telescope, and will be inversely as the aperture. The intensity of the light of the central disc decreases rapidly from the centre: the intensity of the brightest part of the first or innermost ring is $\frac{1}{57}$ of the centre of the disc: that of the second ring $\frac{1}{240}$ of the centre: that of the third ring $\frac{1}{620}$. A patch placed on the centre of the lens in some degree changes the character of the aberration, diminishing the magnitude of the disc, and increasing the brightness of the rings, while it somewhat diminishes their magnitude. Such are the deductions of theory. It is now easy to see what we may expect to find in practice, as far as the trial of a telescope on the fixed stars is concerned.

The whole optical phenomenon is of small dimensions, and therefore demands the use of a certain amount of magnifying power, which must be determined in each case by experience, as it will vary with the aperture. If an insufficient power is employed, the image of a large star will be a sparkling, flashing point, the real character of which will not be apparent for want of sufficient angular value. As we increase our power we shall gradually find the general blaze of light develop itself into a disc of appreciable magnitude in the centre of several rings, more or fewer according to the brightness of the star, and we shall then be able to form an idea of the degree of perfection to which the workman has been able to attain. Beginning with such stars as Sirius, Wega, Arcturus, or Capella, we shall find, with a sufficient power, and in steady air, which is a very essential condition, a considerable "spurious disc" with a succession of rings, which, if the materials are homogeneous, and the centering correct, will appear circular and concentric; any material irregularity in form would probably indicate unequal density in the glass, or inaccuracy of workmanship, neither of which could be remedied; if the rings are merely thrown to one side, the fault may lie in the centering, and admits of being rectified. For a complete illustration I need only refer to a woodcut in the number for February 11, 1870, occurring in one of the articles of "F.R.A.S." whose most important and valuable contributions are, I am happy to see, duly appreciated by the readers of the ENGLISH MECHANIC. As we proceed to examine in succession stars of less brightness, we shall find a decrease in the magnitude of the disc and the number of the rings, till at last with minute objects the latter disappear entirely, and the former is reduced to a mere point. This, it will be at once seen, is in strict accordance with theory. The difference is simply a subjective one, that is, depending on the power of the eye to distinguish feeble degrees of light. The phenomenon exists alike in the case of every star, but the larger ones alone possess light enough for us to recognise it in anything like its completeness; as the brilliancy of the object diminishes, both the external rings and the edges of the disc become too feeble to be distinguished, till at length the centre of the disc alone retains light enough to affect the eye. It is satisfactory to find so intelligible an explanation of what might have otherwise seemed very anomalous—that the telescopic discs of the stars should appear of such very different magnitudes, though we know, from their gradual reduction through passing clouds, and their instantaneous extinction when concealed by the moon, that even the largest of them are still of no sensible dimensions.

Another, and a very important modification of the result of interference has to be taken into account, and in so doing we shall find a fresh agreement between theory and practice. It has been already stated, as part of Professor Airy's result, that the proportional amount of interference will be greater as the aperture is less; or, which comes to the same thing, the diameter of the spurious disc will be inversely as the diameter of the object-glass or speculum: and this is experimentally found to be true. The more we enlarge our aperture the smaller we shall find the discs, and hence arises the great superiority in separating close double stars, which, with equal perfection in other respects, large telescopes possess over smaller ones. We have a very remarkable instance of the accordance of theory with observation, as well as a striking proof of the extraordinary approximation to the limit of perfection which optical skill has now attained, in a series of experiments conducted by one of the first observers of the day, Mr. Knott, the fortunate possessor of a 7½-inch Alvan Clark object-glass. The following table contains a mean of numerous observations on several of the larger stars, showing at once the progressive increase of disc with the diminution of aperture, and the correspondence of theory with observation ("R.A.S. Monthly Notices," vol. xxvii., No. 5.)

Aperture in inches.		Disc calculated. ″		Disc observed. ″
7·33	......	0·752	......	0·693
6·00	......	0·920	......	0·870
4·95	......	1·113	......	1·120
4·00	......	1·380	......	1·487
3·00	......	1·840	......	1·862
2·00	......	2·760	......	2 572

The earliest acquaintance with this result of interference seems to have been obtained by Hevel (a name frequently Latinised into Hevelius). The worthy old burgomaster was, however, completely misled by his own experiment. By stopping down his object-glass to a working aperture of the size of a *large pea*, he succeeded in expanding the discs of the brighter stars into circles of notable diameter, and in his simplicity rejoiced in the idea that he had rendered their real dimensions visible. Who first pointed out this curious mistake I do not know; but it was not likely to pass long unchallenged, since a little acquaintance with focal images is sufficient to show that the smaller they are, the more perfectly they represent the object. He did, in fact, purposely that which every modern optician as studiously avoids—enlarging instead of reducing the spurious disc.

The Astronomer Royal's theoretical result, that the diameter of this factitious appearance depends upon aperture alone, has not been universally admitted. A few years ago, Steinheil, the celebrated German optician, who has attempted to rival the work of the Optical Institute in the same city of Munich, asserted that the magnitude of the spurious disc depended in part also upon focal length. This idea, however, has not been sanctioned by English mathematicians; and our great observer, Dawes, than whom few men have been more practically acquainted with telescopes, has expressed himself as entirely satisfied of the certainty of Airy's conclusion.

From this, of course, follows the known fact that, with equal materials and workmanship, the dividing power of telescopes, or their capability of separating very close double stars, varies as their aperture. Some differences may be found among amateur astronomers on this head, which, if not duly taken into account, may perplex the student. He may possibly hear assertions made in all good faith in some quarters which elsewhere may be looked upon with suspicion. But experience should give a lenient tone to criticism. Many allowances require in fairness to be made among the observing brotherhood, who ought to look upon each other's assertions in a candid and generous spirit. We must bear in mind that, first of all, differences of natural vision must enter into the result. I well remember one night when I had the especial pleasure of visiting Mr. Dawes's observatory at Hopefield, provided at that time with a splendid 8¼-inch Alvan Clark achromatic, that his eagle-eye rapidly picked up Enceladus, the closest but one of the satellites of Saturn, in a spot where I could make out nothing; and yet my own is a fair average sight. Then, again, differences in the state of the air influence very largely any result of this kind, as a little experience, or the perusal of the works of Sir J. Herschel or Dawes, will abundantly prove. And, thirdly, there are differences in judgment. One observer may consider division completely effected when he sees a dark line crossing an elongated disc; while another, following the guidance of Dawes, looks upon such a line as a mere interference result, though of course the precursor of separation; and restrains the latter term to the appearance of black sky between uncompressed circular discs.

However, while we endeavour to practise in this, as well as other matters, the mutual forbearance required from sensible and well-informed men, not to say Christians, there must of course be a limit—a *maximum* of performance—beyond which all claims must be rejected as the offspring of mistake or imagination. And this limit is supplied by the consent of two unimpeachable authorities; the one in the manufacture, the other in the use of telescopes. It has been asserted, and probably with correctness, that Dallmeyer's standard of performance is obtained by dividing 4·33 by the aperture in inches, the quotient expressing in seconds the central distance of the stars which ought to be just divided. On the other hand, Dawes tells us that having ascertained about five and thirty years before (this was written in 1867), by comparisons of several telescopes of very different apertures, that the diameters star-discs varied inversely as the apertures, he examined with a great variety of apertures a vast number of double stars, whose distances seemed to be well determined and not liable to rapid change, in order to ascertain the separating powers of those apertures: and he thus determined as a constant that a 1-inch aperture would just separate a 6 mag. pair at 4″·56 of central distance (it will be observed that the consecutive *run* of these figures fixes them on the memory); and hence the separating power of any aperture *a*, in a moderately-favourable atmosphere, will be expressed by the fraction $\frac{4''\cdot56}{a}$. The quotient thus obtained concurs with Dallymeyer's result even more closely than could have been anticipated, when we bear in mind the influence of what astronomers call "personal equation," or the unavoidable differences in eyes and habits of observation. I once heard the celebrated Alvan Clark assert, in very exact agreement with these formulæ, that a 4-inch object-glass ought to divide 6 mag. stars to 1″.

This standard, in conjunction with a table of the distances of double stars, will enable the young observer to form a fair opinion whether his instrument is up to the mark. But here, again, a caution must be interposed. Many test-objects, otherwise perfectly suitable, are variable in distance, some from binary character, others possibly from differences of proper motion; and it therefore becomes important either to make choice of pairs whose relative fixity is pretty certain, or to depend only upon recent measures; which are not always of ready attainment. η Coronæ, 36 Andromedæ, and that formidable object ζ Cancri (which I saw beautifully, though in very unsteady air, March 31, with 450 on my 9-inch mirror) belong to the changeable class: ε Boötis, 52 Orionis, π Aquilæ, ζ Boötis, η Orionis, and γ^2 Andromedæ (here arranged in order of distance) are much more available as showing apparent fixity. Another consideration, too, should not be omitted. The eye (a bad photometer) takes little, if any, cognisance of the progressive decrease of illumination from the centre of the spurious image, and regards the disc as a flat luminous spangle, giving rise to the old comparison of an unequal pair in a good telescope to a shilling and a sixpence on a piece of black cloth. Yet that an actual diminution of light towards the edge does take place, as required by theory, is shown by the fact that the discs appear somewhat smaller and more separable on the background of a daylight or even twilight sky, as well as from their not being proportionally enlarged with the increase of magnifying power. This latter circumstance, favouring the separation of close pairs, had been detected by the penetration of the elder Herschel as far back as 1782, though, as the theory had not then been investigated, he was probably not aware of the cause. This, however, is sufficiently evident. If we suppose a light of such an intensity that when reduced to one-fourth of its present brightness, it would cease to affect the eye, the doubling of the linear magnifying power, by spreading it over four times the surface, will render it invisible; and thus the edges of the disc will gradually be diluted so as at last to be imperceptible. It must be admitted that this is not quite in accordance with the evidence of sense, which gives to the discs in a good telescope such an appearance of uniform brightness; but it is the only explanation to which we can have recourse. And from this it evidently follows that in employing the formulæ of Dawes or Dallmeyer, regard must be had to the degree of magnifying, as well as to the brightness of the stars to be examined.

The subject has grown upon my hands, but I trust the readers of the ENGLISH MECHANIC are not yet quite weary of it, as it is still not exhausted. Before closing this paper I will add a few remarks on the great telescope at Wandsworth Common, as to which a correspondent made an inquiry some time ago. Of its present condition I know nothing; but when it was new, in 1852, I went to see it, armed with an order from the late Mr. Gravatt, C.E., to whose good nature I was indebted on several occasions. I reached the spot in splendid moonlight late in the evening of October 27, when, as the instrument was then an object of attraction, I had expected to find a number of visitors; I was, however, mistaken in this; no one had come, the outer gate was locked, and the attendants were preparing for their rest; however, on the production of my order they were very obliging, and showed me every attention. The following were the dimensions then given to me:—Height of tower, 64ft.; diameter, 15ft.; thickness of walls, 1ft. 2in.; whole length of telescope (including dewcap), 85ft.; dewcap, 6ft. 2in.; metal tube, 76ft. 6in.; focal length, 77ft.; diameter of widest part of tube, 4ft.; weight, about 3 tons. It was slung in a chain at the thickest part, which was considerably nearer to the O. G. than to the eye-end; the chain passing over the roof, which turned in azimuth with the tube, and carrying a cubical iron box as a counterpoise on the other side. The eye-end of the tube rested on a moveable frame running towards or from the tower on a wooden railway; the outer end of this in turn ran on a circular iron rail encompassing the tower, at a distance of 52ft. The movements, which had, I believe, been arranged by Mr. Gravatt, struck me as simple and easy, considering the bulk and weight of the monster. The O. G., 2ft. in diameter, had its centre stopped out by a 12-inch disc: and I saw no other powers in use but 120 and 240; the latter very bad from wrong adjustment. With the former, little could be said in praise of the O. G. The view of Saturn and his retinue was, of course, brilliant and impressive, but on the whole the instrument could not be considered a success: at the same time, the spirit of such a magnificent enterprise went far to disarm criticism. It was, I think, understood at the time that the chief fault lay in the spherical aberration, but that one or both of the lenses had been worked too thin to admit of further correction. If the apparatus is still in good condition, might it not be practicable to replace the O. G. by a better one, of the same focal length, but smaller aperture, say 12 inches? the cost of which, as well as of necessary attendance and repairs, might be defrayed by an extensive subscription of small individual sums, each subscriber having the privilege of making use of the instrument. This is, perhaps, not a promising scheme; but the idea is thrown out in the hope that some one may improve upon it, and devise means for giving efficiency to the really valuable portion of so noble an undertaking.

A word in conclusion as to Dr. Ussher's excellent "Advice." I had no idea that these lines proceeded from so venerable a source. They were given to me many years ago by Mr. Lawson, then of Hereford, subsequently of Bath, the proprietor of a very fine 7-inch Dollond achromatic, bequeathed by him to the Greenwich Naval School. Some of our readers may perhaps be able to give an account of the present condition and employment of this instrument, one of the finest and most expensive of its day, and which I have several times used with great pleasure in bygone years. But to return to the verses: my edition is somewhat different, and I think with an evident improvement in the sense; the last four lines running thus—

Not that imparted knowledge doth
  Diminish learning's store,
But books, I find, if often lent,
  Return to me no more.

T. W. WEBB.

ELECTRICITY—ITS THEORY, SOURCES AND APPLICATION.

By J. T. SPRAGUE.*

(*Continued from page* 27.)

IN order to examine intelligentlythe wide and interesting subject of Dynamic Electricity or Galvanism, probably the most convenient process will be to commence with a few leading facts and principles, then describe the various forms of battery derived from them, the instruments necessary to examine the actions of the current, and by their aid trace out the general laws and fundamental principles of the science, after which the applications of the force of which the nature has been thus examined will become far more intelligible than by piling up isolated facts, or describing mere processes, however practically valuable. For the same reason, matters of mere history of discovery, however interesting in themselves, will be left unnoticed unless they throw light upon the subject itself.

101. If we place a piece of ordinary sheet zinc in a dilute acid, we find that a tumultuous action takes place, the zinc is dissolved, and hydrogen gas is given off. Another effect is produced which is seldom set forth as it requires when this fundamental experiment is stated, as it of course is in every work on electricity—as the zinc dissolves, the liquid becomes heated. Now this last fact is the one of primary importance; for with all the similar facts in chemistry, it teaches us that whenever an action takes place spontaneously between two substances, heat or force is set free. Let us examine, though only cursorily, as it must be very carefully treated hereafter, what occurs in this instance, and why it occurs. The old explanation, and one even now commonly given, is that the zinc decomposes water, H_2O, gives off the hydrogen and forms oxide of zinc, ZnO, which is then dissolved by the acid, forming a salt of zinc. The true explanation is far more simple; the acids are substances in which hydrogen forms the base, united with a special acid radical; hydrogen, though a gas, and one which has never yet been liquefied has many chemical analogies with the metals, and indeed, there is good reason to believe that it is a true metal, and capable of assuming the solid metallic state in alloy with some other metals being then a conductor of electricity, and displaying the ordinary physical characteristics of metals. At all events, metals are capable of taking its place in compounds; and thus in the case under consideration, say of zinc acting on dilute sulphuric acid H_2SO_4 the metal simply displaces the hydrogen and converts the substance into $ZnSO_4$, sulphate of zinc, instead of sulphate of hydrogen. If we ask, Why does this occur? the ready reply is, because the affinity of zinc for sulphuric radical is stronger than that of hydrogen; but this is merely stating the fact itself again in more high sounding words: it is no explanation, because all we know about affinity, as it is called, is simply that the facts it expresses occur; because if we ask Why is the affinity of zinc greater than hydrogen? the only and usual answer would be that it is so because it displace the latter, thus working in a vicious circle.

102. It is requisite to clearly understand that besides the material elements, *force* enters into the constitution of all bodies; all possess a specific quantity of what we know as heat, and according to the molecular theories, the atoms of which all substances are composed are in a constant state of internal motion; the amount of that motion governing the physical state, as solid, liquid, or gaseous, and also the chemical relations; affinity is, in fact, a function of these motions; the less the motion, the nearer the atoms approach, and the greater the attraction they exert on each other. Hence, when what are called *higher affinities* come into action, the internal motions are diminished; but, as a consequence, this motion becomes external, active and sensible, instead of internal or latent; and thus it is that every act of chemical combination sets free force in some form, usually as heat, while every act of chemical decomposition requires the supply of force to re-establish the internal motions, or latent forces, or, as it is usually expressed, to overcome the chemical affinities.

103. Thus when our zinc is dissolving it gives off hydrogen and heat while forming the more satisfied compound, sulphate of zinc. If we use a piece of iron it does the same, but if we use copper no action occurs, at least to any appreciable extent, but if we use nitric acid the copper is dissolved. Now, if we place in the same sulphuric acid, copper and zinc, but separate from each other, we see gas pouring off the zinc and not from the copper, but if we permit them to touch a new phenomenon occurs. The gas appears to issue abundantly from the copper; still if we examine the liquid we find that no copper is dissolving, while the zinc is dissolving faster than before. Instead of allowing the two metals to touch within the liquid, we connect them by a wire, and we find that this wire is suddenly endowed with extraordinary properties; if it approaches a magnetic needle the earth's directive power is superseded, and the needle no longer points N. and S., but places itself across the wire, and in different directions, according as it is above or below; if the wire be coiled round a piece of iron, it is endowed with powerful magnetic properties; if the wire be cut in two, and its ends dipped in liquids, it produces chemical changes in many of these; lastly, the wire itself becomes hot. But in proportion as these effects are developed, so does the dissolving zinc generate less and less heat in the liquid. Here we have the expla-

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* Sigma

ation of the source of these external actions; there is no creation of force, nothing new occurs except that under the new conditions the force set free by the combination of the zinc takes that form which we call electricity, instead of the other form we call heat, and is capable of manifesting itself by its magnetic, chemical, or calorific effects, thus furnishing the three natural divisions of the study of dynamic electricity.

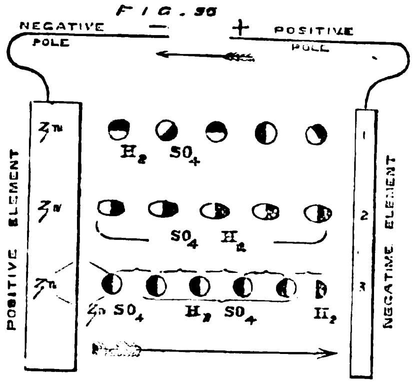
104. The conditions under which the force takes this form are a development of those pointed out in Section 26 under Static Electricity, but more plainly evidenced. The fundamental condition is a complete circuit of molecules, and the whole of conducting substances; where the electricity is developed by chemical action, part of the circuit must be a liquid—an electrolyte, that is, a substance whose molecules will readily assume the condition of polarity, and break up into two distinct parts.

This action occurs under the influence of the zinc, which, as it attracts the sulphuric radical, turns the hydrogen half of the molecule away from itself, and by diminishing the internal attractions of this first molecule disturbs those of others, if there be this complete chain provided along which the force can act; if not, the hydrogen simply escapes, and the heat is at once set free. The action can be traced by the ordinary chemical symbols. $Zn + H_2SO_4$ must evidently first become $Zn + SO^4H_2$, then $ZnSO_4 + H_2$. In this case the atoms of hydrogen are what is called *nascent*, but they instantly form a free molecule, taking up and rendering latent that portion of heat or force necessary to convert them into a gas, but before this process is completed they are in a condition of great activity, and eager for combination, but as they are surrounded only by molecules, the nature of which they would not change—*i.e.*, hydrogen compounds, they are compelled to become free, but where this complete circuit of molecules capable of polarisation and discharge is provided, this action is deferred to the last; molecule after molecule is decomposed, and the hydrogen is not set free till it reaches a point at which its *nascent* energy is powerless to effect a decomposition, and thus in the combination under examination, it reaches the *copper plate* before it becomes free, and *does not do so at all* if it can help it, for if a *metallic salt is present* at the copper plate, such as *suphate of copper*, it displaces the copper, which *fixes itself* in turn upon the superficial molecules of the metallic plate, to which the polarising force is transferred.

105. These two processes furnish us with a natural division of generators or batteries into two classes. 1. Those in which the hydrogen gas is set free. 2. Those in which the hydrogen is not set free, but displaces some other substance, and this latter class consists of two kinds, those in which one liquid fulfils all the requirements, and those in which two separate liquids are required, kept apart by a porous diaphragm or partition.

Before examining these various forms, it will be as well to explain various terms as to which there is much confusion in many minds. As the action commences at the surface of contact of the zinc with the acid, the zinc is called the positive metal or element; and hence the order of polarisation originated there in the liquid is such that the positive or + ends of the molecules are turned from the zinc, and consequently all the negative ends, which are the acid radicals, are turned towards it. This also corresponds with the terms of static electricity, and shows the wire united to the zinc plate and called its pole, in the same electrical condition as the rubber of a glass electrical machine — or negative. The current passing through the liquid to the copper or other collecting plate polarises its molecules with their — ends to the liquid, and their + or positive ends towards its wire. Hence we have the zinc, the positive metal plate, or element, but its wire, the negative or — pole; the copper is the negative plate or metal, but the wire proceeding from it, the positive or + pole. Fig. 36 shows this, together with one series of the reactions shown in their successive stages. Line 1 exhibits the arrangement before action, the molecules indifferent, the shaded part here, and in all future diagrams, representing the + or metallic or basic element or half; the white being the — or acid half. In line 2 we see the molecules polarised under the attraction of the zinc; in line 3 the resulting discharge, the whole chain simultaneously breaking up, one atom of zinc forming a molecule of zinc sulphate; and at the other end of the chain, the two atoms of hydrogen, which are equivalent to one of zinc, are set free, when they satisfy each other's attractions, and together form a gaseous molecule of hydrogen. This step being reached, polarisation again takes place, the molecules making a semi-revolution, and resuming the position of line 2. It will be seen that this view of the action involves two exertions of force at each stage, first the mechanical semi-revolution of the molecules on their axes; and, secondly, the overcoming the chemical attraction within the molecules; and this latter also involves two separate actions, the actual disruption which occurs only as to one molecule of the chain, and the temporary disruption and reforming of all the other molecules in each chain. I only indicate this now because it presents itself, and because the more clearly these various principles are seen, the more thoroughly the subject will be mastered; these various actions, however, will have to be studied further on, as they constitute together the "resistance" of liquids and the internal resistance of batteries.

FIG. 36



106. That this condition of polarization or strain tending to disruption really does occur in this case is manifest, because although actual disruption can only happen when the whole chain is composed of conducting materials, yet the tension which tends to produce it exists exactly as in the cases studied under static electricity. If the two wires are connected to any condensing arrangement, such as Fig. 22, p. 519, Vol. X., the two plates will be found to exhibit electric tension exactly as if they were connected to a machine, only to a degree so feeble that very delicate condensing electroscopes are required to trace it. This indicates the existence of the complete chain, the air or dielectric between the plates of the condenser being polarised; connect the plates by a conductor, and discharge and current are produced.

107. The force generated by a chemical action depending on the degree of that action, the generating substance is best which has the greatest attraction for the radical of the acid, but practical considerations limit us to iron and zinc as the cheapest; both, however, have the drawback that they maintain their action whether we want the force they can give us or no; but pure zinc is, however, very slightly acted on, except when the conducting circuit is closed, while ordinary zinc is continuously dissolved. The reason of this difference is by no means clearly known; though it is usually attributed to the presence of foreign metals, setting up little local circuits; but it has been discovered that common zinc, when amalgamated with mercury, is not to be acted on, and this seems to render this explanation somewhat doubtful. However, a well amalgamated plate is scarcely acted on in dilute sulphuric acid, but the presence of hydrochloric acid nearly, and of nitric acid, and metallic salts, entirely does away with the protection, which appears to depend chiefly on the adhesion of a film of hydrogen gas to the surface, so preventing contact with the liquid. When the circuit is closed, the hydrogen is transferred to the negative plate, and the protection is removed while the conditions of discharge bring fresh actions into play. Amalgamation also renders the zinc a better source of electricity, as it is more positive than ordinary metal. Hence, though it is not required for protection in any forms of instrument where saline solutions are in contact with the zinc, it is an improvement in any case except the Daniells cell charged with salts instead of acid; and as zinc is used in almost all cells, its properties should be known before preparing any forms of battery.

108. Amalgamation is readily effected by thoroughly cleaning the zinc with a strong acid solution, dropping a little mercury on it, and spreading it, and rubbing with a wad of tow or flannel. Sometimes spots are very hard to act on, and may require thoroughly scraping, or first well washing with caustic soda, to remove grease. When plates are removed from a battery they should always be washed and brushed before putting away; and then is the best time to apply fresh mercury, if required. The brushings should be collected (which is easily done by setting a jar apart for the purpose of washing), as they consist very largely of mercury, which can be removed by distillation, when a quantity is collected. A superficial amalgamation is given by immersing plates in water in which a little nitrate of mercury is dissolved, or corrosive sublimate may be used.

Rolled zinc should always be used in preference to cast. The latter is very hard to amalgamate, and has less electro-motive power, but for rods for use in porous jars, and particularly with saline solutions, cast zinc is very commonly used. In this case, great care should be taken to use good zinc cuttings, removing any parts with solder on them, and using a little nitre as a flux, which will remove a portion of the foreign metals. A very pure zinc might be removed from spent battery solutions by first neutralising thoroughly with zinc cuttings, precipitating with carbonate of soda (washing crystals), and then drying and fusing with powdered charcoal, thoroughly mixed; but the process would hardly pay.

Rolled sheet zinc, from one-sixteenth to a quarter-inch thick, suitable for cylinders and plates, costs from 4d. to 6d. per pound. The simplest way to cut it to size is to scratch a groove with a steel point, such as a bradawl, run first acid solution, and then mercury along this groove, and allow it to penetrate; then repeat the process on the other side; when the metal is easily broken. Zinc possesses a peculiar property of softening with a moderate heat, so that hard and brittle as the metal is, it can easily be bent up into small cylinders, if held in front of a good fire till too hot to handle with the naked hand, and then bent round a piece of wood or metal.

(*To be continued.*)

MECHANICAL MOVEMENTS.*

(*Continued from page* 53.)

(*Illustrated on page* 76.)

16. The external and internal mutilated cog-wheels work alternately into the pinion, and give slow forward and quick reverse motion.

17 and 18. These are parts of the same movement, which has been used for giving the roller motion in wool-combing machines. The roller to which wheel F (18), is secured is required to make one-third a revolution backward, then two-thirds of a revolution forward, when it must stop until another length of combed fibre is ready for delivery. This is accomplished by the grooved heart cam, C, D, B, *e* (17), the stud, A, working in the same groove; from C to D it moves the roller backward, and from D to *e* it moves it forward, the motion being transmitted through the catch, G to the notch-wheel, F, on the roller-shaft, H. When the stud, A, arrives at the point, *e*, in the cam, a projection at the back of the wheel which carries the cam strikes the projecting piece on the catch, G, and raises it out of the notch in the wheel, F, so that, while the stud is travelling in the cam from *e* to C, the catch is passing over the plain surface between the two notches in the wheel, F, without imparting any motion; but when stud, A, arrives at the part, C, the catch has dropped into another notch, and is again ready to move wheel, F, and roller as required.

19. Variable circular motion by crown-wheel and pinion. The crown-wheel is placed eccentrically to the shaft, therefore the relative radius changes.

20. The two crank-shafts are parallel in direction, but not in line with each other. The revolution of either will communicate motion to the other with a varying velocity, for the wrist of one

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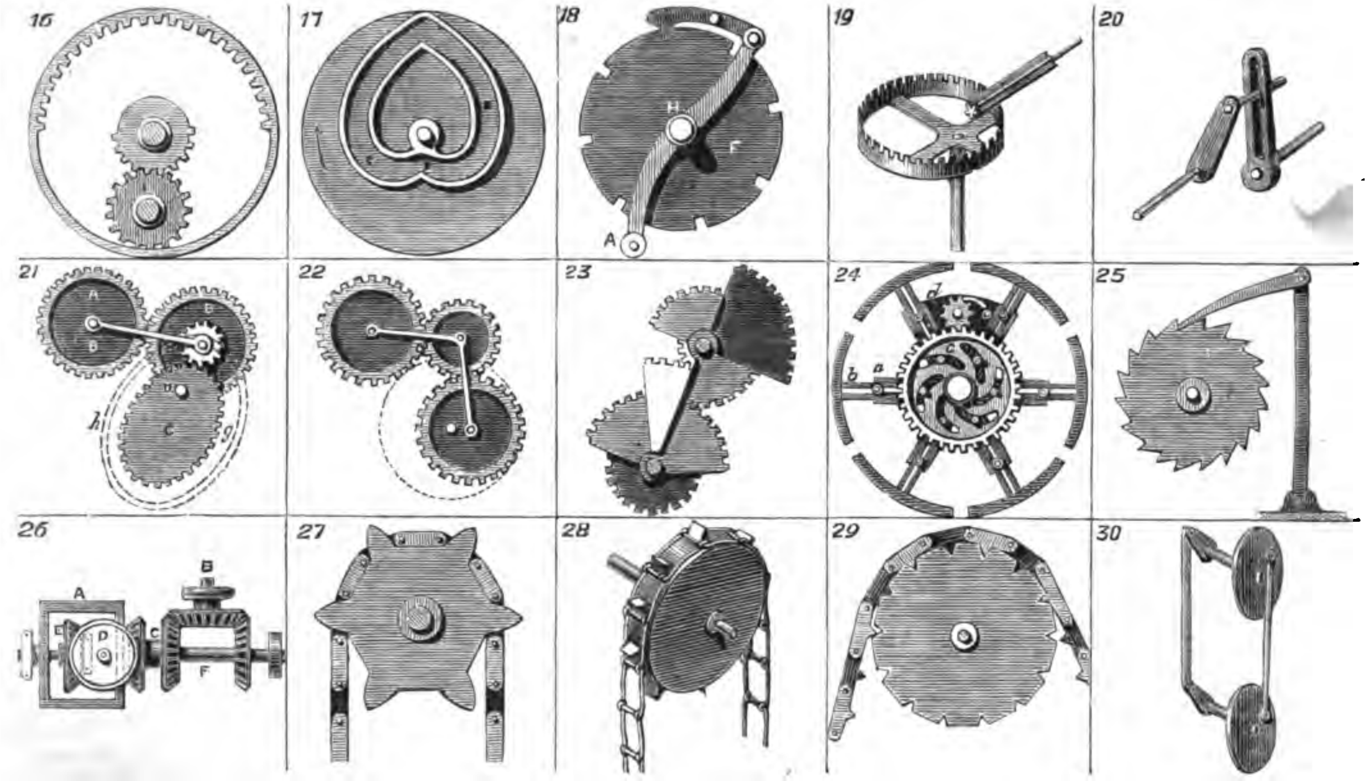
* Extracted from a compilation by Mr. H. J. Brown, Editor of the *American Artisan*.



MECHANICAL MOVEMENTS.

crank working in the slot of the other is continually changing its distance from the shaft of the latter.

21. Irregular circular motion imparted to wheel, A. C is an elliptical spur-gear rotating round centre, D, and is the driver. B is a small pinion with teeth of the same pitch, gearing with C. The centre of this pinion is not fixed, but is carried by an arm or frame which vibrates on a centre, A, so that as C revolves the frame rises and falls to enable pinion to remain in gear with it, notwithstanding the variation in its radius of contact. To keep the teeth of C and B in gear to a proper depth, and prevent them from riding over each, wheel, C, has attached to it a plate which extends beyond it and is furnished with a groove, *g*, *h*, of similar elliptical form, for the reception of a pin or small roller attached to the vibrating arm concentric with pinion, B.

22. If for the eccentric wheel described in the last figure an ordinary spur-gear moving on an eccentric centre of motion be substituted, a simple link connecting the centre of the wheel with that of the pinion with which it gears will maintain proper pitching of teeth in a more simple manner than the groove.

23. An arrangement for obtaining variable circular motion. The sectors are arranged on different planes, and the relative velocity changes according to the respective diameters of the sectors.

24. This represents an expanding pulley. On turning pinion, *d*, to the right or left, a similar motion is imparted to wheel, *c*, which, by means of curved slots cut therein, thrusts the studs fastened to arms of pulley outward or inward, thus augmenting or diminishing the size of the pulley.

25. Intermittent circular motion of the ratchet-wheel from vibratory motion of the arm carrying a pawl.

26. This movement is designed to double the speed by gears of equal diameters and numbers of teeth—a result one generally supposed to be impossible. Six bevel-gears are employed. The gear on the shaft, B, is in gear with two others—one on the shaft, F, and the other on the same hollow shaft with C, which turns loosely on F. The gear, D, is carried by the frame, A, which, being fast on the shaft, F, is made to rotate, and therefore takes round D with it. E is loose on the shaft, F, and gears with D. Now, suppose the two gears on the hollow shaft, C, were removed and D prevented from turning on its axis; one revolution given to the gear on B would cause the frame, A, also to receive one revolution, and as this frame carries with it the gear, D, gearing with E, one revolution would be imparted to E; but if the gears on the hollow shaft, C, were replaced, D would receive also a revolution on its axis during the one revolution of B, and thus would produce two revolutions of E.

27. Represents a chain and chain pulley. The links being in different planes, spaces are left between them for the teeth of the pulley to enter.

28. Another kind of chain and pulley.

29. Another variety.

30. Circular motion into ditto. The connecting-rods are so arranged that when one pair of connected links is over the dead point, or at the extremity of its stroke, the other is at right angles; continuous motion is thus insured without a fly-wheel.

(*To be continued.*)

THE TROTTING VELOCIPEDE.

THIS invention, patented by J. U. Fairbairn, of Southampton, relates to certain improvements in the construction of bicycles, tricycles, or four-wheeled machines, the objects being to dispense entirely with pedomotive and manumotive power as heretofore applied, and to operate the propulsion by a motion of the body of the rider similar to that made use of in riding a horse. The patentee proposes to apply to the cranks connecting rods ascending to pivoted junctions on oscillating levers set on bearings on the socket, through which the stem of the guiding wheel or wheels is passed, and to which socket the main bar, bars, or frame forming the body of the machine are fixed, wrought, or attached. In a bicycle this bar would extend to a fork in order to contain the trailing wheel, but in tricycles, to which this invention is more particularly applicable, a curved or semicircular extension is to be made, the extremities of which are caused to rest on the crank shaft by suitable journals or bearings. One of the oscillating levers is provided with a saddle or seat; this lever is borne above the second, which has a stirrup or foot support suspended therefrom. The rider raises himself from the saddle and rests all his weight on the stirrup, thereby throwing down the crank connected to its lever, and thus when the opposite crank has risen and is passing over its centre the rider seats himself in the saddle, which has risen to an elevated position, and consequently the crank connected to its lever is in turn forced down, and so on successively, thus propelling the velocipede by the cranks with the mere weight and motion of the body. Mr. Fairbairn also proposes to employ a three-throw axle crank to machines to be worked on the above principle. In bicycles the connecting rods would be bent or arched from the oscillating levers, and then extend vertically or obliquely to the cranks, so as to freely pass one on each side of the driving wheel, but in tricycles they would extend in a direct line to the crank shaft. The guiding handle may be of any convenient form, the transverse double handle being preferable as a steadying support. The saddle lever would be of course central in the three-throw machine, the stirrup levers working one on each side, and the angles of their cranks may be made to correspond, if desired, so that both feet may operate with equal power at each forward motion, instead of slightly in advance the one of the other, in which case, which is preferable, the stirrup rod or bearer is in one and the same line. Fig. 1 represents a side elevation, and Fig. 2 a plan of a tricycle constructed on the last-mentioned principle The hollow stem *a* through which the guiding pillar *b* is passed receives the main bar or frame *c* of the tricycle, above which on pivoted joints *d d* the saddle lever *e* and stirrup lever *f* are set; *g* is the saddle, and *h h* the connecting rods to the three-throw crank *i*, and *k* is the connecting rod from the crank to the stirrup lever *f*. In Figure 2 the form of this connecting rod is shown consisting of a bracket, through which the main bar passes, whereby a free vertical motion is afforded to the stirrups or foot bearers f_1. The bracket or compound rod k^1 is capable of adjustment on the lever *f* by means of the sliding socket k^2 and bolts and screw nuts, in order to set the stirrup bearer further from or nearer to the rider's seat. The bearer is also capable of adjustment in the slot *l*, Fig. 1, to suit the rider. The wheels may be made with iron spokes doubly dished, and set in an iron or metal nave or box, as shown, or the spokes and nave may be of wood. *m* is the

FIG. 1

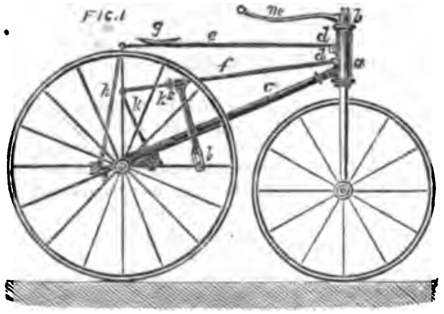
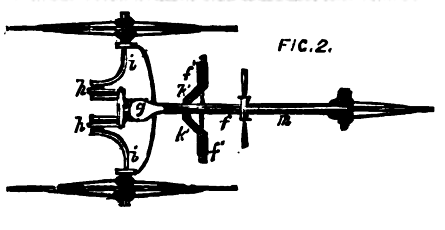


FIG. 2.

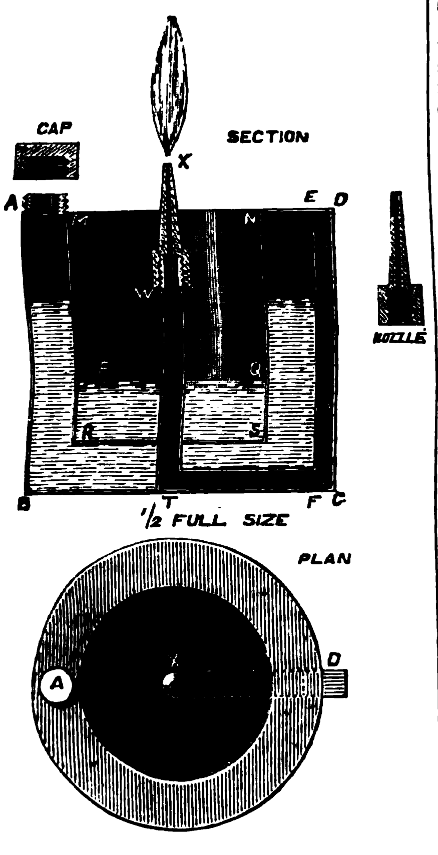


steering handle. On the same principle can also be made a tricycle with a three-throw crank, causing the two side cranks to be worked by duplicate stirrup levers and connecting rods, one on each side of and below the main bar, the stirrup bearer connecting the two transversely; the saddle lever is then connected by one rod to the central crank. The method of working is the same, but in some cases the latter arrangement would be preferred, because the pressure of the feet on the stirrup bearer would be thrown equally on the two external cranks instead of on the central crank, as first described, and consequently a greater steadiness of travel would be effected. In the application of this invention to bicycles it would be necessary to apply a double crank on each side of the driving wheel, and to bring two sets of connecting rods or levers thereto; one set from the saddle bar or lever, and the other from the stirrup bearers, the operation of working being the same.

THE "ENGLISH MECHANIC" BLOWPIPE.

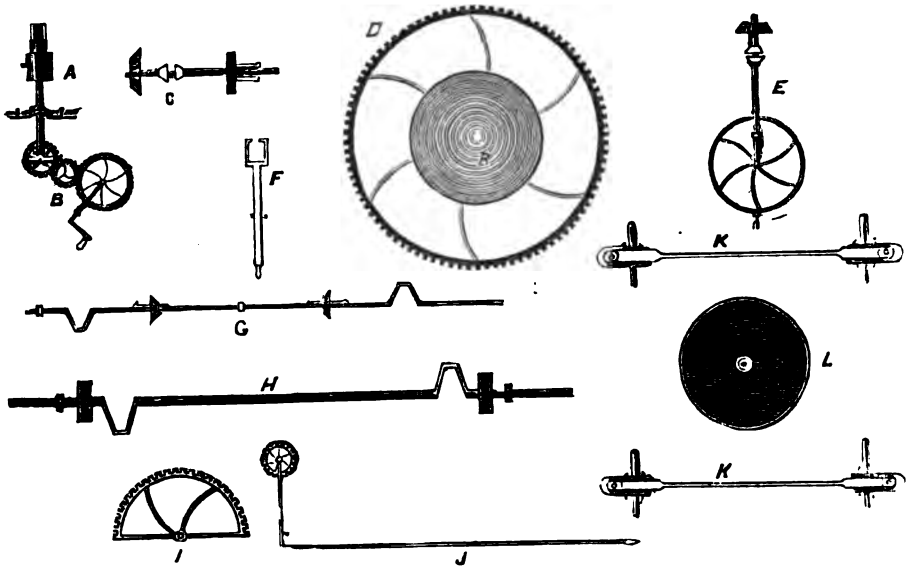
BY CAPTAIN OLIVER HALDANE STOKES (LATE) ROYAL ENGINEERS.

THIS blowpipe consists of two concentric copper cylinders A B F E and M R S N, which are brazed together. A small tube E F T W runs upon the outside of the outer vessel (as shown at D in plan) and passing along the inner surface of the bottom of the outer cylinder, is turned upwards, as at W T. The space between the two cylinders holds the spirit or naphtha to be burned, which is introduced at A. A small quantity of spirit is then placed in the inner cylinder, as at P Q. This spirit being ignited will heat the spirit in the place between the cylinders, and give a powerful jet of flames at X.



SELF-PROPELLING VEHICLES.

LETTERS PATENT have been granted to Ferdinand Constant Colney, of Paris, for the invention of "improved mechanism for the propulsion of vehicles." The patentee asserts that his automaton carriage, set on four wheels, will carry at least three persons, may travel from nine to ten miles an hour, the driving spring requires winding up but once an hour, and as this winding may be effected while the carriage is in motion, it causes no interruption of the journey. The pieces composing the improved mechanism by which he propels his automaton carriage are shown in the drawing; they are, A shaft of the driving spring; B winding up movement; C small pinion; D large driving wheel; E fly wheel; F fork; G shaft; H revolving axle on which the carriage wheels are keyed; I toothed steering gear; J steering lever; K connecting rods; L cover of spring barrel to prevent accident should the spring break; R driving spring. The shaft A of the driving spring R gives motion to the toothed wheel D, which governs the pinion C, and thus turns the shaft G. This shaft governs the connecting rods K K, which in their turn drive the revolving axle H. The pinion on the steering lever J gears with the piece I and permits the carriage being guided in any desired direction. The use of the forked piece F is for starting and stopping the machine, and the fly wheel E serves for backing or advancing the carriage. The whole of the mechanism is on the fore carriage, by the driver's seat. The carriage must be provided with an ordinary brake, to be used when required.



SELF-PROPELLING VEHICLES.

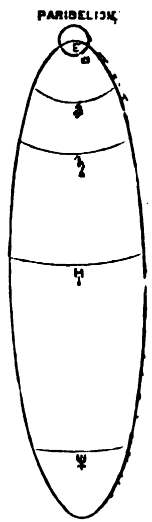
HALLEY'S COMET.

(Continued from page 51.)

BY OMICRON.

THE comet did not attain a sufficient elongation from the Sun to admit of observation till the last week of March, 1795. La Nux, at the Island of Bourbon, detected it on the 26th, and Messier on the 31st of March. On this occasion Delisle permitted Messier to give notice of his discovery, and a formal announcement of the reappearance was made on the 1st of April. The Southern Declination soon became too great to admit of observation in the latitudes of Paris, and observations were discontinued towards the end of the month. In the meantime, however, the observers of Lisbon, Toulouse, and various other places had secured valuable observations, and while the comet did not rise to the observers of Europe, La Nux, as already mentioned, in the Island of Bourbon, devoted his attention to it, and its place was also noticed by Father Cœurdoux, at Pondicherry. In the beginning of May its motion again brought the comet within the reach of European observatories, and Messier and others continued to watch it till the 3rd of June, when it finally vanished, never to reappear till that generation should long have passed away.

If our readers will take the trouble to add on seventy-seven years, which is about the average length of a revolution, they will find that about the year 1835 its reappearance might be again anticipated. Several mathematicians who were already celebrated for their analytical researches, proposed to themselves the task of computing the amount of planetary disturbance that the comet must undergo in the course of its long revolution, while hidden from the sight of the inhabitants of this little sphere. Were it admissible in a short paper like the present, it would be a pleasant task to dwell upon the power of analysis that is evidenced by the capability of following a comet in its tedious course round the sun, in a path that renders the comet so long invisible, from a few observations made at the time that it is within sight, and to be able to predict with certainty the place that the comet occupies in space, at any moment of its revolution, the time of its return, and the position it will then assume. A glance at the accompanying figure will, however, show to those that have honoured me with their attention, the difficulty of the case far more plainly than I can put it in a few words. The ellipse represents the path of the comet, the small circle at the perihelion extremity, the course of the Earth round the Sun. The comet was, perhaps, observed (roughly, as we should consider now) a short distance on either side, beyond the small circle representing the earth's orbit. The problem is to determine, from the knowledge of its motion in this short arc, the remaining part of the curve, subject, as it is, to alterations at every moment from the various planets whose arcs are shown in the diagram. All honour is due to the profound intellect and persevering industry of those who have devoted their energies to the solution of the problem, and brought their investigations to a successful issue. Let us proceed to mention those who have considered the problem, and, briefly, the means that have been employed to solve it.



So early as the year 1817, the interesting question of the perturbations of Halley's Comet began to interest the astronomers of that period. The Academy of Sciences of Turin proposed the successful investigation of this subject for their prize, and the late Baron Damoiseau was the successful competitor. Before proceeding to give an account of the method pursued by Baron Damoiseau, it is necessary to say a few words concerning the advance of analytical science since the days of Clairaut's investigation. The theory of perturbations of comets received its greatest improvement at the hands of Lagrange, in a masterly memoir, which gained the prize proposed by the Academy of Sciences, in 1780, and which may be regarded as finally settling the difficult problem. "Doubtless," says Pontecoulant, "one might wish for a method of determining these perturbations in which the numerical application could be more simple, but by the very nature of the difficulties that the question presents, it appears to me doubtful whether it will ever be attained, and that for a ong time yet the patience of the calculator will have to supply the imperfections of analysis." The method employed by Baron Damoiseau is very nearly identical with that suggested by Lagrange. It will be remembered, when hinting at the method pursued by Clairaut in this difficult subject, we pointed out that there was a difference between computing the perturbations of a comet and those of a planet, though the effect is produced by the same cause in both cases. In planetary perturbations it is possible to integrate the differential variations of each of the elements of the orbit, but, in the case of a comet, the eccentricity is so large, and the inclination to the ecliptic varies to infinity, that it is not possible to develop the disturbing function in a series arranged according to the ascending powers of these quantities, and we must forego the advantage of having, as a means of determining the inequalities of comets, formulæ, which, as in the case of planets, embrace an indefinite number of revolutions, and need only numerical substitutions to give the sought-for results. In order to integrate the differential formulæ of the elements of the disturbed orbit, recourse must be had to a method of approximation, known to astronomers as the method of *mechanical quadratures.* This method consists of dividing the curve described by the comet into small portions, in which the alterations produced by the disturbing forces on each element of the orbit can be computed. Suitable formulæ provide the calculator with the means of computing from these disturbed segments the total variation of the elements in the interval comprised between the two extremities of the arc of the trajectory that is being considered. By these means the astronomer knows the alteration of the elliptic elements of the orbit between two consecutive passages of perihilion. Of course, since the only object is to divide the path of the comet into small segments, this can be effected either by equal portions of time or equal portions of arc of eccentric anomaly. In either case, the amount of interval is left to the discretion of the calculator. The method of mechanical quadratures must be adopted while the comet is pursuing that portion of its path near the Sun, but for the parts distant from the Sun an approximate solution is obtained by supposing the mass of the Sun and planets collected at their centre of gravity, and Lagrange gave expressions by the quadration of which the process is made accurate. He demonstrated also that without considerable error, expressions may be found for these last-mentioned terms which will be integrable.[*]

Damoiseau has applied the method of quadratures throughout for equal intervals of eccentric anomaly, and computed the effect of Jupiter, Saturn, and Uranus only, from 1682 to 1835. Subsequently he calculated the disturbing effect of the Earth. In the first half of the first revolution he appears to have employed the elements deduced from the observations of 1682, and in the latter half the elements deduced from the observations of 1759. In the second revolution the elements are altered for every 30° of eccentric anomaly. These alterations do not appear to be sufficiently frequent. As the result of Damoiseau's calculations, he predicted the return of the comet to perihelion on the 4th of November, 1835, at 8h. P.M., Paris mean time.

Some years later a second attempt to determine the perihelion passage was made by Pontecoulant. In narrating the history of the calculations of this comet in a chronological order, we should have mentioned that Burckhardt computed with admirable precision the elements of the orbit from Flamsteed's observations in 1682, and Messier's in 1759. From these elements Pontecoulant endeavoured to determine the path of the ellipse that would be described in 1835. It would be to lengthen out this paper to a tedious length, to pursue the course of Pontecoulant in his elaborate calculation. His method is that of Lagrange, adapting quadratures throughout. The result to which his final calculations led him was that the comet might be expected to approach nearest the Sun on November, 12d. 17h. Paris mean time, or about a week later than the epoch assigned by Damoiseau.

But the investigation on which is bestowed the greatest care, and the one "that is most remarkable for the extraordinary completeness of its detail, for the pains taken to include every possible source of perturbation, without regard to the numerical labour, and for the masterly manner in which the whole of the vast work is conducted," is undoubtedly that of Professor Rosenberger. "So complete," remarks the present Astronomer Royal, "are the whole of these computations, that if names were taken not from the discoveries of these bodies, or from those who conjecture their identity, but from those who from accurate calculation on an uniform system, combine the whole of our information relating to them, we should call this body not Halley's, but Rosenberger's." He first, and with the greatest care, computed the elements of the orbit from all the observations that were made at the apparition in 1682. Similarly, the observations of 1759 were discussed, and from the method adopted, very great accuracy was obtained for the discussion of the next period, from 1759 to 1835. The perturbations of all the planets (Neptune, at that date, remained to be discovered) were computed with great precision, with the exception of about 60° of eccentric anomaly, when the position of Jupiter was such as to produce great disturbance, and which could not be calculated with the same admirable degree of precision without a more accurate knowledge of the comet's orbit. For these 60° of eccentric anomaly, Rosenberger assumed Damoiseau's results, and the general effect of perturbation is very accurately determined. Nor did Rosenberger forget the effect of such a medium as Professor Encke had demonstrated to exist. He computed that the effect of such medium would be to accelerate the return of the comet by about a week. The Earth hastened the perihelion passage 15¾ days, Venus about 5½ days, and Mercury and Mars together nearly one day. Including all the perturbations, Rosenberger concluded the nearest approach to the Sun would take place on November, 3d. 19h., Paris time. Neglecting the amount of acceleration, due to the existence of the ethereal medium, the time of perihelion was expected at November, 11d. 0h. Paris time.

But one more effort to determine the elements of the appearance in 1835, remains to be mentioned, that of Dr. Lehmann, which, though in some respects inferior to that of Rosenberger, yet demands very great praise. The distinguishing characteristic of the investigation lies in the fact that the computer has carried back the effect of perturbation to the apparition in 1607, adopting the method of quadratures by equal intervals of time. This additional labour was undertaken to detect, if possible, the effect of a resisting medium. The predicted time of reappearance was by this calculation later than in any other—viz., Nov. 26. The cause of the discrepancy is most likely to be found in the fact that the elements were not changed sufficiently often in computing the perturbations between 1759 and 1835; the frequency of the change, as we pointed out, is entirely at the option of the computer.

The excitement that was experienced in 1759, at the approaching return of this comet, was as nothing compared to the anxiety that was felt in 1835, to effect early observations of it. In January, 1835, Dr. Olbers published a paper in which he expressed his opinion that the comet would be visible in the spring of that year. His conclusions are based upon facts drawn from the experience of previous returns, assuming that the comet has sustained no sensible diminution of its mass. The last observation of the comet in 1759 was effected by Messier, when its distance from the Sun was about 1·68, and from the earth 1·42 (the Earth's distance from the Sun being regarded as unity). Olbers remarked that about the beginning of March, the comet's distance from the Sun and the Earth would be nearly the same = 3·78. But as the light of a heavenly body, not self luminous, is proportioned to $\frac{1}{R^2 D^2}$ (R being the Radius Vector, and D being the distance from the Earth) the comet in the beginning of March would be about 30 times less bright than when it was last seen by Messier, and, consequently, the probability of its being seen, small in the same proportion. Nevertheless, Dr. Olbers urges on astronomers the necessity of continual and careful sweeping to attempt to discover it, and to aid in its detection, computed two ephemerides on the assumption of its perihelion passage taking place at the 1st and 11th of November. This paper gives some idea of the anxiety that was felt at its approach, for on carefully going over the paper, as it lies before us, the arguments in favour of its discovery seem very small, and Dr. Olbers must have been guided rather by what he hoped than what he thought.

Aided by a powerful instrument, and the transparent atmosphere of Italy, Father Dumouchel, of the Collegio Romano, detected the expected comet on the morning of the 6th of August, close to the computed place, the error amounting to about seven minutes of arc in Right Ascension, and seventeen minutes of declination. (To such of our readers who have no idea of space measured on the sky, we may say that that distance is rather more than a semi-diameter of the moon.) Rapidly the attention of other observers was concentrated on the welcome visitor, and observations were showered in from all parts of Europe, Sir James South and Captain Smyth representing English activity on this subject. The reduction of the observations shows the 16th November to have been the day when the distance of the comet from the Sun was the least, so that the predictions of Rosenbergen were but 5 days in error, a degree of approximation that can be appreciated only by those who have been engaged in computations of that long and delicate nature. The Royal Astronomical Society of England rewarded the talented mathematician with their gold medal as an acknowledgment of his eminent services.

The comet continued visible till the 22nd of November, when its near approach to the Sun rendered observation impossible. On the 30th of December, on passing from the Sun, Kreil, of Milan, succeeded in obtaining a view of it, but the southern declination soon rendered it impossible for European observers to continue their observations. At the Cape of Good Hope, Sir John Herschel and Sir Thomas Maclear prosecuted their investigation of its path among the stars, till the middle of May, when it was finally lost sight of, till it shall appear again in 1911, when this generation shall have passed away, and its children be anticipating the infirmities of age.

(To be concluded next week.)

SCIENCE FOR THE YOUNG.

BY THE REV. E. KERNAN, CLONGOWES COLLEGE.

(Continued from page 54.)

THE definition being thus briefly explained, it remains to see how it contains the II. and III. part of the treatise on mechanics.

I. Force may be prevented from having its effects by another force. Thus in Fig. 1, the force which would cause the weight A to fall, may be counteracted by an equal weight B at the opposite end of the cord. There is then produced what is called *equilibrium.*

II. Force may be allowed to have its effect entirely, or, more or less modified. Let the weight B be removed, A falls to the ground with the full force acting upon it. Let B be replaced by a small weight; A now falls more slowly. In both cases there is produced what is universally called motion.

III. Force may be allowed to have its effect for *a short time,* to be overcome in its turn by the force which it at first overpowered. In Fig. II. is represented a coiled spring with a weight attached. The weight being raised and let gently fall, at first the spring is stretched beyond its position of rest, dotted coil; then the force of the fall being exhausted, the coils of the

FIG. 1

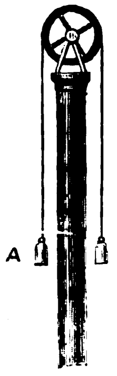
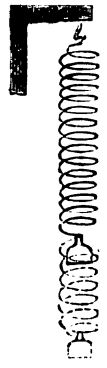


FIG. 2



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[*] Memoir Roy. Ast. Soc., Vol. IV.

spring recover that position. Again the weight falls, and again the spring recovers. This falling and rising continues until the force of the first fall is worn out, by causes to be seen later. Here is produced *vibration*.

The laws of I. are called the equilibrium; or in one word, Statics; of II., the laws of motion or Dynamics; of III., the laws of vibration; which might be entitled Palmotics. This third point, in practice, chiefly regards acoustics (sound), as shall be explained.

The three conditions of force, as above, are to be found in the solid, liquid, and gaseous state, giving new divisions; statics of solids or Statics; statics of liquids, Hydrostatics; statics of gases, Pneumatics; dynamics of solids, or Dynamics; dynamics of liquids, Hydrodynamics; dynamics of gases, Pneumatics; palmotics (acoustics) of solids, liquids, gases.

FIG. 3

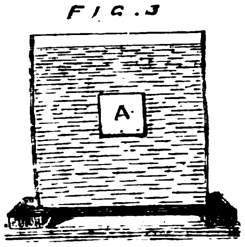
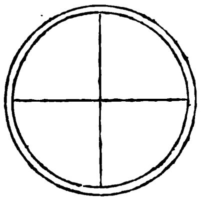


FIG. 8



Here, then, is the general plan and division of the subject matter, each point of which shall be worked out, as far as its importance may require, and the circumstances permit.

Chapter II.

General Properties of Matter.

It will be a great deal done towards uninterrupted onward progress in the study of mechanical principle to have a good notion of the many properties which bodies possess. They may be divided into two classes, essential and accidental. To those which are more important amongst them, will be applied the form laid down in the explanation of the word study—*i. e.*, their laws, proofs and explanation shall be studied.

Section I.

Essential Properties of Matter.

These may be taken singly or in groups, as they are more or less important. Though these latter may not require details of laws, they may have applications important or interesting.

§ I. Extension, Figure, Impenetrability.

I. Extension is the occupying of space by length, breadth, and depth. A body cannot be imagined to exist without these.

Application I.—Rules, Measures.—What these are is sufficiently understood from daily experience, and from treatises of arithmetic with which the student is supposed to be familiar. They are, in short, conventional means of representing portions of space. Any abstract discussion of this, or similar subjects, has no place in an elementary series of mechanics.

Application II.—Reduced Space.—By this is understood the proportional representation of a large space by a much smaller; as, for example, when several *miles* of a country are represented by as many inches on a map. And here it is most important to remark that the greater the difference (the greater the reduction) the more exact must the instrument be; a very small portion of an inch may cause great error.

Sub-Application.—Heavenly Space.—The great extent of the Heavens, which is represented by very small space in our observing instruments, makes it imperative that the greatest exactitude be obtained when there is question of declaring absolute space, otherwise errors of even millions of miles may be admitted.

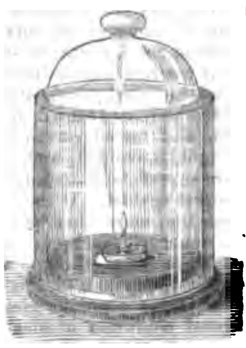
Application III.—Pyramids.—Recent researches of Piazzi Smyth, have confirmed the opinion of Mr. John Taylor, of London, that the Great Pyramid of Egypt was constructed with the design of fixing a system of measures for the human race. The Hebrew measures, and those of many countries, are found to have been established upon this system.

II. Figure signifies shape, form. Besides the countless figures which art can produce, Nature gives to many bodies a fixed determined form, by what is called crystallisation. This subject has its own place in chemistry.

III. Impenetrability signifies the impossibility of two bodies occupying the same space at one and the same time. This is the strict, but not the ordinary notion. When a nail is driven into a block of wood, it is said to penetrate the wood. Such is not true; the wood particles are only pushed aside. The wood does not exist in the space occupied by the iron. In the Fig. 3 there is no water in the space occupied by the immersed body A.

But of the three states the impenetrability of the gaseous is the most remarkable, and may be shown most distinctly to the eye. Fig. 4 represents a glass receiver inverted, and forced down into a vessel of water. Notwithstanding the tenuity of the air, the water cannot pass up into the receiver, to any great height. The air cannot be pushed aside, it resists; it may be forced into a smaller compass; it yields slightly, as a whole, to the external pressure of the water, and lets in a quantity varying with the height of the water, in the outer vessel. A candle floated upon the water helps to make the inside level more apparent. Were it not then for this *making place*, the smallest pin could not be forced into a solid, or into a *small* recipient filled with a liquid or a gas.

FIG. 4



§ II.—Divisibility.

Matter can be reduced to smaller and smaller dimensions. The delicacy of the instrument seems to be the only limit. What is possible beyond this point is of no importance in mechanics. The question is left then to chemical and speculative philosophy. Divisibility of space serves to introduce a somewhat important instrument.

Application I.—The Vernier.—The vernier, named after its inventor, Pierre Vernier (died 1637), is a measure which, without sub-divisions, shows certain fractional parts of a given divided space exactly, or as near as may be required; to be brief and clear, a few points.

FIG. 5

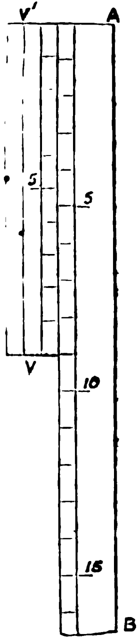
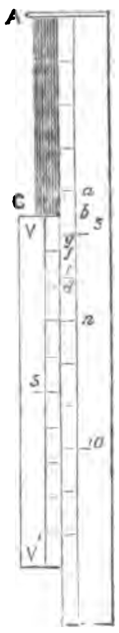


FIG. 6



I. Construction.—A measure is made, shorter by one division than a ceratin portion of the given space. This portion is determined by taking divisions, as many as there are units in the denominator, of the required fractional parts. The *shorter* length, divided into as many parts as there are units in the same denominator, constitutes the venier. Example: Let it be required to show 10ths of a division of the rule A B, Fig. 5. The vernier V is made 9 divisions long, and divided into 10 parts. In the same way, if $\frac{1}{20}$, $\frac{1}{30}$ be required, the vernier will be 19·29 divisions long, and divided into 20·30 parts. In the most general form $\frac{1}{n}$ representing any fractional division, the vernier will be $n - 1$ part in length, and divided into n parts.

II. Principles.—From the construction it is evident that each division of the vernier is shorter by the fractional part than a division of the given pace. In the example the vernier divisions are $\frac{1}{10}$, could be $\frac{1}{20}$ or $\frac{1}{30}$ $\frac{1}{n}$ shorter than those of the rule A B. Consequently, if when laid upon the rule, any division of the vernier correspond to a division of the rule, the divisions of the rule *towards* its zero will show 1, 2, 3 n fractional parts of its own divisions; or, in short, the figure of the vernier, which corresponds, tells the fractional parts. Should no line *correspond*, the nearest correspondence is taken, and the fractions estimated as before, either within or beyond the limit. The error, in *plus* or *minus*, must be less than the fraction for which the vernier is constructed; therefore, by more and more exact vernier, the possibility of error can be reduced as circumstances may require. In many ordinary measurings one millimetre more or less would be of no consequence; in many physical experiments $\frac{1}{10}$ of a millimetre must be shown; in astronomy $\frac{1}{20}$, $\frac{1}{30}$ may be absolutely indispensable.

III. Practical use.—Let it be required to measure the bar A C (Fig. 6) so as to be *within* an error of $\frac{1}{10}$ *mm*. The division being taken to represent *mm*, the rule shows that the bar is 4 *mm* plus the bit ($a\ b$). This bit the vernier will measure. Its zero is placed against the end of the bar, and some line of correspondence looked for. In the figure, the 3rd division of the vernier corresponds. The space $a\ b$ is therefore $\frac{3}{10}$ *mm* long. For each division of the rule from n to a is $\frac{1}{10}$ *mm* longer than the divisions of the vernier, or in another way $d\ e = \frac{1}{10}$ *mm*, $f\ g = \frac{2}{10}$ $b\ a = \frac{3}{10}$

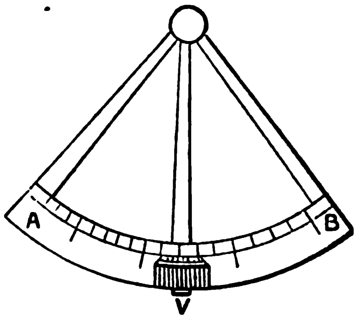
Now, suppose the bar ½ of a 10th *mm* shorter. Here is the greatest possible error; ½ of $\frac{1}{10}$ *mm* too much or too little. Circumstances determine which to take. Other methods of applying the vernier may be met with, but these return in principle to the one explained.

IV. Sorts.—Verniers are of two sorts, straight and curved. These latter are used for the fractional parts of the divisions on a circle. Fig. VII., A B are of circle V vernier. This form is sometimes called the Nonius, from the name of the inventor, a native of Portugal.

V. Limit.—Delicacy of division is the only bar to indefinite vernier division. Practically, $\frac{1}{50}$ *mm* is the ordinary limit. Beyond this point there is danger of confusion. With great care $\frac{1}{100}$ *mm* can be produced. To read these very fine divisions, and observe the correspondence, a microscope is used.

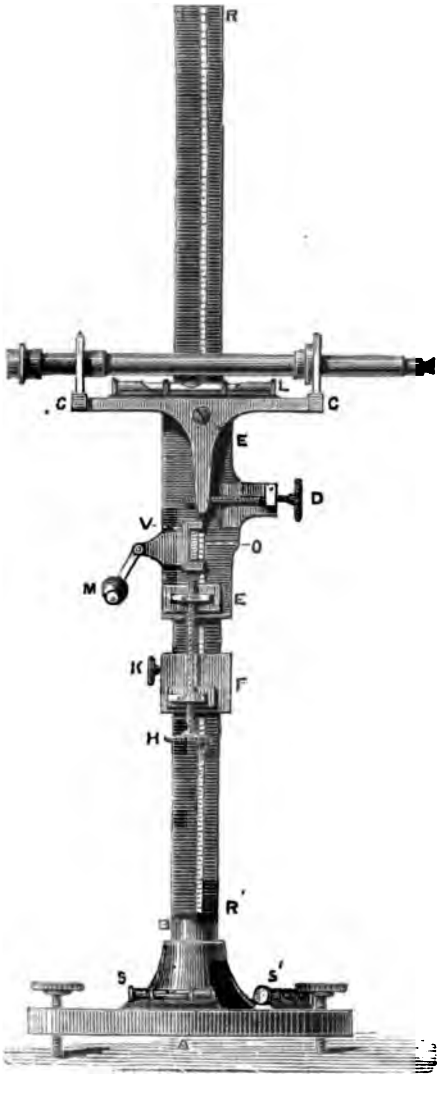
Sub-application.—Cathetometer.—The object of this instrument, invented by Dulong and Petit, and perfected by Gambey and Pouillet, who named it, is to measure, by means of a vernier, the difference of level, of two points in the same, or different vertical. In its essentials, the Cathetometer, is a vertical rule of brass, divided into millimeteres. Along the rule slides a telescope, in the inside of which, in a fixed place, are the very fine threads crossing at right angles *a* Fig. 8. The slide which carries the telescope is provided with a delicate vernier, by which $\frac{1}{50}$ *mm* can be measured. For the details, Fig. 8 A, a heavy foot of metal, provided with spirit levels, S S′ (to be explained later) and screens for raising or lowering the foot, as the spirit levels may show to be necessary. From the foot rises a pillar of steel B.[*] On the top of this pillar revolves a cap of brass, which carries

FIG. 7.



the rule, R R′, and keeps it vertical when the telescope is to be turned in various horizontal directions.[†] The frame C, which holds the telescope, has a spirit level L, and is brought to exact level by the screw D. The slide E has an opening at O, through which the divisions of the rule are seen; and along which is the vernier V; M its microscope, to be moved as required. To the slide E a second slide F is connected by a screw H. This slide F can be tightened to the rule by the screw K. For use, the slides E and F are drawn up by hand until the *crossing point* of the telescope threads seems to be more or less on a line with the first surface. By the screw K the slide F is fixed, and by the screw H the slide E is gently raised until the crossing point is in exact coincidence with the surface. The position of the vernier zero is noted accurately. The second surface is examined with the same precaution; and the difference of the vernier zero in the two positions represents the difference of level desired.

FIG. 9



Jamin, in his *Cours de Physique de l'Ecole Polytechnique*, considers the cathetometer so very useful an instrument that he goes at some length into the conditions requisite for good action. These would be here out of place, as introducing unknown subjects. The same may be said *once for all*, as regards omissions of details of instruments and machines hereafter; as much as possible, all points not yet explained to the student, will be kept out of view until their own principles have been studied. Though this method may not be agreeable to a general reader, it is of immense advantage to one who is only entering upon scientific study. For thus each point receives his undivided attention, its principles are more quickly studied and understood; that weariness caused by frequent divergence into, and forced return from various trains of thought, is avoided; and, above all, the danger of mere superficial knowledge is almost completely guarded against. It then is a source of pleasure when the course has been completed, to review instruments, machines and combinations of machines, as a whole. Each part shows itself with its principles clearly present to the mind; and not as another element, to increase the general confusion of ideas, so commonly consequent on mere general reading.

(*To be continued.*)

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[*] Only a small part of the pillar is seen.

[†] The cap and greater part of the steel pillar are concealed by the rule, which must show *full front*.

ON THE DRESSING OF LEAD ORES.

A PAPER was read on this subject before the Institution of Civil Engineers on the 5th inst. by Mr. T. SOPWITH, Jun., M. Inst. C.E.

This communication was limited to a description of some works the author had had occasion recently to establish in Spain for the dressing of lead ores, as a general account of the present state of such operations in England could not be satisfactorily given in a single paper. Moreover, as regarded this branch of mechanical engineering, Germany was in advance of England. By dressing was to be understood the art of obtaining from the raw material extracted from the mine, called bouse or mine stuff, the pure ore it contained, to the rejection of the impurities with which it was associated. Bouse might be said to yield, in an ordinary way, from 5 per cent. to 25 per cent. of galena, which when pure had a specific gravity of 7·75, and produced 86 per cent. of metallic lead. The lead ores of commerce were usually dressed to a tenour of from 74 per cent. to 78 per cent., though argentiferous ores were frequently delivered with a lower percentage. All galena was mixed with silver; but the term argentiferous was only applied to that in which there was upwards of 12oz. of silver per ton. In dressing, the principle applied was that of separating the lead ores by means of their readier gravitation. This operation was easy or difficult according as the accompanying impurities were of greater or less specific gravity.

At the works referred to, about 350 tons of lead ore were prepared per month. There were two dressing floors, the higher and the lower. On the former manual labour was principally employed. On the lower floor the stuff was treated which required to be passed through the crushing mill; and it was more particularly this machinery and method that it was the purpose of this paper to describe. On the higher floors from 200 tons to 220 tons per month were prepared, or two-thirds of the entire quantity. Two systems of paying the miners were adopted in mineral mines; one, by "tribute" or "bingtale," where the men were paid in proportion to the amount of clean ore the mine stuff excavated by them produced; the other, "tutwork" or "fathomtale," where they were paid by measurement. The adoption of the former system introduced complication, and more expense in the dressing operations than the latter.

The author, in describing the various machines, and the quantities of work they could deal with fixed as a standard the richness of mine stuff treated at about 12 per cent. (by weight), equal to work which would be known in the North of England as producing 2½ bings per shift.[*]

The washing operations commenced by turning a stream of water into the "teams" containing the "bouse," which was raked out by a man on to a grate, and there hand-picked. The author used two grates, the higher one with spaces of 1 inch, and the lower one of ½ inch, in preference to one grate with spaces ¾ inch wide, as usually employed. The stuff passed through the second grate into a stirring trunk, where a partial separation of the coarser particles from sludge and slime was effected. The coarser particles were of a size convenient for hotching, and the common hotching tub could treat from 8 to 15 tons of stuff per day. Between the waste, which was wheeled away, and the pure ore, there was an intermediate layer of what was called "chatts," consisting of particles mixed with ore which could not be separated without further sub-division. This was effected by means of a crushing mill. In England from 25 tons to 30 tons was a fair day's work to pass over one grate. The author found, by the use of two grates, that 40 tons could be passed, without any increase of labour, at a cost of about 2s. 6d. per ton of clean ore produced.

The ore which passed through the coarse wire bottom of the hotching sieve accumulated at the bottom of the tub, and was called "smiddum." This was rendered fit for market by further preparation in the plain buddle. The sludge deposited in the trunks attached to each grate was prepared in a round buddle. A separation having first been made of hard lumps, small stones, or chips of wood, &c., the sludge was delivered at the centre of the buddle accompanied with water. The bottom being inclined outwards about 1 in 10, the particles were carried by the water in that direction; the heaviest and richest being deposited nearest the centre. The buddle described was larger in diameter, and treated nearly four times more stuff then that usually employed. The water on leaving the sludge trunk carried with it a certain amount of slime, which was deposited in pits, and was subsequently treated in a machine called a Brunton's Cloth, the action of which was described, as also of the dolly tub, by which the slimes, after being concentrated in the Brunton's machine to about 45 per cent., were further enriched to about 70 per cent., and so delivered for sale. The crushing mill in common use in England was described, and the inconvenience attached to it, as compared with the simpler form used in Germany, was pointed out. In the apparatus that had been referred to, it was probable that about 80 per cent. of the lead ore produced in England was prepared.

On the lower, or crushing mill floors, which the author had erected, some attempts had been made to secure continuity of action by the use of self-acting machinery, wherever it was possible; though from the circumstances of Spanish labourers being employed, who were totally unaccustomed to the use of machinery, it was necessary that the machines should be of the simplest kind. The stuff which required crushing was conveyed in waggons to the lower floors, being first broken to a size which would pass through a 5-inch ring. This was effected by manual labour, in preference to a stone-breaking machine, as the former allowed of a separation of a small quantity of pure ore, and of a large quantity of waste, which would afford unnecessary work for the crushing mill. The stuff, after being emptied from the waggons into the hopper of the crushing mill, was passed through the rollers, and, when crushed, was elevated by a Jacob's Ladder, and delivered into a classifying trommel, composed of two shells, an outer one of perforated iron plate with holes 1½ millimetre in diameter, and an inner one with holes 10 millimetres in diameter. The crushed material was delivered into the inside of the trommel at one end, and passed onwards, the trommel being inclined. All the sludge and slime were got rid of through the outer shell, the inner shell retaining and delivering apart any particles over 10 millimetres in diameter. These were returned to the crushing mill, to be again passed through the rollers, and the particles, ranging in size between 1½ millimetre and 10 millimetres, were delivered at the further end of the trommel, and passed on to a second, or sizing, trommel, composed of one shell only, and were then subdivided into four sizes, viz., 2½, 5, 7½, and 10 millimetres, each size being treated in a separate hotching tub. For the operation of hotching, the convenience of having all the particles treated of one, or nearly of one, size, was obvious; and in some cases of refractory ores it was a necessity. The hotching machines employed were entirely

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[*] A bing was eight cwts. A shift was eight waggons, carrying about one ton each.

COFFEE AND CHICORY UNDER THE MICROSCOPE.

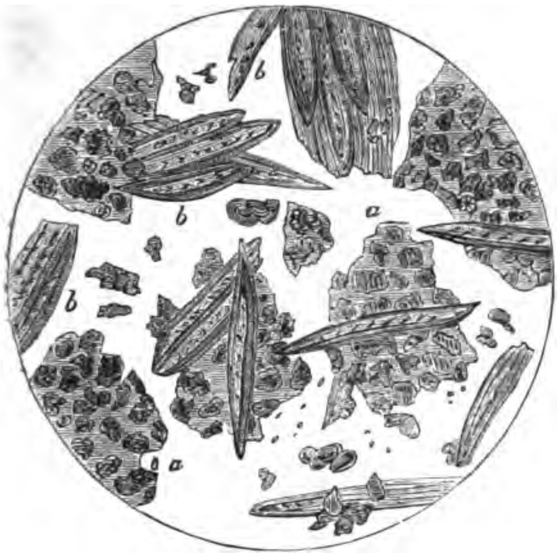


FIG. 1.

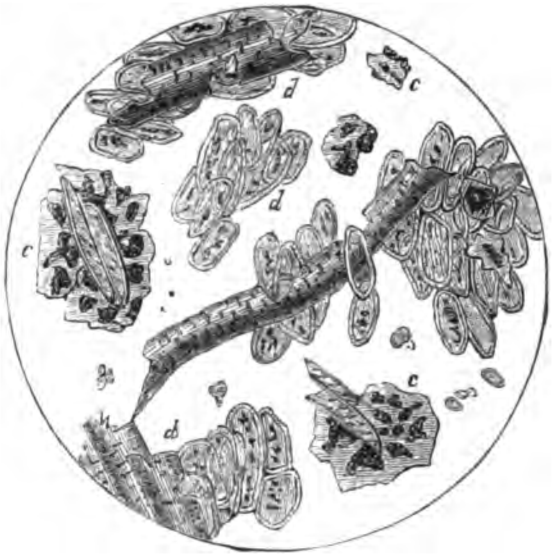


FIG. 2.

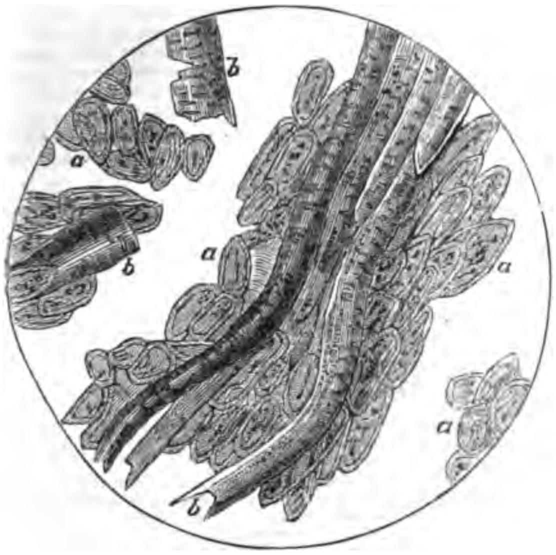


FIG. 3.

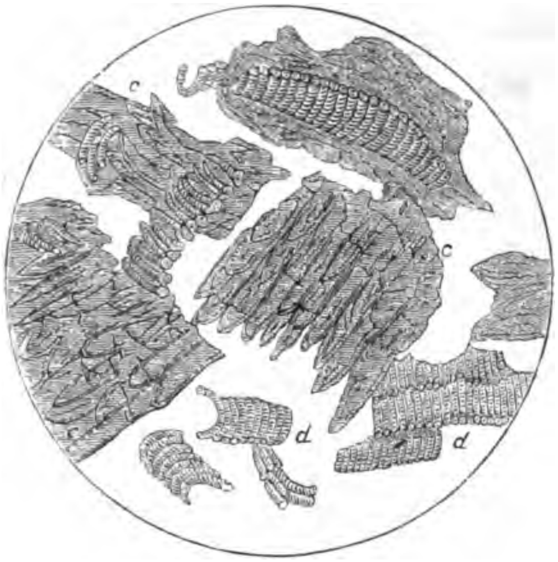


FIG. 4.

self-acting and continuous in action; a fast and a loose pulley being attached to each machine. Contrary to the form adopted in England, the sieve was stationary, the water being put in motion by means of a loosely-fitting piston. The stuff was delivered into a small hopper, and travelled the length of the sieve, a distance of 28 inches, by which time a perfect separation was effected. It had been found advantageous to increase the length of the stroke, and the number of strokes per minute, for the larger sizes. By an ingenious movement, a quick down stroke and a slow return stroke had been given to the piston. The crushing mill was more compact than the form used in England, the rollers being kept in contact by the compression of india rubber buffers, in place of a long lever, with a heavy weight attached. The sludge, which passed through the holes of 1½ millimetre in diameter, in the first, or classifying trommel, was delivered into a separator,—an iron cylinder about 2½ feet high,—where it met a stream of water of sufficient strength to carry the smallest and lightest particles upwards. and deliver them into a launder, whence they were conveyed, by the water, to the sludge trunks and slime pits, and were subsequently treated in round buddles and in Brunton's Cloth. The coarser particles were prepared by manual labour, in a common trunk or tie.

The amount of work crushed and prepared on the lower floors was about 55 tons per day of ten hours. The actual cost in Spain was 21s. 2d., but the equivalent of labour would be performed in English mining districts for 13s., the latter sum being at the rate of 2·83 pence per ton of raw material treated, or 2s. per ton of clean ore produced. If, however, self feeding apparatus was introduced to supply the hotching machines, which could easily be done, the latter cost might be reduced to 2·07 pence, and 1s. 5¾d. respectively. The cost of preparing similar work in England, with machine crusher and machine hotchers, was, the author believed, about 2s. 6d. per ton of clean ore. The whole of this machinery was driven by a 10 h.p. portable engine, supplied by Messrs. Ransomes, Sims, and Head. The cost of erection of the crushing mill floors complete, including the engine, was about £1500. The same arrangement in England would have cost about £1200. Most of the machinery was supplied by Messrs. Sievers and Co., of Kalk, near Cologne. No separate crushing mill for the preparation of "chatts" had been erected, as when the "chatts" had been allowed to accumulate, the present machinery could be adapted for their treatment in an hour or two, advantage being taken of a time when new rollers had been put in.

The author observed that whereas, in England, the machinery employed in dressing operations was for the most part made at the mine with the ordinary staff, in Germany there were manufactories giving employment to four hundred hands, dedicated almost exclusively to the construction of dressing machinery; and it was not surprising to find, in the machines issued from them, bettor proportions, greater elegance, and more efficiency and durability than those used in the mines of this country.

The machinery described in this paper had been in use for two years, and, having given good results in Spain, no difficulty need be feared in its application elsewhere.

EXPERIMENTAL PHYSICS.—A contemporary states that the Imperial Academy of Science, Lille, has offered two prizes—one for the best work on some branch of experimental physics; the other on the use of the thermometer in medicine. The prizes will consist of 1000 francs each.

COFFEE ADULTERATIONS, AND HOW TO DETECT THEM WITH THE MICROSCOPE.

By J. MUTER, PH. D.

(From the *Food Journal*.)

HAVING seen in our last number the properties of coffee, let us now take a glance at those of its chief adulterant. Chicory, as employed for this purpose, is the dried and roasted root of the common endive, so dear to the lovers of winter salads, as a substitute for lettuce. This plant is to be seen growing wild in many of our hedgerows, and belongs to the botanical order of *Compositæ*. It is very similar to the common dandelion, which belongs to the same order, but it is readily distinguished by the colour of its flower, which is blue, while that of the dandelion is yellow. The chicory root also bears a great resemblance to that of the latter plant, being, like it, soft, and exuding when squeezed the milky juice so well known to all of us who have enjoyed, as children, the pleasure of wandering in the fields.

Our wild English plant is not, however, so much esteemed in the market as the German and French varieties, which are specially cultivated for mixing with coffee. The following analysis will show the composition of chicory root in its dried state, and also that of its ash, to which we shall have occasion to refer hereafter:—

I.—*Dried Chicory.*

Moisture	17·480	
Gum	20·416	
Sugar	11·166	
Extractive (bitter)	18·000	
Fat	1·066	
Woody fibre, &c.	29·202	
Mineral matter	2·670	
		100·000

II.—*Composition of the Ash.*

Potash	0·672	
Soda	0·408	
Lime	0·250	
Magnesia	0·184	
Iron	0·085	
Sulphuric Acid	0·284	
Chlorine	0·127	
Carbonic Acid	0·078	
Phosphoric Acid	0·303	
Sand	0·279	
		2·670

From these results it is evident that this plant contains no principles which would render it to any extent a useful substitute for coffee, as we look in vain for the *caffeic acid*, or the *theine*, already shown to exist in the latter article. But what shall we say if, besides containing nothing valuable, it should be proved to be positively injurious when freely consumed? Let us hear Dr. Johnston on this subject:—"Taken in moderate quantities, the ingredients of chicory are probably not injurious to health, but, by prolonged and frequent use, they produce heartburn, cramp in the stomach, loss of appetite, acidity in the mouth, constipation with intermittent diarrhœa, weakness of the limbs, tremblings, sleeplessness, a drunken cloudiness of the senses, &c. At the best, therefore, chicory is a substitute for coffee to which only those to whom the price is an object ought to have recourse." To these remarks we would add that we prefer not being poisoned even at the most moderate cost; and in cases where "price is an object," we would advise the public to abstain from paying anything at all for such a filthy beverage as chicory-coffee undoubtedly is to persons of unvitiated taste. We might bring up many other charges against this nasty infusion, but we will only give one more, and that is a dictum of Dr. Boer's, to the effect that the continual use of chicory causes *amaurosis*, and, consequently, blindness. Since giving our coffee results last month, we have been seriously remonstrated with by a grocer, who declares that he and his brother tradesmen put nothing else into their coffee but chicory. This is, however, only a repetition of the old story, told long ago by Dr. Pereira, who said that "while the grocers, on the one hand, cheat their customers by adulterating coffee with chicory, the chicory dealers in turn cheat the grocers by adulterating chicory." Whether the grocers are, or are not, the chief sophisticators, is comparatively immaterial, for the fact remains that the public continue to suffer. The grocers cannot, however, be held innocent, as they buy *ground chicory*, which article *they can purchase at a cheaper rate than they could the dried root itself*; and of what then do they, in their innocence, imagine it to be composed? Out of twenty samples of ground chicory purchased lately in London (but of the analyses of which we have not space at present to give details) more than half were found to be adulterated.

We now turn to the detection of the adulterations of coffee. Many simple processes have been from time to time proposed, to ascertain whether this article be pure or not, without saying exactly what is the adulterant; and of these we subjoin a few.

1. Take the packet of coffee as it comes from the grocer's, in your hand; and, having given it a good squeeze, lay it gently on the table, and open it. If the contents be found adhering together in a cake, the sample is not pure.

2. Drop gently a teaspoonful of coffee on the surface of a glass of water, and observe if any of it sinks immediately; if so, it is bad. Let the whole be now slightly stirred, and notice the colour imparted to the water. If this be a decided brown tint, then the coffee is adulterated, most probably with chicory or burnt grain of some kind.

3. Make an infusion of the coffee in the usual way, pour some into a cup, and let it stand till cold; if a skin or scum should form on the surface, there is reason to suspect baked animal matter, such as horse's liver.

If, however, we seek methods of discovering the precise adulterants employed by means of chemistry, the subject becomes at once much more difficult, and the results not always reliable. One method is to treat 25 grains of the sample with an ounce of ether, in a closed bottle, for an hour, with frequent agitation; and then, having poured off the solution so obtained into a weighed watch glass, to evaporate to dryness; ascertain the weight of the residue. The undermentioned matters, treated in this way, gave the following results:—

Coffee (plantation Ceylon)	3·75	grains
Chicory (best English)	1·50	"
Roasted Grain	90	"

Several years ago (in 1852), when public attention was much directed to this subject, Messrs. Graham and Stenhouse published a report "On the mode of detecting vegetable substances mixed with coffee." They found that the most striking points of difference between chicory and coffee consisted in the much greater quantities of grape sugar and sand which existed in the former than in the latter. A reference to the various analyses in the present article, and that of last month, will easily show these distinctions. But it unfortunately happens that an equally great proportion of sugar exists in most succulent roots, such as dandelion, beet, and parsnips, and that in wheat and most kinds of grain the silica is as large as in chicory. Taking these points into consideration, we cannot therefore place any great reliance on chemistry for the detection of such adulterations as form the subject of our present consideration. On hearing this, many of our readers will doubtless exclaim: "Well, if chemistry cannot help you, how did you make the investigations reported last month?" We answer, by means of the microscope; and we will now endeavour to show how this instrument is used, and how any person possessing one may easily examine coffee.

The credit of first seriously calling attention to the use of the microscope as a detector of adulterations belongs decidedly to Dr. Hassall, whose food examinations created so much sensation about fifteen years ago; and it is now imperatively necessary that every analyst who turns his attention to food should be not only a good chemist, but also a practised microscopist. In treating this branch of our subject, we will divide it into distinct heads for more easy reference.

1. MODE OF EMPLOYMENT.—The microscope is to be placed upon a steady table, so that the *source of light* shall be *on the left of the observer*, and the "body" of the instrument is to be placed in a slightly inclined position. The operator, looking into the instrument, is then to move the mirror about, with its reflecting surface turned to the light, until a perfect illumination of the microscope is produced.

2. SOURCE OF LIGHT.—The best light is that reflected from a white cloud on a bright day, direct sunlight being always avoided; but, if the day be dull, good lamplight is much to be preferred to bad daylight. The best source of artificial light as that of a good moderator or paraffin lamp, which should be so arranged in height as to bring the flame about halfway between the stage and the mirror, and about a foot away from the instrument. The upper part of the chimney of the lamp should be fitted with a reading-shade, to throw the light down on the mirror, but prevent its being diffused about the room, exactly like the lights over a billiard table.

3. MOUNTING THE OBJECT.—For this purpose the operator should be provided with some slips of good patent plate glass, 3in. long by 1in. wide; also with a box of thin glass covers, cut either in squares or circles, though the former are the cheaper, and do quite as well. He should likewise get some stout needles and fit them into small pieces of wood to act as handles, leaving only about ¼in. of the point end of the needle sticking out. When about to examine the object, he should place a slip of glass on a piece of white paper, and put a few grains of the coffee (taken from the sample on the point of a penknife) near one end of the slip. This portion of coffee is now to be moistened with a drop of water, and allowed to soak for some time. The operator then takes a pair of needles, and by means of them thoroughly tears all the grains to pieces, so thin as to be almost transparent. A few of these fragments are then to be drawn to the centre of the slide, moistened with a drop of water, and a thin glass cover to be adroitly dropped over them, taking care, by letting one end of the cover down first, to expel all air bubbles. The object is now ready for use; but, until one has had some experience, the complete avoidance of air bells is very difficult, and it is therefore advisable for the operator to make himself familiar with their appearance under the various powers of the microscope. The same hint applies to pieces of hair, which are apt to fly about, and through which, along with air bubbles, most ludicrous mistakes have been made by inexperienced persons.

4. EXAMINATION OF THE OBJECT.—The slip, with the object mounted, is to be placed on the stage of the microscope (which has been previously fitted with the ¼-in. power and "C" eye piece), and the body of the instrument is to be brought down to within little more than half an inch from the object. The operator now looks into the instrument, and gently turns the body farther down till the object appears. The focussing is then to be completed by the fine adjustment, and the whole object minutely examined by moving it about gently in various directions. It is always advisable to acquire the habit of keeping *both eyes open* when looking into the instrument; and this ability to, as it were, concentrate all your thoughts on one eye is much more easily learned than would be imagined, and is a great saving to the sight, which is apt to be impaired by much labour at the microscope.

5. MICROSCOPIC APPEARANCES OF PURE COFFEE.—All our preparations being now complete, we look at a sample of pure coffee, and find it presents an appearance similar to that shown in Fig. 1. We notice that there are two totally distinct forms visible. (1.) Several little flat fragments marked all over with irregular angular cells. These are fragments of the body, or substances of the seed; and the cells are those which contained the essential oil, already referred to last month. (2.) A number of peculiar oval, or rather lance-shaped bodies, resting on a fibrous membrane, and having tooth-like oblique markings between their edges. These are fragments of the outer skin or *testa* of the seed, and are wonderfully characteristic of pure coffee. None of those structures appear in any of the usual adulterations of this substance.

6. MICROSCOPIC CHARACTERS OF PURE CHICORY.—Having changed our slide, and substituted pure chicory for pure coffee, we at once see a vast alteration. Here are no lance-shaped bodies, nor angular cells, but instead we have the appearances shown in Fig. 3. We now notice a mass of round and elongated cells, evidently of a soft tissue, which form the principal portions of the substance of the chicory root. We also observe a number of long tubes laid in bundles over the cells, having a most characteristically and beautifully marked surface. These tubes come from the centre of the root, and, once seen, can never be mistaken, except for the similar tubes of dandelion, which we will next describe.

7. MICROSCOPIC CHARACTERS OF DANDELION.—These are shown in Fig. 4, and are so similar to chicory as to be readily mistakeable for that root. On examining them more minutely, however, with a ¼in. power, a difference is observable. The cells are more elongated, and the tubes are more decidedly marked in complete rings, while here and there we find masses of a structure closely resembling the ribs of an animal,

In Fig. 2 we show the appearance of adulterated coffee, in which the reader will recognise all of the structures above mentioned. For the detection of roasted grain, we depend mainly on the appearance of granules of starch, which can be identified by their size and shape. The cells of turnip are much larger than those of chicory, while particles of saw dust, especially mahogany, can be picked out from coffee by means of a needle, and readily identified. Mineral colouring matters may be discovered by burning some coffee in a small porcelain crucible, when, if the ash be red, it is certain that venetian red, or other ferruginous earth, has been added to deepen the colour.

As in this world partisans can be found for almost any dogma, no matter how ridiculous it may be, provided that it is only asserted loudly and unblushingly enough,—so our grocer friends have, by dint of continual asseveration, got a large number of people to positively believe in chicory-coffee, and call this filthy root an improvement! The terrible absurdity of this idea must be manifest to any one who glances for a moment at the subject. Chicory is a root, while coffee is a seed. The former, buried in the ground, deprived of the influence of sunlight or air, only contains a few of the crudest vegetable matters, so to speak; while the latter, flourishing under a tropical sun, has all those complicated and refined organic principles, such as alkaloids, for the formation of which the action of light, &c., appears to be absolutely necessary. The advocates of chicory adulteration know well that it produces a sensation of oppression in the stomach, and they take advantage of this to pretend that chicory-coffee has strength, and are believed by ignorant persons who cannot discriminate between that quality and indigestion, and whose palates have long since been thoroughly vitiated. Another cry of these apologists for adulteration is, that, thanks to chicory, coffee is brought down within the means of the poor, who otherwise could not afford to drink it. This is very like bringing down champagne for the use of the poor by adding three-fourths of small beer, only that in this case two good things would be spoiled, whereas chicory is too nasty to spoil at all. The simple fact is that, as a rule, the poor get little or no coffee in their shilling mixture, while the grocers get that sum per lb. for a substance which would not fetch 6d. per lb. if it were sold in its own name. But we live in a country of "vested interests," and as the grocers have a "vested interest" in this adulteration, it is temporised with, and was for a time actually legalised, under a trifling restriction, which was seldom even complied with.

In conclusion, we have simply to ask that the public should somewhat bestir themselves, and apply the spur to our tardy legislators, so that it shall be made a misdemeanour to sell, under any circumstances, a mixture of chicory and coffee. This would not hurt any of the chicory epicures, as they could still buy their succulent mouthful in a separate form, while it would protect the great mass of the community from a daily-perpetrated fraud. Our authorities every now and then make a spasmodic dash at something, and lately their hobby has been "tea dust" and "re-dried leaves;" but after all, even with the terrible addition of the frolicsome Chinese pigs, about which we have heard so much during the last few weeks, the sale of such commodities is no worse than the daily winked-at traffic in chicory-coffee.

FRICTION.—VII.

BY C. DRAPER, A.B., L.C.E.

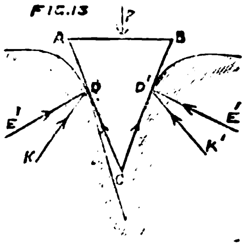
(Continued from page 33.)

THE WEDGE.—As the characteristic property of the wedge is that it owes its mechanical advantage to the existence of friction, it will be proper, in this series of articles, to give at length an account of it.

As the wedge is sometimes, though rarely, urged between the resisting surfaces by pressure, we have a theory for its action founded upon statical principles, but almost invariably the wedge is driven by means of impact or a blow; we must therefore look to dynamics for the solution of the problem of the wedge in this case.

To commence with the statical theory, let A B C, Fig. 13, be an isosceles wedge, P the pressure acting at right angles to A B, and let D E and D′ E′ be perpendiculars to the sides of the wedge erected at D and D′ the points of contact between the sides and the resisting surfaces, or, rather, the points through which the resultants of the mutual pressures pass, for the wedge may be in contact with the resisting surfaces at several points. Since everything is supposed to be symmetrical on each side of the axis of the wedge, D and D′ will lie on the same horizontal line, but it is clearly matter of indifference where the line D D′ is situated, since the question is one concerning angles alone.

FIG. 13



Now, when the wedge is on the point of moving under the influence of the pressure, P must be in equilibrium with the reactions Q′ Q′ acting along D E and D′ E′, and the frictions μ Q, μ Q′ acting along D C, D′ C, at right angles to the reactions Q Q′, therefore the resultant of Q and μ Q acting along D K, making an angle ϕ with D E, together with the resultant of Q′ and μ Q′, acting along D′ K′, must be in equilibrium with P; therefore, by the conditions of equilibrium, calling these resultants R and R′, we must have the components of R and R′ parallel to P equal to P.

Let i be the semi-angle of cleavage of the wedge, or A C B $= 2i$, then since R and R′ are manifestly equal, we have

$$2R \sin. (i + \phi) = P.$$

And if we wish to know the pressure T exerted by the wedge in any other direction, making an angle α with D E, we must have the component of R in this direction equal to T, or

$$R \cos. (\alpha + \phi, = T.$$

Equating the two values for R found from these two equations, we have

$$T = \frac{P}{2} \times \frac{\cos. (\alpha + \phi)}{\sin. (i + \phi)}$$

If $\alpha = 0$, then T becomes equal to Q, and its value given by

$$Q = \frac{P}{2} \times \frac{\cos. \phi.}{\sin. (i + \phi)}$$

If $\alpha = i$, then T becomes horizontal, and its value is given by

$$T = \frac{P}{2} \times \cot. (i + \phi).$$

Let us now suppose that the wedge has been forced into its position, and that it is required to find the force P′ necessary to extract it again. In this case we have the reactions Q Q aiding P′, to that R acts on the other side of E D at the angle ϕ; we have, therefore,

$$2R \sin. (\phi - i) = P'.$$

Example 11.—An isosceles wedge, whose angle of cleavage is 5°, is forced into its position by a pressure of 112lb. If the co-efficient of friction be ⅓, calculate the least force required to extract it.

From the above we have

$$P = 2R \sin. (\phi + i)$$

And

$$P' = 2R \sin. (\phi - i).$$

Dividing the latter by the former we have

$$P' = P \times \frac{\sin. (\phi - i)}{\sin. (\phi + i)}.$$

Since $\tan.\phi = \frac{1}{2}$, we find from the tables that ϕ is 26° 34′ nearly, also i = 2° 30′.

$$\therefore P' = 112 \times \frac{\sin. (24° \ 4')}{\sin. (29° \ 4')}$$

Working this out by the tables we find P′ to be 94lb. Let it now be required to find the pressure P necessary to keep the wedge in its place when driven. In this case we have the frictions μ Q, μ Q aiding P, so that we must have

$$P = 2R \sin. (i - \phi).$$

From this last equation we see that as long as i is greater than ϕ, P has some positive value, and that consequently if P be removed the wedge will start from its position, since it requires the force P to keep it in its place.

If i be less than ϕ, or the angle of the wedge be less than 2ϕ P has some negative value, or a force acting in a direction opposite to that which forced the wedge into its position is necessary to extract it; the value of this force is given in the value for P′ above, consequently if P′ be removed the wedge will not start.

Now as a wedge to be useful should not start when the pressure is removed, it should be so constructed that its angle of cleavage is less than twice the angle of friction. When this is the case it will remain fixed in any position into which it is driven. It is this property which distinguishes the wedge and renders its use so universal in the mechanical arts.

To find the portion of the power employed which is used in overcoming friction, let Q be the normal pressure exerted by a wedge whose semi-angle is i; then if the driving pressure is P′ we have, as above

$$P' = 2Q \times \frac{\sin. (i + \phi)}{\cos. \phi}.$$

Now if P be the driving pressure on a *smooth* wedge having the same angle, which exerts the same pressure, Q, as the rough wedge, we have, making $\phi = 0$ in the above formula,

$$P = 2Q \sin. i.$$

Dividing the latter by the former we obtain

$$\frac{P}{P'} = \frac{\sin. i \cos. i}{\sin. (i + \phi)}$$

Example 13.—A wrought iron wedge whose angle of cleavage is 7° is forced into a mass of oak. It is required to find what fraction of the driving pressure is consumed by friction, the angle of friction being 31° 50′.

Here

$$i = 3° \ 30', \ \phi = 31° \ 50'$$

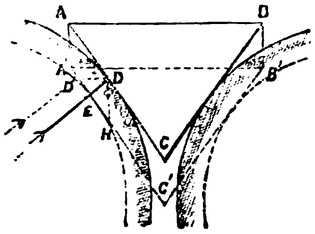
Calculating by the tables we find

$$\frac{P}{P'} = 0{\cdot}09 \text{ nearly, or } P' = 11P$$

Or, in words, ten times the force required to produce the pressure Q is expended in overcoming friction. We thus see that although the efficacy of the wedge is due to friction, still, in this, as in every other case, friction diminishes the effects of forces applied to machines.

We shall now pass to the dynamical theory of the action of the wedge, and suppose that the blow is caused by a given weight P falling through a given number of feet h. This weight at the instant of striking the back of the wedge has accumulated in it an amount of work or energy represented by P h, or, if v be the velocity in feet per second of P at the instant of striking the wedge, the number of units of work stored up in it is represented by the well known formula P × $\frac{v^2}{2g}$ since $h = \frac{v^2}{2g}$. Now this energy is expended in overcoming the tendency of the resisting surfaces to collapse, in overcoming the friction, in compressing both the weight itself and the wedge, and in giving motion to each.

FIG. 14



In Fig. 14, let the dotted lines A′ B′ C′ represent the position of the wedge A B C after it has received a blow. Now, as the resisting surfaces are supposed to move in a horizontal direction only, if D be the point of application of the mutual normal pressure before the blow, D′ must be the corresponding point after, therefore the normal resistance, which we shall call Q, has been overcome through the space D E *in its direction*, therefore the work expended on Q is equal to Q × D E. Also, in consequence of the blow, the point D on the wedge has been moved to H (vertically under D), therefore the space passed over by the rubbing surface *in the direction in which friction acts* is equal to E H, but E H = D E cot. i, since ∠ H D = i, therefore the work expanded on friction is equal to μ Q × D E cot. i, and neglecting the mutual compression of the weight and wedge, &c., we must have

$$P \times \frac{v^2}{2g} = 2 (Q \times DE + \mu Q \times DE \cot. i)$$

$$= 2Q \times DB \left(1 + \frac{\sin \phi \cos. i}{\cos. \phi \sin. i}\right)$$

Or

$$P \times \frac{v^2}{2g} = 2Q \times DE \frac{\sin. (i + \phi)}{\sin i \cos. \phi}.$$

Or, representing the *useful work* gained, which is equal to 2Q × D E by U, we have

$$U = \frac{P v^2}{2g} \times \frac{\sin. i \cos. \phi}{\sin. (i + \phi)}.$$

Since U = 2Q × D E, and U is a definite amount of useful work, when D E is very small Q will be very great. This accounts for the enormous resistances which the wedge can overcome when driven by blows.

In the equation

$$\text{Work employed} = P h,$$

it is clear that we can increase the work done by increasing P or by increasing h, that is, by increasing the weight of the hammer, or by increasing its velocity, but it is found in practice that a better result is obtained by increasing the velocity than by increasing the weight. This has been accounted for by supposing that a rapid blow causes a tremor of the substances, and momentarily destroys the friction.

I shall now conclude this article with the following example:—

Example 12.—The ends of an iron girder, 30 tons weight, resting on two granite piers, are simultaneously raised by means of wrought iron wedges, in the form of a right-angled triangle whose height is 1in. These wedges are driven home by 25 blows each of a hammer weighing 14lb., and which is moving at the rate of 40ft. per second at the instant of striking the wedge. Find how much work is expended on prejudicial resistances, including friction, &c.

The number of units of work developed by one hammer in the 25 blows is equal to

$$25 \times 14 \times \frac{40 \times 40}{2 \times 32} = 8750$$

Now if there were no prejudicial resistances, this amount of work should have raised a weight of 12 times this number of foot pounds, or 105000 to the height of 1in. (which is the height the girder is raised), but from the question each wedge only raises 15 tons or 33600lb. to the height of one inch, therefore the work lost by friction, &c., is 105000 − 33600 = 71400lb. raised 1in. or 5950 foot pounds, or about ⅔ of the total work expended.

(To be continued.)

MATHEMATICS.

BY C. H. W. BIGGS.

CHAPTER III.

DECIMALS.

(Continued from page 58.)

Units.

§ 33. | | | | ‖ | | | | . In the number 1111 to the left of the vertical line above we observe that as the value of the *tens*, place tis ten times that of the units, and that of the hundreds ten times that of tens, and so on, conversely the value of the units' place is *one-tenth* that of the tens', *one-hundredth* that of the hundreds', and so on. Now, if we write digits to the *right* of the units' place, and agree that the law just noticed shall hold for the value represented by them, it is plain that the first to the right of the units will be one *one-tenth* of the unit, the second will be one *one-hundredth*, and so on—*i e.*, a series of ones written after the units' place will represent the fractions one $\frac{1}{10}$, one $\frac{1}{100}$, one $\frac{1}{1000}$, &c., where the number of noughts succeeding the *one* in the denominator is the same as the number of places to the right of the units' place. A *period* called the *decimal point* is placed after the unit's figure to show at what point the fractional part of the number begins. Thus 1·25 means one whole number and two tenths plus five hundredths—*i.e.*, twenty-five hundredths'. ·035 means $\frac{35}{1000}$. Conversely $\frac{31}{100000}$ must be represented decimally, thus, ·00031, and $\frac{751}{10}$ thus 75·1, whence the following rule—

§ 34. To express a decimal fraction in the form of a vulgar fraction. For the numerator set down the digits of the decimal fraction as if they formed the whole number, and for the denominator set down *one* followed by as many ciphers as there are places in the decimal.

Ex. Express 2·51 as a vulgar fraction.

It must be remembered that a whole number is a whole number whether expressed attached to a decimal or vulgar fraction.

Then 1st we have the whole number .... 2·
2nd „ the decimal .... ·51
Which set down 251
Underline and write 100

one followed by two noughts, because there are two places of decimals in the given number.

3rd. The whole answer being .... $\frac{251}{100}$, or $2\frac{51}{100}$.

Ex. Express ·0010101 as a vulgar fraction.

Here write 10101 as a whole number.
Underline 10000000

Then write *one* followed by seven noughts, as above.

Ex. Express 353·03 as a vulgar fraction.

$$353 \frac{3}{100} = \text{the answer.}$$

Ex. Express 5·5 as a vulgar fraction.

$$5\frac{5}{10} \text{ or } 5\frac{1}{2} = \text{the answer.}$$

§ 35. To write as a decimal any fraction whose denominator is 10, 100, 1000, &c., some power of ten. Write down the numerator as a whole number and count as many places from the right hand digit as there are ciphers in the denominator, and there mark the *decimal point*. If there are any places unoccupied by figures write noughts in those places.

Ex. Express as a decimal $5\frac{4}{10}$

Here write down the whole number and numerator as a whole number, thus 5 and 4, counting the number of *noughts* in he denominator, *one*, then mark off *one* figure from the right as a decimal, thus, 5·4.

Ex. Express $\frac{15}{1000}$ as a decimal.

As above, write 15, the number of noughts is three, therefore mark off three places from the *right*. There are, however, only two, and we must prefix a nought, as ·015, to make three.

Ex. Express $\frac{2510015}{1000}$ as a decimal.

2510·015 is the answer.

§ 36. It will thus be seen that a decimal is simply a fraction with a denomination, 10, or some power of 10; this denominator never being written but always understood. Another fact should also be noticed, viz., that unlike a whole number, to add noughts to the right of decimals does not alter their value, thus ·1 remains equivalent to $\frac{1}{10}$ even when written ·100000, but if we add noughts to the left the value is altered, thus ·1 = $\frac{1}{10}$, but ·01 = $\frac{1}{100}$, &c., &c.

(To be continued.)

LETTERS TO THE EDITOR.

[We do not hold ourselves responsible for the opinions of our correspondents. The EDITOR respectfully requests that all communications should be drawn up as briefly as possible.]

*** All communications should be addressed to the EDITOR of the ENGLISH MECHANIC, 31, Tavistock-street, Covent Garden, W.C.

All cheques and Post Office Orders to be made payable to J. PASSMORE EDWARDS.

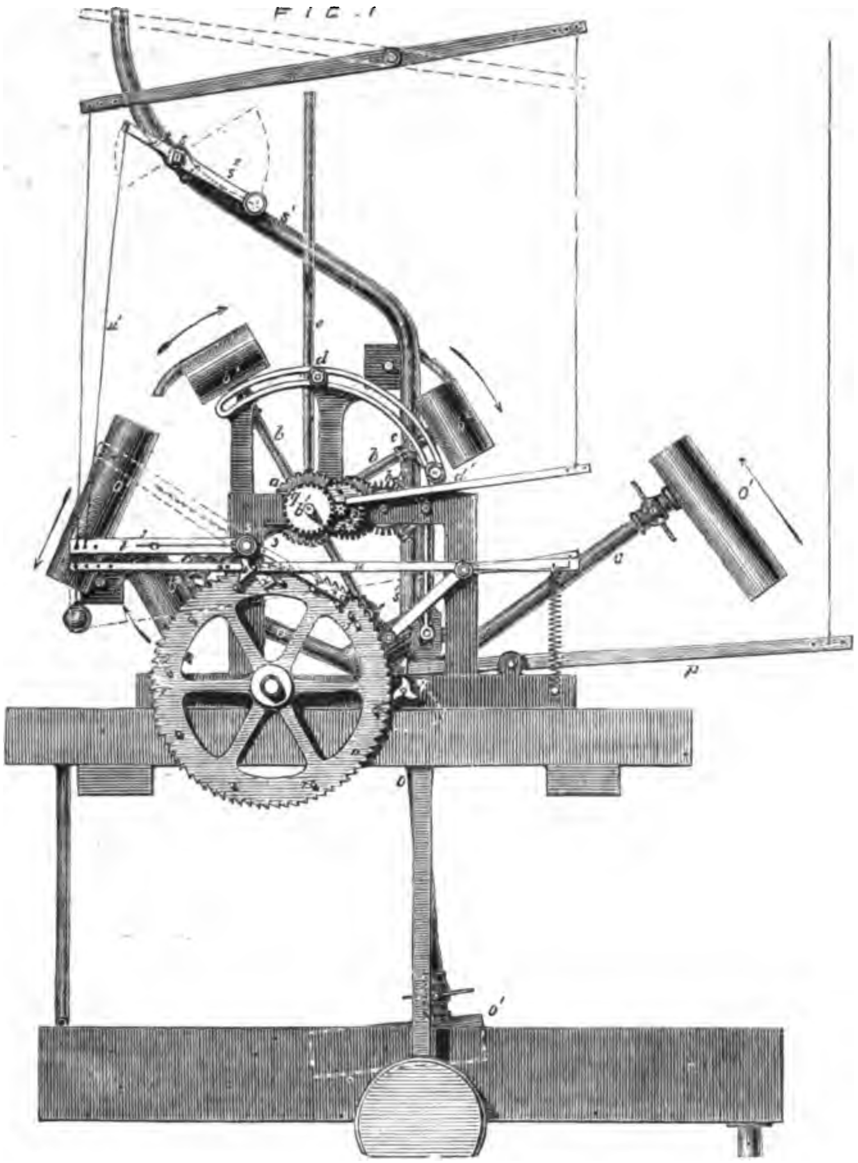
I would have every one write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that, as to other things, knows no more than what everybody does, and yet to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks: a vice from whence great inconveniences derive their original. —*Montaigne's Essays.*

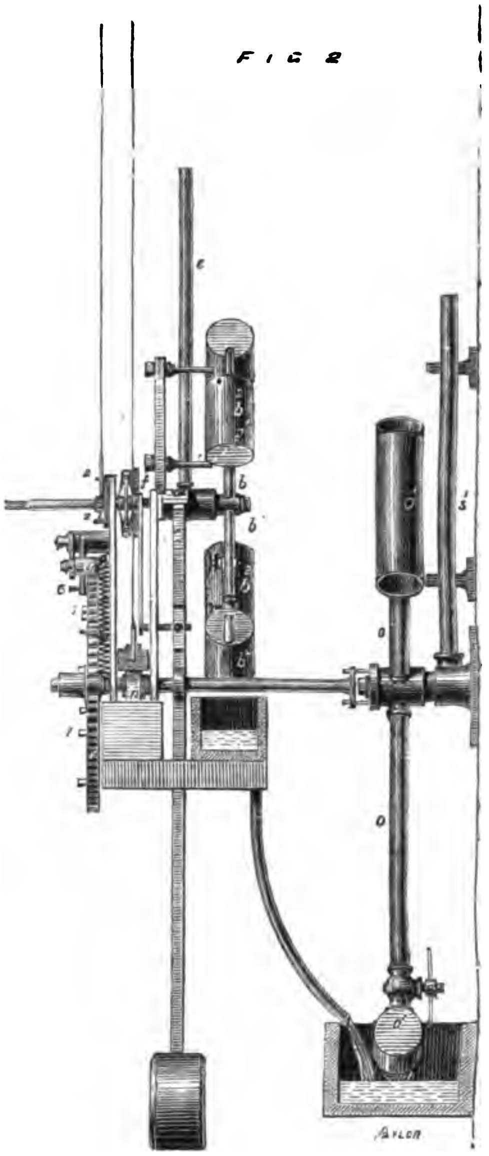
TURRET CLOCKS.

SIR,—The interest manifested by your readers in the above subject induces me to send you the specification of Mr. H. W. Cook, of Ovington-square, London, describing his recent improvements in the construction of turret clocks. STRIKER.

The object of the invention is to dispense with a large portion of the ordinary clock-work gearing, with its attendant expense, and, in fact to eliminate from the clock all the wheels which come before that which actually drives the hands. This gearing in a clock of the ordinary construction, but actuated according to this invention, will consist of three wheels—namely, first, one which goes round once an hour; second, the escapement wheel; and, third, a wheel connecting the other two. The wheels and driving gear are arranged in the manner shown in the accompanying drawing, in which Fig. 1 represents an elevation of a turret clock constructed according to the improvements, and provided with striking gear; Fig. 2 is a side view of the same. It will be seen that to the axles of the central wheel a (on the axle of which the hour hand is mounted) is applied a water wheel, which is driven by a flow of water from a suitable reservoir above. This water wheel may be of any convenient construction, but the form most suitable for this purpose, and which is shown in the drawings, consists of four or more pipes, b b, radiating from a centre b^1, and furnished with small buckets b^2 b^2, at their extremities. These pipes are each provided with a tap or cock, on the spindle of which is mounted a tappet wheel c c, so arranged that as the arms of the wheel revolve in the direction of the arrows 1 1, one of the arms of the tappet wheel c is brought against a pin d, so placed that it will turn on the taps c at a certain point as the wheel goes round in the direction of the arrows 1, 1. Water will then pass down the pipe e from the reservoir above to the centre b^1, and from thence up the arm b into the bucket b^2. The flow of the water down the pipe e into the bucket is stopped as soon as the bucket in question is full by the tappet wheel c of the tap coming against another pin d^1, which will turn off the tap and stop the water from flowing into the bucket. By this arrangement the splashing of an ordinary water wheel is avoided, and a very regular pressure is obtained. The hour wheel a gears into a pinion on the axle of the wheel f. The wheel f gears into a pinion on the axle of the escapement wheel h. A pinion on the axle b^1 gears into and drives the wheel i, on the face of which are pins 2 2, which as the wheel i rotates lift up the tail of a lever j, the other end of which is connected by a wire to one end of a lever k, which is connected at its opposite end by a wire to a lever l below, having its fulcrum at 3. As the tail of the lever l is raised it will draw the catch t into the position shown by dots, and will (by releasing the pin 4 on the lever u) allow the other pin 5 to drop on the back of the catch t. Now when the pin 2 on the wheel i passes the tail of the lever j the latter will fall back into the position shown, and the pin 5 being released from the catch t will allow the lever u to drop down until stopped by a pin 6 at the end of the double lever v v^1, on which it will rest in the position shown by dots and by means of the wire u^1; this lever u will turn on the tap s, and allow

IMPROVEMENTS IN TURRET CLOCKS.





water to pass down the pipe s^1 into the arms o and buckets o^1 of a second water wheel for actuating the striking part of the mechanism.

In applying this invention to the striking movement, the advantages are very great, first, because the weight here employed is greater than that required to actuate the clock itself; and, secondly, because in this case two trains of wheels are eliminated. The inventor applies the power of a water wheel to the cammed wheel n, which consists of three cams, as shown by dots in Fig. 1. These cams, as they are rotated by the action of the tubular arms o and buckets o^1, act on the tail of the lever p, which by the intervention of the wire p^1 lifts the hammer of the bell in the turret above. As the water wheel o will only revolve at a steady pace, the regulating fans usually employed in the striking gear of ordinary turret clocks may be dispensed with. The only wheel required in this arrangement, with the exception of the cam wheel n for lifting the hammer through the lever p and wire p^1 is a ratchet wheel q to drive the locking plate r. The ratchet wheel q has three teeth, and is mounted on the same shaft as the cam wheel n, and therefore at every third of a revolution moves the locking plate r one tooth. It will be evident that so long as the arms o of the large water wheel continue to move round they will carry round with them the cam wheel n, and will consequently act on the hammer lever p, as already explained, and also on the ratchet wheel q, which will drive the locking plate r one tooth for every stroke of the hammer on the bell. The striking will therefore continue until one of the twelve pins 7 7, on the face of the locking plate r comes against the tail v^1 of the lever v, on which the lever u rests. The pin 7 as it moves forward will push back the tail v^1 of the lever, and thus cause the pin 6 to raise the lever u into the position shown in the drawing, an thus allow the counterbalance lever s^2 on the cock s to turn off the water from the arm o and buckets o^1, and thereby stop the cams n and ratchet q until one of the pins 2 of the wheel i comes round again at the end of the hour and turns on the water again in the pipe s^1.

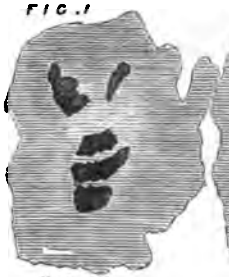
When there is any difficulty about introducing a water wheel large enough to act in the manner above described, or where complicated movements such as chimes are required, the main advantages of this system can be obtained by making the weight and drum of any ordinary clock of power sufficient to strike twelve o'clock with its chimes, if any, and then arranging a small water wheel to wind up the striking movement after every time that it has acted. Thus, for instance, in a non-chiming clock, where it is necessary at present to store up power sufficient to strike 720 times, under this plan only sufficient power is required to strike twelve, thus diminishing the strength and solidity requisite in constructing the clock.

THE SUPPOSED PLANET VULCAN.

Sir,—To the list of observers which appeared in the English Mechanic of the 1st inst, should be added the names of the Rev. Fred. Howlett, F.R.A.S., and Messrs. Thomas Petty and W. R. Bland.

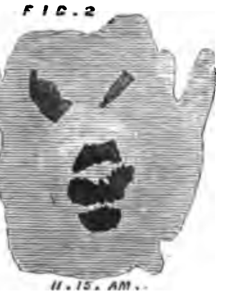
The weather has, fortunately, up to the present time, been exceedingly favourable for solar observations. There have been, and are now, several magnificent groups of spots visible on the sun. Four of these spots have been distinctly visible to the naked eye. At 6h., on March 31, I saw with great distinctness the two groups and large isolated spot near the W. limb, and am pretty certain that another cluster situated on the E. edge of the disc was also visible. On March 28, at sunrise, Mr. H. Ormisher, of Manchester, discovered three of the groups without telescopic aid, and Mr. E. B. Knobel, of Burton-on-Trent, writes that on March 25, 26, 27, 28, and 30, he distinctly saw one or more of the spots with the naked eye. It may be appropriate here to give some measures of the size of the largest spot visible. Mr. T. W. Backhouse, of Sunderland, writes that on the 24th March it was 46,000 miles long, and the principal nucleus 19,000. On the 27th it was 45,000 miles long and 36,000 miles wide. It then contained two umbræ, each 8500m. long. On the 1st April it was 48,000m. long (in a direction nearly parallel with the limb) and 31,000m. wide. Its northern umbra was 8000m. long and 7000m. wide. The above spot traversed the sun's northern hemisphere, and was visible from March 23 to April 4 inclusive. Several other large spots have been visible. On March 24 Mr. Backhouse measure the largest spot of a cluster in the S.E. quadrant, and found it was 36,000m. long.

FIG. 1



11. 9 A.M.

FIG. 2



11. 15. A.M.

Observers have noticed several rapid changes in the form of some of the spots. Mr. E. B. Knobel remarked a phenomenon of this nature on March 26. He says:—"I began to observe the sun at about 10.40 a.m., and gave my attention almost entirely to examining the large spot then visible in the sun's northern hemisphere. I made a sketch of it, which I completed by a few minutes after 11 a.m. At 11.10 a.m. the sun was obscured by clouds, which cleared off at 11.15 G.M.T. I immediately directed my attention to this spot, and was astonished to observe a change had taken place in the bridge across the large umbra. A bright patch seemed to have broken out in the middle of the umbra, which then appeared as in Fig. 2. The moment I had the spot in the field of the telescope it caught my attention, and I felt confident at the time it had not presented that aspect when it had clouded over five minutes before. I should say the bridge was much brighter than the penumbra. I hope other observers have noticed the same phenomenon." The following are the sketches of the spot referred to:—Several other observers have observed somewhat similar phenomena.

No planetary body, or any strange appearance whatever, has been visible on the disc of the sun, or it would have been detected immediately.

I find, on observing the sun this morning with my 4in. metallic reflector, that an immense group of spots have just appeared on the E.N.E. edge of the disc. The photosphere in the region of this group is greatly disturbed, and there are numerous faculæ visible. From the present appearance of this cluster, I imagine it will be of greater dimensions than any other group recently visible. If the weather continues favourable, I will forward you sketches of the appearance of this group, and will duly send you particulars of further observations.

William F. Denning, Hon. Sec., Observing Astronomical Society. Ashley-road, Bristol, April 5.

SHAND'S IMPROVEMENTS IN STEAM PUMPING AND FIRE ENGINES.

Sir,—The following description of Shand's recent improvements in steam pumping and fire engines may not prove uninteresting:—

Mr. Shand claims that they enable him to obtain by

SHAND'S STEAM PUMPING AND FIRE ENGINES.

FIG. 3

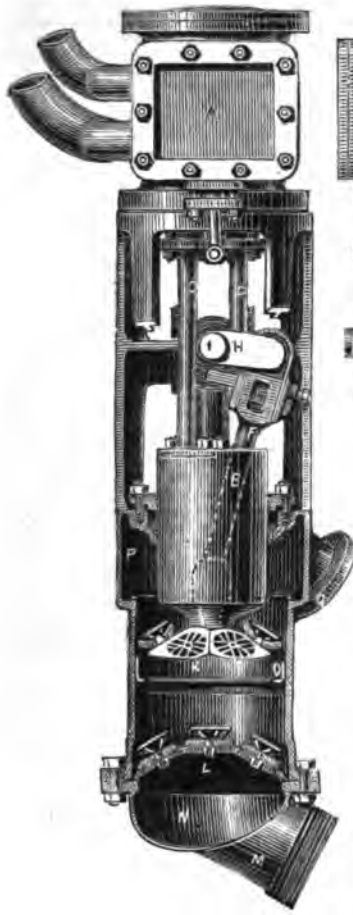


FIG. 1

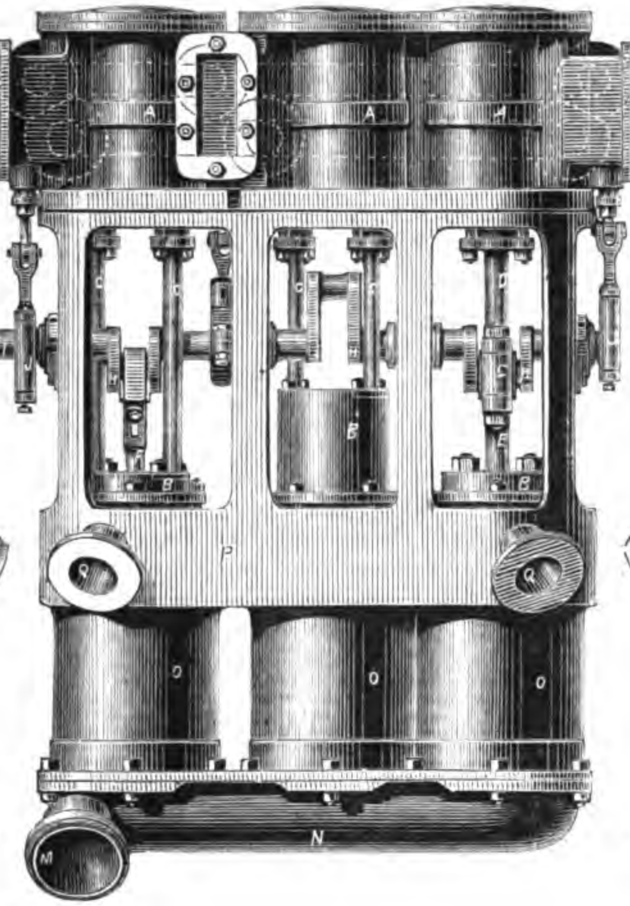
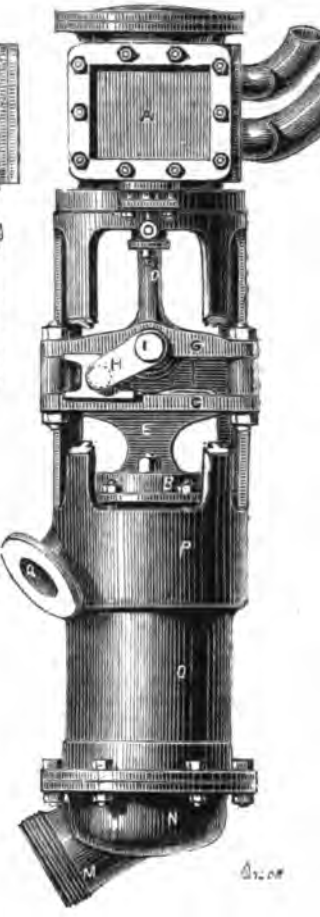


FIG. 2



simple and direct means an uniform action in his pump and perfect equilibrium of all the parts in motion, that is to say, he obtained a continuous flow through suction inlets and delivery outlets, very desirable when used as a steam fire engine, and in effect resembling a rotary action. Greater thoroughfares through the valves are also obtained than can be by the usual means in equal areas of barrel and bucket.

The steam pumping engine is composed of three steam cylinders arranged in line with each other, and the pistons of each attached through its rod directly to a ram and bucket, each of which works in one of three pump barrels, also in line opposite the cylinders. In the attachments of the piston rods to their respective rams a slot is formed, or what is generally known as a slotted crosshead, into which work the journals of a three-throw or equilateral crank, the shaft of which having three eccentrics fitted thereto, each actuating a slide valve to admit and discharge the steam working the pistons, all the working parts are thus made to balance each other. For compactness the three-throw crank may be worked by means of slotted cross heads, but ordinary connecting rods may be used for this purpose. Each pump barrel is connected at bottom to one suction chamber, and at top to one pump head, by which the supply and the delivery is made common to all three pumps, producing the uniformity before named, rendering the action soft, unaccompanied by the violent thud and vibration produced by the ordinary reciprocating pump when speedily driven. The steam and exhaust pipes of the cylinders are also connected each into one, thus constituting but one engine and pump, with continuous instead of the jerking and intermittent action usual in the ordinary pumps. The suction and delivery valves are usually composed of a number of vulcanised india-rubber discs fixed over as many gratings, the outline of each grating being circular, these being formed in a flat plate (also a disc) and forming the foot valve or bucket, and of suitable diameter to the barrels. The size of the rubber disc is by this arrangement limited, as being circles within the boundary of a larger circle the valves can be made no larger than to touch each other.

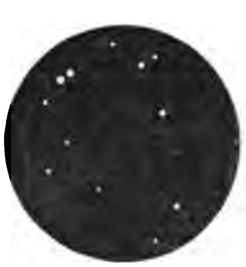
The seats are of a pyramidal form, the inclined faces of which allow of larger circular gratings than can be obtained in the flat valve seat of disc form before described. By these means the thoroughfares through the gratings are increased and an increased flow of water through the suction and delivery valves is obtained.

Fig. 1 is a front elevation, in which are shown the slotted cross head and the connecting rod arrangements. *Fig.* 2 is an end elevation with the frame broken away to show the arrangement of cross head; and *Fig.* 3 is an end elevation, partly in section, showing the arrangement of connecting rod and the pyramidal valve seats.

A are the steam cylinders, the pistons of which are connected directly to the rams B by the two piston rods C in the connecting rod arrangement, and by the single piston rod D and the foot piece E in the slotted cross head arrangement. The connecting rods F or the slotted cross heads G transmit motion to the three-throw or equilateral cranks H, producing a rotary motion of the crank shaft I, on which are fixed the three eccentrics J for working the steam slide vales. Attached to the ram B is the bucket K, in which the gratings of the pyramidal valve seats are shown, also the india-rubber valves in section with their guards. L is one of the foot valves, shown in section, also of the pyramidal form and fitted to the bottom of each pump barrel; M the inlet to suction chamber N from which each pump is supplied; O the pump barrels; P the pump head receiving the delivery of each pump; Q the discharge outlets, of which there may be one or several, as required. FIREMAN.

THE TELESCOPE, &c.

SIR,—A 4in. object glass which will show the 6th Star in the trapezium of θ^1 Orionis needs no encomium of mine to make the owner most legitimately proud of it. I can only tell Mr. Alston (p. 40), that had he paid Dallmeyer (whom I take to be our first living object glass maker), 60 guineas for a 4in. objective, it could not have possibly done more than his "Wray." I scarcely know a more severe test in the whole Heavens than the 6th Star in the trapezium of Orion for an instrument of the size he refers to.



I can give "G" (2273), p. 45. little or no information as to what has become of Kitchener's instruments; which are scattered all over the country. It may, however, assist him in tracing the "Beauclerc" telescope, if I tell him that it was advertised for sale for £130, by the Rev. A. F. Padley, of Lincoln, in the *Times* for February 9th, 1861; who bought it, or whether it was ever disposed of at all, I cannot say.

Mr. J. H. Ward (2275), same page, will find glass of a very dark neutral tint, or of that hue known to Opticians, as "London Smoke," the most pleasant to use as an eye-cap in viewing the Sun. He must be careful, though, either to employ the "Hodgson" reflector (ENGLISH MECHANIC, Vol. IX, p. 180), or to constrict the aperture of his telescope to 2in., or less. Otherwise he will find his dark glass crack at once.

"W. H. P." (2287) can do nothing with his telescope. Lenses are not like trained soldiers, they won't stand fire.

"Astronomer" (2315), p. 46, is delightfully vague. In the absence of any details as to aperture, &c., I can only conceive that his little telescope is a very good one, and his bigger instrument an exceedingly bad one.

"H. A. C." (2347), also on p. 46, is apparently speaking of a reflecting telescope, albeit he says nothing directly to indicate that such is the case. He further omits to state whether it has a vertical motion upon trunnions, or in fact (save by an ambiguous reference to its being "raised or lowered by means of two nuts") whether it has any vertical motion at all. Assuming, however, *pro hac vice*, that he can move it in a truly vertical direction, he must stretch a perpendicular spider line across the centre of the field of his eye-piece; and then obtaining his exact local time, calculate in the way exemplified on p. 2, the precise time of transit of any star near the horizon. He must then bisect this star by his wire, just before its culmination, and, moving the whole instrument bodily after it, stop at the calculated instant of its appulse to the Meridian. His telescope will be then as nearly due North and South as ever he is likely to get it, and he may now lower it and see what terrestrial object forms a meridian mark.

To set the instrument east and west, he may describe a circle on the ground, having the longest leg of his triangle as a centre, and the distance between it and either of the others for a radius. If now he will notice where this shorter leg touches the circle when the instrument is in the Meridian, and will move it round the exact quarter of the circle from such position, he will have obviously shifted the telescope, either into an easterly or westerly position, according to the direction in which he has travelled round the circle.

As for his device for looking at the sun, it is nothing in the world but the "Hodgson" reflector referred to above. It is the best and safest way there is of examining solar detail.

His third query, albeit very indirectly a telescopic one, I may as well answer here by saying that N. P. D. may be converted into declination as follows. When it does not exceed 90°, subtract it from 90°, and the remainder will be North Declination; when it does exceed 90°, subtract 90° from it, the remainder will be South Declination.

For example the N. P. D. of a star is 47° 10′, what is its declination? 90° − 47° 10′ = 42° 50′ Dec. North.

Or, what is the Declination of a star whose N. P. D. is 105° 12′? 105° 12′ − 90° = 15° 12′ Dec South.

An unexpected fine night has enabled me to redeem my promise to look at ζ Ursæ Majoris with Alcor and their neighbours. In preceding column is a sketch of the field of view of a 4½in. telescope with a power of 74, when directed to Mizar. I must, however, expressly caution "Jupiter," or any one else, not to accept the apparent *magnitudes* of the small stars indicated as correct. I do not think that your engraver could possibly cut some of them without making the punctures so minute as to fill with ink in the process of printing. My querist must therefore regard my diagram merely as an eye map of the position of the points of light which were visible when I made it.

With regard to the letter of "α Ursæ Minoris" (p. 50), I am just in this difficulty, that my 10th Vol. of the ENGLISH MECHANIC is now in the binder's hands

So that I have no means of referring to the reply to him to which he adverts. On this account his reference to "24 Lyncis" is a puzzle to me; 4 and 14 Lyncis are both pretty test objects, each about 1″ apart, but 24 and 34 are unknown to me as doubles. What "the first Star on 'F.R.A.S.'s' list" was, I have not the most distant conception either, in the absence of such list from the cause specified. Your correspondent ought certainly to divide the closer pair ε Equulei with the Optical means he possesses; its components are now just over 1″ from each other. The Star "about 15″ (really 11″) to the right and below" it is the third component of the triple asterism.

The list of objects resolved by "α Ursæ Minoris," is creditable to his instrument, albeit it contains some of various values as tests.

—*Apropos* of the 6th Star in the trapezium of θ Orionis, I am disposed, as I have before stated in your columns, to put a 4in. achromatic as the smallest instrument with which, under the most favourable circumstances, this exceedingly difficult object can be glimpsed. If however Mr. Cooke's 3⅞in. *did* show it, such telescope must have been unique as a production of its manufacturer. I should perhaps add, in fairness that suspicion exists of this Star's variability.

I never intended to indicate that the Satellites of Uranus were invisible in anything less than a 2ft. mirror. Some one whose letter bore internal evidence that he was in possession of a 3in object glass, or something of that sort, asked what *magnifying* power was necessary to observe these moons? I jestingly inquired in return if he had a 2ft. mirror, that he put the question? I am quite familiar with all that Arago has written on the subject, and know the story of Lamont and the 11in. Merz refractor, probably very nearly as well as "*α Ursæ*" himself. I will try and be more serious for the future.

Mr. Baguley, p. 68, asks me for some tests for a 3in. refractor. He may try γ Leonis, 49 Leonis, ξ Ursæ Majoris, υ Leonis, 127 P.XIII Virginis or ε Boötis, for separating power. All these are easy objects. He will find more difficult ones in 156 P. XIII Ursæ Majoris, 70 P.XIV Libræ, ν^2 Scorpii, or λ Ophiuchi. For a trial of his light-grasping power he can look at 13 P.VIII Cancri, 67 P.VIII Cancri, 15 Hydræ, ι Ursæ Majoris, θ Hydræ or ψ Ursæ Majoris. The comes to γ Crateris will be just beyond his capability. He may also attempt the resolution of that gorgeous mass of stars 13 M Herculis. I shall be happy to learn what success he has had in the resolution of these few objects; and shall be glad to supply him with a supplementary list, should he be successful with the one I now give him.

I suspect that "Neptune" (2436), p. 70, is merely laughing at me. He has, according to his own showing, got hold of a flint disc of abnormally high dispersive power, but what its exact index is of course I must be ignorant. He tells me the focal length of the crown, and that of the whole combination, and he professes to have such stupendous faith in my mathematical juggling as to suppose that I can from this compute the curves he requires "in a few lines." I do not know whether "Neptune" has ever calculated the curves for an object glass himself; but I can assure him that I *have, ab initio*, and I made a vow when I had finished, that I would never voluntarily wade through such a dreary waste of figures again. To get out accurately, the four surfaces of an achromatic combination of the size of your correspondent's, would involve, *imprimis*, the most accurate knowledge of the refractive and dispersive indices of the materials to be employed; and then a mass of elaborate calculation which I really have neither the time nor the inclination to face. It is not like a terrestrial telescope, or other small instrument, in which Sir John Herschel's simple formula can be employed: it is a serious undertaking, as "Neptune" may satisfy himself by reference to any standard book on optics.

A FELLOW OF THE ROYAL ASTRONOMICAL SOCIETY.

TIME.

SIR,—"Not a F.R.A.S." (2425), p. 70 is slightly confusing two different things. All he has to do is to calculate his own local mean time accurately, and then by adding 8m. 7s. to it he will obtain the Greenwich mean time at that instant. The addition of 1·33s. is to the apparent Right Ascension of the Sun at his local mean noon, because the Earth turns from West to East, and in the interval between the Greenwich Meridian coming under the Sun, and the arrival of that of your correspondent there, the Sun himself will have travelled a little way in the Ecliptic, and have increased his Right Ascension by the 1·33s.

An example scarcely seems necessary, but for perspicuity I give one, worked out at length. What will be the Greenwich Mean Time at 6h. 14m. 50·39s. Local Sideral time in Longitude 8m. 7s. W., on the 15 April? Turning first to p. 63 of the "Nautical Almanac," we find

	h. m. s.
Sidereal time at Greenwich Mean Noon	1 33 46·06
Add proportional part of 9·8565	1·33
Sidereal time at local Mean Noon	1 33 47·39

	h. m. s.
Then from	6 14 50·39
take.. ..	1 33 47·39

There remains 4 41 3·00 The Sidereal hours, minutes, and seconds, since Mean Noon.

Converting this into Solar time, by the aid of the table at p. 506, thus:—

h. m. s.		h. m. s.
4	=	3 59 20·6818
41	=	40 53·2831
3	=	2·9918

We get 4 40 16·9567 Local Mean

h. m. s.

time, and finally if to this 4 40 16·96

we add 8 7·00

we obtain 4 48 23·96 the Greenwich Mean Time at our supposed place of observation at the assumed Sideral Time on the day specified.

I have assumed that my querist's longitude is 8m. 7s. in *Mean* Time west of Greenwich. If it be 8m. 7s. sidereal time, he must convert this into mean time, which he will find to be 8m. 5·7s., and add that.

I can only reply to Mr. W. F. Swallow (2364), p. 68, that I have nothing to explain, modify or retract with reference to what I wrote with regard to the gnomon (*loc. cit.*), in your last volume. Mr. Swallow asserts that the length of the shadow of a gnomon at the time of the equinox is not an arithmetical mean between the two lengths of the same shadow at the Solstices; and I say that it *is*. *Utrum horum mavis accipe.*

A FELLOW OF THE ROYAL ASTRONOMICAL SOCIETY.

PERSONAL.

SIR, I lower my sword to Mr. Proctor. I see the force of his objection with reference to my determination not to argue under any circumstances whatever; and can quite conceive that too rigid an adherence to such determination may often render me liable to misconstruction. *Pro hac vice* then, I candidly admit that my spectroscopic illustration was a most unfortunate one, and my use of the words "*a priori*," where I should have said, and only meant, "at the first blush," certainly calculated to convey the impression that I was enunciating, what I believed to be, a scientific truth. There is less excuse for me, because I was familiar with the form in which the Astronomer Royal had stated his difficulty, and the immediate and convincing reply that was given to him; but I wanted an illustration and, it seems, could only furnish one in this slipshod form. I should be very sorry that it should go forth to the world that I believed that the dispersion of the two dissimilar spectra, might have *theoretically* been expected to go on, *pari-passu*, although on reading may own words over (*litera scripta manet*), they certainly appear to convey that idea.

There is a gentleman signing himself "Veritas," who has honoured me with a considerable amount of attention for some weeks past. It may perhaps save him the expenditure of a great deal of paper and ink if I refer him again to the article "Venus on the Sun's Face," which has formed the text from which he has been preaching. If he will honour me by reading it once more, he will find that I absolutely repudiate rigid accuracy in my figures, my sole object having been to render apprehensible, in the most popular form that I could devise, the *principle* on which the measurements described, are made. To have gone into all the details and refinements of calculation would have been to have expanded what filled some 6 or 7 columns of the ENGLISH MECHANIC, into a thin octavo volume. Once for all, then, I used *round numbers* everywhere, and it is of no use "Veritas" founding any theory upon them.

THANKS.—Permit me to thank Messrs. "Saul Rymea" and G. E. Crick, p. 44, for their kindness in so promptly answering my question as to engraving on slate. I have further to thank Mr. Leicester for the trouble he has taken to reply to me on p. 66. I rather fear, though, that the process which he describes is beyond the reach of a mere amateur.

A FELLOW OF THE ROYAL ASTRONOMICAL SOCIETY.

THE SUN'S DISTANCE FROM THE EARTH.

SIR,—The following information I copy from Vol. LIII., page 1, of the *Phil. Trans.* for the year 1762, with comment, for the notice of your correspondent, "S. B.," in your number for April 1st, 1870, p. 38:—

"Of the Sun's Distance from the Earth, deduced from Mr. Short's Observations relating to the Horizontal Parallax of the Sun. By Peter Daval, Esq., V.P. of R.S. To James Barrow, V.P. of R.S.

According to Mr. Short, the mean horizontal parallax of the sun is 8″·65. Now, this parallax is the angle which the semi-diameter of the earth subtends, as seen from the sun. Therefore, as 8″·65 is to 360° (the whole periphery of a circle), so is the semi-diameter of the earth to the periphery of the earth round the sun. But as 8″·65 is very nearly the 149826th part of 360°, as may be easily proved by division, according to the latest observations, the mean semi-diameter of the earth is 3958 English miles, which being multiplied by 149,826, produces 593,011,308 miles for the circumference of the orbit of the earth. The distance of the earth from the sun is the semi-diameter of this orbit; and the periphery of the circle is to its semi-diameter very nearly as 6,283,185 to 1. Therefore, if we divide 593,011,308 by 6,383,185, the quotient, which is very nearly 94,380,685, will give the mean distance of the earth from the sun in English miles.

As the orbit of the earth is an ellipse, not a circle, the distance of the earth from the sun will be greater in its aphelion, and less in its perihelion, than here assigned.

The result obtained will depend, of course, upon the true value of the mean horizontal parallax. R. H.

THE COLOURS OF JUPITER.

SIR,—I beg to reply to Mr. Purkiss's letter in your last issue; at the same time I may be permitted to inform him that I have not the slightest wish to enter into a long discussion on the points in question. If I have erred in making it a question of colour instead of relative brightness, I am quite willing to stand corrected. I cannot agree with Mr. Purkiss that large apertures and high powers do not enable us to discriminate delicate gradations of light and shade as well as of colour. The fact that this is the case is abundantly proved by the detail shown in a correct drawing of the planet with a large aperture of either object glass or speculum, and by the utter absence of such detail in drawings made with small telescopes. The simple explanation of the fact that the belts actually appear darker in a small than in a large telescope is that in a large instrument we get sufficient power to perceive the belts diversified with many irregularities of light and shade, and hence they do not appear to be such a dense dark mass as when viewed in an instrument in which there is not sufficient power to reveal these details, and which consequently simply shows the belts as dark dense bands across the planet's disc.

Mr. Purkiss dissents from the opinion that no pigments or materials with which we are acquainted can be made to accurately represent the differences which really exist, but such is really the case, and, as an instance of this kind of difficulty as applied to the delineation of terrestrial objects, we may mention that an artist who introduced a lily into one of his pictures was compelled to represent it in different depths of grey, but still preserved the relative purity of the flower in question, although it would obviously be untruthful to call a lily grey, and the requisite force of contrast was only obtained by sacrificing truth to effect, by unduly darkening the rest of the picture.

Mr. Purkiss thinks I am in error in stating that Mr. Browning's drawing is over-coloured, and adds his own opinion that the error lays in the other direction, for, according to his humble opinion, the colour was even more vivid than shown in the drawing. This is in direct contradiction to Mr Browning's own words, quoted in Mr. Denning's letter, where he distinctly says:—"The coloured print taken from my drawing is decidedly over-coloured, the yellow and red are too bright, and the ashy blue, or grey, far too dark." And Mr. Purkiss, in thanking Mr. Denning for h's reply, says:—"It is concise and appropriate, and everything which could be desired." Surely such evident contradictions in the writings of a gentleman of his eminence in optics and astronomy deserve explanation.

On another point I need some little enlightenment. Where can we see paintings which not only equal, but surpass Nature herself?—in which there is preserved throughout such a glowing luminosity as to far exceed the brightest tints of the landscape? I do not profess to be a judge of paintings, but I have spent many a happy hour in contemplating scenes of beauty portrayed on canvas with marvellous fidelity, but could not venture to assert that the gorgeous sunset of the artist equalled, much less exceeded, the real beauty with which the great orb of day gilds the western heavens as he slowly sinks to rest on a bed of clouds.

Mr. Purkiss complains that few skilful draughtsmen practice astronomy, and so difficulties are made of things which ought to be comparatively easy. Now if celestial drawing is so easy, why not favour us with some delineations of objects observed with mirrors of his own manufacture, since he states their definition to be excellent, and I have no reason to doubt for one moment their superior quality. It would, however, be an additional satisfaction to read the testimony of some other observers who are working with his specula. CHARLES GROVER.

COVERING THE KEYS OF PIANOFORTES, ORGANS, AND HARMONIUMS.

SIR,—"Progress," No. 2342, inquires if his worn harmonium keys can be faced—*i.e.*, re-covered with enamel. Many patents for covering the keys of musical instruments with glass and enamel, have been taken out, but those materials have never come into general use, and almost every one prefers ivory for the purpose.

Re-covering keys with natural ivory is a daily practice and any keymaker will do it for "Progress," and a suitable consideration. Perhaps "Progress" would progress fastest if he sent his keys to Messrs. Brooks, supposing he would be satisfied with natural ivory. I don't think he will find any one who will undertake to cover them with enamel.

Artificial ivory has been made of tolerable quality by the French, but by far the best specimens I have seen were the productions of Mr. H. J. Brown, who although best known as a public writer and poet, was by hereditary descent a comb maker. He made excellent combs of his artificial ivory, the composition of which he kept secret, but I think a chemist might give a shrewd guess at its component parts.

Henry Brown was the man the late W. J. Fox alluded to in his article in the *Westminster Review* on "The Poets of the People." After mentioning Ebenezer Elliot, he wrote of Henry Brown:—'There is a man who makes combs in Whitechaple," and compared him to Crabbe, giving deserved praise to his really beautiful poem "Sunday," which, with his "Mechanic's Saturday Night," and his "Saint Monday," graphically portrayed the working man of that period. Of course "ye working man" is now quite a different being, he having been educated into a civilised, refined, intellectual, and moral Christian, who is quite innocent of "Old Tom," and unacquainted, practically, with the meaning of the words "pot of beer."

THE HARMONIOUS BLACKSMITH.

COMFORT FOR TRAVELLERS BY RAILROAD AND STEAMER IN AMERICA.

SIR,—English railway directors are not greatly celebrated for the care they exhibit for the comfort of passengers; perhaps if they exhibited more care for their passengers' comfort than they do it would hardly be appreciated by the majority of travellers, especially if it were accompanied by an increase in the fares, for however Britons may wish to be well-served for nothing, they, as a rule, prefer being served badly without payment, to being well served and paying a fair price for it, and this rule holds good not only in the matter of railway travelling, but also in the administration of justice (I should have written *law*. They are not invariably identical, or our great unpaid, which is only another name for our greatly inefficient, would not be so popular with that numerous class who fancy that a thing which costs nothing must necessarily be cheap, which is usually the reverse of true.)

On some English railways first-class passengers can obtain the luxury of foot warmers in winter, but as our climate—the experience of the last six months notwithstanding—is not quite so extreme as those of Sweden and North America, of course it don't matter if the mass of travellers who, as they go second and third class, do travel with cold toes, for the feelings of such "common people" can't be of much importance, notwithstanding that their fares are, perhaps, in most instances, the only ones which yield a profit; for it is the opinion of some experienced traffic managers that first-class passengers are often carried at a loss. On American railways the practice of heating the cars in winter is universal, so not only can the passengers warm their noses (and their *toeses*, as the Frenchman designated his pedal extremities), but if I am rightly informed the cars are now also cooled in summer, it is stated, by allowing solid carbonic acid to evaporate, and considering that a temperature of 90° in the shade is not uncommon in the Southern States, this must be a great luxury for travellers, nor will it in future be confined to those who travel on land, for it is stated in the *Food Journal* that it is to be extended to those who go down to the sea in (steam) ships.

A steamer trading between New York and Galveston is fitted with apparatus for condensing carbonic acid, and in a recent experiment, its cabin, 66ft. long, 33ft. wide, and 13ft. high, had its temperature reduced from 45 F. to 26 below zero in eight minutes. It is not stated if any living beings remained in the cabin during this experiment, but I fear if they did the effect would have been to induce coma, for it is obvious they would have been compelled to inhale an atmosphere containing an abnormal proportion of carbonic acid, and this, however conducive to sleep and anæsthesia, is hardly conducive to longevity. That carbonic acid in the gaseous state might be employed economically in the treatment of paupers and criminals may be quite true, as I stated in my former communication on the "relief" of the poor and the ratepayers, but it is quite unsuitable for those who can "pay their way," and may be expected to pay their way in their fares more than once, for it would render them quite incapable of paying twice, which is just the thing traffic managers desire, and term development of passenger traffic.

We have imported several American inventions to our advantage, and I think the present is pre-eminently the time to import this refreshing, or rather refrigerating, one, for it might be applied most advantageously at the present time to further the progress of national education by cooling that religious fervour which, strange to say, exhibits itself in a *Christian* land by preventing little children from being taught the three R's, political economy, and their duties to their neighbours. Of course if we continue to bring them up in ignorance we continue to manufacture thieves and paupers, whether we intend it or not. We can hardly expect to gather grapes from thistles, for in morals as in horticulture, verily *as ye sow so shall ye reap.* THE HARMONIOUS BLACKSMITH.

TO MILLERS.

SIR,—It gives me great pleasure to find that so many of our dusty tribe are becoming readers of the ENGLISH MECHANIC, and that a few of them are also correspondents. I should rejoice greatly to see the latter multiplied. It would be the means in an indirect way of promoting its circulation among the former, a class of men to which a scientific paper had no charms if it did not treat upon their particular branch of business.

In No. 262, A. Stoneman has published *his* "notion" to the world respecting millstone balancing, a notion to me quite new, and I believe he will find the universal experience of all practical millers, as well as the laws of centrifugal action or force, to the reverse of his notion, notwithstanding his own to the contrary. He says "that a standing and running balance are the same." As he has expressed his willingness to learn, a few hints from one twelvemonths his senior, may be of some service to prove the impracticability of this assumption. It is certainly new to me that millers have been looking to the face of the stones to find out the cause of the dragging. Most millers know perfectly well that the cause is not in the face, but in the unequal distribution of burr and plaster. The specific gravity of each being as 1 to 2, some burrs are a third heavier, consequently, when the stone has obtained its proper velocity, the centrifugal action or force of these two species, causes the apparent waving or, as it is termed, "being out of balance." It will exhibit this symptom when at perfect standing balance, and I call such to be when a pound weight will turn the centres. It is also quite new to me to find that the level of the bedstone has anything to do with balancing the runner, providing the neck is in good order. We do not shut our eyes to the fact that the bedstone must be perfectly level, but this has nothing to do with balancing, which is done most effectually by a belt running over pulleys attached to the spindles by bolts, the same being in two halves. As a further illustration of what I have stated above, to save space, I refer him to a diagram (intentionally somewhat exaggerated) by Mr. Smith, on page 588, No. 257, Vol. X. A careful study thereof will, I think, throw his "notion" quite out of balance.

Now a word about wire flour-dressing machines. Mr: Sharpe has sent us a description of one he once had, which dressed the modest quantity of six sacks (20st. each) per hour. A machine of the same dimensions as his, with revolving cylinder and external brushes, 6in. fall, covered with five sheets of flour wire, the internal brushes running 520 revolutions, will dress 20 sacks per hour—average produce, 75 per cent. I don't know how many machines there are in Ireland, but I know one in England that does what I have stated above, and the quality of its work will compare favourably with some of that of the silk machine, which I presume he would recommend Mr. Scott to put down in his mill; I would also advise him to do so in preference to the wire. Its work is finer, and takes better in the market. THOS. EVANS.

SIR,—Your correspondent, "A Stoneman," quoting from my letter, asks me to explain how "stones working well out of standing balance only proves that they are in running balance." I did not mean to convey that because they are out of standing balance, that therefore they must be in running balance. But "Salisbury Miller" asked how it is that stones work well although being out of standing balance. I concluded that if they "*worked well*," they must be in running balance; but I very much doubt that they would be found out of standing balance if properly tested. J. SHARPE.

"HOMINY."

SIR,—During a long sojourn in the United States, and while dwelling in the South, I partook daily, and largely, of hominy, a very wholesome and strengthening food, well known to Southern residents. I had never tasted this food before, and discarding rice altogether, which is also largely eaten, took to hominy almost entirely; and since my return to England I have done my best to produce a similar article for my own use, but have not yet obtained the exact thing; and I now venture to ask our American friends to be kind enough to inform me how the article is prepared. I may mention that the instructions given in the numerous recipe books for the making of it are not reliable, and I should therefore prefer to have the information from a States man, one who has had practical experience in preparing it. The mill which I use grinds the grain into five qualities of flour, and in the making of hominy I take the coarsest, including the bran, and the next two qualities to that, and mix them. A sufficient quantity is then soaked in water for two, or three, or four days in winter, but for one day only in summer, or it might become sour. Boiling it in a certain quantity of water for 15 or 20 minutes, stirring it all the time, it is then allowed to thicken gradually on the hob, as near to the fire as possible, and it there remains, sometimes for hours, until it thickens and most of the water has been thrown off by steam. It must be frequently stirred, for it soon burns. When cold it becomes somewhat hard, like pudding, and is most nutritious, since it contains the very qualities spoken of by Liebig, and which are cast away by unwise people as dross. I could give much information as to the best way of using it, but it requires beef, pork, or ham fat, and is excellent with rabbit or fowl fricasseed. It can be eaten in various ways, and in making it palatable people must study their own appetites. Its effects on the stomach and bowels are admirable, and most people like it better if a few bread-crumbs be mixed with it.

This is, however, not the hominy as prepared in the South of the United States, although perhaps a near approach to it; and I should therefore be glad to hear from a States man on the subject, who can give me reliable information as to the *modus operandi*, and who is as fond of buckwheat cakes, hominy, and fresh corn cobs as TAUTAU.

CHINA GRASS.

SIR,—As there have been several discussions about China grass lately in your paper, I think that the following extract from a notification by the Governor-General of India in Council will be interesting to many of your readers:— MINNEHAHA.

"The Government of India, after communication with various agricultural and horticultural societies in India, and with persons interested in the subject, has arrived at the conclusion that the only real obstacle to the development of an extensive trade in the fibre of rheea or China grass is the want of suitable machinery for separating the fibre and bark from the stem, and the fibre from the bark, the cost of effecting such separation by manual labour being great. The demand for the fibre is now large, and no doubt might be extended with reduced prices, and there is a practicably unlimited extent of country in India where the plant could be grown. The requirements of the case appear to be some machinery or process capable of producing, with the aid of animal, water, or steam power, a ton of fibre of a quality which shall average in value not less than £50 per ton in the English market, at a total cost, all processes of manufacture and allowance for wear and tear included, of not more than £15 per ton. The said processes are to be understood to include all the operations performed after the cutting and transport of the plant to the place of manufacture, to the completion of the manufacture of fibre of the quality above described. The machinery must be simple, strong, durable, and cheap, and should be suited for erection at or near the plantations, as the refuse is very useful as manure for continued cultivation. To stimulate the invention or adaptation of such machinery or process, the Government of India hereby offers a prize of £5000 for the machine and process that best fulfils all the requirements named above. Rewards of moderate amount will be given for really meritorious inventions, even though failing to meet entirely all the conditions named."

THE "PHANTOM" WHEEL.

SIR,—In the last impression of "our MECHANIC" I observe an advertisement by "The 'Phantom' Veloce and Carriage Wheel Co., Limited (Reynolds and May's Patent)," wherein is set forth as a new invention a wheel of a precisely similar kind to the one I published in your journal four years ago, and which you will find on page 335, No. 68 of Vol. III., illustrated under the heading "The Spider Wheel." It was constructed for me by my brother—of Bedford—in 1864, who also afterwards made a velocipede upon the same principle, the first, I believe, that was ever constructed with pattens fixed *directly on the cranks.*

The form of wheel under discussion—*i.e.*, on the suspensory principle, was finally abandoned by us on account of several defects that appear to be inseparable from it.

1st. It was found to have a tendency to flatten at the spokes after a short time using.

2nd. The wires being necessarily drawn up "taut," the slightest blow was certain to break them—ample evidence of which was afforded by a countryman, in examining the machine, putting his foot through several of the spokes.

3rd. The passing of the wires, or hooks, through the felloes or rim of the wheel was found greatly to weaken it, and to lead to the first-named defect, however carefully made; and

4th. What altogether condemned it for use as a *crank* wheel or moving power was that lacking the rigidity of the ordinary wheel, there was a springiness in moving it by the cranks when loaded that caused a considerable loss of power in driving it. Otherwise it is very elegant in appearance, and a wheel that will bear an immense weight, and I should say—barring the 2nd defect mentioned above—would be found very suitable for carriages, &c., but certainly is by no means admissible as a *driving* wheel.

As a singular coincidence I also notice, illustrated on page 61 of the same number, a device of mine, whilst at Cardiff in 1861, but one which does not answer in practice, by reason of the impossibility of keeping one's balance, and also on account of the strain both on the ancles and on the wheels through the weight falling on one side, instead of directly over the wheel. Neither do I believe these single wheel skates have ever been used as shown in your illustration.

EDMUND M. T. TYDEMAN, 9, Mighell-street,
Brighton.

AMATEUR FARMING, &c.

SIR,—Now there is such an improvement in our MECHANIC, I think it would not be a bad idea to place a column (as a trial) to questions and answers respecting the breeding, keeping, and rearing of horses, cattle, pigs, agricultural implements, &c., as I am sure a good many of our readers have hobbies of that kind, as well as lathes, organs, &c; but before I say any more, I should like to hear other opinions on it, as I am sure it would take well in the country, and even in the towns. R. W. P.

[Perhaps our correspondent would be good enough to set the ball rolling. We will place some space at his disposal.—ED. E.M.]

QUANTITATIVE ANALYSIS, &c.

SIR,—Mr. Somerville and others, who have addressed queries to me, may think perhaps I have forgotten them; such, however, is not the case. I have been exceedingly busy, and now having a little spare time, I send the answers to their queries.

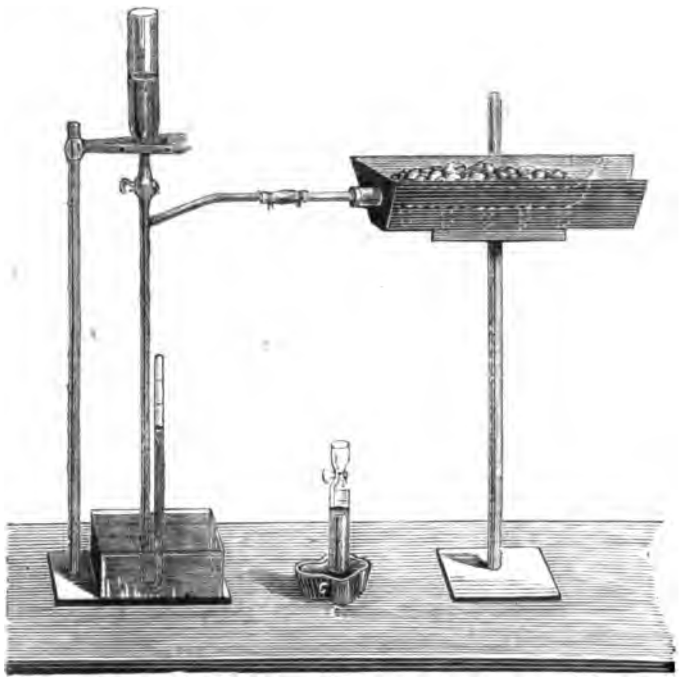
Estimation of Ferrocyanogen in Tea.—A good general sample of the tea should be taken, and of course, examined qualitatively. If Prussian blue be present, take one ounce or so of the tea, add warm water in a flask, and shake well for a few minutes, strain off the leaves, and let the rest settle, pour off a great deal of the water, add a solution of caustic potash, and then acidify with hydrochloric acid. Make a solution of potassium permanganate by dissolving 3·162 grains in 1000 grains of water; this is to be added to the above acidified solution until a *faint* pink coloration is produced. Now, the amount of *Prussian blue* cannot be determined from the amount of solution used, as the organic matter present consumes a certain quantity. A second determination must be made of the amount of ferricyanogen which exists in the solution; this may be effected by adding iodide of potassium, allowing the liquid to stand for some time, and then neutralising the solution with sodium carbonate. The amount of iodine which is liberated is then determined by dissolving 12·4 grains of sodium hyposulphite in 1000 grains of water; each 10 grain division of the burette will equal 0·422 grains of ferrocyanide of potassium, from which the amount of ferrocyanogen or Prussian blue can easily be calculated. Starch solution must be used as an indicator. The determination of the ferrocyanogen should never be made by burning the tea, and estimating the amount of iron found in the ash. Sulphate of iron is often used for blackening spent leaves; in such a case, the iron which naturally would occur as sulphate, would erroneously be set down as existing in Prussian blue. The sulphate may be detected by its reaction with barium chloride.

Estimation of Organic Nitrogen, Carbon, &c., in water.—I shall not give all the minutiæ, but only those details which will lead to a good general result.

Take two pints (32 oz.) of the water, add to it in a glass flask half an ounce of a solution of sulphurous acid, boil for five minutes, and transfer to an evaporating basin, evaporate steadily, and finish off in a drying oven to prevent loss by spirting. Mix the dry residue with oxide of copper and chromate of lead, and transfer it to a warm combustion tube, fill up with warm oxide of copper, and end by placing some clean copper filings in the anterior portion of the tube. This part of the tube is now connected with a Sprengel pump and the air drawn out; the end of the pump is then placed under the end of a graduated tube (this may either be graduated into cb. inches or cb. centimetres, the latter is much to be preferred), 50c. centimetres graduated into 250 parts. Heat is then applied to the copper, and gradually carried back until all the tube is at a full red heat; when no more gas is given off, work the pump again to abstract any gas which may remain in the tubes, and let the receiver cool down to the temperature of the laboratory. Its volume is observed, and the temperature and pressure also noted. The height of the column of mercury having been taken in millimetres (or inches) above the level in the trough, the amount must be subtracted from the height of the barometer; this will give the pressure to which the gas is subjected, which must be calculated to 0° C. and 760mm. A moistened ball of potash (or a concentrated solution), must then be introduced into the gas to absorb the carbon dioxide, the amount of absorption being read off as this latter gas, making the necessary correction for the tension of the aqueous vapour with which the gas is saturated. A bubble or two of oxygen is then added to detect the presence of nitric oxide, and pyrogallic acid solution is added to absorb the excess. The pressure and temperature being noted, the volume of carbon dioxide is known, from which the amount of organic carbon by weight can easily be obtained.

The amount of ammonia present in the water must now be estimated by comparison with a standard solution coloured by Nessler's re-agent.

The amount of gas left in the tube is calculated to 0° C and 760mm., and the weight found. The weight of nitrogen in the ammonia is subtracted from the weight of the gas, and set down as organic nitrogen. The amounts of carbon and of nitrogen, if multiplied by five, give the organic carbon and organic nitrogen per gallon. This is Frankland's process, but as practised by him the receiving apparatus is much more exact, though, as here stated, the process will give good results. The cut on next page shows the apparatus in full work.



The next operation in water analysis is to determine the amount of "skeletons" of sewage, as Frankland calls the nitrates and nitrites:—Take one pint (7000 grains), and evaporate to 4oz., add silver sulphate to precipitate the chlorides, filter and evaporate to a very small bulk; this is placed in the cup of the tube C in the figure, and admitted under the stopcock; concentrated sulphuric acid is then admitted, and the mixture gently agitated, nitric oxide is expelled, which may be accurately measured, and the amount of nitrates calculated. The nitrates vary much in quantity, sometimes being absent altogether, and at others existing in quantities as much as 20 grains per gallon.

"Basin," query 2192.—I suppose the quantity of ammonia contained in the sulphate is what "Basin" requires.

Place 1·7grms. of the sulphate in a small distilling apparatus, with an excess of potash solution, and apply heat; conduct the ammonia, which is liberated, into 50cbc. of a normal solution of sulphuric acid. When all the ammonia has passed over, colour the normal acid with litmus, and neutralise with normal alkali, noting the number of cbc. used; the number used subtracted from 50 gives the percentage of ammonia. If the sulphate is a very impure variety, and it is required to know how much sulphate it contains, take 6·6grms., and proceed in the same manner only conduct the liberated ammonia into 100 cbc. of normal acid; the number of cbc. of acid actually neutralised represents the percentage of sulphate of ammonia.

To "Discipulus," query 2197.—1. Dissolve 1grm. of the sample of salt-cake in 100cbc. of water; then dissolve 122 grammes of barium chloride in a litre of water, and add to 5 cbc. of the salt cake solution until it occasions no further precipitate. A small filtering tube must be frequently used, as the end of the precipitation may be overstepped. Each cbc. of solution is equal to 0·96 SO_3, or 0·04grm. SO_3. 2. He may separate barium from strontium by exactly neutralising the solution, and adding potassium bichromate ($K_2 Cr_2 O_7$); the barium is precipitated as an insoluble chromate of a yellow colour, whilst the strontium remains in the solution. The barium chromate is decomposed by acids. 3, Dissolve 17 grains nitrate of silver in a litre of water; each cbc. of this solution indicates 0·00355grm. of chlorine. To determine the amount of chlorine in any solution, a few drops of potassium chromate are added, and then the silver nitrate solution, until after well stirring a blood colour is still manifest. The number of cbc used × 0·00355 gives the amount of chlorine. 4. Standen's patent manure, which is a bone phosphate, need only be examined for soluble phosphates and ammonia. Ammonia does not exist in the manure, but is formed by the decomposition of the gelatin. Estimate the phosphoric acid thus:—Dissolve 6·9 grammes of uranium nitrate (crystallised) in 100cbc. of water, each cbc = 0·001grm. of PO_3. If the P_2O_5 is required, 9·34 grammes must be dissolved in 100cbc. of water. Bring a known weight of the manure into solution, filter and add a solution of acetate of sodium and acetic acid, then add the uranium solution until a drop taken out produces a brown coloration when placed in contact with ferrocyanide of potassium. The number of cbc. used, multiplied by 0·001, gives the amount of phosphoric acid. To estimate the ammonia, he must add caustic potash, or soda lime in a distilling flask, and lead the ammonia into normal sulphuric acid; 1·7 grammes of ammonia will neutralise 100cbc of the normal acid.

J. Crompton, query 2271, may purify his acid by distilling it in a glass retort. Of course he cannot cheaply recover the nitric acid from the nitrates, which result from the action of the acid on the metal.

"Izgitzar," query 2270, is referred to page 605, Vol. X., for a method to estimate the amount of organic matter in water.

"J. N. from the North Country," query 2325, must take 10grms. of iron ore, and dissolve it in hydrochloric, and proceed with the bichromate of potassium solution, as I have stated on page 605, Vol. X., save that he must, after bringing the ore into solution, divide it into two portions; treat the first directly with the bichromate, and the second portion must be treated with zinc, and afterwards with bichromate; the first will give the amount of iron as protoxide, and this amount if subtracted from the amount of the second, will give the peroxide.

Query 2351.—It would be almost impossible to give a test for alcohol in any kind of liquid; the tests must often be modified to suit the liquid. If "Alcohol" will give the liquid in which he suspects alcohol, I may perhaps help him.

"Rudis," query 2356, may extract the gold from the sand by boiling it with aqua regia (nitrohydrochloric acid) Chloride of gold is formed, and may be obtained by dissolving in water and crystallising. If, however, metallic gold is wanted, it may be precipitated by adding ferrous sulphate, which throws down the gold as a black powder, which may be fused with borax into a button.

Geo. E. Davis

LATHES.

Sir,—I am sorry to have been the means of promulgating the grievous error that Mr. Bennett, who invented the die-chuck I sent you two weeks ago, had ever worked in Mr. Evans's shop. I have not seen Mr. Evans since, but am satisfied that Mr. Baker must be better informed than I. Though Mr. Evans is not able to claim the distinction of having been Mr. Bennett's employer, there is no reason why he should not have some credit given him in a matter of much greater consequence, and which he does not seem likely to get. In your number of April 8 you give a picture of Mr. Salt's lathe, which you say was "chiefly made at Saltaire, but was finished by a London maker." I happen to know that a great part of the lathe which *was* made at Saltaire, and which came to Mr. Evans's, 104, Wardour-street, Soho, London, to be "finished," was put on one side, and entirely re-made. There is no wonder that it cost a lot of money, as everything that could be was made of steel. The whole of the slide-rest, for instance, is steel, and the "bright set of engine-cut wheels" would have been steel if they could have been cut at any reasonable price. They were done in the machine of which a drawing forms the front page of No. 258. The "screw headstock," or poppet head, has the "base slide" arrangement, which, if it has not been altered since I last saw it, has the desirable faculty of going over on the wrong side—viz., *away* from the workman, thus turning cones biggest at the little end. I do not think Mr. Evans had anything to do with the overhead motion further than making some alterations to order; and I hope that his mind is not oppressed with the recollection of ever having made for such a lathe such a chuck as the face plate with four dogs sticking out of it, which is shown on the floor in the picture.

J. K. P.

APPARENT PARADOXES IN EQUATIONS.

Sir,—The "apparent paradox," given in a query some time ago, and which has elicited several answers, but which appear not to be satisfactory to the proposer is simply one of those difficulties which present themselves to the student when advancing over the first stepping stones to a knowledge of the theory of equations. As it is an important subject to the student of mathematics, and may have been a troublesome one to many of your readers, you will perhaps allow me a little space to endeavour to explain it.

If $a = b$, and both sides be multiplied by a and b^2 taken from both sides we have $a^2 - b^2 = ab - b^2$, and if the proposer chooses to take $a - b$ from both sides, we have $a^2 - b^2 - (a - b) = ab - b^2 - (a - b)$ Divide both sides of these two equations by $a - b$, and we have $a + b = b$, or $a = o$, and $a + b - 1 = b - 1$ or $a = o$, or as the proposer put it. $2 = 1$, which reduces to $1 = 0$. Now, this anomalous result, $a = o$, is exactly what every one conversant with the theory of equations would expect, because it is well known that if any equation, say of three degrees, as $x^3 - b^2 x = o$, be produced by the multiplication of three factors, as $x + b$, $x - b$, and x, of which one is the monomial x, then $x = o$ is one of the roots of that equation. The equation proposed by "U. B." is simply the equation $a^2 - ab - o$ in a disguised form, of which the two roots are $a = b$ as assumed, and $a = o$. But this is no answer to the querist. It is required to be shown how the value $a = o$ arises in an equation, which was built up with the value $a = b$ assumed.

Now, since $a = b$, then $a - b = o$, and if both sides be multiplied by a we have $a(a - b) = o$, because o taken any number a times is o still. Now, if we divide both sides by $a - b$, we obtain $a = o$, because o divided by any quantity can never make any more than o.

Now, this arises from the fact that when we multiply $a - b$ by a we treat $a - b$ as if it had some real and definite magnitude, instead of its true value and magnitude, viz, o. Whereas, on the other side we treat o at its real value, o. If we assign to $a - b$ its real value, than we shall have a times o, or o on the left hand side of the equation, as well as on the right.

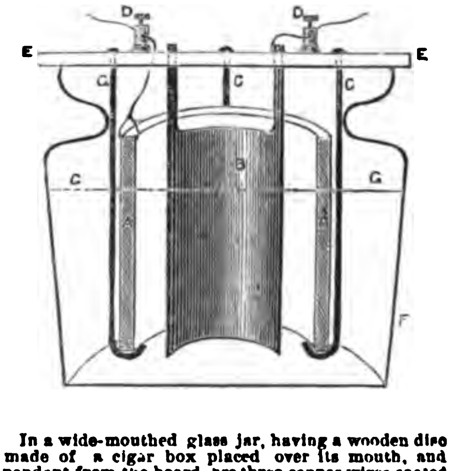
If we treat o as some number or magnitude on both sides of the equation, then the paradoxical result vanishes thus: $a - b = o$, multiplying both sides by a, we have $a(a - b) = o \times a$. Divide the first side by $a - b$, and the second by its equivalent o, then we have $a = \dfrac{o}{o} a = 1$ times $a = a$, when o is treated as if it were a real number or magnitude. But it would not suit our purpose to follow such a plan, because we should never obtain above one root to an equation, no matter of what degree it might be, whereas it is well-known that what are called the "paradoxical" results, give us roots that answer the conditions of the questions in which the equations are involved. Thus: A number squared with 12 added, is equal to seven times the number; what is the number? Here $x^2 - 7 \times + 12 = o$, divide both sides by $x - 4$, and we have $x - 3 = o$. Hence $x = 4$, and $x = 3$ are the roots of the equation, either of which numbers will answer the conditions of the question. If the above equation be tested in the way that $a^2 - ab = o$ was treated, we get the same apparent paradox.

Thus, let $x = 4$, and $x - 4 = o$. Multiply both sides by $x - 3$—*i.e.*, in reality by 1, and we have $x^2 - 7 \times + 12 = o$, divide this by $x - 4$, and we have $x - 3 = o$, or $x = 3$.

T. Brown.

A GOOD CHEMICAL BATTERY.

Sir,—That it may interest the readers of this paper, I give a description of a chemical battery which for simplicity, cheapness constant power, and durability, is the best I know of. It requires very little attention, and is always ready for use.



In a wide-mouthed glass jar, having a wooden disc made of a cigar box placed over its mouth, and pendant from the board, are three copper wires coated with gutta-percha, with their ends turned up, supporting a hollow ring or cylinder of amalgamated zinc of ⅛in. thickness, the lower edge resting on the turned up ends of the pendant coated wires, the gutta-percha covering of the wires preventing contact of the zinc and copper. The zinc cylinder is connected to a wire of copper or platina passing up through the board disc, and through a binding screw.

Suspended from the centre of the disc of wood and hanging plumb in the centre of the cylinder of zinc, without touching it, is a piece of platinised silver (sheet) rolled up, which is connected with a binding screw on the top of the wooden disc by a piece of its own metal; these two connections and binding screws constitute the two terminals.

The jar is to be filled to ⅔ or ¾ its weight with a mixture of oil of vitriol of 66° by Baumé, 1 part, with 12 parts water, to not quite cover the zinc or platinised silver. The parts of the zinc and platinsed silver exposed above the surface of the acidulated water should be coated with well-boiled coal tar to protect it from the gases freed from the reaction and oxidation.

When not in use the two metals can be lifted out by means of the wooden disc to which they are attached, and dipped into water to wash them.

With this battery as powerful a current can be had as is compatible with *durability*, although more powerful currents can be obtained with bichromate of pottasa batteries, but they are of short duration and varying power.

I would recommend that the cylinder of platinised silver be corrugated to obtain more surface of exposure to the acid in a small compass.

Appended is a sectional drawing of the apparatus, with descriptive reference.

A, amalgamated zinc cylinder; B, platinised silver cylinder, which should be corrugated; C, copper wires coated with gutta-percha, for holding zinc cylinder; D, binding screw terminals; E, wooden disc for supporting the cylinders; F, glass jar; G, the top line or surface of acidulated water.

American Subscriber.

ORGAN BUILDING.

Sir,—As many of your subscribers seem interested in the subject of organ building I take the liberty of sending you an idea of my own for making one pedal pipe do duty for two.

Many attempts have been made to accomplish this feat, but all of them have proved more or less useless. The prevailing idea is that of having a valve at one side of the pipe near the top, to be operated upon by the pedal key; but the great objection to this is, that the same quantity of wind which causes, say, the C pipe to speak, will prove too much for it when called upon to sound C sharp, thereby causing it either to overblow, or else give a different or uneven quality of sound.

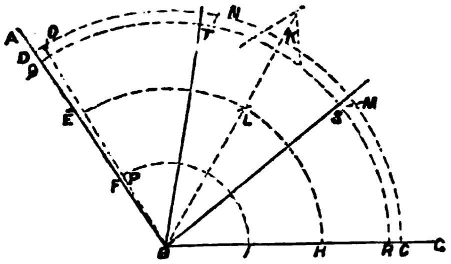
Now my idea is not only to have the valve as before stated, but also to have 2 feet and 2 pallets to each pipe, as it is evident that by so doing the wind for each note would be regulated to a nicety.

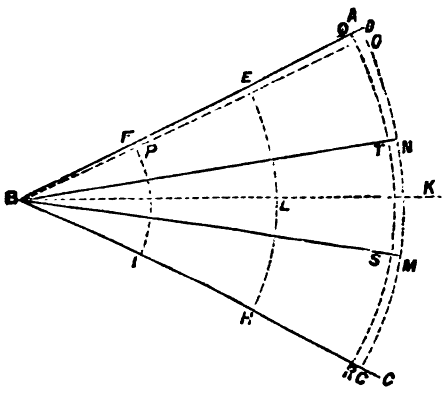
In fixing the pipes, one foot would be placed over one hole, and the other over the one a semitone higher, the action would then be thus: On pressing down, say, the C pedal key, the air would be admitted through one foot and cause the pipe to sound the C note. On raising C and pressing down C sharp, the air would be admitted through the other foot, and the valve at the side of the pipe opening at the same instant would cause the same pipe to sound C sharp. I believe this idea to be entirely original; at least I have never heard of, or seen anything of the sort anywhere. Will "Adept" kindly give his opinion on the subject?

Siddeley.

TRISECTION OF AN ANGLE.

Sir,—I beg to forward you herewith two specimens of the trisection of an angle by an original method. I should much like some of our mathematical correspondents to try the style of doing it, and (if accurately worked) I have no doubt they would arrive at the exact required result. The same letters apply to both figures. Let A B C be the angle to be trisected. On A C mark off any three equal distances B I, I H, and H G, draw the arcs F I, E H, and D G, bisect the angle A B C by the line K B, cutting E H in L, mark off the distance H L on the arc D G from the point G, the points being M N and O, join O B, cutting F I in P from point D on D B, mark off D Q equal to F P, from point Q with centre B, describe arc Q R, the distance L H will then be found exactly to trisect the arc Q R in points S and T, join S B, T B, and the angle is trisected. I wish you success with your new volume!





Vibrator.

[First letter found. If "Vibrator" will send his address the stamps shall be returned.—Ed. E. M.]

ENGLISH MECHANIC MUTUAL IMPROVEMENT SOCIETIES.

Sir,—Having been a subscriber for several years, in fact, since the commencement of our journal, and having been the means of introducing it to several friends, I may be allowed to express my pleasure at the appearance of the first number of Vol. XI. I have been pleased in watching its gradual development, both in importance and size, and am glad it is now so generally appreciated by the lovers of mechanics, science, and art, both at home and abroad.

In the editorial article, "Ourselves and Our Subscribers," our talented Editor states the fact that the "English Mechanic subscribers may be considered as members of a vast mutual improvement society who consider it a duty or a privilege to instruct each other." This is so in accordance with my views that I am prompted to make one or two suggestions which I have withheld until the present, but now consider it a fitting opportunity to bring under the notice of our subscribers, and to hear their opinions.

1. That in large towns where there may be from ten to a hundred subscribers, it would be productive of much good if they could be brought together periodically—say monthly, to discuss the many topics which have been under review in the Mechanic during the preceding month. Then one of their number to communicate to this journal anything which might be considered of sufficient importance, for I have no doubt the Editor would willingly allocate a small portion of his valuable space to report the transactions of "The English Mechanic's Science and Art Societies." Speaking for myself, I have derived so much pleasure and instruction from friendly discussions with the few subscribers I know, that I conceive, if done on the large scale, it would prove highly beneficial.

2. It would be a means of increasing the circulation of the English Mechanic by friends being introduced to the meetings, who would doubtless become interested sooner or later in the proceedings, and would of course take in our journal.

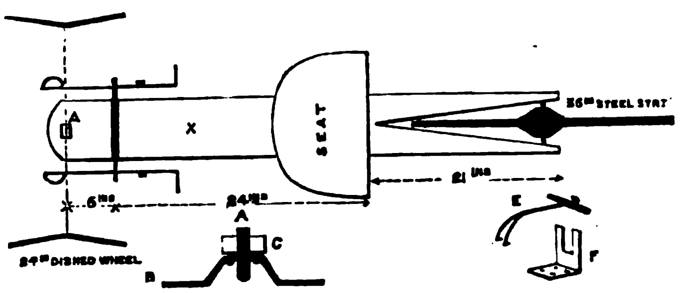
3. Engineers and others who have occasion to remove to other towns, either to new situations or in the way of business, would find a "society of friends" who would sympathise with their every thought, and acquainted with all the topics which may have interested them. Intercommunication between secretaries would also prove useful in matters which could not be referred to in the pages of the Mechanic. I might enlarge on the many advantages to be derived from such associations, but refrain until my fellow subscribers have had an opportunity of expressing their views.

D. William Kemp, Leith.

THE "ENGLISH" VELOCIPEDE ON A NEW PRINCIPLE, AND OUR ENGLISH ROADS.—II.

(*Concluded from page 65.*)

Sir,—Respecting the proper use of the velocipede, I will just mention the frequently imprudent use of the same by those who are strangers to it. A friend was once using mine for the first time, and not being very strong, he almost killed himself by over exertion; let this be a warning to others. The use of the velocipede requires a training by all, especially those who are not strong. Let the following points be particularly observed at first, viz.:—Avoid trying to go fast, avoid going a long distance, and up steep hills; practice only when the roads are in good order, aim at learning the action and at going slowly; when the muscles are being sensibly developed, relinquish the exercise as soon as possible, so as to avoid being fatigued. Go on in this way for a few weeks and you may then increase both your speed and distance. Going at it recklessly at first is the fruitful cause why some have turned away from the velocipede in disgust, and now hold it in contempt because, they say, it is harder work than walking; whereas, had they observed the above rules, and had some patience, they would undoubtedly have come to the opposite conclusion. I have considered the machine, and also its worker. I now come to the subject of roads. These three parts are included in the velocipede question.



A. Centre pin, holding front axle.
B. Front axle, 30in. wide outside measurement.
C. A block of wood to raise the plank 21in. from the ground, as the front must be 3in. higher than behind.
E. Steering handle.
F. Hinged fork to hold steering handle in its place when going down hill.
X. Ash plank, 4ft. 3in. long, 8in. broad, 2in. thick.

Since the railways were made and our high roads have been comparatively deserted, the question arises whether they could not be made of greater use than now? I think so. Let the Legislature be petitioned, and an Act of Parliament obtained to utilise our great high roads. Let them be asphalted, or made waterproof on the suface by some cheap and durable material, in order to avoid mud in wet weather; velocipedes could then be used whether fine or wet; or this plan: let them be divided into three parts—one side of the road for foot passengers, the middle for ordinary traffic, and the other side—say about three yards wide—appropriated exclusively for the use of the velocipede, let this part be asphalted or paved with well-dressed and well-set thick flagstones. Such a road as either of the above would be the solution of the velocipede question; just in like manner as the railroad was the solution of the use of the steam engine as a locomotive. But, it may be said, incurring such a large expense in forming the roads as above suggested would never pay. In answer, I would say, let the velocipedes be taxed. I think no one who has a velocipede will object to be taxed, provided he could get a perfect road to run upon at all times.

In the meantime, while the above suggestion is being ventilated, let us consider if the present system of mending our roads can be improved. I think that it will be admitted by all that rain is the primary cause of our roads getting out of order, from the fact that it softens the roads; from this, it will be clear that everything that can be done to obviate the settling of rain on the roads is essential to their durability. I entirely agree with Sir Joseph Whitworth's remarks, as quoted in the English Mechanic of March 11. The barbarous mode in which our roads are mended is beyond all comprehension. What is the cause of the numerous holes (which are so many lodgments for water) on some of our roads? I was under the impression for some time that it was entirely owing to a weakness in the foundation; it may be so in part, but I believe the cause is also, and more probably, owing to the crossings of the wheel tracks before the road is set. If a good steam roller were used immediately after repairs, and the road set or hardened, we should not have such holes and unevenness as (to our disgrace) is so common in these enlightened days.

But, I fancy I hear a road surveyor say, But what of the expense? Who is to find the money to repair them in that expensive way? In answer, I would say, going on with the present system of repairing our roads is carrying out the old maxim of being penny wise and pound foolish. I say, repair the roads in the way suggested, and I believe in a short time it will, perhaps, not take half the expense to keep them in good order.

I have adverted to the subject of roads because it is so intermingled with the subject of velocipedes that the one cannot be divorced from the other; in fact, the velocipede question is more a question of road than one of mechanics, and I trust that very soon wiser counsels will prevail with those to whom we look for all progress in this respect, and I anxiously hope that, ere long, the roads of this kingdom will be in such a state of excellence as greatly to enhance and encourage the use of that most noble machine, the velocipede, which, rightly used, tends so greatly to promote the health of our people, to give vivacity to society, to add vigour and stability to the State, and to bring honour and glory to our country.

I thank you for the vast fund of information which I from week to week receive, and do from day to day enjoy from the reading of your Mechanic, and I wish you every success in your arduous and praiseworthy undertaking.

A Thinker.

THE "MACCLESFIELD" VELOCIPEDE.

Sir,—Having been inundated with letters requesting measuements and plan of this machine, I purpose answering all the correspondents through the medium of your admirable paper. Let it be taken for granted that it is the *least* fatiguing velocipede I ever mounted; can turn any corner, climb any hill, and stop instantly anywhere in coming down hill, not easily upset, very strong and firm, also free from danger.

All velocipedes require good steering, which is only acquired by practice. This machine is constructed upon the principle that the driving wheel shall bear all the weight of the rider, so that the front wheels are only needed to steer by and hold the frame steady. No springs are required, nor is there any jolting. If the front axle is taken away and a small steering wheel put in its place, it would form a first-rate *bicycle*, which could not upset, because the levers would catch the ground.

Thos. Stanway.

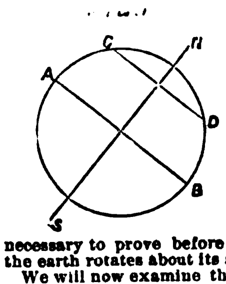
THE FIGURE AND MOTIONS OF THE EARTH. —THE EARTH'S ROTATION.

Sir,—My object in writing a series of letters on this subject is not to establish any new theory, but to so far combat old ones as I deem (and I trust I shall show) are not founded on fact, but are called in to existence from necessity, as an aid, to some extent, in establishing other theories. I think no one will deny that any theory not founded on fact is injurious, in so far as it not only takes the place of what is in accordance with fact, but by a cursory examination tends in some measure to confirm or represent error as truth and so far is positively injurious to the best interests of society.

I propose with your consent to alter the form of my succeeding remarks on this subject from what appeared in the English Mechanic, Vol. X, page 510, and propose to consider the whole matter under the separate heads, Rotation, Revolution, Parallax, and Gravity. These subjects are so bound up together by the modern system as to be absolutely inseparable one from another. And in connection with these subjects I also propose to notice Mr. Proctor's arguments on each as I proceed, as I deem this plan more precise and better connected, and of course will be better understood by the majority of your readers. I will, therefore, without further prefatory remarks, proceed at once to notice the Theory of the Earth's Rotation.

We are told by modern astronomers that the earth is nearly 8000 miles in diameter, which being multiplied by 3·1416 gives an equatorial circumference of 25132 miles, which (performing one rotation every 24 hours) gives a surface speed of 17 miles per minute for any object on such surface, but continually decreasing as we approach the poles. Our Arctic voyagers, so far as I am aware, say nothing about perceiving any difference as they approach the Arctic Circle, as it is called. If, therefore, we examine this theory closely and assist the elucidation by a diagram, we shall find the whole idea to be simply absurd.

Let N represent the north, and S the south pole. It is plain that the centrifugal force at the equator A B must be proportionately greater then it is at C D, and would amount to nothing could we reach the poles themselves (N or S). Thus, while a body on one part of the earth's surface is rushing through space at the rate of 17 miles per minute, a body on the polar surface would be stationary, or nearly so; a matter it is necessary to prove before we can correctly say that the earth rotates about its axis, as it is said to do.



We will now examine the consequences which must arise from this extraordinary speed through space. Suppose a person ascends in a balloon on a calm day to a height of three miles, and remains at that altitude for half-an-hour, he, instead of descending where he went up would be left (17 × 30 =) 510 miles to the west, that is supposing no current of air existed at the time.

Let A B D and E represent an arc of the earth's reputed surface, and that our balloon voyager ascended from B to C (a point three miles above the earth), and remains suspended half-an-hour, the earth would pass under him to the point D, or a little more than 500 miles, and if he remained up one hour, to E, or 1000 miles, and so in proportion to the time he remains suspended in the air.

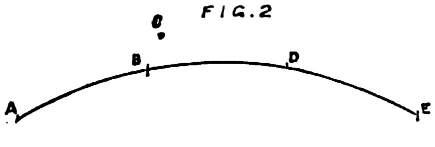


FIG. 2

I need hardly say this is not so, and the idea is only tenable on the ground that the atmosphere is inseperably connected with the earth, that the atmosphere moves with the rotating earth at the same speed and in the same direction; but I am not aware that it has yet been *proved to do so.* How can that which floats on its surface from all points of the compass be said to be a fixture and invariably move with it?

But the double motion of the earth, that is its rotation about its axis, and its revolution about the sun upsets this argument entirely, for if the atmosphere is a fixture considered in connection with the earth's rotation, what is to become of its fixity in connection with the revolution of the earth round the sun, at a speed at which I should think even Mr. Proctor stands aghast, and which I shall eventually show is a manifest absurdity—an utter impossibility.

Even the commonest observer must know that much of the strong wind we experience in this country at certain seasons of the year is from the west, that is in the same direction as the earth's rotation, and suppose the day on which we make our observation is a stormy one, he will find the clouds carried past him at the rate of from 50 to 60 miles per hour, or near one mile per minute. But the earth is said to be *accompanied* in its rotation at a speed 17 times as great as our storm clouds *by the air in which these same clouds float;* how can this be? If it really is so, the clouds must be travelling at a speed of 18 miles per minute, inasmuch as they rush over the earth's surface at a speed of one mile per minute, while the earth rotates at 17 miles per minute, which together make 18 miles in one minute of time.

Again, if the earth rotates from west to east, and a storm comes from the south at a rate of one mile per minute, and the peaks and valleys of the earth's surface are passing at a speed of 17 miles per minute, what would become of us? The centrifugal force generated by the earth's rotation and the wind would cross each other to such an extent as to derange the whole order of creation; the effect must be precisely the same as of two bodies striking each other at opposite angles.

If the atmosphere is really a fixture in connection with the earth in its rotation about its axis, and that both proceed from west to east at the speed just named, how shall we explain away the first and most simple principles of motion? A railway train would not be able to proceed at the same speed from east to west as from west to east, because of the current of speed assumed by the earth in its rotation. For instance, if any one will try to alight from a railway train when in motion, he will find he must alight by springing in the direction of the motion of the train, or he will be brought to the ground, which would be a certainty if he had the temerity to leap in the direction of the rear of the train. This principle holds good throughout all nature. If two objects connected in motion in the same direction are not impeded in any shape, one communicates an impulse to the other in the direction of motion; but if they oppose each other, then, as a matter of course, the superior weight and velocity in the one direction will act as an impediment to the full force in the other.

If the earth does rotate at this fearful speed, what becomes of the centrifugal force which must be called into existence at the equator (and proportionally as we approach the poles)? This force is a universal principle in the circular motion of all bodies in proportion to the extent of the path traversed and to the speed exercised. This being the case, a tendency in all things to fly from the surface of the globe is manifest, and it is here where gravitative attraction steps in, as it were, and presumes to settle the difficulty by applying a power controlling this centrifugal force by a power 17 times as great as the centrifugal force existing. We shall see when we come to examine the theory of gravity, at what an erroneous conclusion its supporters have arrived. The centrifugal force not being called in question, except as its being controlled as above, it need only to be further said that independent of this gravity no living thing could exist, excepting, as I have before shown, near the poles.

John Beardsley.

(*To be continued.*)

HARMONIUM REEDS.—PENDULUMS.

Sir,—To several questions on harmonium matters, I have the pleasure of giving replies.

A few words will solve "J. H. C.'s" difficulty (page 69), and will probably be useful to others, the defect he states being one of common occurrence. The instrument named has two rows of vibrators, consequently it has four of its stops acting directly to give speech to the vibrators or reeds; these we call register-stops. Every instrument ought to have an ample supply of wind for its requirements under the play of the fullest harmonies. The first point to be decided before testing the "grand jeu" is the adequacy of the wind-power when all the register-stops are drawn. We will assume this to have been ascertained in the affirmative. The "grand jeu" stop acts by interior mechanism upon the same valves that are acted upon by the exterior apparatus of the several stop-rods and levers; the defect is not in the wind, therefore, it is in the mechanism actuating the valves; there must be some discrepancy between the work performed by the one stop and the work performed by the four stops; although the grand jeu professes to accomplish as much, it fails to do so. An attentive examination will show the cause of failure to be that whilst the "grand jeu" opens the four valves, it omits at the same time closing the four little escapement valves. Thus it is that the wind escapes so fast that the blowing becomes hard work to meet demands both of use and waste. Why, then, are the escapements ineffective? Because the large valves are not sufficiently depressed to let the escapements fall and set close over the apertures they should cover. So we arrive at the cause of the defect—namely, that the poker or sticker worked by the grand jeu is too short. Insert one that shall be of suitable length, and it will perform its work, giving results precisely the same as the four stops for which it is intended to be a faithful substitute or deputy.

In reply to question of "J. H." on same page. Rivets for harmonium tongues are not of English manufacture; would be obtained only by order from abroad. They are needless, for a yard of iron wire will answer for the purpose of amateurs' practice. Manufacturers find it much cheaper to buy reeds than to spend time on repairing them.

For tuning harmoniums ("Vibrator," page 69) there is no royal road. It is tedious and laborious work. The practised tuner, however, does not open the instrument to each reed, he ascertains what half a dozen or more reeds will require, bears in mind which will want flattening, which sharpening, and the degree of each, and with the catalogue on his tablets of memory, he rectifies the lot, at once opening the instrument, and by habit he can so work with comparatively few discrepancies in results. The finer touches are given in a final survey of the whole.

Fitting up the case of a single row harmonium, as required by "J. W.," page 21, in order to accommodate two rows of reeds, will be a very troublesome affair, and to carry out the design, securing at the same time the proper working of the mechanism, will be a trial to ingenuity. The size of case must be stated before a definite opinion can be pronounced, and another matter of consideration will be the size of bellows, which it appears are already made, for it will be useless to have two rows of reeds unless there is a provision for wind supply equal to the amount required for their speech under full play. A sound board for two rows will measure at least ten inches in width with utmost paring down of frame; one made eleven or twelve inches will give a better character, and more fullness of power to the 16ft. tone. The two sets of reeds are said to be respectively of 8ft. and 16ft. tone, the latter being an octave deeper in pitch than the former, and especially desirable for sacred music.

"Feeders," concerning which "W. D.," page 21, makes inquiry, may be placed at bottom of case, that is to say, in horizontal position, that the feet may act directly upon them without intervention of levers for working. In some small instruments the plan is adopted, but it is not a desirable one for larger sizes, as the command over the wind is restricted and not easily managed. By leverage we can modify the extent of throw given to the feeder, and regulate the stroke to the pressure, considerations of importance when a large supply of wind is in requisition.

Hermann Smith.

P.S.—Pendulum. I notice a statement by "Cats-eye Diamond," page 45, on the sympathetic vibration of two pendulums; if the pendulums, however closely hung, are attached to different supports the same manifestation will not arise. Professor Leslie has shown that the vibration is conducted between the points of attachment of the two pendulums, it passes along the fibre of the wood or metal rod, a phenomena quite distinct from the sympathetic vibration of strings excited by the medium of air.

SEWING MACHINES.—I.

Sir,—The history and development of the sewing machine are subjects of great interest to the mechanic. No other machine of recent years has stimulated the inventive faculty and the application of mechanical skill to a greater degree. It has employed a large amount of capital and skilled labour with great and deserved success, and it is likely to continue to engage the attention of inventors, capitalists, and machinists for some time longer. The failures have been so frequent and numerous, that they are well known to the trade, which, indeed, often evinces gross and culpable ignorance of mechanical principles.

Some, who are unable to invent or improve, but who are fraudulently desirous to take the trade from deserving inventors and patentees, have offered for sale worthless imitations, which have occasioned great trouble and expense, not only to themselves, but also to the users of their useless productions. It is a remarkable thing that some people, who think it criminal to steal a pound of brass, will not hesitate to take by fraud what is worth more than a pound of gold—that which was produced by the hard and honest exercise of their neighbour's intellect. But as the terms of some of these patents have expired, examples of the several classes, with descriptions and drawings, will be given in these pages, so that even the amateur mechanic may be enabled to make a sewing machine, and find ample scope to exercise and display his mechanical skill.

The sewing machine presents an extensive field of inquiry to the student of mechanical appliances, exhibiting a greater variety of ways to effect a definite object than can be observed in engines, lathes, or other similar structures, which, it is well known, have had longer time and more experience to be brought to perfection. The readers of the English Mechanic who have the advantage of contributing to its pages may sometimes employ their scientific acquirements in exposing popular errors, and showing the merits or defects of the various species of sewing machines, and thus in some measure contribute to the welfare and pleasure of a numerous and deserving class of their toiling brethren, by rendering their tasks more facile and agreeable, and preventing the irritation of temper and dejection of spirits, &c., which too frequently arise from the use of implements ill-constructed for their purpose. Communications in these pages of scientific and reliable information respecting sewing machines, from persons having no self-interest in the sale of them, may, while they advert to their comparative merits and defects, direct purchasers to the best system of construction, and so prevent poor people from being imposed upon by the delusive and exaggerated statements of unscrupulous vendors, who represent their own frequently worthless things as superior to all others. Thus, for many reasons it is desirable that the English Mechanic should take up this subject, and furnish in its pages practical and reliable information, which may be referred to as authoritative in the making and using of sewing machines.

This would seem to be a step in the right direction for technical education, and thus many being enabled to avail themselves of the aid and experience of intelligent practical and scientific men, may make successful efforts in improving sewing machines, which may greatly tend to their own and to the public advantage. If some of the workmen who evince decided talent in the construction of these machines could be encouraged to study and to excel in their business—if they would derive their pleasures from instructive books, instead of from demoralising drink—their own mental and physical powers would be improved, and I have no doubt that the sewing machines and other mechanical inplements which they would produce would manifest a corresponding improvement, and so may become more conducive to the pleasure and profit of all who use them. Working men may ask how it is that we cannot keep out foreign manufactured sewing machines. We take from America alone to the value of upwards of £200,000 annually, a sum that would employ 900 men at home in comfort, instead of roughing it in the colonies. We have a position, and the raw material at hand, the most convenient to make sewing machines for all the markets in the world, and ought to employ an additional 10,000 men. Our merchants would do their parts in selling. What is the reason we do not make? If it is simply excessive taxation, let it be discussed elsewhere; but if the misfortune be due to workshop mismanagement, it ought to be debated in these pages, to the ultimate benefit of employer and employed.

There are many sorts of sewing machines, to produce stitching of various qualities—some for ornament, some for strength, some for heavy, some for light goods. Some machines are very difficult to be learned and kept in order, although an experienced teacher may prevent much of the trouble from arising. In some there is little difficulty to learn without a teacher, a few lessons from printed instructions being sufficient to enable a person to do common stitching in a few hours' practice. Some machines, the most difficult to be learned, amply repay the patience bestowed in acquiring a thorough knowlege of their working, and in the course of a few years confirm the truth of the adage, "A stitch in time saves nine," and that a good machine stitch will save ninety-nine. All the machines in common use make the one-thread stitch or the two-thread stitch. The former works thread from one side of the fabric, the latter from both sides. On the top side the stitching is nearly alike in all the machines. On the under side the one-thread machine forms a loop, and in a few machines a half-twist is given to the loop. One class of machines interlace the two threads on the lower side. All these chain or loop-stitches will ravel out by pulling the thread from one end, but the two-thread stitch is more elastic and durable than the single-thread stitch. There are two classes of machines which make the lock-stitch. One carries its thread from the reel in a shuttle through the loop of the needle or upper thread. The other has its thread wound in a spool, and a rotating hook takes hold of the needle thread, and carries it around the spool. For strength and beauty, and command of stitch, the shuttle is the best system. The spool machine makes the least noise, and is very rapid, which advantages over the shuttle machine were at one time very great. The spool machine has undergone the least alteration, but the shuttle machine has been improved so much that it scarcely owns its parentage, except in the original movement of needle and shuttle. By reconstruction, the other parts, in some of the modern machines, nearly equal the spool machines in their quiet and speedy action. The quietness of the spool machine is very much due to the use of a curved needle worked by a rocking lever. The curved needle is more expensive in the first cost, and more liable to break than the straight needle. The nature of these sewing instruments (which will be subsequently found by a person studying them to vary nothing in principle) having been described, it will then be requisite to give patient and observant attention to the formation of the various stitches, and to the action of the instruments in the execution of each distinct sort of stitch. This being thoroughly done, the student will the more easily acquire the knowledge of a variety of constructions to be hereafter presented to him in these pages.

A Practical Man.

BIG HEADS, BIOLOGY, AND MATRIMONY.

Sir,—There is a time in every man's life when he acts foolishly; some do so, discover it, and improve, others do not seem to know it nor acknowledge it. Of the latter there is little hope of improvement, and of these two classes the world appears to be made up. I have been a reader of the English Mechanic for some time, and have been so pleased with the gradual improvement it has made, that I have introduced it to my workpeople.

When your correspondent "Disc" asked how it was that one person has influence over another in mesmerism and electro-biology, seeing that no one replied, I gave what I believed to be the proper answer to his question, and which has not yet been refuted—but a heap of abuse was cast upon me instead. Fifty summers have passed over my head, and I am yet a learner, and not ashamed to acknowledge it. Experience has taught me that the man who abuses you because you differ from him is not the man that society can look to for improvement. I name this, knowing that others are prevented from contributing to your journal, believing from the spirit already shown that abuse might follow from those who know little of the subject they oppose. Three letters appeared the week after mine, in reply to it. That of "Suburban" is candid and respectful; those of "Saul Rymea" and "Anti-Humbug," do them no credit.

In reply to "Saul Rymea," I beg to say a moment's reflection would have taught him the folly of his argument. If Lord Penzance was a practical phrenologist, it would have made no difference, as his duty is to administer the law, not to alter it. "Saul" further says that all clergymen should be practical phrenologists by Act of Parliament, thus inferring that an Act of Parliament can give a man brains, because, if all clergymen could be made so, a thing impossible, they could not prevent foolish and unequal marriages. A man may preach a good sermon, and yet not have the ability for a good phrenologist.

All progress is slow, whether to good or evil, and those unfortunate people who have to appear before Lord Penzance do not come suddenly to the unfortunate position they are brought to, but are led from bad to worse, from a look to an act; and it is for "Saul Rymea" to prove that the attracting and repelling influence referred to in my letter has had nothing to do with bringing them into this unenviable position, and causing them to seek associates more congenial to their feelings and passions.

I still believe, whatever may be said to the contrary, that if young people were to follow the advice of a practical phrenologist, much misery would be prevented and fewer would separate. Here we have a married couple; did they live in love and harmony previous to their coming before Lord Penzance? If they did, why seek a separation? If they did not, let the cause be traced to its origin, and you will find that fifteen out of every twenty were never suited for each other. One thing is certain, where husband and wife live in love and harmony, there is little fear of their disgracing themselves with those crimes that bring people before Lord Penzance.

"Anti Humbug" knows a woman who has a drunken husband, who beats her, and because he does so, he thinks my arguments do not stand good. Pray, what has this to do with the subject? I was not writing about fools and madmen—I can look upon drunkards as no better. I have heard it said that two-thirds of the men who turn drunkards after they are married are made so on account of the unsuitableness of husband and wife. I will not hazard this assertion, although I believe there are many. That the human body contains an attracting and repelling power I have no doubt, call it by what name you like; I call it negative and positive, and in this I am borne out by one of the first authorities of the day, Dr. J. B. Dods, who first discovered electro-biology, or as he calls it, "Electrical Psychology, or the Science of the Soul." The Doctor was twice invited to deliver those lectures before the American Senate. Many years before I knew anything of phrenology or mesmerism, I proved to my own satisfaction that the human body contained an attracting and repelling power, and was astonished when reading the above author to find that he not only bears me out in this, but clearly proves in his lectures that the body does contain negative and positive poles. The work may be had of Tweedie, Strand, London. I give a short extract in the Dr.'s words. *In speaking of the Fowlers of New York and George Combe, he says, on page 44:*—"They have made a righteous developement of true character in the phrenological examination of thousands of human heads; have directed the anxious parent how to train up the child of his affections; have pointed out to the sighing lover how to choose a congenial spirit of companionship for life; and have poured the light of mental and moral improvement in silvery streams on the grand Empire of Mind, yet such a science as this has been called a humbug." Again, on page 54, the Dr. continues:—"It will be readily perceived by everyone acquainted with electrical science, that if I can find an individual standing in a *negative* relationship to myself, or by any process render him so, then I, being the *positive* power, can, by producing electrical impressions from my own mind upon his, control his muscles with the most perfect ease. This is evident, because the *positive* and *negative* forces electrically and magnetically blend, are equal in power, and paralyse each other; or, on the contrary, produce motion." Again, on page 190, he refers to the negative and positive forces in man, which is too long to copy here.

I have for some few years back paid attention to medical galvanism, and often found, when applying the battery to different parts of the body, that the influence which I intended to produce was counteracted, and when the poles were reversed, the influence was also reversed, thus clearly proving that the body, as well as the battery, contains its negative and positive poles. Another proof that will bear me out, and which I think equally as strong as the last: it is admitted by scientific men that the atmosphere is charged with positive electricity, and the earth, as well as the food we consume coming from the earth, is charged with negative electricity. If you sit in a current of air, with your back to it, you are almost certain to catch a cold, but if you turn your face to it, there is not so much danger. Again, when out in a cold day, we instinctively cover the back part of the neck, and leave the front part bare, there being an attracting force between the back part of the neck and the atmosphere; we feel the cold more keenly in the neck, whilst the face throws it off, as if containing a repulsive power. Surely with these proofs so clearly before us it is too much for any man to say I am talking nonsense; if so, the author above referred to has written a book full of nonsense, but it is such as will stand investigation. Your correspondents try to make it appear as if I was led away by big heads, or large heads. If they will kindly refer to my letter, they will find no reference whatever to large heads. I mentioned large brains as taking the lead; I should have qualified it, but when I tell you that my letter was written amidst the noise of machinery, it will, in a measure, account for a slight error, which otherwise would not have occurred. The words, *four kingdoms*, should be *kingdom*.

That I may not be misunderstood, permit me to say that I endorse "Sigma's" description of large and small brain. If we take size as a measure of power, then we must submit that in each head the large organs will have more power than the small ones; and although two brains may be equal in size, one, from possessing a finer texture, will have a more powerful constitution than the other, always keeping in mind the temperament, which, as "Sigma" justly remarked, is the key to the whole secret. The temperaments are distinguished, of course, by the countenance and general formation of the body. This will give an index to the natural qualities, and will be a guide to those who intend to study this interesting science.

In most cases, a person with a large brain and small muscle will naturally incline more to mental than muscular labour, whilst a person with a small brain and large muscle, if of a bilious or sanguine temperament, will incline to exert himself more in bodily labour. These remarks of course have reference to healthy brains, as the brain, like the body, may be diseased, and yet not lessened in size, but rendered almost, if not altogether useless.

I make the foregoing remarks respecting large and small brains that my words in a former letter may not be misunderstood. I now conclude, by advising young men to read "Cobbett's Advice to Young Men," especially his "Letter to a Lover." His remarks, though amusing, are interesting and really useful, and will be found not far from the mark. My time being taken up with business matters prevented this appearing sooner, and as before stated, beidg written amidst the noise of machinery, and at intervals, your readers will have to take it for what it is worth.

T. D., Workington.

EXTRACTS FROM CORRESPONDENCE.

MR. BIGGS ON ALGEBRA.—"Hugo" writes:—Mr. Biggs asks me, on page 35, why he used the radical sign? I have not the faintest idea why he did so; he might just as easily have inserted the actual square root of 175, at least up to a few places of decimals. He has not taken the square root of the expression in question, for that is impossible: but he has certainly attempted it. I must still, therefore, beg him to inform the readers of the ENGLISH MECHANIC how he finds that—

$$\sqrt{-\frac{175}{4}} = -\frac{\sqrt{175}}{2}.$$

I will not occupy any more of your truly valuable space further than to express a hope that such statements as this will not find a place in Mr. Biggs' notes on algebra."

MACHINERY VERSUS STEAM.—"A Clerical Subscriber" writes:—"Many small engines are now made to work by clockwork. Why are they not made on a larger scale? What is done on a small scale may be done on a large one. The beautiful adjustment of a modern watch may be introduced into a locomotive; greater safety would be obtained, enormous expense saved, and coals delivered to the poor at 5s. a ton; besides, in the case of steamers, they would always be independent of fuel by the change. It may seem improbable, but we must remember the derision with which steam was ushered into existence as locomotive power."

SPOTS ON THE SUN.—"G. C. C." writes:—"Some of your readers may not be aware that it is easy, with any good opera-glass, to see distinctly (though not, of course, for purposes of scientific observation) the spots on the sun's surface, by simply taking out the upper or lower pair of lenses, and blackening their interior surface over the flame of a candle. Several spots are now visible, and a great change in their relative positions may be observed, not only from one day to another, but if looked at at different hours on the same day."

THE ILLUMINATED PORTION OF THE MOON.—Mr. John Beardsley says:—"I had overlooked the letter of 'R. L. J.,' in No. 261, until a friend called my attention to it, and although 'R. L. J.' says my 'diagram helps to prove "Sigma's" views instead of my own,' he fails to show how it does so. My argument is that if he extends his thread not 33ft. only, but if he could for 33,000,000ft., he would never find that the plane of such distance would be truly parallel to the higher object, simply because, as I said before, the further he moves from the object the less will be the angle formed by moving a given distance, until such *angles* would not even be *discernible*.

DIGITALIN.—"Pharmaceutical Student" writes:—"Many thanks to the gentlemen who have replied to my query respecting digitalin. I thank Mr. Godfrey for pointing out my error: and I thank "E. K." for his kind suggestion. I vaporised everything that was volatile at 212° *in vacuo*, air pump constantly going, until not another bubble would rise. No heat was applied afterwards except what it received from the warm acid acetic solution. Amongst our readers who take an interest in pharmacy, and who have attempted the extraction of the less stable bases (the isolation of which I believe to be extremely difficult), will they favour me with their result, as I at present have but operated on the more stable? I had been successful till I was brought to a halt by digitalis. In theory I have a universal process for the extraction of alkaloids. I should be pleased to submit it to the notice of brother students. Is there any work devoted to the extraction of the vegetable bases?"

SUGGESTIONS, &c.—"Henry H., Namur, Belgium," says:—"I am happy to see the continued success of our ENGLISH MECHANIC, and must tell you of the several satisfactory letters I have received from my friends to whom I had recommended it. I had the pleasure to procure a good number of subscribers, also some new contributors; all see with the greatest satisfaction the continued improvement of your publication. Recipes should be followed by the words 'tried,' or 'proved,' or 'extracted from such an author,' &c. I see with pleasure that a 'F.R.G.S.' intends to send some accounts of the proceedings of his society. This would be much approved of by many readers, and add to the popularity of the paper. A suggestion was also made last year—I repeat it now—the number of readers being much increased it might find more echo; it is that when a *new produce* comes somewhere on the market, one or other reader might mention it in the paper. He will be sure always to give or to receive information."

REPLIES TO QUERIES.

[1611.]—APPARENT PARADOX.—"Excelsior" objects to my explanation, on the ground that I have "confused division with multiplication." He must excuse me if I do not see it. The error certainly lies in both sides of the equation being divided by $a - b$, which by hypothesis $= o$. No other explanation is needed for a mathematician. By-the-bye, is the term "paradox" properly used in this case? Is it not rather a "contradiction"?—PNEUMA.

[1836.]—ASPHALTE VARNISH.—This can be made by boiling common coal tar until it shows a disposition to harden on cooling; this can be ascertained by rubbing a little on a piece of metal. Then add about 20 per cent. of lump asphalte, stirring the same with the boiling coal tar while melting therein, until all the lumps are melted, when, it can be allowed to cool and kept for use. This makes a very bright varnish for sheet metals, and very cheap and durable. Common coal tar will not dry readily, as it is not properly boiled to expel the volatile hydrocarbons, which prevent its drying. It should be boiled out of doors, as it might take fire and burn the building.—AMERICAN SUBSCRIBER.

[1970.]—VARNISH FOR IRON PATTERNS.—A good varnish for iron is made as follows:—Take oil of turpentine and drop into it, drop by drop, strong commercial oil of vitriol; the acid will cause a dark syrupy precipitate in the oil of turpentine; keep adding drops of vitriol until the precipitate ceases taking place, then pour out the liquid and wash the syrupy mass with water, and it is ready for use. Heat the iron to be varnished to a gentle heat, and apply the syrupy product and allow it to dry; it will be found, on being dried, that this varnish has become incorporated with the surface of the iron, and therefore very permanent and durable.—AMERICAN SUBSCRIBER.

[2167.]—LATIN.—Get Dr. Smith's "Principia Latina," Part I; Murray, price 3s. 6d. Carefully learn each vocabulary a day or two before writing out the corresponding exercise. Learn the declensions and conjugations thoroughly. Make a practice of daily declining or conjugating one or more words, and by continued application "Reader" will soon be able to get a fair knowledge of the language.—C. H. W. B.

[2180.]—ENGINEERING IN GERMANY.—For the benefit of "Y. P. W.," and others, allow me to make an extract from an article by H. E. Roscoe, in *Nature*. He says:—"As a type of this interesting class of science schools, I may cite the two celebrated schools of Carlsruhe and Zurich, beginning with the Carlsruhe school with its 600 students. In the original programme, the school was declared to consist of *one* general and *seven* special departments. The general department, called the *Mathematical*, furnished instruction in mathematics, in natural science, and in modern languages and literature." This programme has been slightly altered, and now the schools are as follows:—Duration of complete course—1. Mathematics, 2 years. 2. Civil Engineering, 2½ years. 3. Mechanical Engineering, 2 years. 4. Architecture, 4 years. 5. Chemistry, —. 6. Forestry, 3 years. 7, Agriculture, 2½ years. In Zurich exist both a University and a Polytechnic School, and although the university is a Cantonal, and the school a Federal institution, they are so far allied that they share one magnificent building, and many students of the university are, at the same time, pupils in the school. The most important department of the Polytechnic School is that of mathematics and engineering. The following extracts from the prospectus of the lectures in the Engineering Department of the Zurich school show how much more complete is the scheme of instruction there than has at present been found possible in England. B. Department of Civil Engineering (duration of course 3½ years). 1st year—Differential and integral calculus, descriptive geometry, principles of construction, practice in construction, drawing, experimental physics, experimental chemistry. 2nd year—Differential equations, technical mechanics, geometry of three dimensions, perspective, technical geology, topography, drawing, descriptive mechanical construction, surveying. 3rd year—Theoretical mechanical construction, astronomy, geodesy, construction of iron bridges, railways and iron roofs, drawing. In addition to these courses, there are similarly extensive programmes for the other departments. The expenses are small. At Zurich, any of the regular courses of the distinct departments or schools, can be attended for the payment of 109 francs, or about £4 4s. for the session of nine months.—C. H. W. B.

[2209.]—OVERLAND ROUTE.—If two letters are posted to India, the one *via* Southampton would proceed from that port by a ship which would enter the Mediterranean by the Straits of Gibraltar, and land her mails at Alexandria. The other letter, *via* Marseilles, might be posted in London six days later, and would go by Dover to Calais by packet, then by rail to Marseilles, and thence by ship to Alexandria, and so join the other letter. The extra threepence is well earned by the delay of six days and the extra trouble.—F.R.C.S.

[2232].—SOLUTION OF PROBLEM.—On p. 44, No. 262, for hypothenuse is divided at "8," read at "D."—BERNARDIN.

[2234.]—COLOURED OBJECT GLASS.—I can second what your correspondent says respecting the excellence of Solomon's telescope. The red glass sent with it is not sufficiently dark; in fact, I find it impossible to use red glasses, as they are so burning hot transmitting all the heat rays. He will find a great improvement if he gets their revolving sun glass, with 4 different colours. Of these, the "London smoke," No. 3, will enable him to look at the sun for hours without the trouble of a second glass. But the grandest views I have had of it have been with the 2 day eyepieces; these give the best idea of its size, and, while showing the penumbra and faculæ, &c., give a magnificent bird's-eye view of the whole mass. For these I have had a dark glass of "London Smoke" made by cutting out the brass of the ordinary day eyehole, leaving only a narrow rim just sufficient to hold the glass, so that the end of the tube is all glass. This answers admirably. Free by post 7s. The revolving sun-glass, also adapted for Venus and the full moon, is 10s. 6d.; both valuable additions to the telescope; the last will screw on the astro-eyepieces only. With this telescope I can discern easily the 3 doubles of Orion's belt—a severe test —AMATEUR.

[2270.]—MOTION OF WATER.—J. Crompton does not state enough in his query to be able to give a very definite answer. If the hole is through a *thin plate* in the side of a cistern or pipe, 5800 gallons per hour would pass through it, or about 929 cubic feet.—Q. Q. R.

[2270.]—MOTION OF WATER.—J. Crompton must particularise, in order to get a correct answer. Is the orifice in the form of the *vena contracta*, and what thickness is the plate in which the hole is bored; this latter will affect the *vena contracta*, and consequently the quantity of water discharged. If J. Crompton has 38lb. pressure per square inch, his head of water is equal to about 85·5ft., which would be valuable for many purposes, even with a quantity of water sufficient to supply only a pipe 1in. in diameter.—SENEX.

[2273.]—TELESCOPE.—Dr. Kitchener's telescope, known by the name of the "Aubert," was advertised for sale in the *Athenæum* of Feb 9, 1861, price £130, by the Rev. A. F. Padley, Lincoln. This is the "Beauclerc Object Glass," mentioned by "G." What became of the Doctor's other telescopes I do not know.—G. J. W.

[2275.]—SUN GLASS FOR TELESCOPE.—J. H. Ward will find the best glass for viewing the sun to be the neutral tint wedge, made for that purpose, and sold by the opticians. Or he can try such combination of common coloured glasses as will give the nearest approach to neutral tint, avoiding deep red, which seems to blot out detail. I find purple, green, and blue, cemented together with old hard Canada balsam (melted, and the glasses made hot), avoiding air bubbles, to answer very well, allowing the mottling of the surface to be well seen. Strips, 2in. by 1in., with an extra thickness over half, in case the other should not be sufficient to prevent the light being unpleasant, or combinations with different shades of the same colours, might be desirable.—S. B.

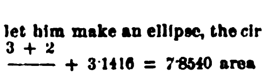
[2275.]—SUN GLASS FOR TELESCOPE.—Any coloured glass, sufficiently dark and clear, may be used to view the sun, or even a piece of smoked glass. More costly eye-pieces for this purpose are made by optician. If no other protection than coloured glass is used, the observer should contract the object-glass to 2in., or he may injure himself very seriously. Throwing the image of the sun on a sheet of white paper, held at a proper distance before the eye-piece, is not a bad plan.—G. J. W.

[2283.]—POWER OF STEAM.—The 32ft. length of steam pipe will not cause much loss of pressure if the pipe is *well covered* and protected from condensation, providing that the pipe is not of a very small diameter, as then the *friction* would be sufficient of itself to reduce the pressure materially.—Q. Q. R.

[2283.]—PAINTING SCENES.—The best way to paint theatrical scenes is, 1st, to sew the calico together, 2nd, melt some glue so that it will be as liquid as possible, then mix the common paint used with oil, with it paint the scene and leave it to dry for about one hour. It won't crack, and no varnish need be used.—H. GARLAND.

[2290.]—BROAD PENCILS.—Winsor and Newton sell the pencils with broad oblong leads.—G. E. CRICK.

[2294.]—THEOREM.—In answer to "E. W. V.," I would say, let him make an ellipse, the circumference of which is $\frac{3 + 2}{2} + 3\cdot1416 = 7\cdot8540$ area $= 3 \times 2 \times \cdot7856 = 4\cdot7124$. Diameter of circle with same per. = 2½. Area of circle = $2\frac{1}{2}^2$ + : 7854 = 4·908750.—W. STEPHENSON.



[2296.]—COPPER DIE.—Take a piece of clean copper, and having heated it to a blood red, place it in a strong iron ring on the anvil, and hold the die over it whilst an assistant strikes a blow with a sledge hammer. The copper will be found to be an exact counterpart of the die, if this has been carefully and quickly done.—CHIP.

[2296.]—MONOGRAM DIE.—"Cantab" will find it the best plan to electrotype his copper counterpart on his steel die By-the-bye, this counterpart has strangely received the misnomer of a "matrix," which term obviously belongs, of right, to the sunk die.—F. R. C. S.

[2296.]—MONAGRAM DIE.—The copper matrix is not cut, it is stamped or cast.—IOTA.

[2297.]—VIOLET INK.—I forward two recipes for "Cantab's" benefit:—1. Boil 8oz. of logwood in 3 pints of rain or distilled water to 1½ pint; strain, and add 1½oz. of clean gum (Arabic), and 2½ oz. of alum, in fine powders; agitate frequently until dissolved. 2. Cudbear 1oz., pearlash 1½oz., mucilage (gum Arabic), 2oz., soft water to make a pint; pour the water hot on the cudbear and pearlash, allow the mixture to stand for 12 hours, then strain and add the mucilage; 1 oz. of rectified spirit may also be added.—EDWARDUM A.

[2298.]—REMOVING OIL PAINT FROM SILK.—If "Cantab" will make a strong solution of common soda and hot water, apply hot with a brush several times over, then rinse well with cold water, he will find it answer his purpose.—W. W.

[2299.]—GENERATION OF ELECTRICITY.—If "Lancashire Lad" will take a piece of iron tub hoop, about 4in. long, bend it in the form of a clamp and force one part between the iron framework and woodwork at the end of the carriage, the other part to rest on the brasses, or, what we call, tops, you can screw it fast to the spindle box, one end to touch the brass, the other to touch the iron work. It has never been found to fail where properly applied. The cause of electricity is the high temper of the spindles and speed—SELF-ACTING MINDER, Blackburn.

[2304.]—PALO DE VELA.—The Spanish word "Palo," means a wooden staff, a mast, and when joined to another word, tree or wood; *Palo de tinte*, dyewood; *Palo de Vela*,' candle tree or candlewood; but this candlewood is not the same as the candlewood of Guiana and the Antilles; this latter is so called because it is used by fishermen during the night. The "Palo de Vela" receives that name from its fruit, which is 3ft. long, and candle shaped; a note on that fruit has just been published, p. 45, No. 262, of our ENGLISH MECHANIC, extracted, I believe, from the French review *Les Mondes*. Botanical name is *Parmentiera pendulus*; the genus Parmentiera is an undetermined genus of Gesneriacea, near the genera Crescentia and Bellonia. The candlewood from the Antilles, &c., comes from *Amyris sp.* (Toxifera ?) Burseraceæ. The name of candlewood is also given in Guiana to the wood of *Toulicea Guyanensis*, Aubl. of the soap-order or Sapindaceæ; perhaps it is also used for lighting purposes.—BERNARDIN.

[2306.]—MORE STEAM WANTED.—I think the boiler of "D. C. W." large enough for the size of his cylinder, and if he would only be at the trouble to turn the exhaust steam into the chimney, he would find it act as a good steam jet, and would cause a greater draught on the fire, consequently making more steam.—F. W. W.

[2306.]—MORE STEAM WANTED.—If "D. C. W." puts (as he suggests) four or five tubes round the smoke flue, he will probably get steam enough, but there is danger of superheating the steam so much as to make it act injuriously on the cylinder, packing, &c., so that I think the best plan would be to put in a few "Field" tubes from the roof of the fire-box. They are very effective, have good circulation, and I believe that all information about them can be obtained from Mr. Lewis Olrick, 27, Leadenhall-street, London.—Q. Q. R.

[2311.]—NEW WORM IN VICE BOX.—"A. E. B." should bore the old worm out of his vice box, and at the open end insert a cast steel bush, cut with a good thread to fit his screw, and fasten it with a pair of small but strong screws, let in countersunk holes; by doing so, he will, with care and oil, find it better and easier than a new box and screw.—TANGENT.

[2311.]—NEW WORM FOR VICE BOX.—To braze the screw in a vice box, or any inside work. Having twisted your inside thread round the screw, file and fit till it reaches the bottom of the screw box, taking care not to drive it in too hard, and make two marks, to enter it always the same way. Having driven it home, make a lute of clay and ashes, and cover the box with it (the screw part), but not much more than one-eighth thick—the reason of this is to prevent the brass running too soon, and also to protect the box—then turn out your screw and put in some powdered borax, shaking it well about, then put in about 1 oz., or 1½ oz., of brass binding wire in a flat hank, reaching from top to bottom of the box, take it in the tongs by the closed end and secure with a coupler, and having a good fire ready, put in the box, and gently turn it round for the clay lute to harden, occasionally taking it out, then let an assistant urge the fire till the box becomes of a bright cherry red, and turn it round constantly. When the wire runs, a blue fire will come from the mouth of the box; when you see this, uncouple the box and roll it round on the floor, to distribute the braze, till it goes down to a low red. Having prepared your strip for the inside screw, just enter it in the thread of the male screw and pinch both in the vice, tapping it down into its place with the hammer, and turning the screw round occasionally to nip it in a fresh place, till it is all gathered, then proceed as above.—G. E. CRICK.

[2316.]—THE SLIDE VALVE.—The writer finds all necessary information in the "Treatise on Steam, &c.," by Main and Brown, price 12s. 6d., used by the certificated teachers under Government, a capital work.—W. STEPHENSON.

[2321.]—SWAN PROCESS.—I believe that the "Autotype" Printing Company, 36, Rathbone-place, Oxford-street, London, (who possess the patent right of that process), have just issued a manual of autotype printing, from which "Scribo" will probably be able to obtain the information he requires.—Q. Q. R.

[2323.]—WATER POWER.—1. Multiply the quantity of water per minute in lbs., by the height of fall in feet, and divide by 33000, the "nominal" h.p. The percentage of useful effect will, of course, differ according as the wheel is more or less perfect. For example:—

Useful effect { Breast wheel, 60 per cent.
Overshot „ 65 to 70.
Turbine „ 75 to 80 (with so *small* a quantity of water and so *small* head, I cannot recommend turbine in "G. P.'s" case).

N.B.—As "G. P.'s" is a very elementary one, perhaps it will be necessary to inform him that one c. ft. of fresh water, weighs 62·4lb., hence, in his case,

$$\frac{62\text{lbs.}\ \cdot4 \times 203\text{ c. ft.} \times 7\text{ft.}}{33000\text{lb.}} = 2\cdot64 \text{ horse power.}$$

2. The volume of water behind the dam, will have no effect so long as the quantity escaping upon the wheel and the height of fall is the same.—SENEX.

[2323.]—TURBINE.—If "G. P." can have a dam 7ft. high, he can work my turbine to great advantage, by having the spout fixed in the top part of the dam; 240 cubic ft. per minute will, by it, give 12 to 14 h.p. Pressure no object.—J. C. SHEWAN.

[2327.]—READY RECKONER.—The best one published is by W. and R. Chambers, called "Commercial Tables," in which he will find everything he requires.—W. STEPHENSON.

[2328.]—DEFECTIVE GUTTER.—If "Salop" were to brush over his cast-iron gutter inside (when perfectly dry, and with the rust scraped off) with hot boiled gas tar or hot pitch, I think that the "weeping" through the metal would be effectually stopped.—Q. Q. R.

[2330.]—BOOMERANG.—The boomerang is a wonderful weapon, but it takes years to bring a man into the knack of proper use, "*Et le jeu ne vaut pas la chandelle.*"—G. E. CRICK.

[2335.]—CONTACT BREAKER.—E. Tucker should make (if a good amateur) or buy one of Rhumkorff's double quicksilver contact breakers, as the only expense connected therewith is the evaporation of it small trifle of spirits of wine. He will not only find a increase the power of his coil, but find it a deal more manageable than the old spring and platinum point breakers. If he requires it, I will send a small drawing and description of it, as it is an instrument that has only come up just lately, and I have not heard of any in England. A coil that gave formerly only a spark 9 centimetres long, was increased nearly 60 per cent. with a quicksilver instrument.—TANGENT.

[2336.]—BRONCHITIS.—"A Three Years' Sufferer" will only get rid of his affliction by change of air. As to its degenerating into consumption, there is no fear of that, if there are no other concomitant circumstances, such as hereditary or other predisposition, &c. I cannot refrain from expressing an opinion that it is highly undesirable to open the columns of the ENGLISH MECHANIC to questions of prescribing, as it offers the opportunity to the uninformed to perpetrate an infinite deal of mischief by the recommendation of their nostrums. A remedy which is useful in one case, may be hurtful in an apparently similar one.—F. R. C. S.

[2337.]—STEAM INDICATOR.—The work recommended by the Science and Art Department, in their examination, is by Main and Brown; Longman publisher.—W. STEPHENSON.

[2346.]—GEOLOGY.—The works edited by Ansted, Jukes, and Haughton, are all good, and are used at the examination as text books.—W. STEPHENSON.

[2346.]—GEOLOGY.—"Permian" will find these two books the very best, "Introductory Text Book of Geology," illustrated, 7th edition, 2s.; "Advanced Text Book," 4th edition, 7s. 6d. Both works by David Page, LL.D., &c. Wm. Blackwood and Sons, Edinburgh and London. There is also a "Handbook of Geological Terms," 7s. 6d., same author and publishers.—BUSY BEE.

[2350.]—RAISING WATER.—The cheapest, and even best, way, is by the simple suction pump, with not less than three clack-valves in the suction pipe. Any plumber will put such a one in for you.—SENEX.

[2360.]—ALUM.—The shale is slowly roasted in large heaps, so as to oxidise the pyrites or sulphide of iron it contains, and generate sulphuric acid, which unites with the potash in the shale, and also with the alumina. The shale is then placed in large pans, sunk usually in the earth, and lined with lead and fitted with steam pipes; here it is boiled with sulphuric acid, till as much as possible of the alumina is dissolved. The liquor, at the proper state of concentration, is then drawn off and mixed with sulphate of potash, which is usually obtained direct by acting on chloride of potassium. Alum is generated, and being far less soluble than the salts it is derived from, precipitates in fine grains, the liquid being well stirred during the cooling. These small crystals are then washed with cold water, and then dissolved at a boiling heat, and run off into vats to crystallise. A very large proportion of alum is made with sulphate of ammonia instead of potash, which is obtained from gas liquor. Ammonia alum is £2 a ton less value than potash alum, but is seldom so free from iron, and is useless for several of the purposes for which alum is employed, such as the preparation of paper hangings, especially the white satin papers.—SIGMA.

[2360.]—ALUM.—The old way of extracting alum from shale, was the following:—The shale was first exposed to the air, when the oxygen of the air, assisted by moisture, effected a wonderful change in it. The original hard stony substance became split up into thin leaves, and became studded over with crystals. When the alum shale thus weathered was digested in water, sulphate of alumina and sulphate of iron were dissolved out; this solution was then treated with chloride of potassium, which decomposed the sulphate of iron, forming sulphate of potash and chloride of iron. When this liquid was evaporated to concentration, and allowed to cool, crystals of alum became separated. The crystals thus obtained were not, however, free from iron, and therefore required to be re-dissolved in water, re-concentrated, and recrystallised. The same operation had to be repeated a third time before the alum was pure. As the weathering of the shale took some years to proceed, a more expeditious method had therefore to be resorted to. The shale is now broken up into fragments and piled up over brushwood in long ridges, and the brushwood being set fire to, the coaly matter of the shale begins to burn, and the whole ridge undergoes the process of roasting; the results of which are the same as the weathering operation. This material is afterwards worked up as above described.—MINNEHAHA.

[2370.]—UNSOLVED PROBLEMS.—No saving of power would result from the use of J. Bannell's invention, however smoothly it may work, since no power is lost through the present mode of obtaining rotatory motion from the reciprocating piston. Many elaborate and ingenious mechanisms have been devised to obviate the use of the crank, from the most erroneous notion that the crank causes a loss of power. But it will be a very difficult matter to find any more simple or efficient contrivance for the purpose than the crank, and I would advise J. Bannell to spend neither time nor money in further developing his invention.—W. H. N.

[2444.]—BEARINGS FOR TUNING HARMONIUM.—Will Mr. H. Smith kindly inform me the best method of laying the bearings for tuning the harmonium?—H. W. Fennell.

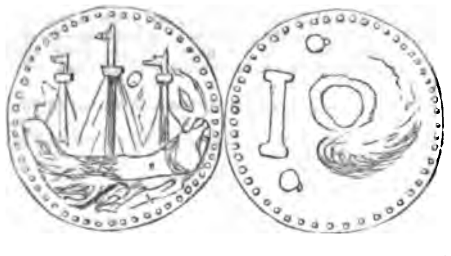
[2445.]—GALVANIC BANDS.—I would feel very thankful to "Suffolk Amateur" for the following information concerning his galvanic bands, viz.:—Breadth of bands, what is meant by *whipping* joints with thread, the meaning of list, and the side to be worn next the skin?—Galvanic Band.

[2446.]—MEAT PRESERVING.—Would any brother reader kindly inform me the method of preserving meat, &c., in tins, for use during the voyage to Australia?—James Smith.

[2447.]—ARTIFICIAL PARCHMENT.—Can anyone inform me how to make artificial parchment?—D. Jones.

[2448.]—PLANET NEPTUNE.—The new planet Neptune, was discovered simultaneously by Le Verrier (by calculation and observation), and by Adams (by calculation only). Has the process employed by Adams ever been published, either by himself, or in any philosophical transactions? I should like to go over his computations, and humbly to follow the footsteps of the discoverer.—Gimel.

[2449.]—OLD COIN.—Will some brother reader kindly give me some information respecting the coin,



a full size sketch of which I append? It is made of what appears to be brass.—E. T. Moody.

[2450.]—FASTENING PIN TO BROOCH.—Can any of your readers inform me how I am to fasten the wire into a jet brooch? I have tried bath-brick and resin, but it does not answer. Any information will be thankfully received.—Yorkshirebite.

[2451.]—DIAMETERS.—I have a 3in. telescope, of which I have only lately employed the day powers of 40 and 60 for solar observation. I find they show the sun of enormous size, but I wish to know whether I am correct in saying that the actual size of the sun, with thea bove powers is—

$$\left.\begin{array}{l}8\text{in.} \times 40 = 12\text{ft.}\\ 3\text{in.} \times 60 = 15\text{ft.}\end{array}\right\}\text{Diameter.}$$

I am of opinion the diameter must greatly exceed these dimensions. The 60 power just fills the field.—Amateur.

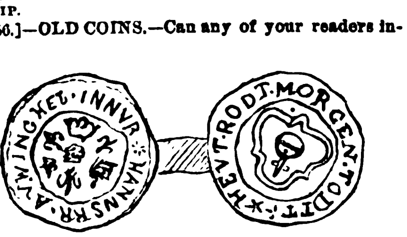
[2452.]—HAS VENUS A MOON?—When looking at Venus, in January last, with my 8½in. silvered glass reflecting telescope, using a power of 240, I saw what I at once thought to be a moon belonging to that planet, it having a sensible disc, and disappearing entirely under a power of only 40. Its distance from its primary being, as near as I could judge, four to five times the diameter of Venus. I asked some one else to look at the planet, and they at once, without a word from me, said, "Oh! it's got a moon, I never knew it had one before." Will any of your readeas inform me whether my supposition is at all likely to be correct, as I see in Mr. Webb's little book, that others have seen a somewhat like appearance before?—H. A. C.

[2453.]—FLASK AND BULLETS.—Will some brother reader kindly inform me how to bronze a small powder flask, and also what advantage is gained by greasing pistol bullets before loading?—Kempster.

[2454.]—GLASS BURNING.—Will someone inform me what is the best material for muffle for burning glass after being stained and painted; and best construction of flue for the same, as I am about to replace my old one (which is iron) with a larger one?—Muffle.

[2455.]—FRET CUTTING ROLLED BRASS.—Is there any machine known for fret cutting rolled brass, ¼in. thick. I have tried many, and all fail to cut more than a smooth file after a very short time, and are only fit for amateurs or toys. Is this owing to the perpendicular motion of the saw, as when used by hand it describes an arc; or is it to the machine saw curving inwards, thus losing the projection of teeth? Any practical information will be thankfully received.—Chip.

[2456.]—OLD COINS.—Can any of your readers in-



form me what this coin is? I have two of them, and they are both alike with the exception of the inscription round the edge. If Mr. Batty, or any other skilled numismatist would like me to submit the coin for his inspection, I shall be most happy to forward it. I have also a coin with a head on one side, and the inscription "Voce Populi"; on the other side, Britannia seated on a harp. Can anyone inform me what it is? And I have a medal of Admiral Vernon's, 1739; on one side there is a fleet of ships, and on the other side Admiral Vernon with a drawn sword. It is a brass medal, and in very fair condition.—Shahazadah.

[2457.]—TEA CHESTS.—Of what wood are the chests made in which tea is imported from China?—Grocer.

[2458.]—PREPARING RHEA FIBRE.—A prize of £5000 is proposed for the best machine; would some one favour us with conditions, &c.—Inventor.

[A reply to the above will be found in the present number.—Ed. E. M.]

[2459.]—BANKALWOOD.—I wish some some particulars about this wood? It comes from the Philippine Islands.—Charles D. S.

[2460.]—METAL PENCIL FOR LATHE.—Can any of your correspondents inform me of some softer metal than lead, which would do to use instead of a black lead pencil in taking figures from the nose of a chuck on paper, instead of a tool on wood? It could be cast to shape, and be firm and true, which, however well-fitted, a black lead pencil never is. I might still act along with the spring holder.—Waherof.

[2461.]—PREVENTING INHALATION OF IRON DUST.—Will one of our readers give me advice to prevent the inhaling of iron dust? I am a turner, and am chiefly on cast iron. What do the needle grinders use to prevent the steel dust from entering the lungs? Is there any such thing as magnetised wire sold in London? Any advice that would be beneficial would be thankfully received.—A Turner.

[2462.]—GAS GENERATING APPARATUS.—At the fat cattle show at the Agricultural Hall, last Christmas, there was a stand with a number of gas jets burning in the window. The gas was generated in a round iron vessel, about 3ft. across and 9in. or so high. I should be very glad to know whether any of your subscribers know anything of it; whether it is safe; and whether the gas is liable to deteriorate after burning some time; what the substance is from which the gas is prepared?—C. E. F.

[2463.]—TO MR. SAMUEL JAMES.—Having made a bicycle to drive by the back wheel, like Mr. Samuel James's, I find I cannot get it to go on the level road, it seems to me I must have got my swinging bar, or the bar that answers to his chains the wrong length, for he says he can go with no noticeable pressure on the treadle, while with me on the level ground it is such very hard work. My back wheel is 3ft. 2in., front wheel 2ft. 10in., crank 5in., the wheels are 1ft. apart. Is that the cause, or what can it be? Being a journeyman carpenter it is a consideration to me, and I want, if possible, to make it go, so as not to have my outlay for nothing.—E. H. Preston.

[2464.]—TARNISHED SILVER-LEAF.—Will any correspondent tell me how to keep work covered with silver-leaf from tarnishing? About six weeks ago I made a picture frame, decorated with an incised ornament silvered, and hoping to preserve it from tarnish varnished the metal with mastic varnish, but it has already gone a very bad colour. I had always supposed that the discoloration was owing to the action of the air on the surface of the metal, but could the air attack it through the varnish? Mr. Furze, of Hanway-street, produces silvered work which never tarnishes, and has the appearance of being varnished, and I had hoped for a similar result. Perhaps I am wrong in using silver, and should use tinfoil, but shall be glad of any advice, as I want to send the work home, and it cannot go in its present condition.—Working Woman.

[2465.]—COIL.—I have made an induction coil with 2lb. No. 39 silk covered wire secondary, and 2 layer No. 16 primary, and can only get a spark (with 4 Groves's cells) of about 1in.; is that what I may expect? Would it spoil the coil to add 2lb. No. 30, as I wish to get a larger spark; and what would be the best battery to use for strength and freeness from noxious gas, which I feel in Groves's very much? If "T. S. C.," who replied to "Nemo," in No. 2, Vol. II. (or any other of the many scientific readers who seem to take a delight in kindly instructing ignorant young men like myself), would kindly answer the above, I should be greatly obliged.—Induction.

[2466.]—ON SHEATHING IRON SHIPS WITH COPPER.—Many years ago I designed a method of sheathing iron ships with wood, for the purpose of protecting them from corrosion and fouling by coppering the wood sheathing. This was communicated to the *Times*, I think about 1862, but, strange to say, not inserted. Being too much engaged in working other patents at that time, I did not patent this, which has since been adopted in the Royal Navy. Can you, Mr. Editor, or any of my fellow correspondents inform me the date of the first publication of this plan for preserving iron ships; and is it now practically superseded by sheating with zinc? Does zinc rapidly become foul?—The Harmonious Blacksmith.

[2467.]—DR. KITCHENER'S GRAND PIANO.—I see an inquiry, No. 2273, for the late Dr. Kitchener's telescopes. May I also inquire what became of his grand piano? This instrument, I was informed, had the harpsichord action in addition to hammers, and several other musical instruments combined with it, which were performed on by the manuals and pedals. I should also be glad to be informed what has become of Earl Stanhope's huge unichord grand piano; This instrument which was from 10 to 11ft. long, was thought an interesting production of acoustic science in its day.—The Harmonious Blacksmith.

[2468.]—ANATOMY.—Can any one recommend me a good book on surgical anatomy, suitable for a would-be medical student? Please say price and publisher.—Busy Bee.

[2469.]—WALKING TOUR.—I think of making a walking tour in the south of England, a few hints would be acceptable.—Busy Bee.

[2470.]—HATCHING MACHINE.—How can I make a compact hatching-machine? A rough sketch would be valued.—H.

[2471.]—SUMMER BEVERAGES.—Will some brother reader give a good recipe for making spruce and lemonade for summer drink?—S. R. Duston.

[2472.]—DYE FOR SILK PLUSH.—Can any reader inform me as to the best method of dyeing black silk plush?—J. Lambert.

[2473.]—TURBINE.—Will one of your readers inform me if a turbine is suitable for driving a lathe and other amateur machinery, and, if so, what fall it would require to produce, say, ½ h.p., and where the best are to be obtained?—T. W. Boord.

[2474.]—APPOLD'S CENTRIFUGAL PUMP.—Will any brother reader be good enough to give the formulæ for calculating the quantity of water thrown by, and the h.p. required to drive, an Appold's centrifugal pump?—R. H. M.

[2475.]—PRINTING WITH COPPERPLATE.—Can any correspondent tell me the way to print with a copper plate?—Tom Tit.

[2476.]—CLEANING SOFT WASTE.—Will some kind reader inform me of a method for extracting the grease from the cotton that is swept off the floors of cotton mills, so that the soft cotton sweepings may be worked over again?—John Wild.

[2477.]—AIR STOVE.—I wish to know the amount of gas saved by using an air stove (*i.e.*, a stove in which the gas is mixed with air previous to combustion) instead of a common ring burner; or, in other words, when burning the same quantity of gas what is, approximately, the advantage in increased heating effect?—R. S.

[2478.]—PITCHING AND TRIMMING COG WHEELS.—Would Mr. Baskerville or some one kindly give us some information on the practical method of pitching and trimming cog wheels just as it is done by any regular millwright?—T. Grady.

[2479.]—MUSIC PUBLISHING.—Which would be the cheaper process of publishing some music, by music type or lithography? The music which I thus want reproduced is at present engraved; it would, therefore, be good copy to set up from, or, I suppose, (for I know but little of lithography) to get "transfers" from.—Clerk.

[2480.]—STAMPING.—I should be obliged if any of your numerous readers could tell me the chief compounds of a good stamping ink, such as that used at the Post-office, for it must be perfectly ineradicable?—Clerk.

[2481.]—IS GUANO INJURIOUS TO HEALTH.—Could any brother subscriber inform me if they ever knew Peruvian guano (Chincas) to affect the health in any way, and if so in what manner?—Cape Horn.

[2482.]—FUEL FOR PORTABLE ENGINE.—I have a 5-h.p. portable engine. I wish to know whether the using coke for fuel destroys the fire-box more than coal; if so, what per cent? Coals cost here 23s. per ton; coke, 10s. per ton.—Subscriber.

[2483.]—BUOYANCY.—Supposing a tin tube exactly 6in square and 16ft. long, what weight would it take to sink it 4in. in the water; also, what is the weight required to sink a cubic foot of air just to the level of the top of the water?—One in a Fix.

[2484.]—COMPRESSED COAL.—I shall feel obliged if some of your correspondents will kindly give me the best and cheapest way of making small slack coal into blocks for using in engines, &c., by some process which is "not a patent," and inform me where I could get the machine, or see the way it is made?—A Subscriber.

[2485.]—GALVANIC ENGINE.—Can any one oblige me by informing me where I can get any information of a galvanic engine, invented some years ago at St. Petersburg, for propelling vessels? I believe a model was shown at the Exhibition of 1851.—Old Salt.

[2486.]—RUBBINGS AND SQUEEZES.—Can any reader kindly tell me the best way to take rubbings and squeezes of inscriptions, and engravings of bells in a belfry? Where can long strips of suitable paper be bought, and what is the best way of fixing the same whilst taking the rubbing? What kind of clay is the proper to use, and how should I apply it?—T. A. T.

[2487.]—ASTRONOMICAL.—The 7-inch Newtonian belonging to a friend persists in showing Jupiter, Sirius, &c., with a glare of light round them; can "F.R.A.S." or some other gentleman explain why? Jupiter shows a clear neat disc, well defined; but after sunset a glare begins to form round it, and sometimes extinguishes his satellites. Sirius also shows a very minute disc, well defined; but also has a similar glare, or cloud of light, round it. The speculum is only partially silvered, and the telescope only used with a single plane convex lens for an eyepiece. I may remark that increasing the power from 60 to 400 did not either increase or decrease this glare of light, and which presents Jupiter as if he was in the centre of a bright nebula. An answer would greatly oblige my friend, and being unable to give one myself, I appeal to "F.R.A.S.," Mr. Proctor, F.R.A.S., Mr. Fothergill, F.R.A.S., Mr. Denning, and our other correspondents, for one.—*a* Ursæ Minoris.

[2488.]—ASPHALTE FLOORING.—"Guillaume" appears to have ignored my question to him under the above heading, Qy. 2061. If he cannot answer my question, can he substantiate his own statement? If not, he ought to state his authority.—Sergius.

[2489.]—VARNISH FOR PAPER.—Will some one of your numerous correspondents kindly inform me, through the medium of your columns, how to make a varnish suitable for paper, that will fold without cracking, bear heat and pressure without sticking, and contain nothing injurious to bright steel goods; or I shall be glad to know where such varnish can be obtained?—Geo.

[2490.]—VELOCIPEDE WHEELS.—I should be very greatly obliged if any of your readers could inform me if there is any chance of tightening the spokes of the wheel of a bicycle, loosened by the oil getting to them; and also as to the best manner of oiling such machines when the hind wheel runs loose on the axle? My plan of oiling has been with a hole drilled through the nave, and a brass tube inserted.—D. B.

[2491.]—THE EYE.—Would Dr. Ussher tell me how I am to keep the patient's eye steady, while taking a mote or fire off the eyeball?—I. N. G.

[2492.]—BENNETT'S CHUCK.—Would "J. K. P." explain how the article caught is set true in this chuck, as I see the screw travels in the sliding piece (piece or pieces?)—I. N. G.

[2493.]—WAXING ENGRAVED BRASS PLATES.—Would "Engraver" tell me how to produce the beautiful gloss I see upon the wax of some newly-engraved plates? as it always comes dull off the stone and polishing-puff with me, and if I try heat I invariably spoil the smooth surface of the wax.—INQUIRER.

[2494.]—PASTE FOR STRAP FOR CARVERS' TOOLS.—Many thanks to "Guillaume" for his recipe for carvers' squeeze wax, which I find to be very good. Would he or some one also inform me, if in his power, or any other reader, of the best method of making a paste for strap for strapping carvers' tools on, so as to leave the tool bright and keen; also, the best method of obtaining designs for carving natural foliage—if from books, where to obtain such?—C. J.

[2495.]—PAPER STAINING.—I am a house painter, and have at times found great difficulty in matching colours to paper hangings, for cornices of rooms, &c. Would any brother reader, a paper stainer, be good enough to inform me, through your columns, what are the principal colours paper stainers use in the manufacture of paper hangings, viz., what whites, yellows, blues, &c.? It would be great assistance to country painters to know.—HARMONY.

[2496.]—TO "MUS."—Would "Mus" be kind enough to help me out of a little difficulty? I started with every requisite for taking glass positives. My success was above my expectations. The following week I got half plain glasses; the third almost plain. The nitrate bath I made up every week with a plain 50 grain solution, new developing and fixing solutions.—J. B.

[2497]—TO "A THINKER."—Would "A Thinker," who describes his excellent velocipede on p. 65, No. 3, Vol. XI., of the ENGLISH MECHANIC, kindly give the dimensions as follows, and oblige one much interested in the construction of velocipedes, and doubtless many others:—Width of frame at seat; width between the wheels; length of crank; distance of bar (on which the front levers work) from the seat; also height of said bar from the ground; length of levers?—CONSTANT SUBSCRIBER.

[2498.]—TELESCOPIC QUERIES.—Can any of your subscribers inform me where I can obtain Ramsden's eyepieces, and what is the probable cost? How can I deepen the colour of my sun-glass, which is red; or can it be coloured any different tint? In reference to "Jupiter," does he not find the two higher powers of his telescope unsuitable for the planets, especially the higher power of 275? I should think the maximum power which his telescope will bear in excellent weather, so as to ensure good definition for the planets, will be 130; and this power will have a limited field of view.—WILLIAM BAGULEY.

[2499]—APPARENT ANOMALY.—Will any of your readers explain to me the anomaly there is in the following case:—In all calculations respecting cotton spinning, the avoirdupois lb. is the standard; and we are told that it contains 7000grs. only, and that 24grs. make 1dwt., and 20dwts. 1oz., and 16ozs. 1lb.: now, 24 × 20 × 16 = 7680, which gives us 680grs. too much in 1lb.! Will some one be so good as to explain this?—EDWARD HABERGHAM.

[2500.]—PAINT.—Will any of your numerous readers kindly inform me what are the ingredients necessary to form a good lasting paint; in what proportion should they be mixed; and if any difference is necessary between the first or priming coat, and the last or finishing coats; if so, what is it? The above is for painting pitch pine. What varnish is the best to stand on pitch pine grained oak? How can I detect any inferior or adulterated paints, or if petroleum or other oils are used?—SURVEYOR.

[2501]—INDUCTION COIL.—Will "Sigma" kindly assist me out of a little difficulty? I have just completed an induction coil, but I cannot make contact between the point of the screw and the spring. The instrument is of the vertical kind; the bobbin rests on a little table, supported by four brass pillars. The points of contact are not platinised; the extremity of the screw is iron, which rests against the spring, which is steel. The hammer is a piece of soft iron soldered on the spring. I cannot see why it will not act, for if I place a piece of iron against the screw, and allow its extremity to touch the spring, it will immediately commence to work.—THOMAS J. O'CONNOR.

[2502.]—CIRCULAR DISC.—I am much obliged to "J. B." and "S. B." for answering my query according to their understanding of it. But it is not simply a question of proportional areas; and as I should feel thankful if "Bernardin" or some other able mathematical correspondent will notice it, I repeat my query:—Required the size of a circular disc, to be fixed with its centre in the boundary or circumference of a circular orifice, 1ft. diameter, so that half the area of the orifice is covered by the part of the disc that projects over the orifice. I find "E. V. V.," Louvain, submits a problem somewhat pertinent to my query (No. 2295), and which no one has yet noticed.—G. B. HORNER.

USEFUL AND SCIENTIFIC NOTES.

THE SENSE OF TASTE.—The sense of taste has rarely been submitted to scientific examination, or at all events has attracted far less attention than its sister senses of sight and hearing, perhaps on account of the impossibility of treating it mathematically. That it differs to a remarkable extent in different individuals is, however, as every culinary artist would acknowledge, a matter of fact; and it is also well known that it is capable of extraordinary cultivation in some men, as shown by wine and tea-tasters obtaining lucrative posts from the delicacy of their discrimination. Recently Dr. Keppler has published a paper in Pflüger's "Archives of Physiology," in which he gives the details of a number of experiments he performed with a view of determining the limits of gustatory discrimination for sapid substances in various degrees of concentration. In these experiments he first made a standard solution, and then successively employed weaker or stronger solutions, which were tasted with due precautions, sometimes before and sometimes after the standard solution, until no perception of flavour was distinguished. The substances he selected were common salt, quinine, phosphoric acid, and glycerine, all of them, be it observed, destitute of odour, which plays so important a part, often overlooked, in our ideas of the flavour of particular objects. In one series of experiments the solutions were taken freely into the mouth, rolled over all parts of the membrane lining it, and then discharged. In a second series the solutions were more carefully applied to the surface of the tongue alone by means of a camel's hair brush. It was found in both cases that when a difference of 2·5 per cent. existed between the standard solution and the experimental one, the observers were able to form a correct judgment on the point that there *was* a difference in 53 per cent. of the trials, but when there was a difference between the two solutions amounting to 10 per cent., the answers were rightly given in 80 per cent. of all the trials. A more correct judgment was given when the standard solution was tasted before than after the experimental one with common salt and quinine, and the acuteness in the perception of a difference was greater when the trial solution was stronger than when weaker, but the opposite held good for the other substances.

ASHWORTH'S PATENT LOOPED BINDER PORTFOLIO.—We can very heartily recommend this binder (which has been sent us by Messrs. Ashworth, Brothers, of 1, Ashley-lane, Manchester) to our readers. It is cheap, simple, cannot easily get out of order, holds every leaf securely, and yet can be opened at any part perfectly flat. Its principal advantage, however, is not only that a person can bind his own serial literature, but that he can bind it *as he purchases it*, thus effectually preventing the loss of copies and the consequent annoyance of procuring back numbers. Messrs. Ashworth prepare a binder especially for the ENGLISH MECHANIC (both old size and new), handsomely got up and lettered with the title outside.

GUM TREES.—The planting of gum trees in Algeria bids fair to lead to a considerable trade in North African timber. The Eucalyptus, or gum tree, was introduced by M. Reinel from Australia in 1862, and thrives wonderfully in Algeria. It is a general rule of vegetable growth that the more rapid the increase the less dense the wood, but the opposite is the case with the Eucalyptus. It grows fast, but its wood is at least as hard as oak. A gum tree of eight years' growth will contain as many cubic feet of as solid timber as an oak of nine times that age. At present M. Trottier is actively promoting its cultivation.

INDIGENOUS MEDICINAL PLANTS OF INDIA.—The Secretary of State has authorised Mr. Broughton, the Government Quinologist at Madras, to investigate the properties of the indigenous medicinal plants of India. This is a most interesting and important branch of science—important to the people of India, whether regarded in a sanitary point of view, or as a means for developing the resources of the country,—and we are very glad to see the Madras Government has given it the attention it merits. Mr. Broughton appears to have *carte blanche* given him in all arrangements connected with the observations, and the results are to be embodied in an annual report to the India Office.

WATERPROOF FACING FOR BRICK BUILDINGS.—This invention is intended to prevent the brickwork of houses absorbing moisture, and is to be used instead of slates or compo. It consists in moulding terra cotta, stoneware, or other plastic waterproof material, into slabs of convenient size and shape, and working these slabs in with the brickwork somewhat after the manner of working facing bricks. One slab is made of such a shape that its edge, when placed on that of another, shall rest against a projecting piece flush with the back of the slabs when superposed; by these means, any water that might accidentally enter at the joints of the slabs, is prevented from entering the brickwork. If desired the slabs may be glazed.

TREATING AMMONIACAL GAS LIQUOR.—The liquor is raised by injected steam to 212° Fah. Hydrated oxide of iron, sulphate of iron, or lime are added. The ammoniacal gas passes off, and is arrested by the purifying substances used. If lime only is employed in the boiling, the liquor is purified by the addition of sulphate of iron, until no further precipitate is thrown down. The precipitate formed is available for a pigment; from 2 to 20lb. of sulphate of iron may be required for 20 gallons of the liquor, according to its strength. The ammonia arising from the liquor is taken up by dilute sulphuric acid mixed with sawdust, spent tan, or shoddy. The iron is used for the purpose of removing the sulphuretted hydrogen.

MR. HAMPDEN'S GOOD FAITH.—Both Mr. Hampden and Mr. Carpenter assented to the details of the experiment recorded by us last week, as conclusive, although the *Field* regrets to say that Mr. Carpenter alleged his opinion was founded upon theory alone, and that it had never, as far as he knew, been tried. Now, the fact really is, that in a little treatise published by "Parallax," and which we (*Field*) have now in our possession, with Mr. Carpenter's name on the title-page, in his own handwriting, an experiment similar in its nature is described as having been made on the very same piece of water as that on which we were then occupied, with a result exactly the reverse of that which recently occurred. Mr. Carpenter was, in fact, engaged to decide a disputed question, of which he and his principal professed to be practically ignorant, although it was in print on the authority of the head of their sect, that it had already been tried in the same locality; *and this must have been then known to Mr. Carpenter, and has since been admitted by him in our presence.* The good faith and perfect fairness of Mr. Carpenter were not, therefore quite of the nature we then believed them to be, and we have no hesitation in affirming that he was a most improper person to be selected to act as referee in such a matter. The deception was, to say the least of it, "unscientific"; yet Mr. Carpenter and his master, "Parallax," both profess to be ardent in the cause of science; and that it has recoiled upon their heads can cause no regret to anyone who values the truth. Although the diagrams of what was seen by the telescopes used at both ends, and acknowledged to be correct by Mr. Carpenter and Mr. Hampden, show the central signal more than 5ft. above the line of the two extremes, these gentlemen coolly claim the victory, and threaten to bring an action against the Editor of the *Field* (who was appointed umpire by Mr. Hampden himself) for fraudently deciding against them!

CHIPS.

A CURIOUS new tube-dwelling Stentor is described and figured in the April number of the *Monthly Microscopical Journal.* In the same number Dr. Carpenter describes the structure of a very peculiar fish ovum.

M. GABRIEL RIVET has found that the spores of *puccinia graminis*, the fungus which causes one form of "rust" on our cereals, will not reproduce the fungus on the same plant; but that when sown on the berberry, they produce orange-coloured spots of *Œcidium berberidis*, which in its turn can be propagated only on cereals, when the original *puccinia* is again produced. This fact (says the *British Medical Journal*,) points to rich stores of materials for experiment and discovery.

ANSWERS TO CORRESPONDENTS.

ANOTHER TESTIMONY.

SIR,—Please insert advertisement I now send you, and I hope I shall do as well as I did when I last advertised with you; I then sold three-fourths of the articles I advertised.—J. JAMES, John-street, Lozells, Birmingham, April 7, 1870.

The following are the initials, &c., of letters to hand first post, Friday, April 8:—

RECEIVED.—Breavington and Sons. J. M. P., T. Berry, P. A Fothergill, J. Dunn, D. Harcourt, J. Jennings Thomas Sloan, James Williamson, A. Johnstone, John Chippendale, W. J. H. Trigg, F. R. A. S., T. Cooke and Sons, C. G. C., John Garratt, D. D., J. A. Clarke, C. Woodcock, Jas. Keeble, T. H., G. D. Griffiths, W. A. Gibbons, F. T., W. H. Bayley, John Metcalfe, E. Griffiths, Rev. J. G., Rev. T. F., John Mills, Ed. Howard, Rev. C. G., Paine and Sons. J. Hincks, S. and B. Solomon, R. S. B., Webb and Son, C. Lindley, H. S., Dr. Ussher, J. P. S., H. H., C. B. B., Henry Hoult, Lincoln, Rev. E. K., R. G., John Metcalf, Ed. Griffith, John Bailey, W. T. Cole, Joseph Lang and Co., D. Harcourt and Co., C. Thirkettle, J. A. M., J. J., W. R. W., J. M. Walters, W. C. S., A. Miner, A. Purbeck J. W. R., Civil Engineer, Dulcimer, Rev. E. B., J. R. D., Omega Capt. S., Young Hopeful, A Lady Subscriber, T. J. S., F. Russell, G. H. W. B., Llewellins and James, Rev. T. B. B., M. Wheatley, S. Musgrove, Antony, R. Somerville, Practicus, R. W. Downing and Son, R. E. T., J. E. Gostard, J. D. M., W. H. G., Cicero, Beta, J. L., Pupa, S. Y. Preston, T. E. D. A. W. O., Soda Crystals.

CRIMINAL LITERATURE.—J. H. T., W. F., Dr. U., Suburban No doubt the subject is a painful and an important one (see lettter, page 63, last week), but there are reasons why the controversy should not be continued, and the denunciations uttered in *our* columns. Verily the originator and Editor of the *Illustrated Police News* has his reward. Probably Parliamentary action will be taken on the matter.

B. C. (Southampton).—Coins—No. 2, denarius of Gordianus Pius. The other two are too indistinct, and a reply can only be hazarded; they are not worth illustrating. Try and decipher the legends.

WILHOLM.—Coin struck for the Turkish Government for Egypt. The characters are Arabic.

TAU.—Coin struck by the Russian Government for Finland.

OLD COINS.—"Flint" and "Taffy." Your queries will appear next week.

F. J. BIGGS.—Queries are frivolous. We do not reply by letter.

MUSIC.—Replies would occupy more space than so elementary a subject deserves. Consult any musical instruction book.

A YOUNG SUBSCRIBER.—See back numbers.

CRUSADER.—There is no "short and easy" method. Pitman's is the best, but difficult, as everything is that is worth attempting.

G. S. COPLAND.—Try nitric acid.

STAEM.—Easy enough. Reduce to the lowest term; In this case farthings, and multiply the result by itself.

HEARTY.—Send your address, that we may return your stamps. We do not insert puffs.

T. J. O'CONNOR.—The first and last four.

ELECTRIC PIKE.—See back numbers.

J. CHIPPENDALE.—You are alone in your expression of regret.

C. E. F.—We do not care about advertising booksellers for nothing. We always give their addresses. Write them.

F. R. SMYTH.—Send the drawings of the prie dieu to us.

J. P. (Post-office, Monkstown).—No stamps enclosed.

J. R. MASON.—The advertisement columns are open to you.

ARGENTE.—We cannot inform you.

W. T.—Write to the Secretary of the Institution of Naval Architecture, 9, Adelphi-terrace, Strand, W.C.

J. CREMER.—Order through a bookseller or newsagent if you can, it is always best.

α URSÆ MINORIS.—We are glad to know that our efforts are so much appreciated, and so useful.

J. R. SOFFE.—About half a score have written to us about Dr. Usher's advice. The Dr. did not send it as his own. See extract from his letter on next page. Quoting from memory, he made a mistake or two.

C. FALLOW, of Bathgate, Edinburgh, says, "I am only expressing the sentiments of the majority of my brother readers when I say that I feel exceedingly sorry to see from 'Adept's' letter that he is still suffering from bad health. I hope a short time will make him all right again, and that he will be able to resume his most interesting papers on Organ Construction, which for so long a time have graced the pages of our journal." We need hardly say that we heartily endorse Mr. Fallow's expression of sorrow, and also his hope.

VERITAS.—Thanks for good wishes.

S., Post-office, Yeovil.—No stamps enclosed.

DR. USSHER wishes to inform Henry Good, and, we may add, many others who have written on the subject, that his "advice is given in inverted commas, and therefore not his own. He quoted it, as he saw it printed on a slip 30 years ago, when he was a little boy." Dr. Ussher also raises his voice against many of the medical suggestions, as not only useless but in some instances mischievous.

W. **HARRIS** asks us to send him by post a receipt to apply a peculiar polish to tin. We do not answer such queries by post, and he ought not even ask us to do so.

J. **NEWTON.**—We could not inform you.

PUZZLED.—Our reporter says that according to the eleventh edition of the "Manual," page 60, paragraph 136, the positions of *all* grammalogues are, as a rule, determined by their vowels, whether long or short.

THE SIXPENNY SALE COLUMN is the only place in which can appear queries forwarded by "A Druid," Neville (first and last query), Delineator, Geo. Marden, "C. C. C.," "Inquirer," J. F. Titchmarch.

GAMMA.—Only as in everything else, by hard work, patience, and a sharp eye for opportunities.

A **BLACKSMITH.**—We cannot answer your queries ourselves; they require the experience of half-a-dozen emigrants. Letters have appeared in recent back numbers, from settlers in the United States, from which you will probably gain information.

BUILDER.—We have described three flooring cramps within the last six months, the last one only a few weeks back. Why not take the trouble to look before writing?

G. H.—Yes, 2s. 6d., or you can purchase a case through your bookseller.

THOMAS DINEEN.—Your letter, which you say many are expecting to see, is inserted to-day.

C. H. W. B.—Please send the description.

J. **ESTOFF.**—We don't remember receiving the query. It should be borne in mind, that we do not insert all queries.

AN EFFICIENT LATHE.—W. J. Evans, of 104, Wardour-street, says, in a letter, that the lathe belonging to Titus Salt, and described last week, was almost exclusively made at his factory. The outlines of the designs of the lathe were made by Mr. John Smith, of Jersey, an able and ingenious amateur.

D. T. **BATTY.**—Thanks for co-operation.

H. **ADAMS.**—Cyanide of potassium will remove nitrate of silver from the hands.

SUBSCRIBER FROM THE FIRST.—We can offer no opinion as to the qualifications of different makers' bicycles.

R. S., of the Irish Constabulary, Dulup, Drogheda, complains that he is obliged to give 2½d. for each weekly number of the ENGLISH MECHANIC. We can only say that a good percentage is offered to the trade. R. S. must see that it will cost more to carry a copy to his quarters, than, for instance, to an ordinary English market town.

W. M. **MILL** denounces the system of trying to get subscribers to publications by offering to give away magnificent prizes "for nothing." He knows of an instance where a subscriber was sufficiently fortunate to get a prize. He was very much elated. But it turned out that the prize after all was not worth the carriage. This is just what might have been expected. When every other dodge has failed such baits are offered to catch the unwary.

J. B. **HALLETT.**—Consult back numbers for varnishes.

SAMUEL WARD.—The alteration in the advertisement pages was made in obedience to continuous and repeated solicitations of subscribers. If the publication suffers, the subscribers will gain.

THE *ENGLISH MECHANIC* LIFE-BOAT FUND

Subscriptions to be forwarded to the EDITOR, at 31, Tavistock-street, Covent-garden, W.C.

Amount previously acknowledged	£164	13	4
C. E. F.	0	2	6
G. Gaterell	0	1	0
J. C. Shewan (2nd don.)	0	1	0
F. W. W.	0	1	0
	164	18	10

THE INVENTOR.

IN obedience to the suggestions of a number of readers, we have decided on appropriating a portion of our space to a condensed list of patents as nearly as possible up to the date of our issue.

APPLICATIONS FOR LETTERS PATENT DURING THE WEEK ENDING APRIL 5, 1870.

910 R. G. Rainforth, Kingston-upon-Hull, consuming smoke

911 W. McNabb, 6, Cambridge-terrace, Clapton, improvements in bale-hoops

912 R. Saunders, Croydon, rendering water-tight dock gates, ships' ports, &c

913 F. J. Upton, 138, Long-lane, Bermondsey, hats

914 J. A. Lund, Cornhill, keys for watches.

915 A. W. R. Robinson, and F. Wilcock, Rochdale, apparatus for preparing cotton

916 J. Holding and J. Eccles, Manchester, and W. B. Cooper, Bowden, temples for looms

917 H. Hughes, Homerton, reducing metal rods

918 C. Cotton, Nottingham, knitted fabrics.

919 J. B. Passedoit and L. A. Ritterbandt, 40, Eastbourne-terrace, Hyde Park, manufacture of peat charcoal

920 J. Fennell, Salford, privies, closets, and commodes

921 T. A. Hickley, Temple, and W. Utting, Palsgrave-place, Strand, steering ships

922 G. Clark, 10, Craven-building, Drury-lane, heating, cooling, or evaporating liquids

923 H. B. Preston, Liverpool, evaporating sugar

924 J. Cofield, 22, Ravenhurst-street, Birmingham, fastenings for braces, belts, bonds, and straps.

925 J. Tietjen, Upper Charles-street, Goswell-road, improved endorsing stamp

926 J. Lister, 46, Duke-street, Moor, Sheffield, knives

927 G. Flashman, Dover, mattresses

928 J. H. Johnson, 47, Lincoln's-inn-fields, artificial fuel.—A communication.

929 A. Stiefbold, and G. N. Cory, London-wall, concertinas and accordions.

930 C. Necker, Berlin, sewing machines.

931 W. Avery, Redditch, umbrellas and parasols

932 T. J. Smith, 166, Fleet-street, machines for reaping and mowing.—A communication.

933 J. Sellers, Preston, shaping, cutting, and boring wood

934 E. Funnell, 54, East-street, Brighton, signal alarum for railways

935 G. Parsons, Martock, feeding apparatus for carding engines

936 M. Knowles, and J. Conlong, of Blackburn, and W. Frankland, of Grindleton, looms for weaving.

937 J. Capper, Clifton-park, Birkenhead, chimney tops or caps

938 C. D. Austin, Newcastle-on-Tyne, lubricators

939 A. B. Reis, Lisbon, apparatus applicable to barrels, casks, or vessels for the preservation of fermented liquors

940 F. Tocher, 81, Southampton-street, Camberwell, ventilation of hats

941 W. McCraw, 6, West Catherine-place, Edinburgh, improvements in photography

942 W. R. Lake, Southampton-buildings, London, mechanism for diminishing friction.—A communication

943 J. H. Johnson, 47, Lincoln's-inn-fields, preparation of soluble phosphates of lime

944 R. Scott, Addiewell, treatment of mineral oils

945 J. M. Clark, Aberdeen, apparatus for soldering tin cases

946 J. N. Taylor, North Shields, clickouts or tools for drawing nails, spikes, and bolts out of timber or other materials

947 W. B. Quelch, Stapleton, chairs and fastenings for rails

948 A. V. Newton, 66, Chancery-lane, preparing Iceland and Irish moss for use as a food.—A communication

949 G. A. Huddart, Brynkir, construction of railways

950 J. Bailey, Wandsworth-road, Surrey apparatus for registering figures or numbers

951 W. R. Mowbray, Drypool, and J. Martin, Kingston-upon-Hull, protecting goods, wares, or stock in vehicles, and buildings

952 R. Atkin, Burton-crescent, plait and fastenings or connections for jewellery

953 J. Drabble, Chesterfield, S. Raworth, Manchester, machines for doubling and spinning.

954 W. MacLean, Glasgow, improvements in printing, lithographing, and zincographing

955 F. A. Harrison, and C. Priestland, Birmingham, metallic adjusters applicable for adjusting braces, garters, &c

956 C. B. Parkinson, and J. Metcalf, of Preston, improvements in working check straps in looms

957 C. Newhouse, Heywood, hoists

958 J. L. De Negroni, Paris stoppers for bottles, jars, pots

959 H. J. Haddan, 21, Lupus-street, London, apparati for assisting in the pedo-locomotion of the human body

960 A. V. Newton, 66, Chancery-lane, improvement in sewing machines.—A communication

961 F. Field, Upper Marsh, Lambeth, application of a new material to the production of illuminating oils and solid hydrocarbons

962 A. Ody, Bristol weighing machines.

963 J. Chrimes, Clare-villas, Merton, arrangements for the safety and convenience of railway passengers

964 J. Wadsworth, Manchester, an improved portable oven

965 H. Law, 15, Essex-street, Strand, meters for measuring fluids

966 H. Jackson, Park-square, Leeds, drying grain, malt roots, spent malt or hops, megass or spent sugar cane, wool, and other substances

967 H. Jackson, Park-square, Leeds, improvements in mills for crushing and grinding

968 A. Barlow and J. Taylor, Bury, apparatus to be employed in preparing cotton

969 T. L. Livsey, Bury, apparatus employed for filling or starching woven fabrics

970 I. Summersfield and J. G. Sanderson, Manchester, impressing machine for tailors.

971 W. Smith, Manchester, railway switches and signals

972 W. Rowden, Whitstable, apparatus for reefing and stowing the sails of ships

973 W. E. Newton, 66, Chancery-lane, machinery for making horse-shoe and other nails—A communication.

974 J. R. Cadman, Christopher-street, Hatton-garden, constructing and fitting brackets for shop windows

975 E. Thornton, Bradford, heating by the circulation of hot water.

976 J. Shackleton, Bradford, improvements in utilising exhaust steam

977 C. Wilson and John Peebles, Errol, improvements in equilibrium slide valves

978 H. J. T. Piercy, Birmingham, tube cutters and screw stocks

979 A. M. Hobson, Brixton, and E. C. Smith, Enfield, velocipedes.

980 W. Johnson, Wynd's Point, Little Malvern, sheet-metal saddle-trees

981 G. Deadman, Hatfield Peverel, improvements in horse-shoes

982 W. N. MacCartney, Glasgow, new process for dissolving crude or manufactured indian rubber

983 J. W. Baker, Bradford, G. Worsnop, of Little Horton, and J. Grainge, of Bradford, improvements in the construction of kilns

984 F. R. A. Glover, Brading, anchors

985 A. Whittaker and E. Stead, Bradford, machinery for spinning mottled yarn

986 A. T. Anquetil, Paris, application of oleic and stearic acids for protecting metallic surfaces from oxidation and preserving wood and other materials

987 W. R. Lake, Southampton-buildings, London, an improved illuminated night clock.—A communication

988 C. J. Eyre, Westbourne-grove, securing envelopes and their contents

PATENTS BEING PROCEEDED WITH.

3319 K. Ogden deodorizing compound

3388 A. McNeill, a safe for ships carrying valuables

3390 W. Thomas, improvements in obtaining power

3391 J. Fogg, machinery for dressing flags

3392 A. Cotton, machinery for preparing fibrous substances

3401 W. C. Mann, hats

3406 R. Goddard, improved machinery for pill mass mixing

3416 W. Pollitt, and W. J. Knowles, improvements in machinery for washing

3417 D. Barker, varnish and varnish paints

3418 J. Denis, producing pulp from wood

3422 E. H. Burke, metallic barrels

3424 W. Perkins, fusees, matches, &c

3424 J. Combe, machinery for hackling flax

3433 J. Pitt, J. Pitt, B. Pitt, and W. Pitt, of Cleckheaton apparatus for drill-cutting and shaping metals

3436 L. Pochet, dressing stone

3445 S. Perry, J. J. Perry, and L. H. Perry, boxes for holding various articles

3460, J. and J. Wood, and W. H. Wood, ventilating hats

3469 R. Milburn, and T. Browning, drying machines

3470 J. F. Crease, construction of tank filters

3472 W. Spence, manufacture of soda crystals

3494 P. A. S. Langlois, and Thomassin, manufacture of sulphuric acid

3510 H. M. Nicholls, apparatus for cutting continuous paper into sheets

3563 J. F. Alexander, undulating propellers for steam ships

3612 W. McGee and W. McGee, machinery for doubling and winding fibrous materials

3657 G. W. Honeyman, preparation for the removal and prevention of incrustation in steam boilers

3641 W. Foulds, apparatus for heating feed water.—A communication

3658 A. M. Clark, jacquard apparatus.—A communication

3665 J. Smiles, breech-loading fire-arms

3705 J. Bourne, apparatus for the production of heat

3722 W. E. Newton, adjusting and packing the rails of railways.—A communication

3723 W. E. Newton, improvements in forming the joints of the permanent way of railways.—A communication.

48 W. Weild, machinery for winding yarn or thread

91 F. H. Knevitt, improvements in shutters and blinds for windows

122 H. A. Bonneville, warming and ventilating close carriages and boat saloons

114, T. P. Bails, moulding and compressing substances for artificial fuel

19 J. M. Plessner, apparatus for the treatment of liquid fuel

35 J. S. Dronsfield, apparatus for grinding the card covered surfaces of portions of the carding engines employed in the preparation of cotton

420 Alfred Fryer, preparation and preservation of animal and vegetable substances to be used as food

433 W. Whieldon and J. Beck, cocks and valves

499 J. Hammond apparatus for washing and cleansing clothes

530 J. J. Aston, propelling vessels on the water

565 J. J. Holden, gas retorts

607 G. Fowler, smelting iron ore

717 J. Wallace, apparatus for distilling

767 P. W. Spencer, improvements in limekilns

798 J. Davis and W. N. Davis, two-furrow ploughs

806 J. H. Johnson, improvements in crimping machines.

816 T. Keely, manufacture of looped fabrics

827 R. F. Fairlie, wheels for rail or tramway locomotive engines and carriages

837. W. R. Lake, improvements in wheels for railway engines and carriages

847 J. H. Johnson, improvements in locomotion and in the means to be employed therein

850 C. J. Eyre, apparatus for producing motive power

870 W. R. Lake, improvements in turbine water-wheels.—A communication

872 W. R. Lake, preparation of ammoniated sulphuric acid for the manufacture of manure

885 W. R. Lake, improvements in valves.—A communication

899 R. Smith, machinery for doubling and winding cotton

Persons having an interest in opposing any one of such applications are at liberty to leave particulars in writing of their objections to such application at the said Office of the Commissioners before April 26, 1870.

PATENTS SEALED.

2857 G. S. and H. Whitechurch, Serle-street, Lincoln's-inn-fields, improvements in stoves and fire-places

2858 J. Butcher, Southport, Lancaster, dentist, improvements in fountain pens and pen-holders

2865 E. D. Farcot, Boulevart Beaumarchais, Paris, an improved mode of propelling and constructing ships and boats and their accessories

2866 R. Broadbent, Islington, Birmingham, improvements in gas governors

2870 P. R. Hodge, Adam-street, Adelphi, C. Hengst, Fulham-road, Chelsea, and N. Wilson, 144, High Holborn, certain improvements in the manufacture and cementation or welding of steel and iron, iron and iron, and steel and steel together, and in adapting such improvements to various useful purposes

2875 Sir C. T. Bright, Knight, Westminster Chambers, Victoria-street, improvements in electric telegraphs

2876 C. Mather and W. Rosetter, improvements in warping or beaming machines

2878 F. F. Villepigue, Brewers-lane, Saint Martin's-in-the-Fields, an improved method of and apparatus for piercing or boring holes in rock, mineral, or other material of a similar nature, applicable in tunnel, mine, quarry, and other such work

2882 W. Horsfall, New York, improvements in machinery for forging bolts, screws, and spikes

2886 W. Morris, Triangle, Halifax, York, worsted spinner, and J. Teal, Sowerby, both in Yorkshire, improvements in machinery to be employed for combing wool

2890 J. Kircher, Cannstadt, E. Ebner, Stuttgard, both of Wurtemberg, an improved black printing ink capable of being removed from paper

2892 E. Smethurst, Stockport, Cheshire, improvements in funnels or funnel measures for the measuring and pouring of liquids into vessels

2895 W. Richardson, Oldham, Lancaster, improvements in machinery for burring or cleaning wool, cotton, and other fibrous materials

2971 J. Halford, Brettel-lane, Kingswinford, Stafford, coke burner, improvements in puddling furnaces used in the manufacture of iron and in other reverberatory furnaces

2993 W. Kloen, Birmingham, a new or improved method of water-colour printing

3017 H. M. Marsden, Sheffield, York, an improved method of manufacturing sheep shears and other articles of cutlery

3051 D. Jackson and J. Riley, both of Oldham, Lancaster, and G. R. hay, Dukinfield, Chester, improvements in machinery for cutting, shaping, and dressing stone

3072 A. M. Clark, Chancery-lane, Middlesex, improvements in hinges and hinge guards for railway carriage and other doors, part of which improvements is applicable for warming and ventilating railway carriages—A communication

2898 E. Wigzell, and J. Pollit, metallic pistons for steam engines

2904 E. R. H. Hammond, and E. Hammond, in breech-loading fire-arms

2913 A. Coleman, latches or locks applicable especially to railway carriage doors

2915 H. Schildberg, signalling apparatus for use in private or public buildings

2919 D. Parish, axle-boxes.—A communication

2931 W. J. Jones, hot-water boilers

2934 J. More, oils for painting or other purposes

2940 H. Reid, Portland and other cements

2941 W. N. Hartley, whitening or bleaching yarns

2943 E. H. C. Monckton, improvements in railways, in motive and locomotive power

2969 W. Lincolne, securing the joints of belts.—A communication

2991 C. L. Page, packing cases or boxes for containing bottles

3046 W. B. Robins, syringes

3080 T. Bevington and S. Courtauld, and J. A. Norberg, machinery for breaking stone and ore

3121 H. B. Barlow, improvements in knitting machines.—A communication

3458 J. Speight, apparatus for spinning, twisting, and roving worsted

3608 H. E. Newton, improvements in net machines

196 J. Paton, P. Harris, and R. Harris, apparatus for generating carbonic acid gas for extinction and prevention of fire

255 J. E. Standfield, four-wheeled carriages

294 W. R. Lake, sewing machine needles and needle arms.—A communication

319 W. R. Lake, an improved friction clutch.—A communication

412 J. W. Dixon and J. Bates, machinery for filing

474 J. H. Johnson, apparatus for lighting, applicable also for signalling purposes

476 W. R. Lake, instrument for determining the altitude and zenith distance of celestial bodies

PATENTS ON WHICH THE STAMP DUTY OF £50 HAS BEEN PAID.

931 W. B. Hilliard, improvements in skates

943 E. S. Jones, an improved mode of and apparatus for rowing boats on water

951 J. J. McComb, an improved mode of coupling telegraph and other wires.—A communication

941 R. Canham, improvements in means or apparatus employed in the cure of smoky chimneys

974 H. A. Bonneville, a new and improved means of readily igniting fuel and lighting fires.—A communication

962 F. J. Manceaux, improvements in fire-arms and in apparatus for charging the same

970 A. V. Newton, improvements in sewing machinery.—A communication

988 W. Clark, improvements in applying and fitting the tubes of multitubular boilers.—A communication

997 P. Spence, separating zinc from certain ores or minerals, and in recovering other substances found therewith

1044 W. R. Lake, an improved mode of embalming or preserving dead bodies and carcasses.—A communication

1181 A. V. Newton, blowing and pumping engines.—A communication

977 J. J. Meyer and A. Meyer, an improved system of tank locomotive engine

990 J. Pickering, improvements in appparatus for raising weights

1009 J. Ladley, apparatus for spinning wool

1012 S. Perkins, manufacture of railway crossings

PATENT ON WHICH THE STAMP DUTY OF £100 HAS BEEN PAID.

507 P. R. Walker, improvements in valves and in apparatus connected therewith

The English Mechanic
AND
MIRROR OF SCIENCE AND ART.
FRIDAY, APRIL 22, 1870.

STRENGTH OF MATERIALS.*

By A. Tolhausen, Jun.

In the undertaking of the following chapters, I have endeavoured to lay before those interested in the subject an elementary treatise on the strength of materials sufficiently clear and compendious to exemplify the method of reasoning in this part of applied mechanics, as well as to impart an accurate knowledge of its most useful propositions, with their application to practical purposes, avoiding at the same time as far as possible mere abstract mathematical investigations.

Originality is not assumed, for the materials are common property, and I have never hesitated to consult the best modern authorities on the subject. I may mention Professor Rankine, Gregory, Rühlmann, Zeuner, Baumgartner, &c. &c., when I thought I might obtain a more elementary demonstration and preciser results.

I hope that I have duly, yet at the same time honourably, availed myself of the advantages which they supply, but still not so copiously as to diminish the utility of those volumes, or to make me an unfair borrower.

On a previous occasion, one kind of attraction—viz., that of gravitation, has been discussed and popularly treated, and pursuing the examination of the invisible, active, and real forces of nature, the attraction of cohesion will next engage our attention.

The term cohesion is derived from the Latin *cum* = together, and *hære* = I stick, or cleave, and may be defined as that force which tends to make the atoms or particles of the same kind of matter move towards each other, and to prevent them being separated or moved asunder.

As examples of cohesion in daily life, we may cite :—

1. The manufacture of glass vessels, the materials of which have been soft and liquid in the furnace, and on the removal of the excess of heat, have become hard and solid, in consequence of the attractive force of cohesion binding the particles together.

2. The surfaces of an apple torn asunder will not readily cohere, but if cut with a sharp knife cohesion easily occurs.

3. A wound produced by a jagged surface is difficult, and takes more time to heal than some of the most desperate sabre cuts, the cohesion of the surfaces of thus cut flesh being very rapid.

4. The art of plating copper with silver, which is afterwards gilt, and then drawn out into flattened wire for the manufacture of gold lace and epaulets, commonly called bullion, is another example of the wonderful cohesion of the practices of gold, of which a single grain may be extended over the finest plate wire measuring 345ft. in length.

Of course these examples might be carried on to any extent; but as they are only inserted to convey more readily the meaning of the term cohesion to the mind of the reader, we shall restrict ourselves to the above.

The cohesive force existing more or less in all materials is not constant, but varies with the nature of the substance and the order of its atoms, as is best shown by the burning of argil, hardening of steel, &c, in which latter cases it becomes greatly increased.

When the particles of a body become separated through the action of external forces, and the cohesive force is not able to unite these again, the body breaks, causing those particles giving way either to move towards or from each other. The greatest or least force required to effect the above is termed the tenacity, strength, or cohesion of that body; the object of the present chapter is therefore the determination of this force in its various appearances, especially in those materials with which the practical mechanic has to deal. It is one of the most important, and at the same time difficult, subjects that we have to contend with, owing chiefly to the very different tenacities of bodies of the same nature. For instance, the strength of all kinds of timber not only depends on the localities where they grow, age and structure, temperature, and when felled, but experience shows that even timber obtained from the same tree has not equal tenacity. Something similar is found in iron, whose strength chiefly depends on the quality of the ores whence extracted on its manufacture, and lastly on the precautions taken in heating, welding, hammering, and stretching it. Hence all experiments are not to be accurately relied upon, but only give us the average strength of the respective material.

All the possible strains to which materials whatever be their forms and arrangements, can be subjected, may be classed under five heads—viz., 1. Tension. 2. Compression. 3. Transverse strain. 4. Torsion or twisting. 5. Clipping or shearing.

We shall now investigate these properties in their respective order.

CHAPTER I.

Tension.

Tension is a strain acting in the direction of the fibres of a body, and tending to pull it asunder, as in the case of stretched ropes, bands, tie-rods, and chains.

Every body subjected to tension may be conceived as having its particles arranged in longitudinal rows, each particle being held to the next by some force which, as already mentioned, is called the attraction of cohesion. Let us now suppose that the applied strain is not capable of breaking the body, but if increased by the least imaginable quantity, a breakage takes place; this strain is then said to represent the absolute tenacity of that body; or, supposing an iron pillar is capable of sustaining 16 tons and no more, without breaking, we should call the absolute tenacity of that pillar 16 tons.

The absolute strength of the different metals is determined by ascertaining the weight required to break square bars measuring an inch each way, or having a square inch of sectional area; the bars are laid horizontally, and fastened firmly at one end, when at the other end a known strain acting in the direction of the bar is applied, which is increased, if necessary, till the bar breaks. That the bar is not placed vertically has also a reason, for then additions to its length would increase the weight, stretching its upper portion, because each portion of added length becomes an added weight; and again, that the length of the bar has no influence whatever on the breaking load is self evident; for if any one part of its length is capable of sustaining the strain, and the bar be of uniform quality, every other part will be able to sustain the same; we have therefore the law that the tensive strength of a body, uniform in all its parts, is directly proportionate to their transverse area, whatever be their figure or length.

When a piece of material is being tested, two considerations must be taken into account, namely, whether the piece is to be afterwards used, or sacrificed for the sake of ascertaining the strength of the material. In the first case, it is self evident that the testing load must be so limited that thereby the strength of the material is not in any way impaired, that is, it must not exceed the proof strength. Care should also be taken to avoid vibrations and shocks when the testing load approaches near to the proof strength. In the latter case, the load ought to be increased by degrees until the piece breaks. To obtain a sufficiently correct result, the load, when the breaking point is being approached, has to be augmented by small weights. One method of approximately arriving at the proof strength of materials is to apply a moderate load, and remove it, then applying the same load again, and removing it two or three times in succession, noticing at each time of application of the load the strain or alteration of figure of the piece when loaded, by tension, compression, bending, distortion, or twisting, as the case may be. If that alteration does not *sensibly increase* by repeated application of the same load, the load is within the limit of proof strength. The effects of a greater and a greater load being successively tested in the same way, a load will at length be reached whose successive application produces increasing disfigurement of the piece; and this load will be greater than the proof strength, which will lie between the last load and the last load but one in the series of experiments*.

Materials used in machinery, and subjected to tensive strains, ought to resist the separation of their particles—fracture—as well as any material elongation; therefore, in practice, where durability and adequate strength are required, it is necessary to give the materials we employ considerably greater dimensions than such as would merely preserve them from breaking, or to load them with considerably less weight than those which would tear them asunder. Again, materials subjected to considerable strains for long periods of time gradually lose their tenacity, which must be provided against when permanence and stability are required.

To obviate these degradations of quality, it is found expedient not to load iron or wood beyond one-third, copper, brass, or lead beyond one-third, or even sometimes one-fourth, of their breaking strain (ultimate strength).

The following table contains the result of experiments on the cohesive strength of various materials. The numbers are given roundly, and may be safely used in calculation, as they have been reduced to one-third or one-fourth of their breaking strength.

Table I.

	Name of materials	Strength per sq. in. of sectional area		Strength per circular in. of sectional area		area in sq. in. to bear one ton	Area in circular in. to bear one ton
		tons	lb.	tons	lb		
1	Alder-wood	3·2	7000				
2	Apple-tree	3·2	7300				
3	Ash-wood	2·2	5000	1·73	3000	0·45	0·57
4	Beech	1·5	3400	1·18	2700	0·68	0·84
5	Boxwood	2·7	6000	2·12	4700	0·37	0·47
6	Brass	2·7	6000	2·12	4700	0·373	0·475
7	Brass-wire	6·1	13700	6·1	13700		
8	Cane	1·0	2300				
9	Copper, wrought	5·0	11200	3·93	8800	0·200	0·255
10	„ wire	5.1	11400				
11	„ cast	2·8	6300	2·20	4900	0·356	0·454
12	Deal, Christmas	1·8	4115				
13	Elder	2·2	6000				
14	Elm	1·4	3200				
15	Fir	1·6	3600	1·26	2800	0·62	0·79
16	„ Memel	1·4	3180				
17	Gold, wire			8·5	19100		
18	Hazel-nut	3·0	6700				
19	Horse-chestnut	2·0	4500				
20	Iron cast, Engl.	2·9	6500	2·14	4700	0·373	0·476
21	„ horz. cast	2·5	5000				
22	„ vert. cast	2·5	5700				
23	„ wrought, Engl.	8·3	18600	6·52	14600	0·120	0·153
24	„ German	8·9	20000				
25	„ French	8·7	19600				
26	„ Swedish	9·7	21800	7·41	19·000	0·093	0·118
27	Iron-wire			11·1	28100		
28	Larch	1·8	4060				
29	Lead, cast	0·3	650	0·24	500	3·446	4·300
30	Mahogany	1·1	2400	0·86	1900	0·93	0·79
31	Oak	1·4	3100	1·10	2400	0·72	1·18
32	Osier	2·3	5200				
33	Pear-tree	1·3	3000	1·02	2360	0·75	0·92
34	Plane-tree	2·0	4400				
35	Poplar	1·2	2700				
36	Steel, cast	19·0	44700	15·7	35000	0·050	0·064
37	„ blistered	19·8	44300	15·7	35000	0·050	0·064
38	„ shear	18·5	41500	14·54	32500	0·054	0·069
39	Sycamore	1·4	30215				
40	Teak	2·0	4500	1·71	3500	0·50	0·64
41	Tin, cast	0·7	1600	0·55	1260	1·400	1·783
42	„ wire	0·8	1800				
		I		II		III	IV

(To be continued.)

ON CHEMICAL SYMBOLS.

By George E. Davis.

CHAPTER II.

Symbols as applied to Molecular Structure.

Most of the elements differ from each other in their degree of chemical force, and this force or power of the element was for some time termed its atomicity, but now that term has been completely superseded by the term *equivalency*.

The equivalency of an element, then, is that power which it possesses of combining with other elements to become saturated; thus a tetrad will always exhibit some degree of chemical force if only partly satisfied, but if the force is completely neutralised by combination with other atoms, then a saturated and comparatively inactive body, taken as regards its chemical force, is formed. Hydrogen and several other elements are monads—that is, they have only one unit of chemical force; carbon, on the contrary, is a tetrad, or possesses four units of force: therefore carbon is only saturated, or its affinities satisfied, when it is in combination with four atoms of hydrogen. When two atoms of carbon are concerned, each atom exchanges an affinity; so that six units of force only remain to be saturated. There exist other series in which two or more affinities of the carbon are exchanged; an instance of such grouping is to be found in the aromatic series of alcohols and hydrides. When a group of atoms exists which shows some degree of chemical force, then that group is termed a compound radical; and its equivalency depends upon the number of affinities which remain unsatisfied. Thus sulphur, which is an hexad, if combined with two atoms of oxygen, is partly satisfied, leaving only two units of force; SO_2, then, is a compound radical of dyad equivalency.

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* Professor Rankine's "Engineering."

The marks employed to represent the equivalence of an element or of a compound radical were proposed by Dr. Odling, and are of great use. They consist of dashes or small Roman figures at the upper right-hand corners of the symbols. In the monads they are generally omitted, though in some instances they are used. Thus I' indicates monad iodine; O'', dyad oxygen; Au''', triad gold; C^{iv}, tetrad carbon; N^{v}, pentad nitrogen; and S^{vi}, hexad sulphur.

The elements do not always exhibit the same degree of chemical force. Thus, in hydrogen, sulphate sulphur is evidently an hexad; in several organic compounds it appears tetradic; whilst in the metallic sulphides it acts as a dyad. From this it appears that sulphur has more affinity for oxygen than for most other elements, for under certain conditions it will saturate itself with oxygen, one atom combining with three of the latter.

Sodium has always been classed as a monad, but Wanklyn (*Chem. News*, pp. 293 and 313, vol. xx.) tries to make it appear trivalent, a fact which, perhaps, will explain the constitution of some of the so-called double salts.

The equivalence of a radical is expressed by the same means as for an element. The dyad radical ethylene may be formulated thus $(C_2H_4)''$, the two dashes showing its equivalency; $(C_3H_5)'''$ is the triad radical propylenyl, or glyceryl.

Those elements which exhibit an uneven equivalency, such as hydrogen, boron, gold, or nitrogen, are called perissads; and those of even equivalency are termed artiads: specimens of this latter class are to be found in oxygen, carbon, and sulphur.

In graphic formulæ, of which we shall speak farther on, the atom is demonstrated by a circle containing the initial letter of the element, its symbol; and the equivalence, or chemical force, by projecting lines, each line or connecting link being equal to one unit of chemical force, and generally termed one affinity.

Symbolic formulæ may be of several kinds:—

α. Empirical.
β. Rational.
γ. Typical.
δ. Graphic.
ε. Constitutional.

Empirical formulæ generally expresses the total number of atoms in the molecule. This is not any, or very little, inconvenience in inorganic chemistry; but when considering organic structure it should be very seldom used: in fact, the system expresses only such data as would lead to the calculation of the percentage composition; it gives no clue whatever to the probable position of the atoms in the molecule. Hydrogen sulphate is designated by the empirical formula H_2SO_4. This does not tell us whether the oxygen is totally or only partially united with the sulphur; rational will tell us that. Again, the empirical formula for hydrogen orthosilicate is H_4SiO_4; and hydrogen metasilicate, H_2SiO_3: this expresses nothing more than the number of atoms in the molecule. But there exists another kind of empirical formula. This modification is not much used in mineral chemistry; it is the formula gained by the ultimate analysis of an organic compound. The same formula is gained in the analysis of metallic salts, when the number of atoms in the molecule can be further divided. Thus cuprous chloride may have an empirical formula of CuCl, which is a multiple of the real formula Cu_2Cl_2; hydrogen dithionate, $H_2S_2O_6$, would have an empirical formula of HSO_3, which is obtained by calculation from the percentage composition, but as it is a bibasic acid we know that it must contain two atoms of hydrogen, therefore the true formula is $H_2S_2O_6$.

In calculating the percentage composition from the Empirical formula, we proceed thus:—

$H_2 = 2$ $S_2 = 64$ $O_6 = 96$	162 parts of hydrogen dithionate contain 2 of hydrogen, what will 100 contain?
162	162 parts of the above contain 64 of sulphur, what will 100 contain?

Estimate the oxygen by difference:—

$$\frac{100 \times 2}{162} = x, \text{ or amount of hydrogen.}$$

$$\frac{100 \times 64}{162} = y, \text{ or} \quad ,, \quad \text{sulphur.}$$

And

$$162 - (x + y) = \quad ,, \quad \text{oxygen.}$$

On the other hand the empirical formula may be derived from the percentage composition thus: The percentage composition of calcium carbonate is:—

Calcium	40
Carbon	12
Oxygen	48
	100

These numbers, when divided by the atomic weights of the respective elements, give the empirical formula thus:—

$$40 \div 40 = 1 \text{ of calcium,}$$
$$12 \div 12 = 1 \text{ of carbon,}$$

and

$$48 \div 16 \text{ gives } 3 \text{ of oxygen,}$$

therefore the formula would be $CaCO_3$.

Rational formulæ gives us *some* clue to the constitution of a compound, but often this is very slight. It indicates the manner in which a compound is affected when brought under the influence of certain reagents, and as one compound is affected in various ways it is certain that there must be several kinds of rational formulæ for such a compound. Hydrogen orthosilicate may be formulated in either of the following:— $H_4(SiO_4)$, $SiO_2(H_2O)_2$, $Si^{iv}(HO)_4$; the first expresses the constitution on the binary theory—four atoms of hydrogen being united to silicic radical SiO_4, the second shows that it is a compound of water with silicium dioxide, and the third that tetrad silicium is saturated with hydroyl.

The next on the list is Typical formulæ. This formulæ is used on the supposition that all bodies may be represented, and referred to substances of simple origin. There are five distinct types, although some reckon only four; some, indeed, reckon more than five, but the excess may be referred to types of more simple origin, or condensed types.

The first, or hydrogen type, is called the molecular type, because Gerhardt placed under it the molecules of the metals and compound radicals:—

$$\left\{\begin{matrix} H \\ H \end{matrix}\right. ; \quad \left\{\begin{matrix} I \\ I \end{matrix}\right. ; \quad \left\{\begin{matrix} Ag \\ Ag \end{matrix}\right. ; \quad \left\{\begin{matrix} CN \\ CN \end{matrix}\right. ; \quad \left\{\begin{matrix} C_3H_5 \\ C_3H_5 \end{matrix}\right.$$

Hydrogen. Iodine. Silver. Cyanogen. Allyl.

The hydrogen chloride type, commonly called the hydrochloric acid type, is ranked by some with the above; but it is a mixed type, or rather an intermediate stage between the molecules of the chlorous and basylous elements. Thus:—

$$\left\{\begin{matrix} H \\ H \end{matrix}\right. ; \quad \left\{\begin{matrix} H \\ Cl \end{matrix}\right. ; \quad \left\{\begin{matrix} Cl \\ Cl \end{matrix}\right. .$$

Chlorides, iodides, bromides, and fluorides are represented on this type, and the polyhaloid combinations are represented on what are termed condensed molecules:—

$$\left\{\begin{matrix} H_3 \\ Cl \end{matrix}\right. \begin{matrix} \text{condensed} \\ \text{molecule} \end{matrix} ; \quad \left\{\begin{matrix} Au \\ Cl_3 \end{matrix}\right. \begin{matrix} \text{Gold} \\ \text{tri-chloride} \end{matrix}$$

$$\left\{\begin{matrix} H_4 \\ Cl_4 \end{matrix}\right. \begin{matrix} \text{condensed} \\ \text{molecule} \end{matrix} ; \quad \left\{\begin{matrix} Pt^{iv} \\ Cl_4 \end{matrix}\right. \begin{matrix} \text{Platinum} \\ \text{tetrachloride} \end{matrix}$$

$$\left\{\begin{matrix} H_5 \\ Cl_5 \end{matrix}\right. \begin{matrix} \text{condensed} \\ \text{“molecule”} \end{matrix} ; \quad \left\{\begin{matrix} Sb^{v} \\ Cl_5 \end{matrix}\right. \begin{matrix} \text{Antimony} \\ \text{pentachloride} \end{matrix}$$

The third type, under which a very numerous group of chemical compounds may be classed, is the water type. To start from water, by replacing an atom of hydrogen by a positive basyl, we obtain a class of bodies called hydrates. When we substitute a basyl for the whole of the hydrogen contained in the molecule of water, we obtain an oxide; when, on the contrary, the hydrogen is replaced by a chlorous element or radical, we obtain an acid.

The steps of substitution, on passing from water to a metallic oxide, may be seen thus:—

$$\left.\begin{matrix} H \\ H \end{matrix}\right\} O \text{ water}; \quad \left.\begin{matrix} K \\ H \end{matrix}\right\} O \begin{matrix} \text{Potassium} \\ \text{hydrate} \end{matrix} ; \quad \left.\begin{matrix} K \\ K \end{matrix}\right\} O \begin{matrix} \text{Potassium} \\ \text{oxide.} \end{matrix}$$

And the formation of acids:—

$$\left.\begin{matrix} H \\ H \end{matrix}\right\} O \text{ water}; \quad \left.\begin{matrix} Cl \\ H \end{matrix}\right\} O \begin{matrix} \text{Hydrogen} \\ \text{hypochlorite} \end{matrix}$$

Condensed molecules of water are taken in certain cases, such as forming the hydrate of a dyad metal, &c.:—

$$\left.\begin{matrix} H \\ H \end{matrix}\right\} O \atop \left.\begin{matrix} H \\ H \end{matrix}\right\} O \quad \text{or} \quad \left.\begin{matrix} H_2 \\ H_2 \end{matrix}\right\} O_2 ; \qquad \left.\begin{matrix} H \\ Ca'' \\ H \end{matrix}\right\} \begin{matrix} O \\ O \end{matrix} \quad \text{or} \quad \left.\begin{matrix} Ca'' \\ H_2' \end{matrix}\right\} O$$

Water condensed molecule. Calcium hydrate.

$$\left.\begin{matrix} H_2 \\ H_2 \end{matrix}\right\} O_2 \text{ water}; \quad \left.\begin{matrix} H_2 \\ (SO_2)'' \end{matrix}\right\} O_2 \begin{matrix} \text{hydrogen} \\ \text{sulphate} \end{matrix} ; \quad \left.\begin{matrix} Zn'' \\ SO_2 \end{matrix}\right\} O_2 \begin{matrix} \text{zinc} \\ \text{sulphate} \end{matrix}$$

$$\left.\begin{matrix} H \\ H \end{matrix}\right\} O \text{ water}; \quad Ca''\} O \text{ calcium oxide}; \quad Cu''\} O \begin{matrix} \text{copper} \\ \text{oxide} \end{matrix}$$

$$\left.\begin{matrix} H_3 \\ H_3 \end{matrix}\right\} O_3 ; \quad \left.\begin{matrix} Au''' \\ Au''' \end{matrix}\right\} O_3 ; \begin{matrix} \text{gold} \\ \text{trioxide} \end{matrix} ; \quad \left.\begin{matrix} PO \\ H_3 \end{matrix}\right\} O_3 \begin{matrix} \text{trihydrogen} \\ \text{phosphate} \end{matrix}$$

The above are specimens of compounds arranged on the water type, which, though admirably suited to inorganic chemistry, is not sufficiently explicit when applied to bodies of organic origin; for instance, hydrogen oxalate is expressed:—

$$\left.\begin{matrix} (C_2O_2)'' \\ H_2 \end{matrix}\right\} O_2$$

This does not give us its proper constitution, as the group (C_2O_2) exists divided in the molecule, partly saturated with hydroxyl, in the form of *oxatyl* or *carboxyl;* the constitution, then, would be

$$\left\{\begin{matrix} CO{\cdot}HO \\ CO{\cdot}HO \end{matrix}\right.$$

This *water type* is made to embrace a large number of bodies, as by its means is demonstrated the constitution of all acids and oxides. Wanklyn, however, objects to this on the grounds that such a powerful base as potash can never be formed from such a neutral compound as water. This view may be correct, but in potash we have a much more basylous radical than the hydrogen in water; in fact, the hydrogen in water is brought by Odling very near the chlorous elements, as in several places in his *Practical Chemistry* he writes water as hydric acid. According to Wanklyn's views, the affinities of the oxygen in potassoxyl, &c., are completely satisfied, that which holds it on to the chlorous radical being the affinity of the potassium, which is thereby saturated.

By giving most of the monad metals and metalloids a triadic signification, we are able to assign a definite formulæ for most of the double salts, which before had no form of classification. A simple substance is under our notice at once, and one which is very familiar—alum. This is a double salt, formerly regarded as a combination of two sulphates, and called the *double sulphate of aluminium and potassium.* However, there is a chloride very similar in its properties, and there is no doubt that there is a family likeness. We may represent the chloride:—

$$\left.\begin{matrix} K \\ Al \\ Al \\ K \end{matrix}\right\}^{viii} Cl^{8} ; \quad \text{and the sulphate} \quad \left.\begin{matrix} K \\ Al \\ Al \\ K \end{matrix}\right\}^{viii} (SO_4)_4$$

A fourth type, which is of immense use in organic chemistry, is the ammonia type, by which means the constitution of all the compound organic ammonias may be clearly shown. Condensed molecules are used in this mode of demonstration and classification, as in those types before shown. An addition to this type is the ammonium chloride formula, or ammonia plus one atom of hydrogen chloride. Thus:—

$$\left.\begin{matrix}H\\H\\H\end{matrix}\right\}N\ ;\quad \left.\begin{matrix}H_2\\H_2\\H_2\end{matrix}\right\}N_2\ ;\quad \left.\begin{matrix}H_3\\H_3\\H_3\end{matrix}\right\}N_3\ ;\quad \left.\begin{matrix}H\\H\\H\end{matrix}\right\}NHCl$$

Ammonia. Condensed molecules. Ammonium chloride.

The organic ammonias or amines are formed from ammonia by replacing an atom of hydrogen by an alcohol radical. Thus, ethylamine is formed by abstracting an atom of hydrogen in ammonia, and inserting the radical ethyl in its place; when two atoms of hydrogen are replaced by an alcohol radical, such as ethyl, then diethylamine is formed, and, consequently, when an organic ammonia contains three alcohol radicals, it would, as is the case when three ethyl radicals replace hydrogen, be called triethylamine:—

$$\left.\begin{matrix}H\\H\\H\end{matrix}\right\}N\ ;\quad \left.\begin{matrix}C^2H_5\\H\\H\end{matrix}\right\}N\ ;\quad \left.\begin{matrix}C^2H_5\\C_2H_5\\H\end{matrix}\right\}N\ ;\quad \left.\begin{matrix}C_2H_5\\C_2H_5\\C_2H_5\end{matrix}\right\}N$$

Ammonia. Ethylamine. Diethylamine. Triethylamine.

The ammonium chloride formula shows that ammonia has united with hydrogen chloride, which is better represented by calling it the chloride of a metallic radical, ammonium, instead of an hydrochlorate of ammonia. The formula shows us the existence of the radical ammonium united with a chlorous radical, which may be replaced by hydroxyl, then forming ammonium hydrate; each atom of hydrogen can be replaced by an alcohol radical, forming the hydrate of an organic ammonium:—

$$\left.\begin{matrix}H\\H\\H\\H\end{matrix}\right\}NHO\ ;\quad \left.\begin{matrix}C_2H\\C_2H\\C_2H_5\\C_2H_5\end{matrix}\right\}NHO$$

Ammonium hydrate. Tetrethyl ammonium hydrate.

The utility of this ammonium formula does not stop here, for by its means we may indicate the composition of the so-called metallammoniums, as *cuprammonium sulphate* and *platosammonium chloride*:—

$$\left.\begin{matrix}H_2\\H_2\\H_2\\H_2\end{matrix}\right\}N^2{\cdot}SO_4\ ;\quad \left.\begin{matrix}Cu''\\H_2\\H_2\\H_2\end{matrix}\right\}N^2SO\ ;\quad \left.\begin{matrix}Pt\\H''\\H_2\\H_2\end{matrix}\right\}N^2Cl$$

Ammonium sulphate. Cuprammonium sulphate. Platosammonium chloride.

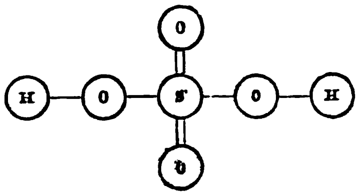
The last type we will consider is the marsh gas type. By its means we can demonstrate the constitution of nearly the whole class of organic bodies. By starting with marsh gas we can, by the substitution of methyl for hydrogen, pass up the series to those members of the group which contain many carbon atoms.

If we take an atom of hydrogen from marsh gas and replace it by the methyl radical, we pass to the next in the series—ethyl hydride; and if we replace another atom of hydrogen by hydroxyl, we pass from an hydrocarbon to an alcohol. Again, by abstracting hydrogen we can form aldehydes; and by adding oxygen to the latter, we form acids. All these changes can be represented by the employment of formulæ on the marsh gas type:—

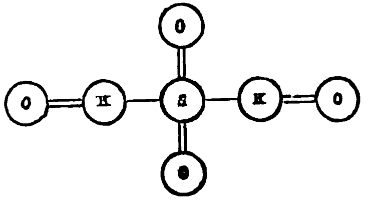
$$\left.\begin{matrix}H\\H\\H\\H\end{matrix}\right\}C;\quad \left.\begin{matrix}CH_3\\H\\H\\H\end{matrix}\right\}C;\quad \left.\begin{matrix}CH_3\\H\\H\\HO\end{matrix}\right\}C;\quad \left.\begin{matrix}C\\H\\O''\end{matrix}\right\}C;\quad \left.\begin{matrix}CH_3\\O''\\HO\end{matrix}\right\}C.$$

Marsh gas. Ethyl hydride. Ethyl alcohol. Ethyl aldehyde. Acetic acid.

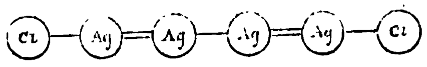
Graphic formulæ are seldom seen in any textbook on elementary chemistry, but specimens are given in Miller's *Elements* Vol. III.; Frankland's *Lecture Notes for Chemical Students*; and in Buckmaster's *Inorganic Chemistry*. This species of formulæ is utterly ignored by some chemists; but it must be remembered that it does not intend to represent the actual way in which the atoms are united in a molecule. It is intended to show how the affinities, or degrees of chemical force, are probably balanced. For instance, in hydrogen sulphate there are four atoms of oxygen; but we know they are not *all* combined with the sulphur with the same degree of force, and we know that the hydrogen is not in combination with the oxygen, which is firmly fixed to the sulphur, but is in connection with the feebly-combined atoms. In representing, then, the constitution of hydrogen sulphate on paper, by the use of a graphic formula, we must have resource to some method whereby we may demonstrate clearly the equivalency of the constituent elements. The following is the graphic formula for hydrogen sulphate:—



If we regard potassium as a triad element, the graphic formula would become:—

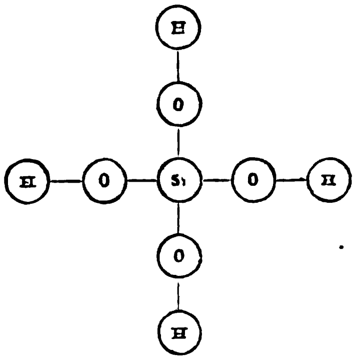


And silver must not be excluded, the sub—or argentous—chloride, instead of being looked upon with doubt, must be regarded as a definite compound, in which the affinities of the silver are tightly held together, so that the molecule easily yields metallic silver. The following would be the graphic formula for this compound:—

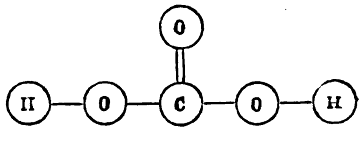


Chlorine, in this case, being a monad. A few instances, however, occur in which it puts forth chemical force equal to a triad.

Silicium, by combining with hydrogen and oxygen, forms an acid called *Hydrogen orthosilicate*. The constitution of this acid is shown as follows, in a graphic formula:—



Carbon, being also a tetrad, is supposed to form an acid analogous with the above, called hydrogen orthocarbonate, H_4CO_4; the normal hydrogen carbonate being:—



From the above formulæ, and by the careful study of molecular structure, the result of exact experiment, may be deduced another kind of formula, which is called Constitutional.

This kind of formula determines the combination by radicals, the groups breaking off where the affinities are weakest. Thus, in hydrogen sulphate, the group SO_2 leaves only two units of combination unsatisfied, and these units belong to the sulphur; the two atoms of oxygen, therefore, are saturated, and are tightly held to the sulphur, causing the group to act as one atom of a dyad element; in point of fact, SO_2 is called sulphuryl, and it is a dyad radical, and being a dyad radical it is saturated in hydrogen sulphate by combination with two hydroxyl radicals.

The following are specimens of constitutional formulæ:—

$$\left\{\begin{matrix}HO\\SO_2''\\HO\end{matrix}\right.\ ;\quad \left\{\begin{matrix}HO\\PO'''HO\\HO\end{matrix}\right.\ ;\quad \left\{\begin{matrix}KO\\CO''\\KO\end{matrix}\right.$$

Hydrogen sulphate. Trihydrogen phosphate. Passium carbonate.

Formulæ and nomenclature are at the present time wofully confused, nearly every work taking a different view of matters. We can but hope for a revision of names and the introduction o some general system of chemical formulæ.

A PRACTICAL TREATISE ON THE HARMONIUM.*

By Hermann Smith.

THIRD DIVISION.—CHAPTER II.

Of The Upper Sound-Board, or Swell

> "Fully to possess, to command, to rule an object we must first study it for its own sake. All beginnings are easy, and it is the last steps that are climbed most rarely and with greatest difficulty."—Goethe.

We have brought the harmonium to tha particular stage of construction at which it may be considered as fully developed according to the intent of its original design. It has variety and power; it has its five and a half rows of reeds, each row possessing distinct qualities; it has its second manual, by which musical effects valued by the artist may be obtained; is furnished with coupling movement; and is a complete instrument in all that pertains to musical execution. It is a rival to the pianoforte in the hands of the amateur, and is the "concert-grand" of its class. In making such an allusion we assume that the harmonium we specify is equal in point of workmanship, and is a good specimen of the excellence which skill may achieve in the production of this species of instrument. If the work of an amateur is taken to be the standard, then the harmonium should be placed in competition with a piano of amateur construction. If comparisons are fairly instituted between the cardinal features or characteristics of the two instruments, we have little doubt of the general verdict being in favour of the harmonium on the ground of its superiority as a generator of sounds of varied character and impressive fulness; setting aside the dexterity of the performers we believe that it has in itself higher capabilities for satisfying the musical susceptibilities of our organisation. Some will smile and say, "Of course you do; personal partiality influences such an expression of opinion." Doubtless, yet how can it be otherwise? Goethe in his mature wisdom, and knowing his own human nature, says, "I can promise to be upright, but not to be impartial." A noble, large-minded utterance; one which all may profitably lay to heart and remember. We cannot be free from partiality in judgment and opinion. Like will tend to its liking. By our observations we would intimate that we who give our attention to the harmonium, that amateurs who devote time and money to the practice or to the construction of the instrument, are driven by an impulse stronger than mere preference or casual fancy; are impelled to do so that we may satisfy an irrepressible longing for qualities of tone, for varieties of melodic charms, and sustained and richly-coloured harmony, which we feel the pianoforte is wholly inadequate to supply.

As the representative of its kind, the harmonium at the point we have reached may be held to be complete, but beyond the ordinary requirements of the musician there is a speciality of demand, to meet which the instrument will have to extend its scope, to take new rank, and invade by consent

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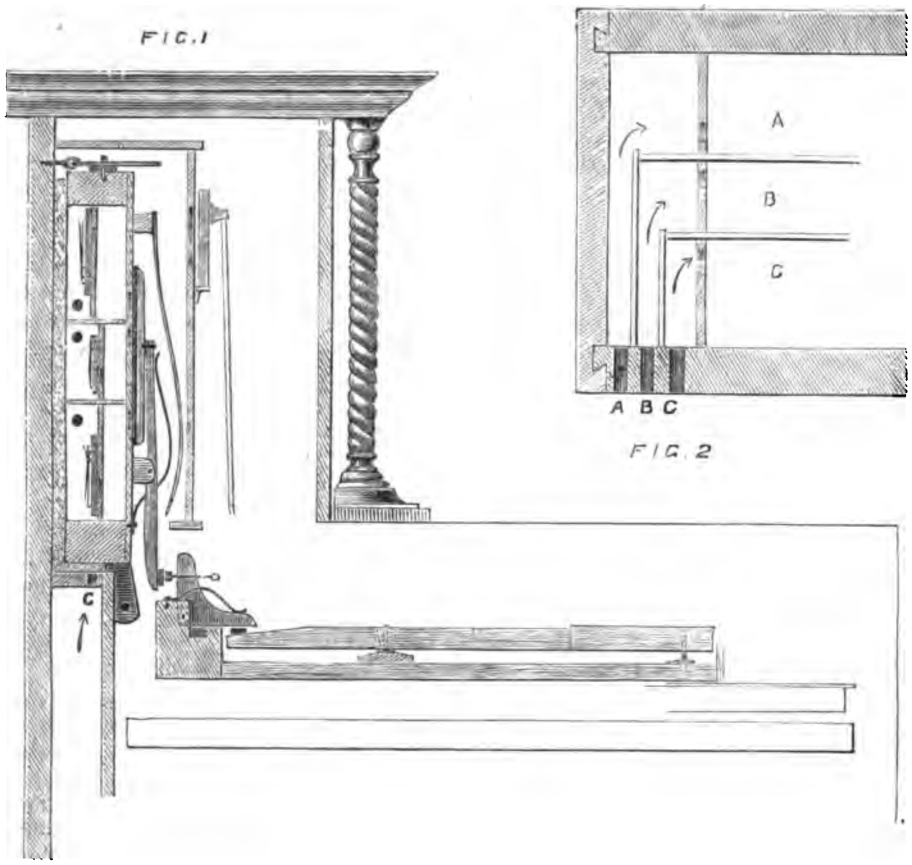


FIG. 1
FIG. 2

the province of the organ. Many changes of plan and purpose become expedient; to fulfil the duties of its higher state, expenditure on a grander scale is inevitable, we must set up additional sound-boards, increase the numbers of the rows of reeds, provide ampler reservoirs, and lay down a full scale of German pedals—the pedals, the ambition of every musician, the organist's own inalienable estate, the broad dominion of his pride.

"How many rows of reeds can I have in an harmonium?" is the first question that presents itself to the enthusiast who happens to possess a roll of bank notes. It would not be courteous to reply, "As many rooms as you can in a house that you contemplate building," but in truth the whole question is one of expense in relation to comparative utility. If the space to be occupied is limited to a small area, the increased number will so cut up and cramp the space that comfort and convenience will be sacrificed. In the attempt to do too much in limited compass or with restricted means, real worth will be swallowed up in display. Everything depends on judiciousness in plan. Additional rows of reeds demand extra space, not alone for the sake of mechanical facilities of arrangements, but for their exercise of power. Unless there is ample room for the expansion of tone, a large instrument will be a very lame and impotent affair. Given, space, money and time, skill and experience, and it would be difficult to fix a limit to the musical effects possible to the harmonium. Let us restrain ourselves to an average want—namely, an instrument with sufficient volume of tone to afford to the organist a means of estimating at home the character of the music as he will give it upon the organ; that this volume of tone shall be capable of every gradation of light and shade, ranging from pianissimo to fortissimo, and shall be separable in distinct varieties of quality. With the swell manual and the pedals, the harmonium is then qualified for rendering a faithful copy of the organ's music.

The additional sound-bound and reeds shall first receive attention. The illustration shows an upper sound-bound with three rows of reeds. These, we think, will fully meet the conditions stated, not too many to be cumbersome by the extra size of instrument they involve, and yet sufficient for the end in view. Four and half rows of reeds on the lower manual, three rows on the upper manual, and two rows on the pedals. Well planned and skilfully carried out, this instrument will possess a grandeur of tone fitting it to be the substitute for the organ, and affording the means of a daily familiarity with the works written for the king of instruments, the practice in which the musician never ceases to covet opportunities for at his own home.

A large instrument like this will be two feet six or eight inches in depth from front to back, and to economise space we find it desirable to arrange our plan for an upright sound-board independent of the other. To make the addition as an extension of the horizontal sound-board we should encroach on ground space to the extent of quite another foot. Few rooms would afford to give up so much space, and not only would the shape of instrument be disproportionate, but the sound-board would be too ponderous and clumsy for handling in tuning and adjusting. Free access to every part we must have, and with as little displacement as possible. So we place it upright and fix it to a back-board, contriving that it shall swing on side-pins or screws, and yet when closed shall press tightly against the back-board, with a roll of wad intervening to make it air-tight, and also in the same way press upon the trunks which are carried up from the valve-board to meet it.

You will notice that there is a side-iron projecting at the bottom of the sound-board, by which it is screwed to the side of the case. If the height is sufficient to allow the lifting up of lower sound-board, then this plan may be allowed, but otherwise it will be better to slot or cut the side-iron up to the hole, so that the sound-board shall be capable of being lifted off the screw-pins when requisite to have it out of the way for operations on the lower portions of mechanism. It can be taken away in a moment when the upper hooks that fasten it are released. The manual itself should be arranged that it may be disengaged, taking with it that portion of the action work which is made a fixture to its frame; this consists of a stout bar and action-rail, with its series of right-angled levers, called "squares," although when shaped they look more like triangles or cranks, each having a spring keeping it down on the resting-rail, which, as you will see, prevents its descent below a determinate level, therefore preserving the keys to an invariable level, their own weight of balance to fore-end keeping them up to their proper contact with the squares; cloth washers are required, placed between, to prevent noise and abrasion of surfaces, and cloth also along the rest-rail. The springs, sixty-one in number, combined together, will exercise a large amount of pressure, and need that the bar and action-rail should be firm enough to be free from any chance of bending upward by the strain. At the upper arm of each square or crank a tapped wire passes through, having a button on its point, which can thus be screwed up to its work with utmost fineness of adjustment The remainder of the mounting of the sound-board corresponds with the method adopted in the horizontal plan. A toning-leather covers the stems, and beyond that a cover or enclosure of wood, sliding in grooves or fitted in any convenient manner to the sides of the case, and removable at pleasure; this cover may also be fitted with a shutter upheld by a rod connected with a stop-rod, when the stop-rod is drawn, the lower end of the lifting-rod being thrown out of the vertical, allows the shutter to open sufficiently to afford greater freedom to the tone. Another arrangement of shutter and a different method of carrying out several details will be given in our next. In the present plan the admission of wind is by trunks at either end of sound-board; by this we save something in depth, a consideration of some moment, though it be only a saving of an inch or two, and therefore we present it first; it has its disadvantages, but then we already have end space to spare, the key-blocks of large instruments being always made wide—from four to six inches, and the amateur can allow this excess in length often much more readily than he can an increase in depth.

Fig. 2 gives a view in section of the sound-board, showing the added length of sound-board and disposition of the wind-way to each register; the whole face of these is covered over when finished. The trunks upward from the valve-board will have to correspond with these. On the top of the trunk each division is to be separately wadded or leathered, to make an air-tight connexion. Below these trunks the admission-valves are fitted on the under side of sound-board, in the same manner as the valves belonging to lower sound-board, and actuated in a precisely similar way by stop-rods and levers, presenting no complexity for the consideration of the amateur, and therefore needing no further explanation. It cannot, however, too strongly be pressed upon his attention, that with the enlargement of his aims the tax upon his skill, ingenuity, and patience will increase in compound proportion; the multiplicity of details, the relations of the various portions of the mechanism each to each, and each again to the whole, will demand from him great watchfulness, and an accuracy which the constructor of smaller instruments is never called upon to display. Those who have never undertaken such work cannot imagine the amount of patience and sagacity they will be called upon to exercise before they can bring their task to even an approximately satisfactory condition. It may no doubt appear to most amateurs that the building of a large instrument is only a multiplication of the work of small ones—a question of time and expenditure which depends solely on his own good pleasure. Speaking from experience we know differently, and do not say so to discourage you in the attempt, but rather to incite you to energy and perseverance, under a full sense of the high task undertaken, and anxious also to give you the assurance that success, when achieved, amply repays for all the labour and patient care, and thoughtful endurance. Love your work for itself, not for the show you can make of it.

Of the characteristics which it is desirable the registers of upper manual should possess, whether treated as the correlative of the swell organ or of the choir organ, we shall speak in another chapter.

(To be continued.)

HALLEY'S COMET.

(Concluded from page 78.)

By Omicron.

IT will have been noticed in giving the history of the comet, that from the time of the discovery of its periodicity till its final disappearance, the name of no English astronomer is mentioned as taking part in the interesting calculations connected with it. In the last fact that we have to relate concerning the theory of the comet, however, one of our countrymen has distinguished himself in no moderate degree. The able Superintendent of the *Nautical Almanac* at that, date applied himself to the task of computing an ephemeris of the comet, "the most extensive in its plan, and the most accurate in its execution, that the world has ever seen. Valuable as it will be to the physical astronomer of the present day, it will be much more so to those that shall discuss the observations of the year 1911." With this remark from the lucid account the Astronomer Royal has given of the theory of the comet, in the "Memoirs of the Astronomical Society," and the careful study of which we recommend to every reader, we quit this portion of the subject, and address ourselves to consider the history of the comet previously to the discovery of its periodicity.

In order to discover whether the comet has been observed, or rather noticed, at the times of its arrival at perihelion, previously to the discovery of its elliptic motion, it will not be sufficient to examine the meagre records of astronomy, as they have been preserved to us. Pingré has remarked in his valuable "Cometographie," that comets were regarded not as objects to be observed, but as signs to be remarked, and to be compared with events; and that in consequence the history and chronicles of every country and of every age were the most fruitful sources of information, and which it was the most essential to examine. Numerous difficulties beset the patient investigator of these ancient records. The very slight distinction that is drawn between comets and meteors, the eccentric and ridiculous method of describing the appearance presented, the frequent errors that the observers have made in their rough observations of the comet among the constellations, are a few of the troubles that must be carefully put aside by him that shall attempt to unravel the mysteries that surround the writings of the middle ages. Another circumstance that tends to spread a degree of doubt over the motions of this comet is the varying degree of brightness that it has presented at its different apparitions in modern times. In 1682, it appears to have presented a very brilliant appearance, while in 1607, and 1759, the brilliancy was less startling. In 1835, again, it was certainly more conspicuous than in 1759, though less so than in 1682. It is very possible, therefore, that at some of its returns it escaped notice altogether, and although the labours of Mr. Hind appear to trace the comet up to the year 11 B.C., and recognise it at every apparition, great doubt attaches itself to some of the intervening returns to the neighbourhood of the sun. We shall therefore only notice those observations which appear to refer to the comet with tolerable certainty.

In 1607, which is the first date of its becoming visible before the time of Halley and Newton, sufficiently accurate observations were made to enable Halley to compute the orbit of the comet on the Newtonian hypothesis, and it will be remembered that this apparition taken in conjunction with the one immediately preceding and following, led Halley to make his remarkable prediction. The light of the comet appears to have been "pale and watery," and its course was through the constellations of Ursa Major, Boötes, Serpens, and Ophiuchus. As an instance of the superstition that was prevalent at this period, we may remark that the old chronicles mention among the direful effects that the comet produced "The death of the Duke of Lorraine, and a great war between the Swedes and the Danes."

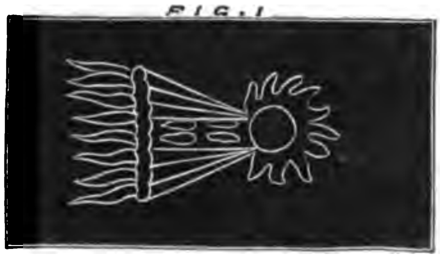
The most careful observer of the comet in 1531, was undoubtedly, Appian, of Ingoldstadt, and from his observations Halley has calculated the elements of the orbit. Appian began to observe the comet on the 13th of August, and appears to have continued his observation till the 23rd. Appian noticed that the tail was always turned from the sun, and that when the comet's nucleus sank below the horizon, the tail disappeared with a celerity as if some cloud had suddenly obscured it. Appian's observations commence in the constellation Cancer, and are pursued into Leo. The comet is said to have been of a bright golden colour. A contemporaneous writer remarks that on the 25th July, "une poutre de feu" was observed, and two comets appeared. The remark evidently refers to a meteor, and we have introduced it to convey some idea of the obscurity in which the accounts are involved, and the necessity of "sifting" the evidence before admitting it as an astronomical fact. It is, however, right to say that Pingré remarks of this author, that it would have been better if he had never written, that he is inexact even in the dates of events that happened in his own time, and that he manifests no extraordinary credulity in everything tending at the marvellous.

The next previous return, in 1456, is a remarkable one, remarkable for the brilliancy of the apparition, and the terror and consternation occasioned throughout the whole of Christendom. The tail of the comet on this occasion is recorded to have been upwards of 60° in length, of a slightly curvilinear form like the blade of a sabre. Historical readers will remember that at this period Calixtus III. filled the papal chair, and that Mahomet II. was at the zenith of his success, and Christian Europe threatened with the inundation of the Moslem power. A brilliant comet appearing at a critical moment such as then prevailed could not be without its influence in an age eminently superstitious. Accordingly the comet was regarded with pleasure or dread, as the spectator presumed it to betoken success or failure. At Constantinople an eclipse of the moon, at the time that the comet was at its brightest, drew particular interest to the phenomenon, and gave full work to the astrologers of the period. A contemporaneous writer thus describes this peculiarity in the heavens:—"Each night soon after sunset, a comet was seen like a straight sabre, approaching the moon. The night of the full moon having arrived, and then by chance an eclipse having taken place, according to the regular process and circular orbits of the celestial lights, as is customary; some persons seeing the darkness of the eclipse, and regarding the comet in the form of a long sword, which arose from the west and travelled towards the east, approaching the moon, thought that the comet in the form of a long sword, thus designated with regard to the darkness of the moon, that the Christian inhabitants of the West had agreed to march against the Turks, and would gain the victory; but the Turks also considering these things, became not a little fearful, and had great discussions." How the Christians argued so as to augur defeat from the same cause, history sayeth not, but Pope Calixtus III. enjoined on all good Christians a repetition of the Ave Maria three times a day instead of twice, and composed a prayer soliciting protection from the devil, the Turk, and the comet. After some months daily excommunication and cursing the comet waned away, and finally disappeared, and the terror it had spread was forgotten, though the deep-rooted superstition remained as firm as ever.

It would be to lengthen this paper to a tedious and unnecessary extent to follow the history of the comet through the long interval of time that the industry of Mr. Hind has pursued its motions and identified its appearances. In 1378 the comet does not appear to have created any surprising effect, and its return in 1301 was possibly unnoticed. The Chinese and European observations, however, leave no doubt as to its appearance in 1145, when it was visible nearly two months, from the 15th April to the 19th June. The tail is said to have been 10° long, extending in a north westerly direction.

In the Bayeux Tapestry is to be found the representation of a comet, which there is every reason to believe is Halley's, though Mr. Hind has found it necessary to advance the longitude of the perihelion 30°, to make the observations accord with the places deduced from the eelemnts of Halley's comet. We are able to give our readers a sketch of the comet as there exhibited, from Admiral Smyth's "Speculum Hartwellianum."

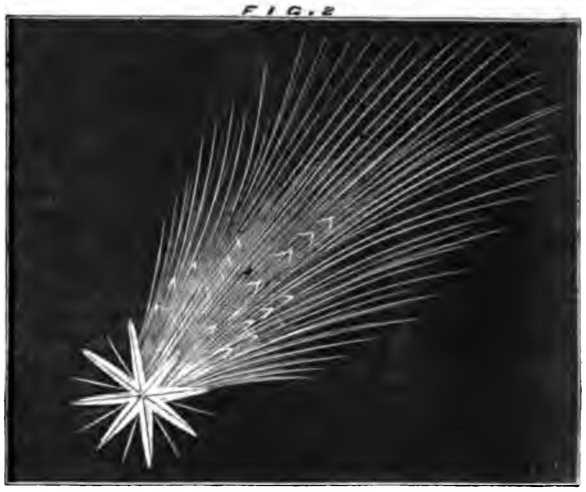
FIG. 1



Admiral Smyth has given the full picture, in which the terrified courtiers are represented in awe-stricken attitudes, which, however interesting as a specimen of high art of the eleventh century can scarcely claim a place in the ENGLISH MECHANIC. The comet at this apparition was regarded as presaging the conquest of England, by William of Normandy, and one far-seeing monk, probably aware of the expected attack, apostrophised the comet thus:—"There thou art, the source of the tears of many mothers. Long since have I seen thee; but I see thee now more terrible: thou threatenest my country with complete ruin."*

As we attempt to trace the comet in the scanty information that ancient chronicles leave us, more and more doubtful do our conclusions become. In 989 and 912, Mr. Hind believes to detect the mention of the comet, but in 837 there is great doubt whether the comet was seen. However in 760, M. Langier has shown with great probability that a very brilliant comet that appeared in that year was identical with that of Halley; and Mr. Hind remarks that the probability in his opinion amounts to little less than certainty.

FIG. 2



From the same source that we derived the picture of the comet as it appeared in 1066, we present a sketch of a comet that was visible in 684, which was the year that Halley's comet would have been visible, judging by its period of 76 years. The sketch is taken from the old Neuremberg Chronicle, though, says Admiral Smyth, "from what authority the staid xylographers of that recondite work took it, does not appear."

The identity of Halley's comet with comets of the years 451 and 218, appears very probable. The observations are provided chiefly by Chinese historians of those dates, and the deduced elements exhibit some considerable marks of agreement with the general orbit of Halley's comet. The year 11 B.C. is the most distant date to which Mr. Hind has carried his investigation, and the comet of that year is one of the most certain of the ancient appearances. All the circumstances of the observations are in accordance with the motion of Halley's comet, if the inclination be reduced some 8° or 9°, an amount which the perturbations of so long a period would be quite capable of effecting.

THE *ENGLISH MECHANIC* LIFEBOAT.

OUR Lifeboat Fund, during the last week or two, has increased but slowly. We think, therefore, we are justified in making another appeal to our readers, especially to those—the vast majority—who have not yet favoured us with their subscriptions. We have been very much pleased this week with a donation forwarded to us by Mr. Hurst of £3 6s., which is acknowledged elsewhere, and is sent by that gentleman as the proceeds of a concert given at Heybridge, near Maldon, Essex, in aid of the ENGLISH MECHANIC Lifeboat Fund. The concert was given at the head-quarters of the 1st Essex Engineers, and was got up by Messrs. Mulley, Andrews, and Hurst, in the employ of E. H. Bentall, Esq., M.P., of the Heybridge Iron Works. Mr. Hurst has enclosed us a very neat programme of the proceedings, the song of the evening being, of course, "Man the Lifeboat," sung by himself. Mr. Hurst expresses a wish, which we heartily endorse, that many other subscribers may adopt his plan, and that we receive many more subscriptions embodying the results of similar efforts for the cause of "our lifeboat." Another concert in aid of the fund will be given on the 21st inst. at Staunton Harold, Ashby-de-la-Zouche, under the patronage of the Earl and Countess Ferrers and the Lady Augusta Shirley. This concert has been originated by Mr. George Luff.

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* Pingre, Cometographie.

May we be permitted, for once, more directly to appeal to those of our readers who can afford to give more largely? One of those seasons is now with us when it is especially "more blessed to give than to receive;" and to those who have no other special call on their generosity the English Mechanic Lifeboat affords a fitting object for many an Easter-offering. We do not at all wish to have to *beg* on behalf of our project; we think better of our subscribers, and believe that next week's list will justify our good opinion. The thousands of our correspondents who so generously afford aid to their fellow-readers which no money could purchase will not, we feel sure, grudge a few pence, pounds, or shillings, according to their means, towards the cause we plead.

PROFESSOR HUXLEY ON THE GEOLOGICAL PEDIGREE OF THE HORSE.

On Friday, April 8th, Professor Huxley delivered a lecture at the Royal Institution, before a very large audience, upon "The Pedigree of the Horse." Sir Henry Holland, Bart., F.R.S., presided.

Professor Huxley began by saying that time now travels faster than it used to do. It was now 10 years since he had the honour of addressing a public audience on the origin of species and the theory of evolution due to the genius of Charles Darwin. At that time the theory was passing through the trial, through the struggle for existence, which all youthful organisms in nature have to undergo. On that occasion he succeeded so far in overcoming his natural love for peace and quietness—(laughter)—as to advocate what was then a repressed doctrine. Now all was changed. The doctrine which then was regularly refuted and overthrown once in every six weeks had since grown to such an extent that it was now the leading doctrine of most of the first scientific men in Europe, and he thought it would be well to get up a little constitutional opposition to its tenets, for now it entered even into the consideration of its adversaries. The nineteenth century, as far as science was concerned, would be known in history as having given birth to two doctrines—namely, the doctrine of the conservation of force, and the doctrine of evolution as set forth by Charles Darwin. The foundations of the first of these theories are as firmly set as the walls of the Royal Institution, but the other is not yet on quite such a stable footing. The doctrine rests upon three pillars of observation and experiment. The first of these is the production of living matter from matter not living; the next is the production of new species by natural selection; the third pillar was historical evidence of living animals succeeding each other in a way which met the requirements of the doctrine. When these three lines of evidence were complete, what was now hypothesis would become theory. As regards the first of these we were now in an unsatisfactory state; as regards the second, in spite of an enormous accumulation of probabilities, we yet stand without the direct production of a new species from one common stock; but as regards the third point, which not long since was the weakest of all, it is now, in a sense, the head stone of the corner, and may be more satisfactorily relied upon than either of the other two. The rocks reveal to us transitional forms between animals now existing and those long gone, and yield to the philosopher fossils transitional between groups of animals now far apart. At a lecture delivered at the Institution two or three years ago, he had brought under their notice forms transitional between the widely spread groups of birds and reptiles; and the reasoning he then adduced had been rendered stronger by subsequent observation, more especially by the discoveries of Professor Cooke, of Philadelphia. What was required to form good historical geological evidence? Let A, B, and C be three geological strata, each successive one older than the other; and let X, Y, and Z be groups of animal forms, succeeding each other. If he could show that there was a gradual progression of A X to B Y, and from B Y to C Z, it was the highest kind of proof which could be given. But it is exceedingly hard to find evidence of this kind good enough to satisfy critical minds, and at present it would be very injurious to bring forward evidence of a less conclusive nature. But he had one particular case to bring before them, which he thought would stand any amount of worrying, and tearing, and pulling about. The case in question was of particular interest, because it concerned an animal of which Englishmen were exceedingly proud, that is to say, the horse. He was told that some among his listeners were on the look-out for what are called "tips" in his lecture—(laughter)—but on this occasion he was going to treat the subject in a thoroughly scientific way, and none other. All animals and things which were very accurately and delicately balanced were apt to be very beautiful. On the same principle the beauty of the body of the horse probably has much to do with its being one of the best possible pieces of apparatus for running swiftly along the land. In many respects the organisation of the horse departed in an extraordinary way from what may be called "the average quadruped," and the peculiarities to which he desired to call special attention were those of the fore limbs, the hind limbs, and the teeth. What was called the "knee" of the horse was in reality the wrist of the animal. Human beings had two bones in the fore-arm, and this was also the case with most quadrupeds, but in the horse these two bones were completely fused and bound together into one. In most horses and asses the two bones were soldered together, and the shaft of the ulna nearly disappeared. The horse's hoof answered to the fingers of the human hand, only in the hoof some of the bones and fingers of the hand were missing, and the horse in reality rests upon the end of the nail of the middle finger. What has become of the other fingers? Two of them were taken away, and two of the other bones were reduced to little splints, which could be seen from the outside of the horse's foot. This peculiarity was found only in these animals. In the hind-legs of the horse the small bone was reduced, as in the fore-legs, and the middle toe was there with its nail made into a hoof. The horse had also a peculiar construction of the grinding teeth of the upper and lower jaw, some portions of these teeth being harder than other portions, so that each tooth wore unequally in different parts, whereby it always had a rough surface for grinding purposes, something like the face of a millstone. The tooth was composed of ridges and pillars, bone and cement, very curiously arranged with respect to each other, and a set of such teeth made a very efficient mill for the use of the horse. In a very young horse—that is to say, in a horse a toot long, before it was born—there were the remains of the ulna much more complete than in the grown animal, and in the young horse the rudiments of the toes were larger in proportion than in the adult. Sometimes horses were born with extra toes, and there was a specimen of this kind in the Museum of the College of Surgeons. At the present time also there was a South American pony in the Victoria Docks with an extra toe to each hoof, and the toes could be felt by the finger. If these facts were interpreted by the doctrine of evolution, what did it say? It said that the missing toes of the horse must have vanished from some animal preceding the horse, which had the normal number of toes, and that the ancestors of the horse must at one time have had the leg and foot bones complete, although these were blotted out before the horse was turned into a perfect running machine. It also said that at one time the teeth of the horse must have resembled those of other herbivorous animals. It also said that the young or embryonic form often resembled the common form more than the adult animal did. The extra toe, in some cases, was probably but a reversion to the type of some remote ancestor—nevertheless, he did not lay much stress upon this point himself. Now what did palæontology say to all this? The remains of the horse were found in profusion all over Europe and Asia, and they existed in geological strata of enormous antiquity; they could be traced back to periods long before any indications of the existence of man had as yet been found, yet the horses and asses of that remote period resembled in nearly every respect the horses and asses which now ran wild in many parts of Asia and Africa. On going still further back to the upper miocene period—a time when the world altogether differed from its present condition as regarded its geographical features—the horse was still found with all its present peculiarities, and the two differ from each other only in minute details. But side by side with the remains of the horse in this deposit were the remains of another horse-like creature called the "hipparion" or "little horse." As much was known about the hipparion as about the horse. There was no break in the series of time, for both are found in the same deposit. In the fore limb of the hipparion the leg bones were united, but the extra one was traceable, and the leg bones were nearer to the average type; the animal also had two little hoofs or fingers, one on each side of the main hoof, but they appeared to have been of no use whatever. The tooth was still very horsey, but it was changed nearer to the ordinary type. There was, therefore, in the upper miocene an animal which resembles the horse in some particulars, and departs from it in others. Professor Huxley continued: Did the horse succeed the hipparion? Was it conceivable that the one animal was struck out of existence altogether, and that the other was then created afresh out of nothing? Was it thinkable? If so, he might as well give up his theory altogether. Having proceeded thus far, the investigator turns with considerable confidence to his geological remains to look for the hypothetical ancestor of the hipparion. This ancestor was found in the anchitherium, and its remains were found in the lower miocene, but not in the upper as yet, so that there is a greater gap between the anchitherium and the hipparion than between the latter and the horse. In the anchitherium the leg bones are still more separated; it has three toes in the fore limb, the two outside ones being half as big as the middle toe, so that the foot somewhat resembles that of the tapir. This animal, therefore, has the fore foot which theory requires that it should have. In the hind leg the bones are more divided than in the case of the hipparion, the hinder feet have three toes, and the teeth have not the plasticity of those of the horse, but approach more nearly to those of the ordinary type. Thus in these three animals there are proofs of gradual progression in teeth, hind legs, and fore legs, all the rest of the organisation of each being horse-like. He submitted, then, that these animals fulfilled the conditions which he laid down at the beginning of his lecture, and that it was impossible to obtain evidence more complete in kind than this of the pedigree and origin of the horse. If a man says that he can trace his pedigree back to the time of the Conquest—well, there is no harm in that; but if he says that he is descended from King Arthur or Noah, the evidence is not worth much. In like manner the history of the horse had been traced by him in the lecture as far back as the Conquest; but he wished to go a little further, and look a little over the edge of certainty, to get some idea of what is lying on the other side. He then pointed out that in the eocene period there are remains of animals which are probably remote ancestors of the horse; the plagiolophus minor to wit. This animal more approaches the rodents in type, but it differs from the horse only in degree, and not in kind. He concluded by remarking that if Darwin's doctrine is made out in this one case of the horse, it is strong evidence that similar modifications have taken place in all cases.

PROFESSOR TYNDALL ON FILTERED AIR.

Professor Tyndall has supplemented his famous lecture on "Dust and Disease." In a letter to the *Times* he describes and defines the germ theory of the putrefaction of wounds:—The entrance of air into a wound (he says) is the dread of the surgeon. When an abscess is opened he must prevent the air from mingling with the blood-clots if he would avoid putrefaction and its teeming accompaniment of animalcule life. Some eminent London surgeons inform me that they never squeeze an abscess, lest when the pressure is relaxed the air should be sucked in. Now, whence this dreaded power? Is it the air itself that causes putrefaction, or is it something carried mechanically by the air? A follower of Gay-Lussac would affirm the former; a heterogenist would refer the animalcules to spontaneous generation; a holder of the germ theory would ascribe the putrefaction to seeds or eggs floating in the atmosphere, and which, when sown upon the wound, sprout into this crop of minute organisms. Do any data exist which will enable us to say with certainty which party is right? I think so. It would be very difficult to reduce the purifying power of pure air, even if it exist[illegible] to absolute demonstration; for, however cleansed in appearance, a stubborn objector might still urge that the air was not cleansed in reality; that germs exist though they baffle our attempts to reveal them. But this difficulty does not hamper the other side; for if, notwithstanding the risk of these residual germs, "visibly pure air" can be proved incompetent to produce the phenomena of putrefaction, there is no escape from the inference that, as regards the point to be decided, such air is perfectly filtered; and its proved impotence would be a demonstration of the truth of the germ theory. By "visibly pure air" I mean air which, where traversed by a powerful and intensely-concentrated beam of light in a space not otherwise illuminated, reveals no trace of floating matter to the eye. How, then, are we to obtain our filtered air, and, having obtained it, how are we to apply it to a wound and mix it effectually with the blood? Two or three years ago an observation and an inference, which, taken together, reflect the highest credit on his sagacity, were made and drawn by Professor Joseph Lister, of Edinburgh. He found, and I believe it is the universal experience of surgery to find, that when the lung is wounded by the spike of a broken rib, air from the pleural cavity may mingle freely with the blood, but that putrefaction never ensues. Here is the statement of Professor Lister, abbreviated, but in his own words:—"I have explained to my own mind the remarkable fact that in simple fractures of the ribs, if the lung be penetrated by a fragment, the blood effused into the pleural cavity, though freely mixed with air, undergoes no decomposition. The air is sometimes pumped into the pleural cavity in such abundance that, making its way through the wound, it inflates the cellular tissue of the whole body. Yet this occasions (as regards putrefaction) no alarm to the surgeon. Why air introduced into the pleural cavity through a wounded lung should have such wholly different effects from that entering through a permanently open wound penetrating from without, was to me a complete mystery till I heard of the germ theory of putrefaction, when it at once occurred to me that it was only natural that the air should be filtered of germs by the air passages, one of whose offices *is to* arrest inhaled particles of dust, and prevent *them from entering* the air-cells. In truth this *fact in practical* surgery, when duly considered, affords as good evidence in support of the germ theory of putrefaction as any experiment that can be formed artificially."

Here is a surmise which bears upon it the mark of genius, but which nevertheless needs verification. If in the place of the words "it is only natural," we were authorised to write "it is perfectly certain," the demonstration would be complete. Now, this is exactly what experiments with a beam of light enable us to do. One evening towards the close of last year, while pouring *various* gases across the dusk track of a beam in *the laboratory* of the Royal Institution, the *thought* occurred to me of displacing by my *breath* the illuminated dusk. I then noticed for the first time the extraordinary darkness produced by the air expired towards the end of an expiration. By an intentional effort of expulsion the lungs may be far more effectually emptied of air than by ordinary respiration; and by such an effort, which discharges the air from the interior portion of the lungs into the beam, the darkness is changed to absolute blackness. There is no speck or mote of any kind in such air. It is a true elastic fluid, without a trace of cloud or floating matter. Thus, by ocular evidence we prove the filtering power of the lungs, and by the experience of surgery we prove the incompetence of air so filtered to produce putrefaction. The germs removed by the process of filtration are therefore the cause of the putrefaction, and its associated phenomena of animalcule life, which was to be demonstrated. As a guide to the *practical surgeon*, the establishment of this fact *is plainly of* the very highest importance. Professor *Lister* now avails himself of the filtering power *of cotton* wool in treating a numerous class of wounds. He first destroys the germs adherent to the wool, and by a proper lotion he kills those which may be scattered on the flesh. The cleansed wool placed upon the wounds permits of a free diffusion of the air, but entirely intercepts the germs, and thus keeps the blood perfectly sweet. It is essential that no matter from the wound should reach the outside air, for such matter would open a highway for the animalcule I may add that when the foregoing observations on the filtering power of the lungs were made I had no thought, and but little knowledge, of the germ theory. Their value as evidence is enhanced by the consideration that they are absolutely independent of all theoretic bias.*

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* The black wreaths produced by placing the flame of a spirit lamp underneath the track of a sunbeam may now be clearly though imperfectly seen in every drawing-room in London. The light, save that passing through a single aperture, ought, as far as possible, to be excluded. A candle flame also shows the effect, but very imperfectly.

PROBABILITIES IN SCIENCE.

(*From the Student.*)

ALL science depends upon the probability of certain things being true, and certain inferences being correct. If an hypothesis explains a number of phenomena which do not appear to be susceptible of so good an explanation, or of any explanation at all, by another supposition, we have a strong inducement for believing it to be correct. Up to a certain point of knowledge, astronomical facts and appearances were accounted for to the satisfaction of acute minds by the Ptolemaic system, and in like manner a certain quantity of fact relating to light was explicable upon the theory of an emission of luminous particles, radiating in straight lines. Both these theories had to give way before before an increase in the number and kind of known phenomomena which had to be accounted for, and which they proved incapable of including. Within limits, which are perhaps impossible to define, that theory is the most probable which explains the largest number of phenomena, but mere quantity of this sort of evidence does not always strengthen belief. For example, our belief that the sun will rise at the time calculated by astronomers to-morrow morning is so strong as to be termed complete, and it will not be increased this time next year, because there will by that date have been a certain number of additional coincidences between the predictions and the results.

In many cases our minds are strongly influenced by the variety, as well as by the quantity of the facts which a given theory cöordinates in that particular manner to which we apply the term *explanation*. Thus, in the case of light, the capability of the undulatory theory to explain phenomena of polarisation and diffraction, as well as those of reflexion and refraction, adds much to its credibility.

In like manner, the nebular hypothesis has grown in probability by a succession of discoveries and observations which are found consistent with it; but there is at present so much that remains unaccounted for, that we may be justified in thinking that this theory will have to be modified, as well as completed, before it can reach the degree of probability attained by the undulatory theory of light. Mr. Proctor has, we know, some interesting speculations on this subject, which we hope he will work out.

In all speculations on the condition of highly attenuated matter, such as nebulæ, or comets, swimming in the cold and rare fluid that occupies the regions of space, we are under great difficulties from want of analogies to help us. The matter of comets is in a condition not like any thing we are acquainted with in some important particulars. Sir John Herschel says, "It is evident that the most unsubstantial clouds which float in the highest regions of our atmosphere, and seen at sunset to be drenched in light, and to glow throughout their whole depth as if in actual ignition, without any shadow, or dark side, must be looked upon as dense and massive bodies compared with the filmy, and all but spiritual texture of a comet." In 1767, Lexell's comet approached Jupiter, by whose attraction its orbit was materially changed, but its mass was so small that it was not able to produce any noticeable disturbances in the little bodies of the great planet satellites.

Cometary matter does not appear to be in one state only. Sir J. Herschel says of comets:—"In all probability they admit of great varieties of structure, and among them may very possibly be bodies of widely different physical constitution and there is no doubt that one and the same comet, at different epochs, undergoes great changes, both in the disposition of its materials, and in their physical state." We do not know matter in the state in which comets must be when they shoot out their enormous tails with astounding rapidity, and to prodigious lengths. The comet of 1680 was found by Newton to have emitted a tail 20,000,000 leagues long in two days, and it went on increasing. The comet of 1843 was seen to shoot out a ray, or tail, to the extent of nearly 100° in a single day, and upon this Sir John Herschel remarks, "It is clear that if we have to deal here with matter, such as we conceive it, possessing inertia at all, it must be under the dominion of forces incomparably more energetic than gravitation, and quite of a different nature." Soon after passing its perihelion the tail of this comet increased thirty-five million of miles a day. The emission of cometary tails takes place in a direction opposite to the sun, and that body is presumed to exert a repulsive force upon the matter so made to travel with astounding rapidity. If we are to follow analogy and recognise all the forces acting upon matter as modes of motion of the particles thereof, we shall be led to suspect that cometary matter is in a condition to be impressed with motions different from those we know more or less about, as they are exhibited in heat, electricity, and so forth. It is obvious, therefore, that when the spectroscope is applied to a comet, though it is highly probable that Mr. Huggins is right in the conclusions at which he has arrived, we do not really *know* how to compute the probability of his interpretation of its indications being correct. This is perhaps still more the case in the spectroscopic investigation of nebulæ. An indication of incandescent hydrogen, for example, obtained by such means, is not quite conclusive, and it is, in the present state of knowledge, impossible to ascertain exactly what it is worth.

An experimenter wishing to obtain a spectrum of incandescent hydrogen operates with a coil machine and a Geissler tube. He makes the rarefied gas luminous by a powerful electric discharge, which strongly heats it, and in comparing his results with those obtained with the light from a nebula, two suggestions occur. First, we have no evidence that the luminous nebula is intensely *heated*, by any internal action, or by any external force. In the next place we know scarcely anything about the density of the matter that composes it. At first it would seem that if highly heated hydrogen gave a particular spectrum in the laboratory experiment, it was highly improbable that exactly the same spectrum should appear except similarly heated hydrogen were its cause. The amount of improbability of *accidental* coincidence is enormously great—great enough to be discarded. From a moderately extensive range of experiments we know that a considerable number of the bodies which we call "simple," simply because we cannot, or have not decomposed them, afford, in the state of incandescent vapour, characteristic spectra, and from this it is inferred that this rule holds good under all circumstances. Certain facts in the spectra of gases raise some doubts,* but it must be admitted that a powerful probability is established that certain nebulæ are composed of luminous, if not of incandescent† gaseous matter, to which the term incandescent is commonly applied, though before we know how to estimate the value of this probability we must see what other probabilities are raised by the same or other researches.

On making his most important examination of a nebula in Draco, Mr. Huggins saw three isolated bright lines, instead of the continuous spectra given by stars, and he said, "A spectrum of this character, so far as our knowledge at present extends, can be produced only by light which has emanated from matter in the state of gas. The light of this nebula, therefore, was not emitted from incandescent solid or liquid matter, as is the light of the sun and stars, but from glowing or luminous gas."

On comparing the spectrum of nitrogen with that of the nebulæ, Mr. Huggins says, "I found

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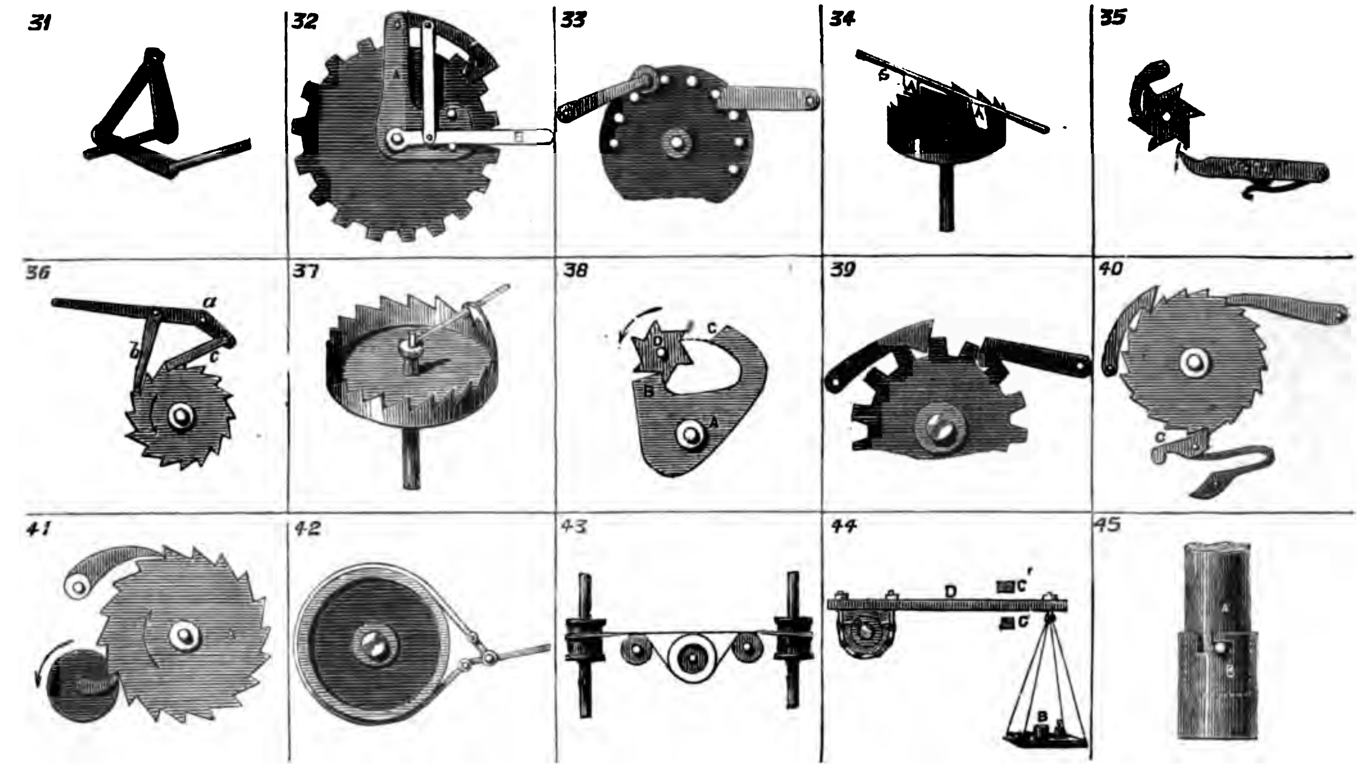
* "An apparent exception to the law that the nature of the spectrum of a gas remains constant throughout a great temperature range ought to be remarked in the case of nitrogen, which changes the nature of its spectrum at a very high temperature. This is viewed by some as an indication that nitrogen is really a compound body, since the same change takes place in the spectra of some other gases, which we know to be compound."—Balfour Stewart, "An Elementary Treatise on Heat." Plücker has made important observations on this subject.

† Incandescent properly means being made white by heat.



MECHANICAL MOVEMENTS.

that the brightest of the lines of the nebulæ *coincided* with the strongest of the lines that are peculiar to nitrogen. It may be, therefore, that the occurrence of this one line only indicates a form of matter more elementary than nitrogen, and which our analysis has not yet enabled us to detect. In a similar manner the faintest of the lines was found to coincide with the green line of hydrogen." He adds, "The middle of the three lines which form the spectrum of the nebula does not coincide with a very strong light in the spectra of about twenty of the terrestrial elements. It is not far from the line of barium, but does not coincide with it." A minute nucleus of this nebula appeared to be the source from whence a faint continuous spectrum was obtained, and thence it was inferred to consists of opaque matter, which may exist in the form of an incandescent fog of solid or liquid particles." The comet of 1866 afforded a continuous spectrum from its coma, indicating that it was visible by reflecting solar light; but the nucleus was self-luminous, and gave a gaseous spectrum, "suggesting that the material of the comet was similar to the matter of which gaseous nebulæ consist."

It is difficult to suppose that such thin bodies as comets and nebulæ can keep themselves very warm in the intense cold of space. From Professor Tyndall's researches, it appears that oxygen, nitrogen, air (which is a *mixture* of them), and hydrogen possess very feeble powers both of radiation and absorption. A heated mass of these gases would cool slowly from radiation, but a cold mass would be very difficult to warm by absorption of heat radiated from any other body. To retain nebulæ or comets in a state of incandescence from *heat* would require conditions that we do not know to exist. No one, we suppose, would imagine that heat, radiated from any other body, could keep a nebula white hot, and matter in so rarefied a state is not under favourable circumstances for violent chemical actions, such as we know produce great elevation of temperature. We may, however, have recourse to that refuge for those destitute of accurate information—electricity, and assume that the nebulous glow which acts upon our spectroscopes comes from electric excitation. But if this be so, we have gaseous matter not *heated* to incandescence giving the same spectrum as gaseous matter that is so heated in our laboratory experiments; and before we can tell the probabilities of the inferences usually drawn from the spectra of comets and nebulæ, we must ascertain that the same gaseous matter in these two conditions would give the same spectroscopic results. Any probabilities that nebulous matters are not incandescent from heat are probabilities that the laws of luminous spectra are not so simple as to be comprised in the statements we usually receive, and according to which we are invited to be believe that the same form of matter in the same condition gives a spectrum belonging exclusively to that matter in that particular state.

When we consider comets, how are we to be guided in guessing their temperature? The comet of 1843 went so near the sun as to be exposed to 47,000 such suns' heat as we experience the warmth of, and Sir J. Herschel, from whom we take this statement, observes that the heat emitted by the sun in such a position would be equal to three-and-a-half times that obtained with Parker's great lens, thirty-two and a half inches in diameter, when used with a concentrating lens, increasing its power sevenfold, and melting carnelian, agate, and rock crystal with the solar rays. The actual temperature of the matter exposed to this solar glare and glow would depend upon its nature. If very transparent to heat, it would let much through and retain little. If the heat excited other actions, such as great expansion, or other internal work, all so employed, would not raise its temperature. Many comets seem to grow smaller as they approach the sun, and this has been supposed to arise from portions being converted into a more attenuated and invisible condition. As they recede from the sun they have been observed to get visibly bigger—probably from condensation. If cometary or nebulous gas passes from a condition the same as or like what we call simple gases, to that of compound gases, its powers of absorption and radiation would, according to Tyndall's researches, be enormously increased.

Professor Tyndall, in his "Heat as a Mode of Motion," affirms that the chances that iron is in the sun are 1,000,000,000,000,000,000 to 1, on account of the coincidence of certain dark lines in its spectrum with certain bright lines yielded when incandescent vapour of iron is employed as the source of light. This is put forth as an *actual* calculation. It may be *actual* in the sense that Professor Tyndall actually made it, but purely imaginary at the same time. The elements for a *real* calculation of the probabilities are not known. Very likely the professor is right if he thinks only of coincidence arising from *chance*, but we have no information whatever concerning the probabilities that coincidences may result from *law*. The quantity of experiments yet made is insufficient to justify such extravagant assertions, and no one has yet arrived at a law explaining why the spectra of different so-called simple bodies vary exactly as is found to be the case. No philosopher really imagines that there are scores of substances which are really simple, and if, as is probable, the chemist may find means of decomposing metals, and certain gases, or carbon, who can venture to predict what fresh spectra may appear?

MECHANICAL MOVEMENTS.*

(*Continued from page* 76.)

31. DRAG-LINK motion. Circular motion is transmitted from one crank to another.

32. Intermittent circular motion is imparted to the toothed wheel by vibrating the arm B. When the arm, B, is lifted, the pawl, C, is raised from between the teeth of the wheel, and travelling backwards over the circumference, again drops between two teeth on lowering the arm, and draws with it the wheel.

33. Shows two different kinds of stops for a lantern-wheel.

34. Represents a verge escapement. On oscillating the spindle, S, the crown-wheel has an intermittent rotary motion.

35. The oscillation of the tappet-arm produces an intermittent rotary motion of the ratchet-wheel. The small spring at the bottom of the tappet-arm keeps the tappet in the position shown in the drawing as the arm rises, yet allows it to pass the teeth on the return motion.

36. A nearly continuous circular motion is imparted to the ratchet-wheel on vibrating the lever, *a*, to which are attached the two pawls, *b*, and *c*.

37. A reciprocating circular motion of the top arm makes its attached pawl produce an intermittent circular motion of the crown-ratchet or rag-wheel.

38. An escapement. D is the escape-wheel, and C and B the pallets. A is the axis of the pallets.

39. An arrangement of stops for a spur-gear.

40. Represents varieties of stops for a ratchet-wheel.

41. Intermittent circular motion is imparted to the wheel, A, by the continuous circular motion of the smaller wheel with one tooth.

42. A brake used in cranes and hoisting machines. By pulling down the end of the lever, the ends of the brake-strap are drawn towards each other, and the strap tightened on the brake-wheel.

43. Represents a mode of transmitting power from a horizontal shaft to two vertical ones by means of pulleys and a band.

44. A dynamometer, or instrument used for ascertaining the amount of useful effect given out by any motive-power. It is used as follows:—A is a smoothly-turned pulley, secured on a

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* Extracted from a compilation by Mr. H. J. Brown, Editor of the *American Artisan*.

shaft as near as possible to the motive-power. Two blocks of wood are fitted to this pulley, or one block of wood and a series of straps fastened to a band or chain, as in the drawing, instead of a common block. The blocks or block and straps are so arranged that they may be made to bite or press upon the pulley by means of the screws and nuts on the top of the lever, D. To estimate the amount of power transmitted through the shaft, it is only necessary to ascertain the amount of friction of the drum, A, when it is in motion, and the number of revolutions made. At the end of the lever, D, is hung a scale, B, in which weights are placed. The two stops, C, C', are to maintain the lever as nearly as possible in a horizontal position. Now, supposing the shaft to be in motion, the screws are to be tightened and weights added in B, until the lever takes the position shown in the drawing at the required number of revolutions. Therefore the useful effect would be equal to the product of the weights multiplied by the velocity at which the point of suspension of the weights would revolve if the lever were attached to the shaft.

45. Bayonet joint. On turning the part, A, it is released from the L-shaped slot in the socket, B, when it can be withdrawn.

(*To be Continued.*)

SCIENCE FOR THE YOUNG.

By the Rev. E. Kernan, Clongowes College.

(*Continued from page* 80.)

§ III.—Inertia.

THE indifference to a change of state of motion or rest, which is observed in bodies, is called Inertia. This property is of considerable importance, both theoretical and practical. Hence, in full form,

No. I.—Laws.—Here, and elsewhere later on, may be found laid down as laws what do not deserve strictly to be called such. They are put under that title that they may be more marked, more attended to, and better appreciated. The same reason may be given for detail of Laws, the dividing into two or three what might be in one. The first sentence of these laws will usually contain the *law*; the rest is but explanation.

Law I. All bodies are indifferent to a change from rest to motion. Solids, liquids, gases, will remain at rest for ever, if not forced to change that state by some cause; external cause, as explained in the definition of Mechanics.

II. All bodies are indifferent to a change from motion to rest. Solids, liquids, gases, if once set in motion, will never cease to move without the action of some external force, which sooner or later reduces them to a state of rest.

III. Time is required to overcome the inertia of a body, whether at rest or in motion. When force is applied to a body a certain amount of time is necessary for the production of the effect of motion or rest.

When this time is not allowed, the body acts as if fixed—immovable.

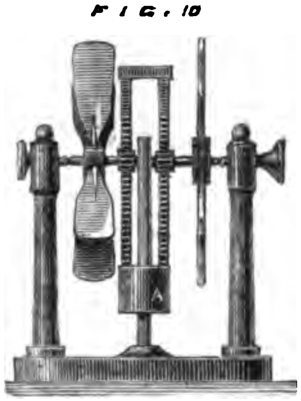
IV. The time required varies directly as the quantity of matter in the body. As the body to be moved or stopped has more or less matter, it will require more or less time to change its state.

No. II.—Proofs.—These are separated from the laws for several reasons; that the laws may be more easily found; that they may be more evident, short, concise; that the student, with but little time, may know what he can pass over with less disadvantage. Should he be compelled to omit the proofs, he is sure that no principle has been neglected or omitted.

Law I. This law is so self-evident that it requires no proof. In fact, the experience of the youngest teaches that where a body is laid there it will stay for ever, unless some force affect its state of rest.

II. Bodies in motion, like those at rest, have nothing in themselves which can effect a change of state. To prove this law experimentally strictly, it would be necessary to solve the impossible problem of perpetual motion. Still it can be very well proved that it is the action of external forces which prevents the continuous duration of motion once imparted. Thus a square block of iron, even with considerable force, will move but a short way on a table. Let it be made into cylinder, it will go much farther; into a ball, still farther, under the action of an equal force. Now try the ball upon a rough floor—on smooth iron—on ice; the same force goes on increasing its time of continuous motion as the external impediments are diminished. The stopping force of the impenetrability and inertia of the air shows in one experiment how the inertia of motion may be overcome by external force, and is overcome only by such means. Fig. 10, a pair of vane mills, mounted on delicate axes, provided with pinion wheels which receive motion from a rack joined to a falling weight, A. One set of vanes can be turned flat or edge-wise to the air. Turn them flat, push down the weight, both mills are set in rapid motion; but soon the flat vanes are stopped, by the quantity of force expended in overcoming the inertia of the air, and pushing it aside. Turn the vanes edge-wise; the indifference to rest is now seen by the second mill continuing to move as long as the first. This experiment will be still more confirmed when the means of removing the obstacle (the air) has been studied. Then it will be seen that flat, or edge-on, both move for the same time. It is, therefore, the external force which destroys the motion. Other obstacles than the air, as shall be seen in their own places, are here in action against the motion of the mills. It may, then, be fairly concluded that they would continue in motion for ever, but for some external cause which destroys sooner or later the first force.

FIG. 10



III. The force applied to a body at rest or in motion must transmit itself from particle to particle of that body. This transmission can only be effected in consecutive moments of time. When there is not sufficient time, those particles which have not received the force resist, as would a mountain. This can be shown by a simple experiment, Fig. 11. A small weight A is laid on a table. A thread joined to the weight is taken in the hand. Raise the weight slowly, the thread is not broken (*a*); try to raise the weight with a sudden jerk, the thread breaks. There was not time for the motion to communicate itself to all the particles of the weight they resisted; the thread might as well have been joined to the table or floor. For motion, pass a thread over the pulley A, Fig. 12, draw up the weight B to the top, join to the drawing end of the thread a light disc E, and dispose on rings fastened into the shaft S a number of light weights (*a*, *b*, &c.), the sum of which is a trifle more than the weight of B. There is a hole and slot in each weight, as *x*. Let B fall. As E is drawn up it lifts off the weights (*a*, *b*, &c.) one by one. Their combined weight stops B, or lets it tap gently on the table, without breaking the thread. Draw up B again, and place one heavy weight, W, at C. Let B fall. As E moves up it is suddenly stopped by W; there is not time to stop the particles of B, the thread is broken.

FIG. 11

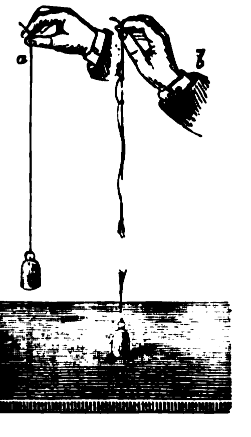
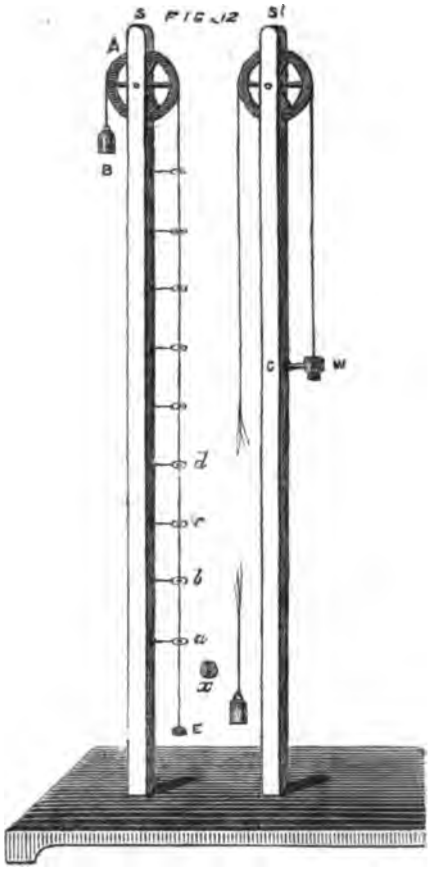


FIG. 12

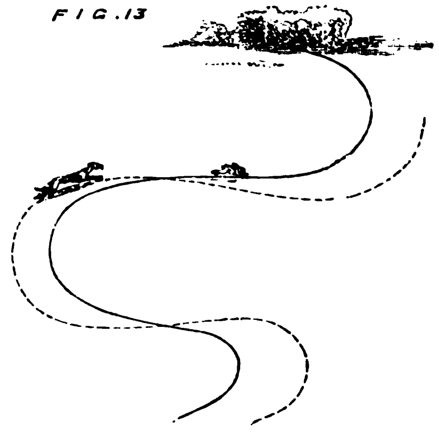


IV. This law is clearly a necessary consequence of Law III.; more particles, more time must be given to communicate motion or rest. The same experimental proof as in Law III., by using weights of different quantity. With heavy ones, the least increase of rapidity, or stoppage, will cause a breaking of the thread.

No. III. Applications.—Under this head are introduced facts, ordinary and extraordinary, natural phenomena; machines, &c., &c., the explanation of which depends upon the matter just explained.

The passing reader may feel inclined to pronounce some of these trivial, unworthy of scientific notice. Such is not the case; the simplest toy is raised to the dignity of a scientific instrument when its action is explained on true scientific principles. Again, the applications may be considered at times too multiplied. The effect of

FIG. 13



this multiplication of common facts explained is to produce a spirit of inquiry than which nothing serves better to foster and develop scientific talent.

Application I. The dog and hare, Fig. 13. The hare gradually gathers itself in, to turn. The dog cannot turn—cannot overcome the inertia of his heavier body so quickly. The time he requires is gain to the hare. Other principles, even stronger against the dog, will be seen in their own place.

(*To be continued.*)

HIGH-PRESSURE ENGINES.

(*Illustrated on page* 109.)

TWO generations (says the *Engineer*) have all but passed away since Jacob Perkins preached the gospel of high-pressure steam—high-pressure above and beyond any high-pressure with which modern engineers have to do. We think it something to boast of that the engines of the North London Railway use steam of 160lb. pressure; but Jacob Perkins proposed to use steam of 1000lb., and actually did use it under certain circumstances. The great body of mechanical engineers labour under the impression that Jacob Perkins' ideas died with him. No notion could be more erroneous. His ideas live with his grandson, and we saw them in practical application on Wednesday week on board the steam-tug Filga, the property of Mr. Henwood. On board this boat, we confess that we stood for the first time over a marine boiler carrying 200lb. of steam. Time and space alike forbid us to enter into details. It must suffice to say that the boiler consists of a great number of wrought iron tubes, about 3in. diameter outside, and varying in length from 12ft. to 10ft., within which the water is contained, and round which the heat plays. The engines of the Filga are illustrated, as far as general arrangement is concerned, in the annexed engraving. They were designed by Messrs. Perkins, and constructed by Messrs. Hodge, and consist of four cylinders, arranged steam-hammer fashion. The two upper cylinders are high-pressure, 15in. in diameter. The low-pressure cylinders are immediately beneath them. They are 32in. diameter, the stroke of both being only 1ft. The valves are all of the double-beat Cornish type, raised from their seats by spindles driven by eccentrics, but dropped by the pressure of the steam acting on the plus area of one valve. The surface condensers are of a peculiar construction, of which we shall have more to say. The circulating water is driven through it by a pump worked by an eccentric on the screw shaft.

The Filga is of the ordinary Thames screw-tug type, and it is doubtful if engines of any other form of 80-horse power nominal could have been got into her. She is 70ft. long, 14ft. beam, and draws 10ft. She has a three-bladed common propeller 9ft. 6in. diameter, and 12ft. 6in. pitch. The boiler has not less than 2200 square feet of heating surface, the grate surface being but 30ft. The estimated consumption is a little under 2lb. of coal per horse per hour, but the actual consumption appears to be much less. On this point we shall have something more to say. The engine illustrated in the annexed engraving is almost precisely the same as that of the Filga, the only difference being that the cold water circulating pump is arranged vertically outside the engine frame instead of horizontally, as shown at the left of the cut. The Filga left Blackwall on Wednesday, the 6th inst., for a run down the river. The trip was in no sense a trial trip; it was simply intended to prove to a select body of engineers that it was possible to work 180lb. steam at sea, and, so far, it was completely successful. Steam was easily maintained throughout the trip at 150lb. to 190lb. No trace of steam was to be seen about engine or boiler, because the joints are absolutely steam-tight. The tide was strong against the little vessel on her run down, yet, on the measured mile in the Lower Hope, she attained a speed of 8·33 knots, with nearly one and a-half knots of tide against her. This was not a trial run, and no special precautions were taken to secure a good result; but there is no doubt that the result is very good indeed considering the size of the boat. The general particulars of the run may be thus summed up:—The Filga left Blackwall at 12·30, passed North Woolwich Railway Pier at 12·55, and Erith at 1·47 p.m. Gravesend was reached at 2·48, Thames Haven at 3·38, and the run back was made at such a pace that Blackwall was reached at 6·40. Throughout the working of the engines was most satisfactory.

SKETCHING FROM NATURE.

(*Concluded.*)

BY SUNSHINE.

WITH the permission of our Editor, I now resume the pen for a last brief paper upon the above art, just to pick up a few stray notes dropped by the way. Since my last, the spring has really dawned, and the time for practical outdoor work has almost arrived, but, except for artists of strong constitution, a little delay is still advisable, for the treacherous east wind is apt to creep stealthily over the tenderest parts of the body, doing no slight mischief, while the bright sun makes a pretence (and a pretence only), of counteracting its baneful influence. To those who are not provided with the necessary materials for outdoor sketching, I am inclined to recommend the moist colour *tube* boxes, Fig. A, which contain a dozen colours and folding palette, in preference to the moist colours in open pans. Certain colours in both are too apt to dry, especially the brown madder and burnt sienna, but the tubes protect their contents more completely from atmospheric influence. These colours are used after the manner of oils, a small portion of those likely to be needed being squeezed out on a row on the upper edge of the white palette, and the brush, dipped in water (contained in a cup attached to the palette), is applied to each as required, compound colours being mixed on a separate part to the tint required. The advantage of tube boxes is, that it is impossible to spoil pure colours by accidental admixture with others. The brush, dipped alternately into the open pans, in the other kind of boxes, carries colour from one to another, sullying the whole, as is evident on inspection of any such box freely and often used. Indeed, I have hardly ever seen a pan box in which the colours were pure as when first sent from the maker's, and purity of colour is to be considered in all cases one of the essentials of success to be constantly aimed at. To facilitate finding the right tube at at a moment's notice, I find it a good plan to colour the labels with the same paint which they respectively contain. Barnard attaches such coloured labels to his oil tube colours (I've not seen his water colours), and I have found it a great convenience, as in an oil colour box, one has often a long hunt for a required tube, which may have been several times overlooked in the search. To those in possession of colour boxes with pans, I do not reccommend a change, as many prefer them to the tubes, and it is no use wasting money in this, which is a matter of choice or habit. I think it is, however, advisable to have a small palette knife for taking up a little colour from the pans. With a rag at hand to wipe the knife (an instantaneous operation), the mixing of colours is less likely to occur than if the brush (often being wet), is dipped into the cells. An artist of my acquaintance, a remarkably clean hand at water colour sketching, sticks to the cake colours, rubbing a few on the palette as a stock, and working from these. The tubes give of course a more ready method, and, with a palette knife, as recommended, the open pan colours answer the same purpose. Some kind of camp stool is generally necessary, because the ground is often damp, and a big stone or convenient extempore seat cannot always be found on the desired spot. In many cases, nevertheless, a waterproof cushion of some kind (a square of carpet with a waterproof lining, for instance) is more convenient to carry, and will answer as well. A folding easel is easily constructed of three slips of deal, and an india-rubber ring to hold them together at the top when in use; or a straight bolt run loosely through the three at one end, allowing the legs to be stretched out to form a tripod. The sketch block rests on a couple of pegs fitted into holes in the front pair of legs at the required height, Fig. B; a more complete affair is given in Fig. C, from a catalogue of Rowney's. All these bought contrivances are, however, sold at too high a price, and any ingenious hand at the plane and chisel can make such at one quarter the sum demanded at the shops—in point of fact, a great number of beautiful sketches are taken without seat or easel, a fallen tree or stone, or the dry ground supplying the first, and the knees the second, and it is a nuisance on a hot day having much to carry.

FIG A

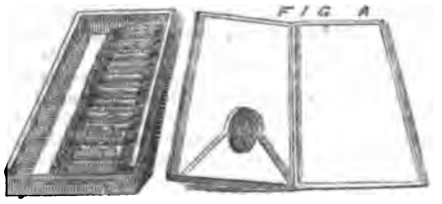
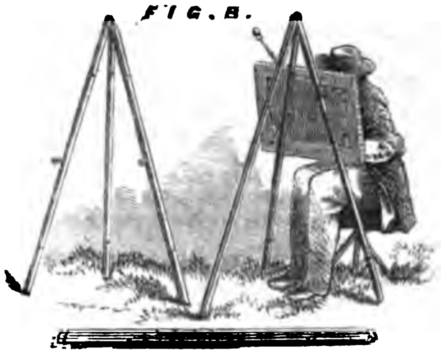
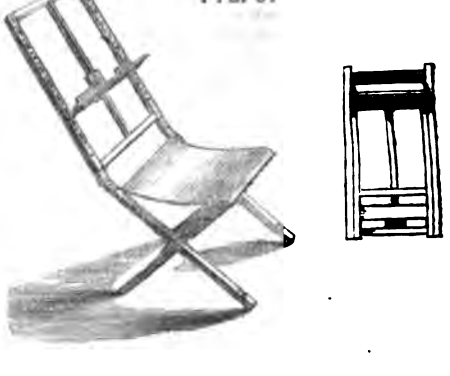


FIG. B.



An umbrella, however, with a spike to screw into the handle is of use, not only to protect the sketcher from what may be a dangerously hot sun, but to prevent the colours from drying too rapidly. A short three-legged camp-stool can be strapped to an umbrella, and the latter used as a walking-stick without inconvenience, a light easel may also be strapped to it, and in a pocket, made inside for the purpose, pencil, rubber, brushes, &c., can be conveniently stored. On the whole, it is hardly possible to make a better arrangement. Let it be remembered that in a sketch you will not require deep or elaborate colouring. The general fault of the beginner is heavy handling and dirty tints. Aim specially at clearness, and remember to sacrifice ever *to light*. The whole beauty of a scene frequently arises from the light which falls upon it, and what under other conditions appears wholly without interest is thus rendered picturesque and lovely. Recollect in your work that *bright* light absorbs or conceals detail, and so does deep shadow, while such detail is clearly seen under a half-light. Observe, also, that the greater part of your sketch will be neither intense light nor deep shadow, both of which occupy small points only, from which are many gradations of the one

FIG. C.



into the other. It is generally recommended to begin colouring a sketch systematically by carrying a broad wash of colour, blue, or red, or orange of a light tint, over the whole, and then the operation is to be repeated, omitting to cover certain parts with this ground tint. The object is two-fold—to shut out the white paper, and to ensure breadth or uniformity of treatment. The fault is (and it is often fatal) losing the purity of the colours afterwards laid on. An adept will, no doubt, improve his work by such treatment—a novice will spoil it. The white paper is most precious—it has to express your light from first to last; and even those light orange, or other tints used over surfaces illuminated by the sun, depend for effect of light upon being laid on thinly, thus permitting the paper to appear partially through the colour. Points of *high light* must be left wholly uncovered, and in all the purity of the white paper itself. Do not, therefore, sully your work by broad washes to constitute an under-tint, and to ensure what is called "keeping"—*i.e.*, a uniformity of appearance, but colour each part at once with the tint required, laying it on carefully and steadily to the outline. To do this well, needs some practice; out-of-doors it has to be done rapidly so that the whole may be laid before any part has dried, or the colour will be patchy and uneven. Suppose you have to colour the gable end of a plastered cottage on the light side, it will generally be slightly yellow, or it may be, perhaps, light-brown. Make a wash of yellow-ochre, sepia, vandyke brown, or other colour that appears to match the original. Let it be a thin, clear light wash, not pasty, nor dark, or thick. Take a sable brush, fully large, and dip in the colour, so as to take up plenty, but not enough to drop from the brush. Your picture being on a slope on the easel, or on your knees, begin at the peak of the gable, lay colour up to the edges at once, down the incline of the roof, then draw back a little and carry the tint down, then to the *edges of the walls*, and so again rapidly back and downwards, keeping a full brush, so that the colour may flow easily down the paper. If it should run down in streams by itself, shake a little out of your brush, but go on, don't stop (except for a second to dab up the colour, if it has gone much too far, and is likely to sully any other tint in its way), and when at the bottom of the gabled wall, take up on the brush dried for the purpose, any extra colour that may lie there in a wet line, and if you have done well you will have a beautiful clear light tint of great purity. Thus, also, map down all your patches of colour, each by itself and to its proper limit, and where very bright light falls, stop with your brush rather more dry, so that there may be a *clear edge*, but not a harsh line, and resume below the point of high light. These bits of light, or broad light, as the case may be, add greatly to the beauty of a sketch, so guard them carefully throughout. Now by this mode of work your sketch will probably have a *raw* appearance, and will be generally patchy, without that uniformity, oneness, or keeping, that is so desirable. *Never mind at first*, remember you are learning to sketch from Nature, and to lay on colour clear and bright and true to the original, and you have, as you will find, work enough to do, without troubling about those higher qualities in which artists excel. Yet, be it observed, if you can correctly copy the tints before you which express the light and shade and colour of the various objects in their due proportions, you will have breadth and keeping too, and Nature will have already taught you that she manages these details of art rather better than those who are guided by arbitrary and artificial rules. The reason you will not succeed in this at first is because the untrained eye fails to appreciate the colour, tint, shade, &c., of the natural object—does not at first catch those niceties of gradation which become evident to the more educated sight. You will find after a few trials that the same tint does not in Nature extend far over any given surface. Even the cottage wall, if carefully observed, will be found to be of various colours—here a pure yellow, there a pale brown, in another place light red, in another, greenish, from dampness, and so forth, and an accurately-coloured sketch would of course *so represent it*. At first, however, the learner will certainly fail to be impressed with these minutiæ of tint. The sketch, nevertheless, will lack variety if too large a surface is coloured uniformly. Hence one of the following methods may be adopted:—If a tint of yellow ochre has, as supposed, been used, a wash of light red may succeed after the former has become quite dry, but this should not cover the whole. Upon these, when dry, may be laid partially another tint, say of vandyke or madder brown, both of which are transparent. If a patch of green is required, lay a thin wash of cobalt upon the pure yellow, and you will have it at once, and thus your wall will be of various hues, but all clean and transparent. For the *highest* light leave the pure paper. This is one way of work, and a safe one. The second, nevertheless, is more artistic, and, in some respects, better. Make a wash of ochre, another of burnt sienna, a third of madder brown, a fourth of sepia. Begin at the top with the ochre, and carry it irregularly downwards; then dip into the burnt sienna with the same brush, give a quick stir or two, and so mix partially, and proceed to lay it on. After a while do the same with the madder and sepia, and carrying this to the end, leave all to dry. You ought to have a beautifully-varied tint; perhaps, however, harsh lines will appear here and there. If so, leave it alone till quite dry, and then wash with a large soft brush of pure water, and again let dry. You may practise all this at home even better than out-of-doors, for you must be eventually able to gradate in all sorts of ways firmly and surely; sometimes with colour over colour (the chromo-lithographs are done thus), and sometimes by running one wet tint into another, as described. Try also to gradate from dark to light, and *vice versa*, in *one* colour—say sepia, for practice. Rub a full rich dark tint in a saucer, and after laying on a little of it, add a drop or two of water and go on again, then more water, picked up from a glass without *washing the brush*, and continue. Every time you add the water stir up with the brush, and never run the latter too dry, because you need a line of liquid paint at the lower edge of your work as you proceed, so that the new tint may blend with the old. In a similar way vary the character of the tints. Take up light red, carry it into Indian red, then into burnt sienna. You will soon see that your powers increase, and your work will become easy and delightful. Most of your sketches will depend on broad and varied washes of this kind, but you will have to lay in detail over these with a drier brush. Don't get the sketch generally too dark or heavy, and let it remain as a sketch, don't finish it at home. Copy it and work a more elaborate drawing if you like; but I suspect the sketch after all will prove the best for a long time. But I must cease, though I should like to have written a good deal more.

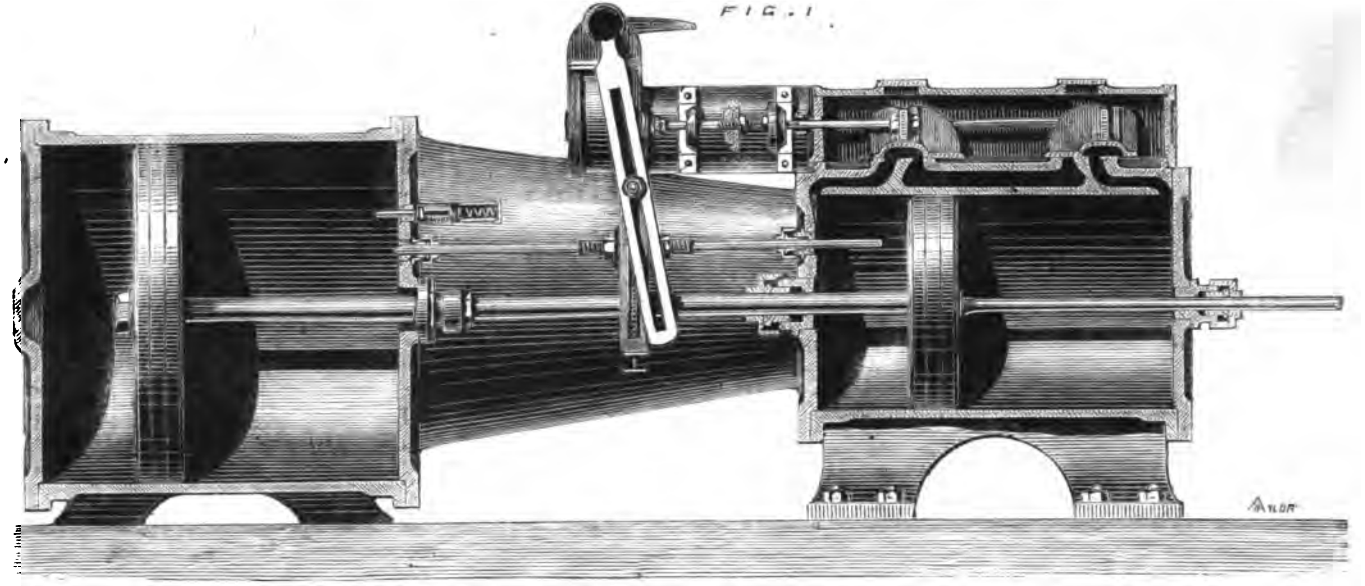
J. L.

THE VALUE OF DIFFERENT ARTICLES OF FOOD.

THE theory of nourishment, advocated for more than a generation by Baron Liebig, which divides food-substance into nitrogenous and non-nitrogenous, has of late years given occasion to many physiological investigations. The most recent and most thorough of these we owe to Professor Voit, of Munich, who has followed, by the most careful analysis, the transformations, under various circumstances within the organism, of the substances which are absorbed into it, and those which are excreted from it. According to Liebig's classification, albumen is the representative of the nitrogenous, fat, starch, and sugar, of the non-nitrogenous, articles of food; and he assigns to the two kinds different offices in the economy of the body. Starting with the view that the motor muscles consist mainly of albuminous substances, he enunciated the theory that the function of albumen is to produce mechanical labour, that is, motion. This view is confirmed by the experimental fact that a generous meat diet makes men strong, while the want of flesh-meat renders them weak and incapable of endurance. Horses which have to perform great muscular efforts, must be fed on oats, which are much richer in albumen than the ordinary articles of vegetable diet. It is further confirmed by the result of all experiments, which show that life cannot be supported on fat, starch, and sugar, without albumen. All animals fed in this manner die of debility. To the non-nitrogenous articles of food, Liebig therefore attributed another purpose, and held that they are employed in the chemical process of respiration. In connection with this inquiry, the next question was, whether more albumen is consumed by the body when in a state of muscular activity than in a state of rest. This problem has been approached in two different ways; by Bischoff and Voit on the one hand, and by Fick and Wislicenus on the other. The former have investigated the amount of nitrogen excreted from a body, both in activity and in rest, the quantity of food consumed being the same in either case, The two last-named experimenters have measured the quantity of nitrogen excreted during the violent muscular exertion occasioned by the ascent of the Faulhorn. Now, since the quantity of nitrogen given off from the body can result only from the decomposition of the albumen taken up as food, these experiments lead to two certain conclusions. They prove, first, that, during the activity of the body, no more nitrogen is evolved than during rest; and secondly, that if, from the amount of nitrogen given off during muscular effort, the quantity of albumen is calculated which must have been decomposed in order to produce it; this amount is not sufficient, even if consumed in a furnace, to account for the amount of labour performed. The greater number of German physiologists are, therefore, at present of the opinion that in muscular activity it is not albuminous substances, but non-nitrogenous substances, such as the hydrocarbons, which are consumed; and, owing to the relation of albumen to the latter, the muscular system has been compared to a machine, the moving portion of which is formed of albumenous substances subjected to a continual process of waste and repair. The motor force, on the other hand, furnished in the case of the steam-engine by the fuel and the steam, is, in that of the body, solely the result of the oxidation of the hydrocarbons. Hence, during muscular activity no more albumen is consumed than during rest, but more hydro-carbons. Voit has gone a step further, and investigated the reciprocal functions of albumen and the hydro-carbons in the joint nourishment of the body. He fed dogs on pure flesh freed as far as possible from fat, and carefully set down the change of weight in their bodies, and the quantity of nitrogen which was given off during this time. The result of these experiments was the remarkable discovery that, even with a diet very rich in flesh, the animals scarcely increased in weight, but were only just able to equalise waste and repair. The more flesh free from fat was given them, the more completely was it assimilated in the body without its organs becoming richer in albumen. If the amount of flesh given was inconsiderable, a loss of weight took place, the animal giving off more albumen in the form of excreta than it took up with its food. Comparatively small quantities of fat had a remarkable influence on the process of nourishment. Under this latter treatment the quantity of nitrogen excreted immediately declined, and when there was a somewhat larger amount of flesh in the food, the absorptive and excretive process were found to balance each other. If the proportion of flesh in this mixed diet was increased, a greater increase of flesh took place in the body than could be obtained by an exclusively flesh diet, however generous. These facts have led to the conclusion that the hydrocarbons diminish the decomposition of flesh in the body. The addition of fat to the diet can never entirely replace albumen, but renders necessary a smaller portion of it in the food. In close connection with these investigations of food comes the question of the value as nourishment of the *extractum carnis* (see *Academy*, No. 5, p. 132). It is well known that the *extractum carnis* first prepared by Liebig contains nitrogenous substances soluble in water, which, together with albumen, occur in flesh. As they form an essential ingredient of broth, it follows that they play a definite part among the constituents of food. It must not, however, be forgotten that a very important element of broth is wanting in the *extractum carnis*—viz., gluten and fat, which compose the greater part of the solid portion of broth. Although, therefore, the *extractum carnis* is of very great service in nourishment it is going too far to believe that it can ever be a substitute for broth. Liebig has conjectured that a vegetable article of food containing albumen and hydro-carbons, forms, together with the *extractum carnis*, a complete diet, and that this combination has the same effect as a meat meal. In order to verify this conjecture, Bischoff has fed dogs upon bread, and has observed the result of the addition of *extractum carnis*. The conclusion arrived at was, however that the latter had very little influence. Whether it be added or not, animals fed on bread decrease in weight, and on this diet cannot be made to live very long.

STORER'S IMPROVEMENTS IN DIRECT-ACTING STEAM ENGINES.

FIG. 1.



STORER'S IMPROVEMENTS IN DIRECT-ACTING STEAM ENGINES.

THIS invention, patented by John Storer, of Peekskill, New York, U.S., relates to certain improvements in that class of direct-acting engines in which the valve's motion is effected by the action of the pistons working in the main steam cylinder, and in a pumping or blowing cylinder connected therewith upon a tappet rod or pin which projects through the heads of the said cylinder and controls the valve motion of an auxiliary cylinder, the piston-rod of which is connected with the slide valves of the main steam cylinder. The improvements consist in the arrangement of an adjustable slide in combination with the lever which transmits the motion of the tappet rod to the slide valve of the auxiliary cylinder (and which may be termed the valve lever) in such a manner that the time occupied by the motion of the said slide valve can be accommodated to the velocity of the motion of the main piston or pistons, and that the said main piston or pistons can be kept from slamming against the heads of their cylinders. Also in the arrangement of a friction clutch in combination with the valve lever and adjustable slide, in such a manner that the said lever is permitted to follow the motion of the tappet rod after the valve of the auxiliary cylinder has completed its stroke, and injury to the mechanism is prevented. Further, in the arrangement of a double exhaust in the auxiliary cylinder, which controls the valve motion of the main steam cylinder in such a manner that the exhaust from either end of the said cylinder can be easily regulated, and the valve motion can be rendered easy. Also in the arrangement of a rubber cushion secured to the valve rod, and acting against stationary plates provided with corresponding sockets in combination with the valve motion of the main steam cylinder, in such a manner that the slide valve or slide valves of the said main cylinder are kept from slamming if the engine is worked rapidly. Further, in the arrangement of a gauge secured to the head of the main steam cylinder, or to that of the blowing or pumping cylinder, in such a manner that the distance between the piston or plunger when it reaches either end of its stroke and between the cylinder head can always be observed, and the valve motion can be regulated in time to prevent injury.

Fig. 1 represents a longitudinal section of this invention; Fig, 2 is a transverse section of the same; Fig. 3 is a detached longitudinal section of an auxiliary cylinder which controls the motion of the slide valve or slide valves of the main steam cylinder; Fig. 4 is an end view of the same.

FIG. 2.

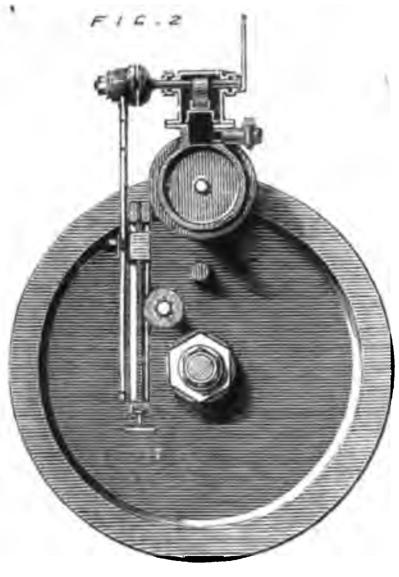


FIG. 3.

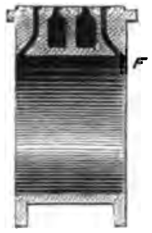
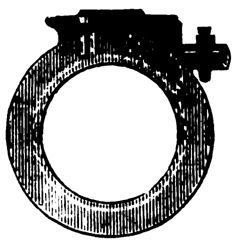


FIG. 4.



WRIGHT'S IMPROVEMENTS IN PADDLE WHEELS.

THE objects of this invention (patented by Lemuel Wright, of Brooklyn, U.S.), are to prevent concussions as the buckets of the wheel strike the water, to avoid the swell or sidewise wave from the paddle wheel, and to lessen the lifting of water as the buckets leave the same. These objects are attained by placing the buckets diagonally (at about 45°) to the axis of the shaft, and arranging them in ranges or rows around the wheel, the buckets of one range standing at an opposite inclination to those of the next range, and the buckets of one range placed intermediate to those of the adjoining ranges. In the drawing *a* is the shaft of the paddle wheel; *b b* the arms connected to the shaft *a* and to the rings *d* in any suitable manner, and to these arms the buckets *c* are attached, the whole composing the paddle wheel. These buckets are to be arranged in two, four, or more ranges or rows rimming the wheel, each range standing at an opposite inclination and each bucket in a position dia onal to the axis of the shaft and intermediat t the buckets of the adjoining ranges. The diagonal position of the buckets should be about 45° to the vertical planes of the rims or arms to which they are attached. By reference to Fig. 2 it will be seen that by placing the buckets in the diagonal position above-mentioned, and by making the inclination of each range of buckets run in an opposite direction, each of said ranges forms a section of a many-threaded screw, one range corresponding to a right-handed screw and the next to a left-handed screw, and the buckets of one range standing intermediately to those of the next range, the water, instead of receiving a backward movement as soon as struck by the buckets will be thrown against the buckets of the next range, increasing the resistance or hold of the buckets on the water, preventing the side swell in a great measure, and finally passing the water directly to the rear. The outer ends of the buckets are shown as projecting beyond the edges of the arms or rims of the wheel, and each bucket, coming to a sharp point. Instead of being so formed they may be made with a circular or straight outer edge, as shown at *f g* by dotted lines, Fig. 1, or if desired the buckets might be flush with the rims of the wheel. A paddle wheel made in the manner above set forth possesses many advantages over the wheels heretofore used

FIG. 1.

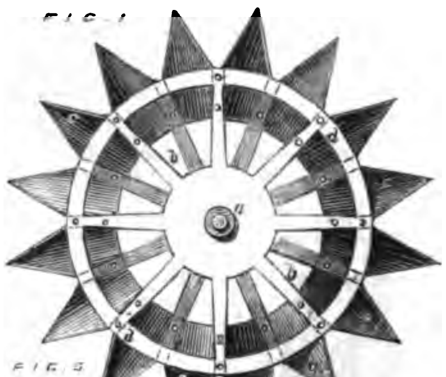
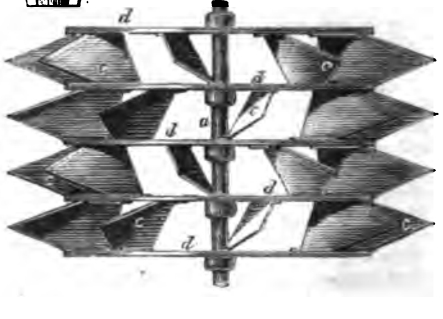


FIG. 3.

FIG. 4.

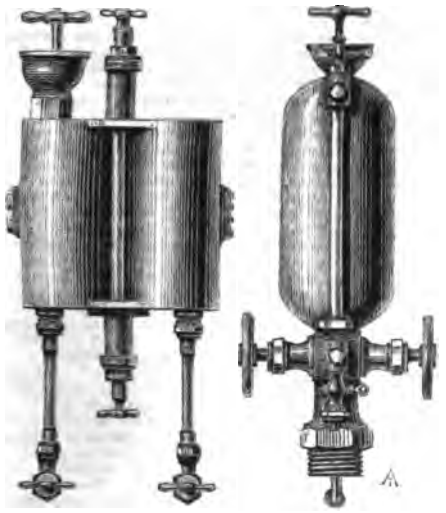
FIG. 2.



The diagonal position of the buckets prevents concussion as they enter the water, and gives to each of the buckets the properties of a section of a screw, so that each bucket commences to take a hold upon the water at the point of entering, and continues during its entire passage through the water to act against the water, and during the latter part of its passage very little or no water is lifted, and as the lateral tendency of the water as thrown by the buckets of one range is counteracted by the next range of buckets, the water is passed directly to the rear, and the heavy side swell caused by the ordinary paddle wheel is avoided. The wheel acts equally well or nearly so when going in either direction, and the wheel may be immersed to a greater extent than the paddle wheels heretofore made without injuriously affecting the same, thereby increasing the hold of the wheel on the water, and the paddles are not liable to be injured by the waves.

CLEMENTS' ECONOMIC LUBRICATOR.

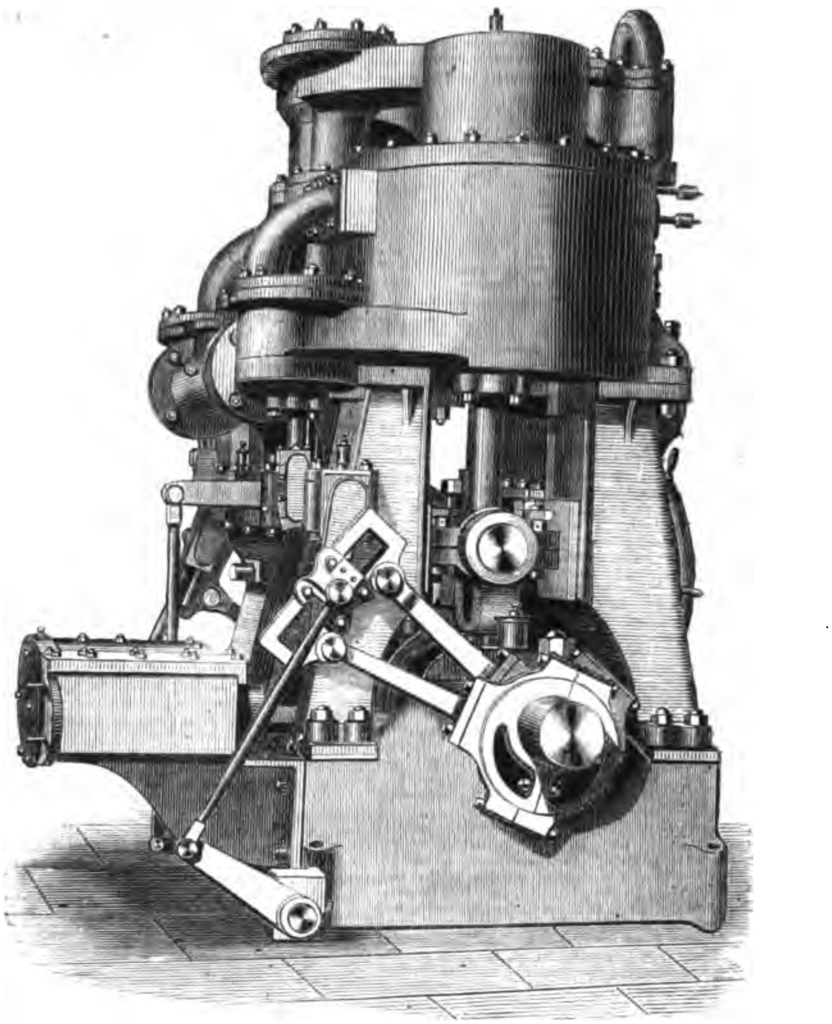
We illustrate Clements' economic lubricator, now so well known that it scarcely needs our description, but as the makers, Llewellins and James, of Bristol, have latterly so modified and improved it as to make it of more general adaptation, we have thought fit to notice it here. This steam lubricator, or impermeator, we believe to have been the precursor of the many now before the public. It was first introduced some years ago in the A form, with a hollow or curved back, as shown in our left-hand illustration, so that it might be fixed against the steam pipe by means of a band; the advantage in this being that the heat from the pipe always keeps the grease in a fluid state. Latterly, however, the forms have been varied so that it may be used in any position, vertical or horizontal, and either for marine, stationary, or locomotive engines, one of which—the C form—we illustrate on the right hand. To briefly describe the lubricator, we may say that A is the body or grease vessel, to which is attached a gauge glass E; C is the charging valve; D the air vent; P is the steam inlet which rises to the top of the grease vessel, and G is the grease outlet, which has an elongated perforated stem to project into the steam way, and H is the blow-off valve. There is the advantage of simplicity about this instrument, and we may remark that screw valves are used instead of plug-cocks, which are not so easily regulated, and are more liable to leak.



PROCEEDINGS OF THE ROYAL ASTRONOMICAL SOCIETY.

At the meeting of the society (W. Lassell, Esq., in the chair), on the 8th inst., only three papers were communicated—one from Mr. Hind, giving an account of an investigation recently made by Mr. Plummer on the orbit of the comet of 1683, another from Mr. Tebbutt, jun., of New South Wales, on the lunar eclipse of January 17, 1870; and the third from Mr. Birt, giving his result of the observations on the lunar crater, Plato.

Mr. Hind said that attempts had been made to represent the path of the comet of 1683, both by a parabolic and an elliptic orbit, the former by Halley, and the latter by Dr. Claussen. Dr. Claussen's investigation had led him to conclude that the comet moved in an ellipse of 189 years' period, and that consequently the return of the comet might be expected about the year 1871; but the computations of Mr. Plummer did not lead him to a similar result, but tended to show that a parabola represented the observation with a greater degree of accuracy, and that there was no reason to believe that the comet would return to the neighbourhood of the sun in a few years.



PERKINS'S HIGH PRESSURE ENGINE.—(Described on page 106).

Mr. Tebbutt's observation of the lunar eclipse contains very little information peculiar to lunar eclipses. The effects of the penumbra were strongly marked, and the usual copper colour of the shadow was noted, which colour was also noticeable on some light clouds in the vicinity of the moon. The occultations of several stars of the seventh, eighth, and ninth magnitude were observed, and the times of disappearance and re-appearance given. The telescope employed was of 3½-inch aperture, with a power of about 30.

Mr. Birt gave the results of a twelvemonth's watching of the crater Plato, with a 9-inch refractor. The result has been to observe and map many spots on the floor of Plato, hitherto unobserved, with the changes that have taken place in their number and position, and Mr. Birt expressed his intention of continuing to observe the moon, which he had little doubt would lead to valuable results.

The President then observed that there was a possibility that Government would furnish a ship, similar to the Himalaya, perhaps the Himalaya itself, to carry observers to Spain to observe the total eclipse of December 22, 1870; but before any certain result could be obtained, it was indispensable that the society should know how many gentlemen contemplated a voyage, and what accommodation would be required, and what instrumental means the intending observers could command. Xeres, Syracuse, and Oran (on the African coast), appeared to be the stations that offered the greatest facilities. Oran, on French territory, could be left to the astronomers of that nation; but Gibraltar being the seat of an English garrison, it was desirable that the English should send observers to that port. To supply effectually all the departments of astronomy, and to employ a complete set of instruments, about twenty observers would be needed at each station. The President concluded by inviting observations and discussion on this interesting subject from those Fellows present, and announced that a circular would be despatched to warn other Fellows who were not present, but who were likely to take part in the expedition.

The Astronomer-Royal, who rose amid some applause, said that though he was not in the confidence of the Government, he might open the discussion the president had invited by pointing out the probable assistance the Government would render. The Astronomer-Royal briefly traced the course the moon's shadow would take on the earth's surface. It would not touch any of the Atlantic Islands, Cadiz and the neighbourhood of Gibraltar being the first possible observing station. Gibraltar offered considerable advantages, being on British territory, easy of access, and possessed of considerable matters of interest. Oran and its neighbourhood, which was likewise an important station, could in safety be left to the enterprise of the French. Afterwards the shadow rests on Sicily, and passes over Syracuse, a locality that the Astronomer-Royal had never visited, and he was unprepared to say what accommodation Syracuse could afford. From Sicily the shadow passes over a desolate part of Greece, over the Black Sea, over the Crimea, and midway between Balaklava and Sebastopol. To what part of this line individual enterprise might carry individual observers, Mr. Airy could not undertake to say. The result of the inquiries he had set on foot was that the Government would give no assistance in money, but possibly a vessel might be allowed to carry observers as far as Gibraltar or Oran, as the observers might of themselves decide, though possibly Catania, on the eastern side of Sicily, might offer better chances of transparent atmosphere than elsewhere. Mr. Airy did not think it desirable that a part of the observers should be left in Spain, and the ship employed in carrying the remainder to Sicily, not on account of the delay in time to the ship, but the delay occasioned to the observers, being left a week sooner than needful, and detained a week longer after the eclipse, before the vessel could return for them. Mr. Airy conjectured that the peculiar season of the year (the winter solstice) would deter many from going, though he had no doubt that those who faced the storms of the Bay of Biscay, and the probably unpleasant passage, would be well rewarded by the sight of the eclipse. Mr. Airy insisted, in the most positive manner, on knowing the number of persons who intended to take part in the expedition, as no positive answer could be obtained from the Government till such data had been furnished as a basis for further progress. The Astronomer-Royal then treated of the subjects of observation during the eclipse, and the necessity for organisation of the observers, more especially as the time of total obscuration was short. Mr. Airy had no doubt but that the "Corona" would receive the greatest degree of attention from all observers; and, to anyone who intended to make observations of it, a knowledge of the phenomena of polarization was indispensable; and it occurred to him (Mr. Airy) that on this point there was a great amount of ignorance, and, before organizing a band of observers to use the polariscope, it would be necessary to teach them how to use it, or at least to examine if they were competent to observe with this instrument, none being more capable to give information on this point than Professor Stokes. With regard to favourable weather, Mr. Airy would take the opportunity to ask those present who were acquainted with the climate of Gibraltar, by experience, to favour the society with their opinions, and begged to introduce to the attention of the society,

Lieutenant Brown, who said that, being called upon unexpectedly, he could not furnish the society with accurate information, though the general impression on his mind, derived from a stay of six winters in Gibraltar, was that the season of the year was eminently favourable, and that, had astronomers the power to choose the time of the year most favourable for witnessing an eclipse, their choice would probably have fallen upon the month of December. As a photographer, he remembered that the lights and shades of his copies were not so strongly marked as in the summer months, but were beautifully soft. He doubted whether Gibraltar could find accommodation for such a large party as would probably visit it, but Xeres could accommodate a portion, and there were plenty of gentlemen of sufficient love of science a

Gibraltar who would be pleased to make the necessary arrangements to receive the deputation of astronomers.

Admiral Ommaney coincided in the remarks that had fallen from Lieut. Brown, and believed Gibraltar preferable to Syracuse, and could afford sufficient accommodation

The President was very gratified to hear an opinion so favourable from such eminent authorities, and although he had been of a different opinion, he yielded most willingly to those of greater experience.

Mr. Warren de la Rue called attention to the necessity of observing with the greatest accuracy the corona, which might consist of two or three phenomena, and he trusted that the attention of astronomers would be given to that portion of the corona between the prominences, which had always been seen very brilliant. Mr. De la Rue conjectured that this belonged to the sun, as the advance of the moon covered some of this brilliant portion, and disclosed others. but any doubt on the subject he trusted, would be cleared up by attentive observation.

Mr. Vignolles informed the society that he had learnt from the Vice-President of the Cortes that he (the Vice-President) would be very happy to render all the assistance in his power to astronomers that should visit Spain on this occasion, either in providing accommodation, or conveying them into the interior.

A Fellow asked what length of time would probably be consumed on the journey, and in making the necessary observations; and whether there would be any attempt at organisation, or each observer left to carry out his own design in the manner that seemed to him best?

The Astronomer-Royal replied, judging from the experience of former eclipses, a month would probably suffice, and that a complete organisation was desirable. In the eclipse of 1860 this organisation was effected on board the Himalaya, but if intending observers sent in their names and instrumental means, such an organisation might be effected sooner, which was desirable. Mr. Airy said that among the instruments of the Royal Observatory were three 6in. refractors, and four 4in., which he had no doubt the Government would allow him to put at the command of competent observers.

Mr. Huggins remarked on the organisation of spectroscopic observers, that as the time was short, it would be advisable to divide the complete spectrum between two observers—one to scrutinise for bright lines on the less refracted half, and the other for bright lines in the more refracted half of the spectrum. This only referred to the portion of the corona nearest the sun, alluded to by Mr. De la Rue. For the corona more distant, a spectroscope might be employed that should show the whole of the spectrum at one view; and, further, he thought it necessary that each spectroscope should be furnished with three observers—one to look through the instrument, another to direct the instrument at the desired portion of the sun, and a third to write down the observations: two spectroscopes being required to examine the prominences, two for the corona between the prominences, and one for the distant part of the corona, making in all five instruments, and fourteen observers, or manipulators, for each station.

Colonel Strange offered a few remarks upon the necessity of examining the observers in the peculiarities that polarised light presents, observing that if the eclipse took place next week, very few observers would be found capable of observing the phenomena—an opinion in which the society coincided, and he concluded with a few remarks on the connection between astronomical observations and general science and knowledge.

In answer to a question from the President, Mr. De la Rue replied that the number of manipulators required to manage the photographical department would be five, one principal, and four assistants. Hence for the spectroscopic and photographic observations alone, nearly twenty observers are required at each station.

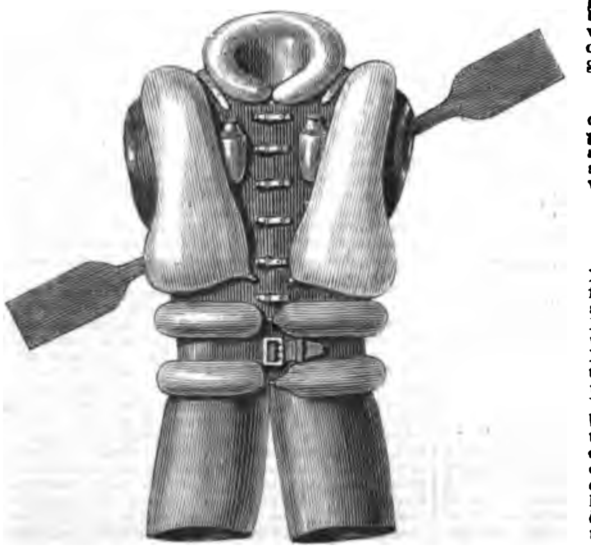
The meeting concluded with some remarks from Mr. Watson on the geographical structure of the moon, which being an abstract theory unsupported by facts or observations, offers little of interest.

MR. J. NORMAN LOCKYER ON THE SUN.

On Saturday, the 9th inst., Mr. J. Norman Lockyer, F.R.S., delivered his fourth and closing lecture at the Royal Institution, on "The Sun." In the course of the lecture he observed that when the flame of a common candle is examined in the same way that the sun is observed with a spectroscope, it is found that when the flame is in any way disturbed, gases of different kinds are thrown out from its interior towards its exterior. In like manner, when from any cause disturbances are set up in the sun, there are storms or outbursts of luminous iron, magnesium, barium, and other vapours. It is evident, therefore, that there are layers underneath the external envelopes of the sun, portions of which layers become visible to us whenever there is the least disturbance. Spots being depressions in the external envelopes of the sun, it follows that an examination of the solar spots brings the astronomer nearer to the centre of the sun than does the observation of any other part of the orb. On examining the spots with a spectroscope, a general absorption of the rays of all parts of the solar spectrum is seen, as well as a selective absorption, the latter being especially noticeable in the so-dium lines, and the greater the pressure of the sun's atmosphere the thicker are these absorption lines. In order to prove that increase of pressure, without variation in temperature, broadens the absorption lines, Mr. Lockyer threw upon the screen a continuous rainbow-like spectrum of the electric light, the dispersion being produced by means of two hollow glass prisms filled with bisulphide of carbon. Just outside the slit of the electric lantern the light was made to pass through a glass tube filled with attenuated hydrogen gas; the tube contained also a lump of metallic sodium. Heat was applied to the bottom of the tube, so as to gradually vapourise the sodium, and the vapour was at first, of course, densest near the bottom of the tube, rather than at the top. The vapour intercepted none of the rays of the spectrum, except a portion of the yellow, consequently a dark band was cut in the yellow part of the spectrum upon the screen, but this band was thickest where the light had previously passed through the denser portions of the sodium vapour. The appearance of this tapering dark line consequently proved that where the pressure of the sodium was densest, it broadened the dark line in the yellow of the spectrum. Thus the broader the sodium absorption lines produced by a sun-spot, the greater is the pressure and quantity of the sodium atmosphere over that spot. There are now many large spots upon the solar disc, and it is a very curious fact that they give scarcely any absorption in the yellow part of a spectrum, showing thereby that the spots are not alike at all times. There are, in the ordinary solar spectrum, bright lines as well as dark ones, and he thought that these would be found to be the most unchangeable lines in it, for the dark ones are constantly varying. The yellow line, so often seen in the spectrum of the solar prominences, was once surmised to be a line belonging to hydrogen gas when the gas became luminous under certain very unusual conditions, but after many experiments with hydrogen, tried by Dr. Frankland and himself for more than a year, they were unable to make the luminous gas produce any such line. It was only on the previous Saturday that, while he (Mr. Lockyer) was examining the spectrum of a solar prominence, he saw the bright hydrogen lines of the prominence disappear almost entirely, while the yellow line retained its full luminosity and length. It would appear, therefore, to be certain that it is not a hydrogen line; neither is it a sodium line, for it does not fall at the right part of the yellow of the spectrum. Probably this perplexing line is due to some new substance common in the sun, but not yet known upon earth. A very valuable paper on solar physics, once communicated to the Royal Society by Messrs. Balfour Stewart, De la Rue, and Loewy, set forth that the photosphere of the sun might be considered to be a plane of condensation, and any changes in the pressure of the plane of condensation will cause very considerable changes to take place in the spectra observed. For example, when the pressure of the plane of condensation of a common candle flame is reduced by the aid of the air-pump, a halo of blue light begins to spread outside the flame as the pressure is diminished, and at last the candle flame will give the spectrum of nearly pure carbon. The F line of hydrogen varies very much when the pressure is reduced, so this line is a very delicate indicator of the pressure of the atmosphere of the sun. Light is composed of waves varying in length, so that when a prominence bursts out upon the sun, and in the direction of the eye of the observer, more waves are thrown into the eye in a second of time; if, on the other hand, the prominence be receding with a velocity at all comparable to that of light, the waves will be lengthened out, and a smaller number will enter the eye in a second. This variation in wave-length caused by the rapid motion of solar flames produces zig-zag and irregular lines in the spectrum, and by measurement of the deflection of the bright lines from their normal position, the velocity of motion of portions of the solar prominences may within certain limits be determined. The flames often rise or recede with a velocity of from 50 to 100 miles per second, which, considering the size of the sun, is not a very excessive rate of motion. It seems as if the chromosphere is the outer limit of the sun, for very little absorption takes place outside it, and there is evidence that the absorbing atmosphere of the sun and the photosphere begin together. As to what is below the photosphere, spectrum analysis gives no information whatever, and he thought that in a sun-spot astronomers never get below the photosphere; he considered the spots to be purely surface phenomena. The photosphere may be gaseous, cloudy, or even liquid, but certainly is not solid. He did not know the origin of the continuous spectrum of the sun; a continuous spectrum may be thrown by dense luminous gases, as well as by white-hot solids; but it is consoling to be aware that it is equally unknown whether the continuous spectrum of a candle flame is due to solid, liquid, or gaseous matter. He would close his lecture with a few general remarks about the nature of the sun. The sun, after all, is nothing but the nearest star; it is also a variable star, for the spots upon it, as proved by observations extending over the last 50 years, are very plentiful at some periods, and very scarce at other periods; the interval between two maximum periods or two minimum periods, is about 11 years. We are now in a maximum period. There is also some connection between the spots on the sun and the sun's family of planets, for the positions of the planets, more especially of Mercury and Venus, have an influence upon the area of the spots on the sun. The sun cannot be a ball of fire, for if it were it would burn itself out in a ridiculously short space of time, and there is reason to suppose that it is a hot globe now slowly cooling. If we accept the hypothesis of Laplace, that the sun was formed originally by the condensation of a tremendous nebula, it is not difficult to imagine that it is now slowly cooling; and as it had an enormous initial temperature to start with, the cooling will go on through untold ages, until at last, having absorbed all its surrounding planets into its mass, it will in the end roll through space a cold dark ball. Afterwards, perhaps, it may clash against another dark ball like itself, and the force of the blow may be proved by calculation to be sufficient to generate light and heat, a new sun, and other worlds.

RIHOUX'S IMPROVED LIFE-PRESERVING DRESS.

The invention, patented by Emile Rihoux, of Paliseul, Belgium, has for its object the supplying shipwrecked people and others with a means of keeping themselves afloat, and, moreover, has the advantage of overcoming the difficulties at present found in life-preserving dresses made of india-rubber, gutta percha, or like material, as it does not impede the movements of the wearer or stop his natural perspiration.



The invention consists in making dresses of india-rubber, gutta percha, or other waterproof material, provided with cushions which form separate and distinct receptacles or reservoirs, and which are filled with air, and suitably arranged and adapted to the human figure, there being no communication between the receptacles, so that if by any accident one should be injured the safety of the wearer would not be jeopardised, as the other receptacles would still be sufficient. In addition to the dress, an air-tight chamber or chambers, made of the same materials and on the same principles, that is to say, in separate and distinct compartments, may be provided and made of such a shape that if necessary the wearer of the dress may sit on it and move himself about by means of an oar. The dress and the riding chamber lastly described may be made of india-rubber, gutta percha, or other waterproof material, and may be provided with pockets for carrying anything that may be necessary.

LETTERS TO THE EDITOR.

[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]

⁂ All communications should be addressed to the Editor of the English Mechanic, 31, Tavistock-street, Covent Garden, W.C.

All cheques and Post Office Orders to be made payable to J. Passmore Edwards.

I would have every one write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that, as to other things, knows no more than what everybody does, and yet to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks: a vice from whence great inconveniences derive their original.—*Montaigne's Essays.*

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VOICING WOODEN ORGAN PIPES.

Sir,—I feel very strongly tempted to follow the example of a certain chickabiddy who resides in my neighbourhood, and "crow." About a year ago I related that I had heard organ *wooden* pipes so skilfully voiced that I could not distinguish their sounds from those uttered by metal pipes; and, notwithstanding my testimony was corroborated by another correspondent who heard the trumpet calls alternately performed on a wooden trumpet and on a brass one without being able to distinguish "t'other from which" by their difference of timbre—perhaps the most severe test which is possible to apply to two pipes, and pretty clearly demonstrating that the difference of their timbre depends much more on their voicing than on their material—I say that notwithstanding all this, I, being only an ignorant, humble amateur, was duly snubbed by professional authority: but, *Magna veritas*, &c., which has been translated for the benefit of us *un*classical blacksmiths, &c., by the quaint author of "The Mechanic's Saturday Night," to mean "Truth is great and will pre*v*ail a bit." Being in no great hurry, I could well afford to wait until truth did pre*v*ail; and I now have the reward of my patience in the testimony of no less an authority than that of our "Adept"—N.B. I don't think even Mr. Kemble will dispute his statement on this matter—that by making a pipe with a circular mouth, bevelled from within, we can obtain from it a tone so clear and bright that it surpasses that of the ordinary metal pipe. It even "took in" a *practical* organ builder—I do so like to see the practical knowing ones "taken in"—see "Adept's" note to his article in p. 533, No. 255, after reading which I was sorely tempted to cry "Cock-a-doodle-doo;" but in mercy to Mr. Kemble and the rest of the weaker brethren I forbear to utter so offensive an *Io pæan*, only begging them thankfully to look this very valuable "gift-horse" in its "mouth," and to forbear from showing their own teeth at what may tend to save us part of the cost of organ construction by enabling them to substitute cheap wood for that dear metal which is, or ought to be, tin, and, alas! costs a good deal of our tin.

The Harmonious Blacksmith.

P.S.—If Dr. Ussher has not quite deserted his first love—*i.e.*, pipes, and gone over to the enemy—viz., a reed shaken by the wind, perhaps he will say a word for clear bright tone from wooden pipes at moderate cost?

ACHROMATIC TELESCOPES.

Sir,—Will "F.R.A.S.," Mr. Webb, Mr. Proctor, or any other adept, inform me if I can obtain any printed account of the performance of Mr. Buckingham's 21½in. refractor; also that of the 25in., made by Cook for Mr. Newall? If these deserve the title aplanatic Mr. Webb's suggestion to put a new OG to the great tube at Wandsworth might be improved on by making the new OG as large as the old one, and the flint glass thick enough to bear grinding to the required depth to produce the needful curves without making a great hole in its centre, which required a *black* patch bigger than the top of my "chimney pot"—I mean elegant artistic hat—fashion compels me to wear. For Mr. Webb's account of this monstrous abortion I respectfully tender him my sincere thanks. Well might "F.R.A.S." say, in his extremely neat manner—when he perpetrates a jest it is invariably a good one—that he trusted this telescope was something very much "out of the common." Such a vile OG is to me an ogre; but, surely, the tube and the tower may be utilised for another OG of equal diameter, and such apertures, besides their value for sidereal astronomy, could we find a place to use them in which the stormy winds do not blow, ought to enable us to see "the man in the moon," presuming he is "at home," which, considering he can have no present duty to perform towards our "free and independent electors," he probably may be, unless, indeed, his customary search after such of the inhabitants of his native satellite who have strayed to the earth—see the book entitled "De Lunatico Inquirendo"—occupies the whole of his time, and compels him, like other ambassadors, to *lie* abroad for the good of his country from the time of one general (parliamentary) election until the next, when the calls of duty must become so onerous to him that he is not likely to agitate for the repeal of the septennial act in favour of annual parliamentary elections. The Harmonious Blacksmith.

PLATINISED GLASS SPECULA FOR REFLECTING TELESCOPES.

Sir,—I am informed platinum, when polished, reflects a larger proportion of incident rays than silver, and that it can be deposited in thin films; the existing manufacture of what are termed platinised looking glasses is sufficient proof. A silvered mirror is perhaps yet more liable to become tarnished by atmospheric influences than one of bronze or speculum metal, but platinum does not readily become tarnished, which liability is one of the greatest objections to the employment of reflecting telescopes, so I would respectfully ask Mr. Purkiss, "F.R.A.S.," Mr. Webb, and others who are acquainted with reflectors, if there is any practical objection to coating glass specula with platinum instead of silver, and if there be none, how best to do it? I presume, laying it on with a brush, and afterwards heating the specula, as if it were a fictile production, which is the process employed for so called platinised looking-glasses, would not be applicable to specula, for I fear it might *slightly* alter their form, and not be conducive to correct definition.

The Harmonious Blacksmith.

THE VIBRATION OF THE BELLIES OF VIOLINS.

Sir,—"E. P.," p. 357, Vol. X., says that I have overstated the mark when I wrote that the belly of a violin could *not* vibrate *upwards* without overcoming the downward pressure of its strings. Now as this *downward* pressure never ceases, because the strings of a fiddle vibrate *horizontally* and remain deflected *vertically* while they are vibrating, I think "E. P." will, on further consideration, see that the upward vibration of the belly *must lift* the bridge, and of course the strings which are resting on it.

The fact that the belly is propped up by the sound-post no more relieves it from the downward pressure of the strings than a plate of lead on the top of a column is relieved from the pressure of the superincumbent weight by the column beneath it. The sound-post is simply a column which props the belly, and transfers the downward pressure of the strings to the back of the instrument (the belly being squeezed between the top of the sound-post and the bottom of the bridge); but this is not relieving the upper surface of the belly from downward pressure, but only enabling it to support that pressure with less distortion. The Harmonious Blacksmith.

COMBINED DRILL, REIMER, AND TAP FOR GAS MAINS.

Sir,—On page 473 is the representation of a drill, reimer, and tap combined, or formed of one piece of steel, to which your correspondent "Machinator," p. 508, very reasonably objects that it would be drilling, reiming, and tapping at once, and be broken in the attempt to use it. The idea is so good, that it is worth carrying out, and this may be done by the very simple expedient of getting rid of the reimer, which is between the drill and the tap, for if the latter be the proper size for the former, it is obvious the hole it makes cannot require to be reimed, but if it be desired to retain the reimer, to compensate for the workman's want of care, who might grind the drill until it became too small for the tap, and induce the breaking of the latter in the hole, all that is needed is to form a cylindrical neck the same size, or rather a trifle smaller than the largest portion of the reimer, between it and the tap. If this neck be as long as the thickness of the pipe which is drilled, the reimer must finish the hole before the tap can enter it, and there will be no danger of breaking the latter from the hole being too small for it. I need hardly add, that the drill ought to be long enough to perforate the whole thickness of the pipe *before* the reimer enters the hole, or there will be a jam.

The Harmonious Blacksmith.

BLUE MAHOE AND OTHER WOODS FOR FISHING RODS.

Sir,—In the *Field* of March 28, a correspondent states he has a fly-rod made of the above wood, which, he says, is at once light, stiff, tough, and very elastic. This combination of qualities renders it especially suitable for fly-fishing rods—indeed for many other purposes. The undersigned would be greatly obliged by being informed where it can be purchased.—Query, can this wood be the blue mahogany of Jamaica?

I have had considerable experience as an amateur fishing rod maker, and I have found the most elastic material yet tried, to be logwood. Hickory, lancewood, greenheart, and ash, are commonly employed, and, next to logwood, their elasticity is, I think, in the following order: lancewood, greenheart, hickory, ash. Logwood, although the most elastic of all, has the great defect, for careless fishermen, of being very brittle; it will not bear rough usage. Lancewood is much tougher, but is heavy, nevertheless it makes excellent top joints, and for short rods, not exceeding ten or eleven feet in length, excellent middle joints also. Greenheart has come into extensive use of late years, especially for salmon rods, but it is more brittle than lancewood, and, I think, yet heavier. It may do very well for our President of the Board of Trade, yclept stout John Bright, and other athletic salmon anglers, but I do not like it for a light trouting rod; yet less for dace whipping.

Well selected heart of hickory makes a very fair fly rod, but it is not so elastic as lancewood (not to mention logwood); it has, however, that desirable quality for careless anglers, *toughness*, and of some kinds of ash, very good fly-rods may be made, especially the French ash, imported for billiard cues. Major Grant, whose apparatus for military cooking excited so much attention a few years ago, and who is an enthusiastic salmon fisher, prefers his ashen salmon rod to any other he possesses, he having used it for several seasons in Norway with great satisfaction, but I suspect its good proportions have more to do with its excellence than its material.

I have been told, very good fly rods may be made of mountain ash, also of wych elm and of hazel, but having no experience of those woods, I cannot form any confident opinion of their merits. I doubt if they are so good as the woods commonly used. According to the *Field's* correspondent, blue mahoe wood is far superior to them all, and is not heavy, a very important consideration in a long rod in the hands of "our weaker brethren" of the craft; indeed I esteem lightness of so much importance, that I had a rod made, whose top, nearly five feet long, was a finely grown and moderately taper piece of North Carolina cane, with about a foot of split jungle bamboo forming its point. The middle joint of this rod was also of North Carolina cane, and its butt was made out of an ashen billiard cue. It was nearly sixteen feet long, and so light, that it might be used with one hand. It answered admirably for throwing a long line when chub whipping, but its action was not so regular as that of a well made solid rod, probably because the maker had not a sufficient stock of North Carolina cane of large diameter to select the middle joint from, for it hardly tapered enough—*i.e.*, had rather too much action at its larger end, where it entered the butt. This is a very common defect in fly rods, especially those made in Ireland, and if an advantage when playing a heavy salmon, is far from advantageous when throwing a long line for chub in the river Lea, when you are compelled to throw right across the stream.

The Harmonious Blacksmith.

INCREASE OF INSANITY.

Sir,—There is a question of vast importance which I have not seen discussed in your versatile pages—the increase of insanity in this country.

Although, says a writer, there is some difference of opinion with regard to the cause of it, we can hardly doubt that insanity is greatly increasing in these islands. It would seem as if the worst of all human diseases was liable to grow with the growth of civilization, and as if medical science was impotent to stay its progress. This is what the non-professional observer will gather from certain statements and statistics on the subject, and it is, indeed, admitted to a large extent by medical men in scientific periodicals. Thus, for example, in the *Quarterly Journal of Science*, just published, Dr. Martin Duncan writes that "the cures of the insane in our fine asylums are not more numerous than they were from 1748 to 1814, when the treatment of the insane was a disgrace to humanity;" that "our social state is producing year after year an increasing amount of insanity more than ever difficult of cure;" and, again, that "there is no denying or explaining away the fact of the rapid accumulation of insane persons in all parts of the kingdom." In the *Medico-Chirurgical Review* for this month there is an article on the same subject, in which the writer states that in the course of ten years the number of recorded lunatics has increased 45 per cent., and that the immense additions made to hospital accommodation during the same period "have been fruitless so far as they were intended as means of bringing all pauper lunatics under proper supervision and under the protection of the lunacy laws—a privilege not belonging to workhouse inmates." In proof of these statements the writer adds that while, during the last ten years, asylum accommodation has been enlarged by nearly two-thirds, "yet the lunatics detained in workhouses in 1869 were close upon 3000 more than in 1860. At the same time the pauper insane distributed in lodgings have advanced from 5930 to 6987." Both these journals thus assert the increase of insanity, both declare that the plan of large asylums has proved a comparative failure and is inimical to recovery, and both are in favour of placing pauper lunatics in cottage homes, as is done in some parts of Scotland and at Gheel, but under a careful system of registration and supervision. Dr. Tuke, writing to the *Journal of Mental Science*, arrives in the main at a similar conclusion. He points out the evils of the cottage system as exhibited in Kennoway in Fifeshire, but believes that sooner or later it must be brought more fully into play, and that if improved and elaborated it may be the best way of providing for harmless and incurable lunatics. Neither of these writers holds out to us any hope that the growth of insanity is a temporary evil. Luxury is advancing with gigantic strides, and poverty, with its attendant miseries, grows in a like proportion. Consumption and scrofula, says the *Medico-Chirurgical Review*, are increasing throughout the country. A degenerate state of body tends to produce a weak mind, and the *Journal of Science* affirms that insanity is due far more frequently to insufficient nutriment, to poverty, and to physical deterioration, than to the severe mental strain which is so often demanded in the present day from the upper and middle classes. The increase of lunacy is not to be found among educated men, but is to be traced almost wholly to the pauper class. In proof of this it is enough to state that in the five years ending January 1, 1867, the increase of private patients in asylums was 36, while the increase of pauper lunatics during the same period was 5049. It would seem, therefore, that in proportion as we can diminish the pauperism of the country, we shall stay the progress of the most awful disease which can afflict humanity.

I don't know that a discussion of this question in the pages of the English Mechanic would assist materially in checking the evil so much to be deplored or preventing its extension. Still, if any one could suggest any means whereby this malady could in any way be diminished, he would so far perform a public good. J. H. C.

COTTON SPINNING.

Sir,—I notice with pleasure the remarks of a "Factory Lad" respecting the absence of anything relating to the cotton manufacture in your paper. Certainly a very few things have appeared, but no discussion of any moment has followed, considering the enormous number of persons interested and having to do with the mechanical operations and contrivances connected with this large business.

It is surprising that more has not been brought forward when we think of the number of persons into whose hands your paper falls in the Lancashire and cotton spinning districts, and of how many different notions and opinions about certain matters connected therewith are held among those engaged.

As "Factory Lad" says, it would be a great advantage if some person would give a description of the machines and processes of cotton manufacture, and until such appears perhaps a little discussion may arise from the following question:—A carding engine, whose doffer is 24½in. in diameter, has on a 26-tooth wheel, driving 26 on side shaft, on which is 17-change wheel into 154 on feed roller of 2in. diameter. On doffer end is also 207 through two carriers into 45 on bottom callender, on this 39 into 39 on top callender, both 4in. diameter. Required the draught?

From several publications now before me I find the following rule:—

Multiply the driving wheels on ends of side shaft and doffer together with diameter of feed roller for a divisor; then the driven wheels on side shaft and feed roller with diameter of doffer for a dividend; quotient, the draught.

Is the above rule strictly correct?

Mutual Improvement.

Sir,—"A Factory Lad" is quite correct in his remarks, p. 59, on "Gitche Masite," and the cotton willow and scutching machines. Evidently "G. M." did not understand what he was writing about, or he would not have so confounded the two machines. I can also supplement "A Factory Lad's" statement of the estimation in which the English Mechanic is held in the manufacturing districts; it circulates extensively in the town and neighbourhood of Rochdale, and is patronised by the Rochdale co-operators, at their noble building, the Central Stores, where it graces the tables of their splendid reading and news rooms, and its pages are eagerly perused by many of the numerous members who frequent those rooms.

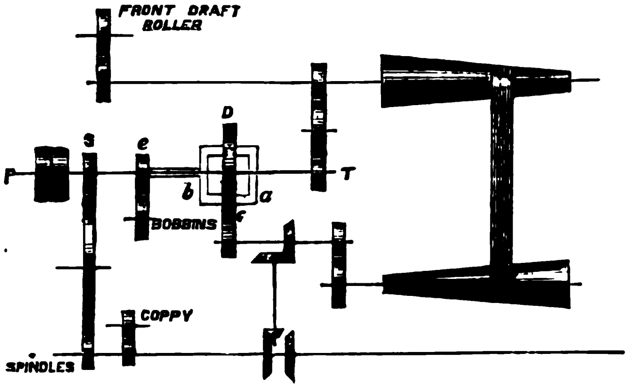
Hitherto matters connected with the cotton and woollen manufactures have been but barely treated of in our journal. With "A Factory Lad," I hope that in future they will receive more notice, and I think our Editor will acknowledge that we may fairly claim for those branches of industry a fair portion of the space set apart in the English Mechanic for mutual instruction. I have seen several questions on cotton spinning which have received no answers, the reason no doubt being that to give the information asked for would make such a demand on your space that persons able and willing to give it have been held back by the consideration that you would not grant the necessary space.

Some five or six weeks ago "Excelsior" asked a question (1927) to which I have not yet seen any reply. He requested an explanation of the working of the cone, sun, and planet wheels, and reversing motion in Higgins' roving frame.

I presume "Excelsior" is sufficiently well acquainted with the roving frame to know that the spindle twists the fibres of cotton together as they are delivered in a band from the draught rollers, that after being twisted the roving passes down one of the legs of the flyer and is wound in a spiral manner round the bobbin in layers until the bobbin is full? The bobbin and spindle both revolve in the same direction, and if they both ran at one speed, "Excelsior" will readily see that there would be no winding on of the roving. To wind on the roving as it is delivered from the rollers we must either run the bobbin quicker than the spindle, or run it slower; or, as we say, the bobbin must either lead the flyer or the flyer must lead the bobbin. Whether bobbin or flyer leads is immaterial to the description; the same mechanism is used for each, the arrangement only being different. We will take the case of the bobbin leading the flyer.

The delivery roller and spindle revolve at speeds which have a fixed proportion to each other, the bobbin revolves at varying speeds because of its varying diameter. As the diameter increases the speed decreases, so that its speed is always equal to the speed of the spindle plus a proportionate speed of the rollers, which additional speed will, of course, be as their diameters are to each other.

For example, suppose the spindle to make 10 revolutions for the roller's 1, and the diameter of bobbin equal to the diameter of roller, the bobbin in that case must make 11 revolutions for the roller's 1; if the diameter of bobbin be increased to twice the diameter of roller, the speed of the bobbin is reduced to 10½ revolutions for 1 of roller, and so on for any other diameter of bobbin. To regulate this varying speed of the bobbin is the office of the cone drums and differential pulleys, or, as "Excelsior" calls them, sun and planet wheels. Besides revolving round their axes the bobbins have an up and down motion given to them by the reversing bevels, by which means the roving is made to traverse from end to end of the bobbin, and is wound in a spiral manner round the barrel; this up and down motion is called th



motion. When one bevel, in gear with the pinion, has driven the bobbins to the top, it is immediately thrown out of gear with the pinion; the other bevel coming into gear at the same time, reverses the motion and causes the bobbins to descend, and so on for each layer of roving as the bobbin fills; the speed of this up and down motion of the bobbin also decreases as the bobbin increases in diameter.

The following rough sketch of the arrangement in Higgins' roving frame will render the matter more intelligible, and enable the motions of the several parts to be traced out.

P T is the driving shaft, the driving pulleys at P are turned by a strap off engine shaft; spur wheel S keyed on same shaft drives the spindle shaft; spur keyed on end of shaft at T drives top cone drum shaft, on the other end of which is a wheel that drives the draught rollers.

It will thus be seen that in the speeds of the spindle and roller there is no variation. The bevel *a* is keyed on the driving shaft, the bevel *b* and the spur *e*, which are connected together, run loose on the driving shaft and drive the bobbin shaft. Communication between the wheels *b* and *a* is by means of the two bevels *c c*, which revolve on studs fixed in the wheel D; the wheel D also revolves loose on the driving shaft and carries the bevels *c c* round with it.

If the wheel D were a fixture, the wheel *b* would revolve at the same speed as the wheel *a*, there would be no variation in the speed of the bobbin, and being geared like the spindle, it would run at the same speed as spindle, consequently there would have been no winding on of the roving, but the wheel D being allowed to run loose on the shaft and receive motion from the cone drums, its speed is regulated by them and communicated to the bobbins.

The top cone drum receives its motion from the end of driving shaft, as mentioned above; this is communicated by means of the strap to the bottom cone drum, and thence to the differential wheel D, which in this case revolves in the same direction as the wheel *a*, to whose speed it adds its own, thus causing the wheel *b* to revolve quicker than the wheel *a*; consequently the bobbin runs faster than the spindle, and winds on the roving as delivered from the rollers.

The cone drums are set out so that they will give speeds corresponding to the different diameters of the bobbin; at each increase in the bobbin's diameter the strap is shifted by a rack the required distance on the drums, the bottom drum is driven slower, and, consequently, the wheel D, which, adding less than before to the speed given out by the wheel *a*, reduces the speed of the bobbin as required.

The reversing bevels, also receiving their motion through the cone drums, are also driven slower, the speed of traverse of bobbin being reduced accordingly.

To "Excelsior's" second inquiry, the best books on the subject are Dr. Ure's "Cotton Manufacture of Great Britain," and Montgomery's "Cotton Spinning," both of which were old; no doubt there are new editions embracing recent improvements in machines. Works of this description he would get by applying to Thompson, bookseller, Market-street, Manchester.

B. W. R.

QUESTIONS FOR MILLERS.

Sir,—Thomas Evans, page 59, quotes my words, "the long spindle will make the stone hang steadier." I certainly should not recommend a spindle 15in. long, for of course if it hangs steadier it will hang more sluggish. Near the centre of gravity is the proper place for the bearing, but I much prefer the crossbar to the universal irons; we tried two or three sets many years since, but found them inferior to the crossbar. A more practical letter than that of Thos. Evans I have seldom seen, and any one following his advice will not be far out, although doctors will differ. I think we millers have had a lion's share of the English Mechanic. I want to see that most important trade "Bakers and baking" fairly represented. I consider they have been left out in the cold much too long. I beg to say in my bake-office the heats of all the liquors were taken with as much care as they are in a brewhouse, and the result was a first-class trade.

R. N. Smith.

THE ORGAN AND ITS CONSTRUCTION.—No. 18.

By An Adept.

Sir,—In continuation of the division of our subject which was treated of in the last communication, on page 533, No. 255, we next come to a form of pipe in which the four sides, instead of being straight, as in those previously described, are formed in the manner represented in Fig. 74, which is a front elevation of the pipe complete; it is to be understood that both front and back are curved in a similar manner to the sides, so that the internal measures are—at the upper surface of the block, 1in. by 1¼in. (being the same as the other experimental pipes), and in the middle at the largest part 2in. by 3in. Some special arrangements are requisite for its manufacture, which must be next described, as otherwise it will be found extremely difficult to construct. Referring to the instructions given on page 410, No. 250, it can be readily understood that the block being cut of the necessary taper, the upper ends of the sides after the first gluing will diverge into a V form; these, after being perfectly dry, are to be treated as represented in Fig. 75, which almost explains itself—the stretcher A it must be remarked is not made in one piece, but of three or four narrow strips, as otherwise it cannot be got out at the top of the pipe after the whole is finished. The means of keeping the upper extremities of the sides in position is shown at B, being simply a piece of ¾ stuff with a notch of suitable form cut into it sideways to the course of the grain, which forms a good and strong clip or temporary fastening with very little trouble. When thus secured into the proper form, the edges are to be planed over, which, from their curved form, is a somewhat delicate operation, and the second and third gluings proceeded with in the ordinary manner as before described; only from the wood forming the front and back of the pipe requiring to be forcibly bent into shape, similar wood clips to that just described are to be used to the number of six or eight along each side, thereby affording a very neat and ready means of retaining the work until the glue is thoroughly hardened; also it will be well to put a slender ¾in. screw into both upper and lower extremities at each angle as an additional security.

The next peculiarity to be noted is the circumstance that in the forms of pipe previously described the passage for the wind was constructed by bevelling either the inner side of the cap or the front of the block, the opposing surface in either case being simply a plane, but in this description of pipe both cap and block are bevelled, as shown in the section Fig. 76, the internal appearance of the cap being represented in Fig. 77. This system of construction is remarkable for the great sonorosity it produces; the pipe itself now before the writer, if struck with the finger nail, emitting a sound resembling that produced by the body of a violin under similar treatment, and the note when sounding being of a singularly penetrating character. It will also incidentally afford a useful lesson on another point—viz., that from the internal area being increased in the manner described, the resulting note will be found to be considerably lower in the scale than that produced by a pipe of equal length and with a similar-sized block but straight sides.

Note.—I consider this one of the most interesting—albeit undoubtedly one of the most troublesome—forms of construction. I can well remember my own first attempt at making a pipe upon the plan, before I knew how to go to work, and even using the method I have described, it will take three or four times the ordinary amount of time and care, but it is nevertheless well worth using where space and labour are of no consequence. The peculiar character and intensity of the note well repays the additional trouble. I trust the description given will be found sufficiently explicit, the greater part having been written during severe bodily suffering.

FIG. 74

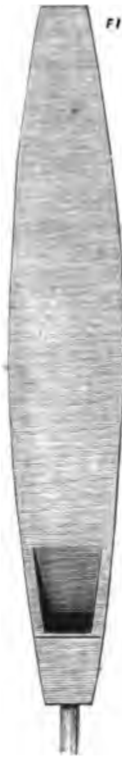


FIG. 75

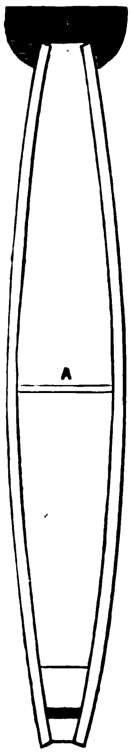


FIG. 76

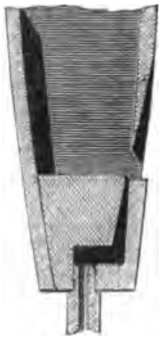
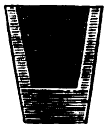


FIG. 77



SLOT-CUTTING REMARKS.

Sir.—I wish "F.R.C.S.," 2439, had sent copy of the question to which he wants an answer. I have only taken the English Mechanic during the past nine months, and if I had the back numbers could hardly be expected to search for it. I should think a modification of the drill used in Shanks's machine for slotting metals would suit, provided a moderate depth only is removed at a time, and the following will describe it with assistance of the sketch Fig. 1. The rod prepared for the drill having been flattened on both sides till only about one-third of diameter remains in the middle, a broad diagonal notch, *a b c d*, is cut with a file, and the faces *a f*, *c e* filed away to clear, and leave keen-cutting edges at *a* and *c*. This tool should take a cut as deep as the diagonal notch itself, which might be a great deal deeper than I have shown in the sketch, for economy of space; and for metal the extreme corners of the cutting angles should be ground off. Such a tool works capitally in iron, brass, or steel; but for them is not filed away at *f a*, *e c*. The tool may be made as shown by the curved dotted lines, as the corners are, of course, too keen for leaving the bottom of the slot smooth, and the feed must be given during the travel of the tool backwards and forwards, and not at the ends of the slot, unless a hole has been bored there first to start the tool into. Both these objections are got over by the use of a half-round bit, Fig. 2, relieved round the back, as shown, so as to make the cutting edge prominent, and running in the direction indicated by the arrow, and I believe this would be found the best tool possible, or nearly so. A friend who has had great practice says a half-round bit is better for drilling holes than any American twisted drill, and I have frequently used them for drilling out of the solid metal such things as rifle-barrels as much as 33 inches long.

J. K. P.

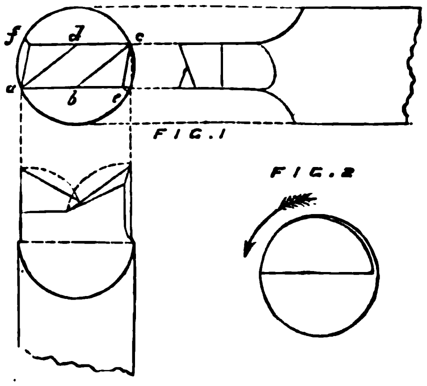


FIG. 1

FIG. 2

EXPLANATORY

Sir,—I must beg those of your readers who have asked questions of me not to look on my silence as discourteous. I am, as you are aware, over-pressed with work in connection with my atlas and other matters, besides the necessary collection of materials for a lecture I have engaged to give at the Royal Institution on May 6th. I do not like to answer questions unless I have full time to consider them in all their bearings, and just now this is not the case.

I salute "F.R.A.S." and sheathe *my* sword also. Every line he writes tells me that he will be the last to misinterpret my anxiety to see in scientific questions the exact facts stated, where possible. When *my turn* comes I shall be ready to welcome cheerfully his criticisms on whatever error I may make.

I am glad to see he has "screwed up" "Veritas," whose numerals were a nuisance. If "Veritas" would only carry his figures to the *locale* commonly assigned to Truth, we should all be ready to obey the old proverb and "let well alone."

Richard A. Proctor.

MR. BEARDSLEY'S DYNAMICS.

Sir,—As I read through Mr. B.'s letter, I rejoiced, saying to myself "How lucky that it requires no answer, being so clearly written by one who does not even know the fundamental laws of dynamics." But, alas! there was that in the letter which required reply. So long as Mr. B.'s ignorance of dynamics only makes him try to stop the earth's rotation, all is well; but when it leads him to teach people how to jump out of a train or carriage in motion, it may be apt to do mischief. Let me beseech Mr. B., if he ever should have occasion to jump out of a carriage in motion, not to leap the way it is going; but the other way. If possible let him jump with all his force from the back of the carriage. He will find that even if he fall (which is likely) the fall will not be severe (he might add the precaution of letting his head come first to the ground); on the other hand, by jumping the way the carriage is moving he will add to the violence of the fall.

It would be a waste of time to touch on his reasoning (save the mark!) about the earth's atmosphere. Galileo laughed away such puerile objections two centuries and a half ago.

R. A. Proctor.

MATERIALS FOR PAPER.—A HINT TO CORNISHMEN.

Sir,—Will you allow me to call attention in your far-reaching journal to a little matter which may be of importance to many people?

There is at present a great demand for materials for making paper, so much so that paper-makers have decided to increase the price of paper ten per cent. I remember some years since, while walking over the immense sand banks between Hayle and Porth Towan, Cornwall, seeing large quantities of tall rushes which grew in profusion on the sand banks. It struck me at the time that these rushes might be collected and made into paper. If so, it would be a benefit to many. It would benefit Cornishmen, who are in rather low water just now on account of many mining operations being abandoned, and it would benefit the community by introducing into the market a new material, which costs nothing in its cultivation, for making paper. I write this somewhat in ignorance of the quality of the fibre required in the material for paper. But I know that the Cornish rushes are tough, and I should think would be just the thing.

A WEST BRITON.

KELSEY'S PATENT WEDGE-DRIVING DRUMS OR PULLEYS.

SIR,—Enclosed I beg respectfully to hand you tracing and short description of my patent wedge driving pulley.

On reference to the illustrations it will be seen that these pulleys are intended for transmitting power by means of wire ropes, the rope being held firmly between the sides of the pulley, and thus preventing a "slip," a difficulty hitherto felt by colliery engineers and others whose operations rendered the use of wire rope necessary. These pulleys are extremely simple in construction, and consist of two loose discs, an internal wedge-ring, and a boss, or nave, divided in the centre transversely, all the castings being of an ordinary and inexpensive character. Fig. 1 is a section, and Fig. 2 a side elevation. The two discs are made with an angular recess on the inner face of each, and the centre holes are cast slightly curved transversely, and made to fit with ease the octagonal boss. The internal wedge-ring is made with a straight point, the periphery being concaved to receive the rope, and, in order to allow for wear upon the latter, the point is also made of less thickness than the diameter of the rope. The nave or boss is provided with a flange cast on each end, which flange is for the purpose of retaining the disc in position. The nave is faced and bolted together and bored out to fit the driving-shaft, to which it is secured by means of two short keys, driven from each end. The action of the pulley is brought into operation by means of the pressure of the rope being thrown, on one side of the pulley, upon the internal wedge-ring, which is thereby forced against the inclined faces of the recess in the discs on the other side of the pulley, the result being that the discs are driven apart on the bottom side and towards each other, so as to compress the rope on the top side.

FIG. 1

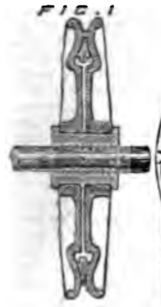
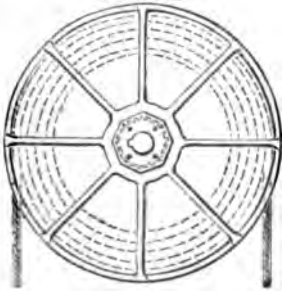


FIG. 2



The practical result of the trial of these pulleys has proved the principle to be a correct one, and, as there are not any parts to get out of order, their use must be attended with considerable economy.

WM. KELSEY, 18, Cannon-street, E.C.

DODS' ELECTRICAL PSYCHOLOGY.

SIR,—Lest the commendation bestowed on this work by Mr. Dineen. p. 91, should induce some of your readers who are interested in these subjects to throw away their money by buying the book, I think it right to say that it is one of the most pretentious pieces of rubbish ever published. Its author is one of those claptrap talkers who pour out streams of high-sounding verbiage without the trace of an idea; in fact, he is a mesmeric Barnum.

The quotation given, "it will be readily perceived by any one acquainted with electric science,'" &c., is enough proof, for the following statements no such person would endorse; but the Doctor's idea of electricity is the wildest nonsense. He talks about the gold and the chloride of lime in electricity, &c., and describes electricity as the source of matter, and containing in itself all matter, and talks generally with the usual sublime impudence of the charlatans who invent systems and impose them upon others who know just as little as themselves of what they are professing to explain.

As to positive and negative. they are terms only; their value depends on the sense we put on them. That the human body displays polar actions, like magnets, there is little doubt, and the study of this by Reichenbach is a valuable contribution to knowledge, very different from Dods' assumptions, which are so gross as to destroy the value of what he says as to the facts and actions which he describes in common with all other writers on the subject. Finally, J. B. Dods was *not* "the discoverer of electro-biology," but simply a peripatetic lecturer thereon.

SIGMA.

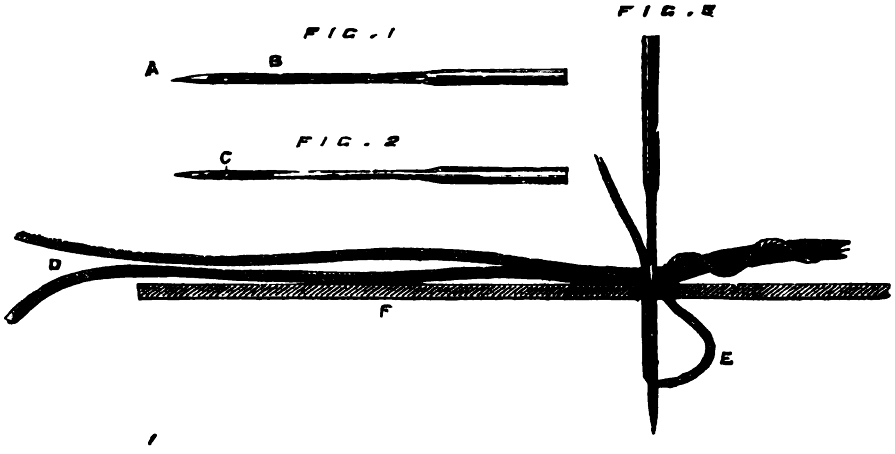
A POOR GLASSBLOWER'S QUERY.

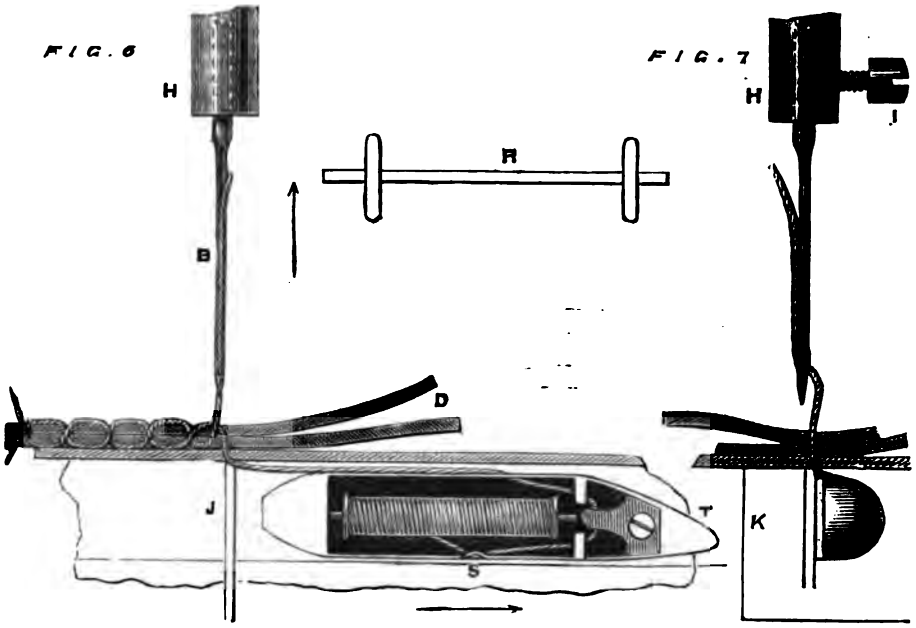
SIR,—The readers of the ENGLISH MECHANIC are greatly indebted Mr. Joseph Leicester for his clear description of glass-making and staining. I should like to see him give the poor glassblowers who cannot afford to make new glass a hint or two how to colour old metal, say a pot that will hold from half a hundredweight and upwards, a cheap dark ruby from zatinium ore and copper, the proportions for a half hundredweight of metal. Also what amount of oxide of chromium would do for a half hundredweight to produce a good colour? Then, is there not a rich colour derived from uranium, lemon yellow? Also a cheap opal from *bone ash* and carbonate of barytas?

HANLEY.

P.S.—I might be able to give him a few colours for glass in return.

SEWING MACHINES.





SEWING MACHINES.—II.

(*Continued from page* 90.)

NEEDLES.

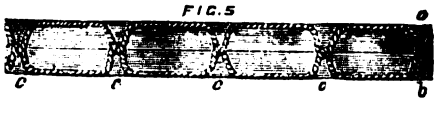
SIR,—The needle is the accompaniment, if not the pioneer, of civilisation. It is a rare or a make shift thing in savage life, and its withdrawal from use would be a sore trial to such tempers as cannot bear the accidental absence of a shirt button. We can purchase a packet of needles for one penny, and seldom think it a marvellous production, or estimate the accumulated skill that has brought this, the lightest and most extensively used tool, to its present perfection.

The majority of the mothers and daughters of England ply their needles at the rate of 30 stitches per minute; many, more fortunate, make from 500 to 2000 stitches per minute by using the sewing machine, while others have given up machine sewing in disgust, having selected a bad machine, or, having been misled by some vendors who professed the thing could be learnt in an hour or two, and without trouble.

Let the disappointed try again, and be content to proceed slowly, but surely, acquiring first a rudimentary knowledge of the action of the needle, and the shuttle, spool, or looper employed in the formation of the stitch.

Figs. 1, 2, 3, and 4, represent a sewing machine needle enlarged. A, the eye of the needle; B, the front or long groove; C, the back or short groove; D, the fabric under the needle: E, the thread, showing the loop formed under the fabric, and the cloth plate or table F.

FIG. 5



Most persons on first seeing a sewing machine needle feel surprised at the eye A being near the point, and are perplexed to understand how the thread forms its loop a thousand times per minute. Without grooves in the needle the thread would be liable to be broken on entering the fabric, but laying in the grooves B and C, protects it from cutting and fraying. If it were necessary to prevent the formation of a loop the thread would require to be drawn out faster than the needle, it being double the length of the needle through the fabric; it is this extra length which forms the loop in connection with the pressing of the fabric against the thread and needle, preventing the thread rising with the needle. The front groove B is large enough to allow the thread to pass up with the needle, while it is drawn off at the back, as represented at E. Into this loop the point of a shuttle, or the hook of a lock-stitch machine, enters, so that the whole length of the under thread is carried through the loop; both sides being tightened at the same instant.

THE LOCK-STITCH.

This application of needle and shuttle to a sewing machine was the invention of the late Elias Howe, Jun., of America, whose career as a mechanic is one of the most extraordinary on record. Maturing his invention kept him poor, and then he had to defend his rights at law, finally obtaining royalties from the American sewing machine makers which amounted to a very large yearly income, in addition to the large profits he made in the manufacture of the Howe sewing machine.

Fig. 5 represents the formation of the Howe or shuttle stitch, the upper, or needle thread *a*, laying on top of the fabric, and the lower or shuttle thread *b*, laying below the fabric, the threads being interlocked at *c c c c* with each other in the middle of the fabric between the four stitches.

It is the strongest stitch made, and cannot be ravelled. The stitch being alike on both sides, and using the least quantity of thread, it is in general use, without complaint, unless badly made by an inferior machine, or an incompetent operator.

Fig. 6 shows a front side, and Fig. 7 an end view of a shuttle and needle, the arrows showing the direction of their movements when about to pull up a stitch, and they are so *timed* or *adjusted* as to complete each one its stroke at the same instant, so that the shuttle pulls forward, and the needle upward, giving a pull of the two threads in like manner to the shoemaker when stitching the sole of a boot.

R is the shuttle reel. After winding the thread very evenly upon it by the machine, it is placed in the shuttle, and kept in a position by a spring or catch so as to turn freely. The thread in working off it is directed from the underneath side to a hole in the bottom edge of the shuttle passing outwards, then by a hole adjoining it returns inward, then to holes in the front end, and to the outlet holes in the top edge of the shuttle to the fabric. A spring in the front end of the shuttle at T, with its screw to regulate the *tension* or *strain* on the thread, gives the operator the power, in conjunction with a *tension* on the needle thread, to interlock the threads in the middle of the fabric; or, if preferred, to pull one thread tighter than the other, according to the requirements of the work in hand.

H is a part of the needle bar, into which the needle is inserted and fixed by a screw I. In the return stroke the needle descends through the fabric, the needle hole in the cloth plate, and into a slot in the metal K, against which travels the face of the shuttle. If these parts are not truly fitted and well polished, the machine will be very troublesome, although the workmanship of other parts may be very good.

A Practical Man.

LATHES.

Sir,—In my letter on the subject of the Saltaire-Wardour-st. lathe, you have altered my sense in the 24th line by inserting the word "cut." The *cutting* would be the least part of the expense of steel wheels, as, when once forged and turned, the cutting would be done with no more difficulty in steel than in brass, only taking a longer time to accomplish. In the slide rest of that lathe there are several small wheels cut out of the solid steel, besides, if I recollect right, a rack for one motion, and a segment equivalent to a portion of a large wheel for another. During the past week I have had to cut teeth of ⅝in. pitch, ⅜in. deep, and through cast steel ⅝in. thick, which took 3¼ minutes each to do, so the cutting, *alone*, of a set of wheels would not come to very much money, but I am not prepared to say where the necessary forgings could be got done, up to 9 or 10 inches in diameter, and soft enough to be cut at all.

J. K. P.

RHEA GRASS.

Sir,—The following information, which I copy from a contemporary, may be acceptable, supplementing as it does that given by "Minnehaha" in your last number.

D. V.

"The great drawback which has hitherto prevented the utilisation of this grass has undoubtedly been the difficulty of extracting the fibre, the manual process being so expensive as almost to amount to a prohibition of fibre manufacture being carried on. During the last twenty years or so, a number of machines have been brought out for extracting fibre, but none of these have been considered entirely satisfactory. Up to the present time, the common mode of extracting the fibre from such plants as the aloe is by soaking the leaves in water till the vascular matter has become rotten, and then beating off this decayed matter from the fibre with a wooden mallet, or scraping it off with a blunt knife. This process is not only a slow and nasty one, but is attended with much waste of fibre; it also discolours, and, what is most important of all, weakens the fibre. At the London Exhibition of 1862, two American gentlemen, named Sandford and Mallory, exhibited a machine for extracting fibre from aloe, plantain, or pineapple leaves. This machine has been used in America, but would scarcely be found either sufficiently simple or cheap for the ryots of India, its cost being about £45. What is wanted is a cheap machine of simple construction, by which the fibre can be easily extracted; and we think it only due to those of our readers who have contemplated entering the competitive list for the above-mentioned prize to state that a machine, possessing, so far as our present information goes, all the necessary requirements, has already been invented in India by Mr. Donald Cruikshank, representative of the Telegraph Construction and Maintenance Company. No preparation of the leaves is required for this machine; they are taken to it green, just as they are cut from the bushes, and in the wonderfully short space of two minutes, the fibre in the leaves is brought out stripped of vascular matter, and in admirable condition. The rotting process not being necessary with this machine, the deteriorations in colour, as well as in the strength and fineness of the fibre which follow upon the adoption of that process are avoided. A correspondent of an Indian contemporary asserts that the samples from Mr. Cruikshank's machine were "fine, delicate, and even; not one was cut or broken; and the material would readily fetch £50 a ton in the home market." Assuming that the efficiency and simplicity of the machine are equal to anything that is likely to be set up in competition with it for the offered prize, we very much doubt whether it is likely to be surpassed in point of cheapness. It is so easily worked, we are informed, that any native may be taught to use it in an hour's time, and its construction is so simple that it can be sold for 10 rupees (£1 sterling). We hope shortly to be able to give some further description of this machine, which, if equal to the opinion as yet formed of it, from its experimental results, seems calculated to meet a want which is not confined only to the fibre-yielding plants of Eastern India.

CASE HARDENING.

Sir,—If I may, I beg to inform "St. George" (p. 54), that I believe Mr. Armitage's method of case hardening or complete hardening is not only new but that it is the best for engine and machine gearing. During 24 years' experience at some of the leading engineers', such a process has not been adopted. For two steamboat companies and an eminent firm of engine makers, I have case hardened the gearing of several pairs of vibrating steam engines, but not by the plan of immersion. If the granting of a patent to the gentleman would do him some good I verily believe that it would not do any manufacturer the least harm. By the process in question, would "St. George" inform me what quantity of the prussiate of potash would be required to thoroughly harden a crank pin or a piece of iron of the following dimensions:—15in. long by 4 in diameter, and how many times the retort would have to be fed with prussiate of potash before the article would be ready for cooling?

R. E. T.

BENNETT'S CHUCK.

Sir,—In reply to "I. N. G.," anyone accustomed to turning knows that a hammer is constantly used for setting work true in all sorts of chucks; this is no exception, but it is, perhaps, rather a weak point in this one that after you have got your work to run as true as may be with the help of the hammer, the big screw still wants tightening, which must, to some trifling extent, alter the setting of the work. In my description of the chuck on p. 41, 23rd line, the word *that* being omitted before "the reason," makes me too willing to admit that defective fitting is the reason for my liking my specimen so little as I do; whereas I do not, on the whole, think it anything like so good as the one I call mine, figured October 22nd last year (or Feburary 18th this year, with the addition of a shield for the hands), which I have been using constantly for 12 years, and cannot suggest any improvement in. The 4-dog-chuck is the king of chucks for everything above 1in. diameter, and mine the best for everything under that size. Universal chucks, with right and left-handed screw, and 2 dogs only, are very well for amateurs, possibly, but are a delusion and a snare, and, I should think, not an effective snare for a practical man. Clements made three of them, I believe, for his own use, and any one of the three fitting interchangeably on four different lathes in his shop. I am, as I say above, not a believer in them, any more than I am in Clements's driver chuck, which you find put on all high-class lathes, bound, as I must be, to admit that Clements was a man of extraordinary talent and, perhaps, the best mechanician of his day.

J. K. P.

FRAUNHOFER'S LINES.

Sir,—I have a grave suggestion for Mr. Proctor's consideration, regarding the origin of the dark lines crossing the solar spectrum. They are generally supposed to be caused by the absorption of those rays from the body of the sun by its luminous atmosphere, which that atmosphere itself emits.

I do not like to be continually at variance in my opinions with the rest of the scientific world, but greatly doubt whether these lines have not their origin nearer home, and represent the absorption of those portions of the solar beams by the chemical action established in their passage through our own atmosphere.

T. A.

ASTRONOMICAL.

Sir,—1. I should be glad of an explanation of the reason why, in Dietrichsen's Almanac, the time given between the rising and southing of a star is four minutes *less* than between its southing and setting. I do not see what connection there is with the fact that a star sets four minutes later every day.

2. Will "F.R.A.S." kindly tell us how he succeeded with the object glass he commenced some time ago?

3. Sir John Herschel states that "the total thickness to be abraded from the edge of a spherical speculum 48in. in diameter, and 40ft. focus, to convert it into a paraboloid, is only 1-21333rd part of an inch." How is this result obtained?

Frank Fothergill.

THE SUNFLOWER.

Sir,—When I think of the many uses of this plant, and of the great ease with which it is grown, I feel surprised that it is not more largely cultivated. It ought to be, if properly grown, far more productive than barley, as food for poultry, who are very fond of sunflower seeds, and eat them greedily. This climate is not exactly suitable for the growth of buckwheat, the seeds of which are excellent as food for fowls, but if it were suitable, there can be no doubt that it would be extensively grown, and since that is impossible, we may regard the sunflower as a good substitute. It will do for poultry of every description, and it grows rapidly and readily, almost anywhere; it gives no trouble. I have grown it to a gigantic size, 9ft. or 10ft. high, at all events, with exceedingly large heads, full of hundreds and hundreds of seeds, and this too without any trouble whatever, and without any manuring or preparation of the soil.

There are tall and dwarf varieties of the plant, but the above-mentioned size, equalling in fact the *Helianthus Californicus*, I can only attribute to some peculiarity in the soil or in the air. If there be sunshine, it will certainly grow vigorously in damp lands, and it takes up a great deal of moisture, and if planted on an extensive scale there can be no doubt that it would contribute to the health of a place by assisting in the destruction of the various miasmata which have such deadly and potent effect on human beings. A saline atmosphere is no obstacle to its growth; on the contrary, it grows well when sown near the sea. There is a considerable quantity of pith in the stalks, which I should think might be used to some profitable account, and the stalks themselves, if broken up and well dried, form an excellent sort of firewood. The seed is not perishable, and with proper precautions may be kept a very long time in good condition.

The stalks, when burned, yield potash. In many instances, several heads will appear on one plant, but it is advisable to destroy all of them while young, except the largest, which will then increase in growth, and furnish an abundance of rich seed.

Tautau.

THE ARITHMOMETER.

Sir.—Our old friend, the arithmometer, or calculating machine (by which all the rules of arithmetic are worked, and calculations of the greatest intricacy, both for financial and scientific purposes, performed with unerring accuracy and promptitude), is gaining favour in England, as evidenced by its employment amongst the most eminent engineers and leading actuaries, and also in Government offices; yet its progress here is slow, considering its merits, compared with what it is in France, which, it should be borne in mind, is the country of its origin. This restriction to its usefulness is doubtless in some measure also due to the inventor not being, like many inventors, a needy man, and leaving the instrument to work its own way.

In bringing out the arithmometer, M. Thomas de Colmar proposed combining cheapness with simplicity of construction and portability, a problem which, at that time (nearly thirty years since), appeared of doubtful realisation. M. Thomas de Colmar, however, applied himself to the task with the energy of a man determined to conquer all difficulties, not the least being his ignorance of practical mechanics, and by dint of time, labour, and expense, he succeeded in producing an instrument which, in principle only, was similar to the present. The perfecting of the arithmometer, from its primitive form, was still to be accomplished, and it was not till after many years of practical experience that it was brought to a state of efficiency. Indeed, it is only recently that the latest improvements, or what we may call the finishing touches, have been applied, by which its manipulation is rendered as easy as child's play.

Although the inventor's first object was to sup the want of his own peculiar sphere (insurance companies), it may be readily conceded that his idea soon took a far wider flight, and suggested its employment in the various branches of commercial enterprise, in most of which the arithmometer is now employed in France, as also by bankers, philosophers, and men of science, by whom it is found to effect a great saving of time. It is coming into use in Russia and America, but there high protective, almost prohibitive, duties are a bar to its rapid development.

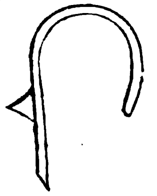
The instrument is a marvel of rapidity, and those who feel interested can see its manipulation at my office. Since writing the above, I have heard that M. Thomas de Colmar died on the 1st of March last, in the 85th year of his age, acting until then as director of the Sun Fire Office.

L. de Fontainemoreau, 4, South-st., Finsbury.

INDEX FOR DIVIDING PLATE.

Sir,—Allow me to suggest a trifling alteration in the usual arrangement of lathes for ornamental turning, which, however, I do not in any way claim as an idea of my own or a novelty. It is that the index, or spring point for the dividing plate, instead of being placed, as it generally is, on the *near* side of the mandrel (that close to the operator), should be fixed on the side farthest from him; mine has been in the position I propose, for many years, and though at first it seemed a little awkward having to stretch the hands across the mandrel for every change of division, I got used to it almost immediately, and soon found the convenience of the new arrangement. The advantages are, instead of the head of the index coming between the eye of the operator and the hole into which the point is to drop, as it does in the ordinary plan, you look, as it were, under the spring, and have the division always in sight; the light falls much better on the divisions, and, if necessary, it is easy to throw additional light on them by placing a piece of white paper in such a position as to reflect light on the dividing plate, which cannot well be done on the near side.

Though I almost invariably use the index as I have described it, I still retain one in the ordinary position, so that, in case of requiring unusual steadiness in the work for some special purpose, I can use both the indices at once, in opposite sides of the mandrel. The upper end of each index is carried round into a curve, and bent back so as to form a convenient handle to take hold of, as in the accompanying figure.



G. C. C.

STAINED GLASS.

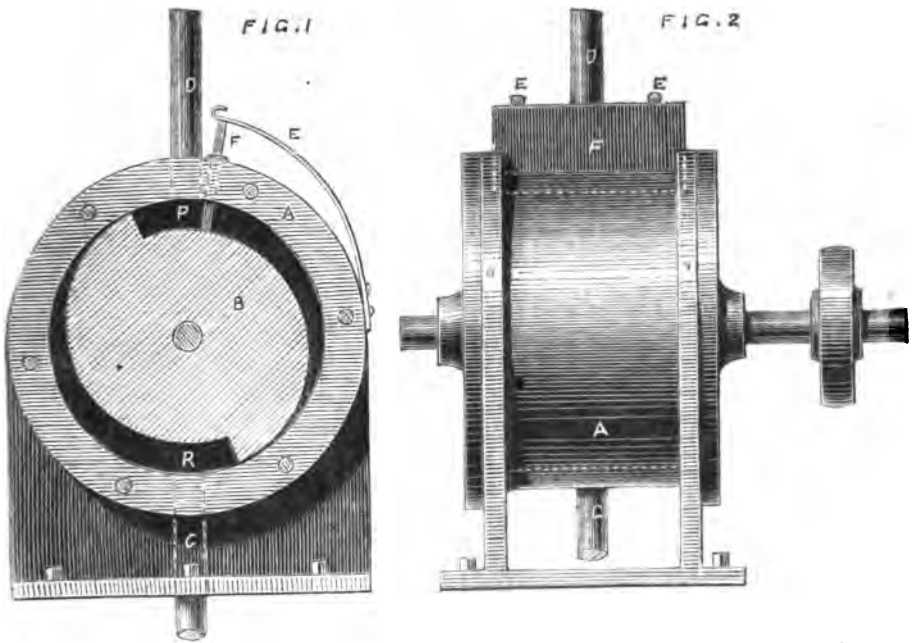
Sir,—In answer to Gustavus Knox's question 2233, No. 261, I have been doing all I can to give him the information he desires. The following is the result of my inquiries:—There is *only* one stain used for glass in England, that is yellow. There are many different shades, but they have *all* one base—namely, silver. The flux for silver is antimony; the silver is melted in a crucible, when melted, it looks like a black deposit, and is put into clean water from the crucible, then it is ground as fine as the finest flour; when required for staining, small portions are mixed with Venetian red, or common red ochre, which forms a vehicle for the silver. The ochre and silver are ground to the consistency of very fine flour, and by adding a little gum water, are made to follow the brush just like paint. It is laid or flowed on the glass according to the design required, rather thick; it is then allowed to dry, then placed in the burning oven; when it has been subjected to a gradual moderate heat for about four hours, the grating of the oven is pulled out, and when cold, the silver has eaten in the glass, produced a bright yellow stain, while the ochre washes off with the greatest ease. If a deep yellow is wanted, the proportion of silver is increased, and just as the yellow is to be light or dark, so is the amount of silver regulated. "The reddish brown" stain is produced by using brown enamel; the blue, by using blue enamel, and the different shades of all colours, except yellow, are produced by using enamel. The enamel is ground very fine, just like paint; a large slab of glass or iron is used. The ground enamel is placed upon it, and a large glass crusher is rubbed upon it by hand until it can be worked just as paint is worked. The flux (glass and red lead) is also done the same as the enamel; both are worked to form a substance of the consistency of paint, and, when painted on the glass, as required, the flux leaves the enamel to melt in the window-glass, and produces the beautiful colours referred to. There is great art in the burning of the colours in the glass; success is only attained by long practice. The glass itself is so various in its nature with regard to being hard or soft that only those who by long practice in the business have come to understand these things are fit to become glass stainers.

Jos. Leicester.

ROTARY ENGINE.

Sir,—I have noticed several specimens of rotary engines in the English Mechanic, and if you think this worthy of your notice, I shall feel obliged to you for its insertion, as it may be of use to some of the readers of the English Mechanic. It is called Hammond's rotary engine. A, Fig. 1, is the outer box, which is stationary, with the end or side plate

ROTARY ENGINE.—(See preceding page.)



off, showing the interior; B the inner box, which revolves; D pipe for conveying the steam to the cylinder; G waste steam pipe; F a sliding plate through the outer box; E a spring to keep the plate close to the inner box. While revolving, the steam enters at P and makes its exit at R, whereby a rotary motion is obtained without compressing the steam again in the engine before it can make its escape, which is the case in most rotary engines. **Philip.**

SLEEP.

Sir,—In your issue of April 8, I find a scrap of information at the head of the section of your paper designated "Chips," which I should like further information upon. The passage reads as follows :—"M. Sommer propounds a new theory of sleep; his idea is, that sleep is simply a result of the deoxygenation of the system, and he believes that sleepiness comes on as soon as the oxygen stored in the blood is exhausted." In the first place, I should like to know who M. Sommer is, and in what particulars his theory differs from the popular theory. The fact is, I very much desire (by your permission and through your invaluable paper) that the subject (sleep) should be thoroughly ventilated—*i.e.*, come to some conclusion, scientifically, as to what sleep is, and what is the cause of sleep. Personally, I should be much obliged if any one of your numerous correspondents could point me to a good work on the subject. **Coma.**

GEOGRAPHY AND EMIGRATION.

Sir,—There are two reasons why I should be very careful when writing anything for insertion in the English Mechanic. The first of these is, that your space is very valuable, and, therefore, it is desirable to say what we mean in as few words as possible. Secondly, my time is limited, and upon this score fancy must never be allowed to roam. You have kindly intimated that space is at my disposal to give epitomised accounts of the transactions of the Royal Geographical Society. It has struck me that whilst doing this I can be of much more service to your readers, and supply a vacuum in our periodical literature. Emigration is, and has been for a long time, a standard topic for conversation and debate throughout the length and breadth of the country. There are questions—and are very difficult ones to answer—which arise upon the first thought of emigration. When shall I go? What country or colony am I most suited for? To answer these questions it is necessary to be acquainted with the various natural characteristics of the colonies, &c., open to emigrants, their climate, fauna, flora, &c. Now, Sir, backed up by the splendid library of the above-mentioned society, I think if your readers who wish for some instruction regarding geographical matters will kindly forward queries to you in the ordinary way, embodying in them their special requirements. I shall be enabled to give the information required at an early moment. **F.R.G.S.**

BEES.

Sir,—As I see a proposal to have space in the English Mechanic for amateur farming, I would, in the event of such space being given, say a word on profitable bee-keeping. I learnt my lesson from the aged apiarian, Mr. Payne, of Bury St. Edmunds. He always asserted that it should be made a paying business; and if, on an outlay in the spring of 10s., one hive will, as is often the case, produce 16lb. of honey, and more, it would go a long way towards paying the rent. Mr. Payne, although having all the new inventions of his day, yet adhered as a rule to the flat-topped straw hive, with a hole 4in. in diameter on the top, which was plugged up in the winter, but which in honey-making time was taken out and a smaller hive of straw, or a bell glass, or an old tea-chest, placed over it. In a "cap," as it is technically called, of the latter kind, I have myself secured 16lb. of honey in a few weeks. The hive itself should not be fastened on its stand by mortar; we may leave the bees to do that; they will do it effectually. A straw roof to preserve from the weather is very picturesque, but is a great evil, as it harbours earwigs and a host of enemies to the bees; an old cracked red basin, or, in fact, anything but straw, to keep the wet off is all that is needed. Besides, these straw roofs are generally fixtures, and then the impossibility of taking the honey without killing the bees. All observations, and as much of necessary work as is possible, should be carried on in the year. With quietness and self possession, the bees will never sting. I will add no more.

Once a Beekeeper.

THE "PHANTOM" WHEEL.

Sir,—Will you kindly allow me to ask those of your readers who are not yet our customer to suspend their judgment for a week, alike upon the claims and the condemnations put forth in the modest letter of Mr. Edmund M. T. Tydeman, which appeared in your last issue. Pressure of business of other kinds, and the very limited time within which I understand you will go to press with your next number, prevents me from now dealing with the subjects.

J. A. Mays, Secretary and Manager, Phantom Veloce and Carriage Wheel Company.

DR. KITCHENER'S TELESCOPES.

Sir,—I am glad that an inquiry for Dr. Kitchener's telescopes has been made. I hope that some of our many readers who are interested in astronomy will be able to answer the question.

The author of "The Cook's Oracle" had, for his time, one of the finest collections of instruments in England. No expense was spared by him in the purchasing, and no one knew better how to preserve the objectives from injury.

I am therefore inclined to think that wherever they now are there must be some of those fine treble object-glasses made by Peter Dollond a hundred years ago.

I have heard the work done then was superior to much for some time afterwards, though, I have no doubt, inferior to the productions of our best artists of the present day

Still, a great interest attaches to these telescopes. It is well known that some fifty years ago Sir John Herschel published his formulæ in the "Philosophical Transactions." And he says in 1861 that they still are generally the tables used by our best opticians. But when Dollond made these triple object-glasses, no tables practically of any value were in existence. I suppose he found out the curvatures by successive trials.

Mr. Webb need not be afraid that we shall be weary of his "Hints." Anything from the author of that delightful book, "Celestial Objects for Common Telescopes"—a book which has made more astronomers than any other in the English language—will always be received with pleasure.

Will any of your readers kindly state the smallest aperture with which they can see the cómes to Rigel? I have found 2in. show it well when the night has been by no means good.

I entirely concur with "F.R.A.S." in thinking that 4in. is the very smallest object-glass which will pick up six stars in the trapezium.

I am glad the name of Mr. Wray has been lately brought forward. I have seen some fine work done by him, and his prices are extremely moderate—which just now is a great recommendation. **Stella.**

PRESENT STATE OF OUR KNOWLEDGE OF METEORITES.—Herrr Rammelsberg, of Berlin, has just given a summary of what is known, from a mineralogical and chemical point of view, of the meteorites, those messengers from other heavenly bodies which from time to time reach our earth. The essential constituents which are always present in very distinct classes of these foreign bodies are nickel, iron, phosphorus, sulphides of the metals, oxides, silicates, free silicic acid, and, in rare instances, carbon, or combinations of carbon. The same subject is treated at great length by M. Daubrée in the *Journal des Savants* for Jan., Feb., and March.

EXTRACTS FROM CORRESPONDENCE.

A GOOD SUBSTITUTE FOR BINDING SCREWS.—E. C. Murray writes as follows:—"I send the following, thinking that it may be of service to those of your subscribers who have, or are about to construct batteries in which "carbons" are used. Bore a hole in the top of the carbon ¼in. deep, and about ⅜in. in diameter, scrape it out towards the bottom so that it is rather larger than the top; procure a piece of stout copper wire about 8in. long, bend the end, thus, } make the end of carbon hot in a clear fire take it out, place the crooked end of the wire in it and fill it in round the wire with some solder (which should be melted in a small ladle). Of course the other wire may be soldered to the zinc. To connect the batteries. I clean and lap the ends over ¾in. and bind them with some fine copper wire, which must be clean.

THE "ENGLISH" VELOCIPEDE.—"Over Sixty" says:—"Living in a country where there are many hills to mount, I am always looking out for a three-wheeler that will really go up hill. I want one for use, and not for mere amusement. It strikes me that the arguments of 'A Thinker' in favour of the front guiding wheels bearing the load are good, but the principle of his machine seems to me to be precisely similar to the 'Edinburgh' velocipede, manufactured by Mr. Brown, 67, St. Leonard's-street, Edinburgh, the latter having a much lighter appearance on paper than 'A Thinker's.' The 'Edinburgh' weighs from 54lb. to 60lb., but in the drawing of the 'Edinburgh,' although evident that the guiding apparatus is on each side, it is not made plain what the contrivance is. The driving wheel behind is higher than the two front guiding wheels."

REPLIES TO QUERIES.

[1875.]—ANGLE IRON HOOPS.—"N. B." can find the length of angle iron for the hoops, by adding six times the greatest thickness of the iron to the circumference of the hoop, which can be found by using the rule given by "Leo I.," p. 510, Vol. X., and for the length of the iron for the hoops, with the flange on the inside, subtract six times greatest thickness from the circumference of the outside diameter. In the two hoops that he gives, first one, 2ft. diam. inside, with flange on the outside, circumference 2ft. = 75·3in., add 6in., which is about six times the greatest thickness, and it gives 81·39in. = 6ft. 9⅜in. for the length: the other one, 2ft. diam. outside, with flange on the inside, subtract 6in. from 75·3in. = 69·39in. = 5ft. 9⅜in. This rule was given to me by a foreman boiler maker.—**Scire Volo.**

[2000.]—PROBLEM.—In the first number of the present volume, there are solutions to my query, and the result in each case is, that "the difference between P and Q is equal to half the difference between the weights of the arms," which is not the solution asked for in the query. As the answerers of the problem doubted the correct copying of it, I wrote to or three weeks ago, informing them of its being correctly taken from "Todhunter's Mechanics for Beginners," chap. XII., sum 12. As my answer did not appear in your paper, I presume it was overlooked, and I again beg to thank "Franck" and others, who solved the problem, and should be glad to know whether the sum or the answer is worded incorrectly in "Todhunter's" book.—Y. P. W.

[2143.]—SOFTENING CAST IRON.—"Blue Ruin" is in error when he states that "G. B. K" cannot soften cast iron. He can do so by heating the metal to a bright red, cooling quickly in water, reheating, and then annealing by cooling slowly in ashes.—J. B.

[2153.]—VERTICAL SAW FRAME.—I doubt very much that "J. T. W." would ever get a frame to cut his oak logs, unless he went to an enormous expense, that is if the timber is English oak, at such a place as Sunderland, for wood ship building. I never knew the English oak cut up with the frame, unless it was pretty straight along the bottom, or was first sided up on two sides.—**Mill Sawyer.**

[2184.]—SULPHATE OF LEAD BATTERY.—Will "A Good Boy" please say whether he amalgamated the zinc plates to his battery, and will some experienced contributor inform me if it is better without?—**Plumb. Sulph.**

[2223.]—ENGRAVING ON SLATE.—I see two correspondents giving advice on this, but I doubt the querist will be much aided by it. I have cut some thousands of letters on slate, and my mode is, draw in the letters with a blacklead pencil, if wanted very accurate, come over with a draw point, taking a square graver, cut a deep bold line up the centres of the letters; this line if done with one cut will be broken and jagged at the edges, then take a flat tool (a tool about a quarter of an inch broad, and sharpened exactly the same as a joiner's chisel, but mounted in a graver handle), and with the flat side to the slate, cut from the centre stroke to the outside edge of the letter, holding the tool so as to cut the outside of the letter bevelled; it cuts as clean as a bit of cheese, the letter when finished being deep in the centre and bevelled off to either side.—I. N. G.

[2233.]—STAINED GLASS.—See answer by Mr. Leicester among the "Letters to the Editor."—Ed. E. M.

[2236.]—DIRTY CEILINGS.—Only ceilings, the outer portions of which are exposed to the influence of temperature, have the "ribbed" appearance. In damp weather the plaster absorbs moisture, the dust and smoke adhere to the damp portion; the joists keep the plaster dry, hence that portion is less dirty and smoke-stained.—**The Welsh Shepherd.**

[2263.]—AMBER.—Amber is soluble to a certain extent in alcohol, ether, chloroform and turpentine.—**Beta.**

[2270.]—**MOTION OF WATER.**—38 × 2·5 = 95 depth of water in feet. $\sqrt{95} \times 8{\cdot}1 = 78{\cdot}5$ the velocity of discharge in feet per second; diameter of orifice 1in. = ·00546; the area in square feet

$$78{\cdot}5 \times {\cdot}00546 \times 60 = 25{\cdot}7$$

cubic feet discharged per minute.—ANTHONY.

[2293.]—**NICOTINE.**—"Maues" should put two drops of oil of sassafras on his pipe of tobacco, which will entirely prevent vertigo, and all the other disagreeable effects of smoking.—VIATOR.

[2294.]—**THEOREM.**—It seems to be a particular case of the theorem "the circle is greater than any isoperimetrical figure," which is proved in several authors.—A. BLANCHET.

[2296.]—**DIE.**—I think "Cantab" would have a great trouble to cut a good counterpart to his die with tools. A much better plan would be to *stamp* a copper counterpart with the steel die itself, provided it is hard enough. If it is not, he must harden it by one of the many recipes given in these pages.—W. H. THORPE.

[2297.]—**VIOLET INK.**—Boil 4oz. of logwood in 1½ pint of water to one-half, strain, and add 6 dr. of gum and 1¼oz. of alum; set aside for 12 hours, and decant for use.—BETA.

[2309.]—**ETCHING ON GLASS.**—To etch on glass with fluor spar, cover the glass with beeswax by melting the wax and running it over the glass, about 1-16th of an inch thick, then write on it with a needle, after which sprinkle some fluor spar upon the writing, and pour sulphuric acid on it, let it stand for 10 or 12 hours, then wash off the superfluous acid, and take off the wax and wash the glass clean, and it will be seen that the fluor spar has eaten away the glass on those parts not protected by the wax.—PRACTICUS.

[2331.]—**PATENT DRYERS.**—The mixture is considered a secret, but the following may be the material chiefly employed:—Proto-sulphate of iron (green copperas) is put in a clean iron pan upon a clear low fire, when melting, stir about and evaporate to dryness only. This substance, ground in oil, acts as a dryer. Sugar of lead, ground in oil, is the best dryer for delicate tints. Litharge is the most active dryer of all, but can only be used for dark colours, as it discolours light and blue tints. All oxides are dryers, as a general rule.—THE WELSH SHEPHERD.

[2332]—**UNNOTICED QUERY.**—The traced patterns for embroidery are printed, when many copies of the same pattern are wanted. If a dozen or two are only required, the patterns are made by hand, as follows:—The drawing is made upon paper, lay the drawing upon an even cloth, and perforate all the lines with a fine needle, close and even. Now take finely powdered charcoal three parts, resin one part in fine powder, mix and tie it in a piece of porous calico, so that it forms a dusting bag. Lay the perforated drawing upon your material, hold down with one hand, rub the dusting bag over the drawing, the dust falls through the holes, and forms the drawing on the material, remove the paper drawing, lay blotting paper over the dust pattern, and go over it with a worm flatting iron; the heat will melt the resin and fix the drawing on the material.—THE WELSH SHEPPHERD.

[2341.]—**CANOE.**—From "Oversands'" query I suppose he wants a ship for cruising, if so, the dimensions given will furnish what he requires:—Length over all, 15ft.; greatest beam, 2ft. 2in.; depth, less keel, 9in.; rise of deck, 3in. This boat may, with the exception of ribs, carlins, and risings, be built entirely of pine, which should be fresh cut from the balk, as it will then be easier to bend and less liable to split; or if "Oversands" prefers, the keel can be made of oak or American elm, and the curved stem and stern pieces of oak, the ribs of chestnut, steamed or boiled till soft, to be fixed hot, as they set in cooling, and will not alter in shape when once in; keel, allowing for scarphs about 13ft. long, 1½in. deep, 1¼in. wide, to have a rabbet worked on each side and up the curved pieces (as high as boat is to go), where the rabbet flattens. Fig. 1, section of keel midships; Fig. 2, method of scarphing cutwater to keel; T, places for screws, which should be brass; Fig. 3, section of stem (stern is similar), through *a b*; Fig. 4, half of main section, ¾in. to the foot. A board should be cut out and boat built up to it.—MATY.

FIG. 1

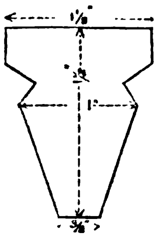


FIG. 3

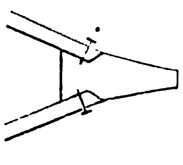


FIG. 2

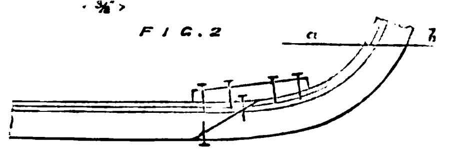
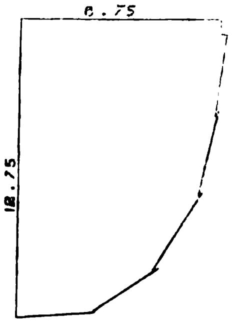


FIG. 4



[2324.]—**GYMNASTICS.**—Let "Gymnastikos" char the ends of the posts that are let into the ground, and they will last a very long time indeed; another plan is to steep them in creosote oil a week or so before putting down.—MILL SAWYER.

[2341 AND 2355.]—**CANOES AND BOATBUILDING.**—I have seen several inquiries on this subject, and had hoped that some abler pen than mine would have answered them. For the benefit of canoe builders I give below the dimensions of the Rob Roy class, as published by the club:—Length over all, 14ft., beam outside, 26in.; depth from surface of deck at fore end of well to top side of keel 11in.; keel to project 1in. outside, and to have 1in. camber or round in its length. The best material for wear is English oak cleaned up to 5-16ths of an inch thick, but for lightness, white fir or white or yellow pine are used. In answer to "C. D. R." the keel should be of oak or American elm; the timbers or ribs of the same, or ash; American elm is the best in my opinion. The stem and sternpost are worked of oak grown to about the right curve and scarphed to the keel. In building, the strakes or planks are worked first, and then the timbers are steamed and bent in and fastened while hot. I shall be happy to furnish sketches of any parts required, or to give any information in my power on this subject or yacht building to any who may think of attempting this pretty art.—BOATBUILDER.

[2346.]—**GEOLOGICAL MANUALS.**—Having regard to the limited prices, there are only three published in England—Jukes's, Houghton's, Page's, the publishers are known to all booksellers. I will now pass my opinion on these; they are all good works, but the ground of preference must depend on the student. If he likes a book that has "grit" in it, technical and directly, *ad rem*, and is not afraid of a hard book, let him buy Jukes's; I like it myself, because conceited enough to undervalue popular works in the popular style of science. If something easier and more diffuse would suit, why then order Page's "Advanced Text Book;" the other, Houghton's, has peculiar features of its own; does not so much allude to English examples; has a good deal to say about distribution of the organic life on the globe, the orders, their first appearance, and their extinction; takes a glance at the "plasma" of the earth's crust, and such like physical theories, and is Irish in reference to examples. It would not hurt a student to buy, at intervals, each of the works named. I could give advice as to an early course for a student, but to do so effectually I should require to know something of his previous education, his means, his opportunities, his locality, &c. Perhaps I may put together a few hints on the subject for the ENGLISH MECHANIC, at no distant period; meanwhile, I advise the student to hang on to the skirts of the nearest practical geologist he can meet with. Publishers: Jukes, Black; Page, Blackwood; Houghton, Longmans.—F. S., F.G.S.

[2346.]—**GEOLOGY.**—One of the following works might suit:—"Page's Textbook," price 6s., Blackwood; "Jukes's Geology," price 12s. 6d., Black and Co.; "Phillips's Treatise," price 7s., Longmans.—BETA.

[2362.]—**COPPER SMELTING.**—In answer to "E. V. D. S." I am not aware of there being any copper smelting establishment in London.—T. ROSKELL.

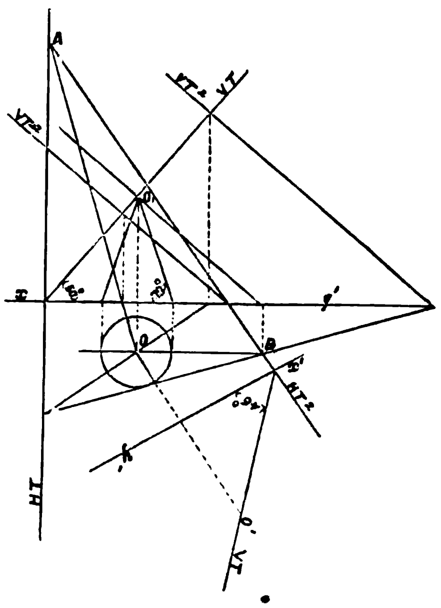
[2363.]—**SILVERING BRASS.**—In answer to "Poor Clock Jobber" respecting silvering brasswork or clock dials, the following is the method used for many years to silver the clock rims or inside bezils:—6d. of pure silver dissolved in half a teacup of nitric acid, the solution of silver to be carefully washed to free it from the acid; afterwards to be mixed with 1d. cream of tartar; when the tartar is mixed add half a brick of common table salt, pounded fine, the whole to be well stirred together. The articles to be silvered must be dipped clean in aqua fortis, or scoured with fine sand. The part to be silvered must be rubbed with a clean cork dipped in water, then in the silver powder. The whole to be rinsed in lukewarm water, and dried in clean box sawdust, and then be varnished with copal varnish made thin with turpentine. This is an old method. The modern one is to laquer the work with colourless lacquer.—J. M., Birmingham.

[2371.]—**HEATING OF JOURNALS.**—If "Relwot" were to remove the brasses from his heating journals, and replace with hard wood, and state the result in the pages of the ENGLISH MECHANIC, it might benefit others as well as himself. It is best, if possible, for the wood to be endways of the grain. I was in a very large windmill last week, where the lower end of the wind-shaft was working against wood, but in this case, the wood was strongly bound by an iron band, to prevent splitting, as the pressure was very great, and brass had been removed on account of heating; it has been at work thus for many years. The necks of all the stone spindles in the mill, four pairs, are working with wood instead of brass in a satisfactory manner.—R. N. SMITH.

[2371.]—**HEATING OF JOURNALS.**—"Relwot" should apply clean soft soap, let the neck revolve in this a few moments, then pour on common washing liquor, which will fetch out the dirt. Repeat if necessary. This can be done without stopping the engine, and has often proved effectual.—MUTUAL IMPROVEMENT.

[2371.]—**HEATED JOURNALS.**—Heated journals in many cases may be cooled by pouring a mixture of antimony and oil frequently on them.—VIVIS SPERANDUM.

[2376.]—**GEOMETRY.**—The following is perhaps the easiest method of solving this rather long problem. First of all determine by its traces (H T and V T) the plane inclined 50°, assuming this plane perpendicular to the vertical plane of projection; next determine by its plan and elevation, a perpendicular line to this plane; then a plane containing this line, no matter in what position, must be perpendicular to the given plane. To determine the position of the second plane (70°), make the point O (where the line intersects the plane), the apex of a right cone, whose slant edge is inclined at 70°. All tangent planes to the slant sides of this cone must of course be inclined at 70°, then a tangent to the base of the cone passing through the horizontal trace of the line, will be the horizontal trace of the second plane (H T²); the plan of the line of intersection of these two planes must pass through the plane of the apex of the cone, and through the intersection of the horizontal traces of the two planes. It is easily seen that the horizontal trace of each plane is perpendicular to the plan of the line of intersection of the other two planes. Then, if we draw a line perpendicular to the line of intersection, and passing through the horizontal trace of the perpendicular line, we have the horizontal trace of the third plane, and a line drawn through A O will be the plan of the second line of intersection. The third line is drawn from O to B, then having got the horizontal traces and one of the vertical traces, it is an easy matter to get the other two. The inclination of the third plane is got by making an elevation on a ground line, perpendicular to its horizontal trace. Draw x' y' perpendicular to H T³, and project the point O perpendicularly through x' y', then set up the height of the point O′ taken from the other ground line (x y), then a line v t, drawn through this point, and the intersection of the trace with the x' y' will give the inclination required, which is 46°.—M. WHEATLEY.



[2380.]—**MERCURY BREAK FOR COILS.**—"R. S." will find a description of a mercury break in the appendix of "Chambers's Electricity," by Dr. Ferguson. It consists of a vibrating spiral of copper wire. Another form is given in Du Moncel's work on the induction coil as constructed by Gaiffe, which, like the ordinary spring break, derives its motive influence from the core of iron wires. It is constructed; as follows:—A brass pillar with a slot cut in the top carries a lever of soft iron some 6in. long, one end of which terminates in a cylinder like that of the spring break; the other end has a wire depending from it tipped with platinum, which dips into a cup containing an amalgam of mercury and platinum, or mercury and silver (which is cheaper and more easily made); the iron lever is centered in the slot by means of a pin passing through it, so that it can slightly oscillate in the vertical plane; a spring bent in the form of an arc is fixed to the under part of the lever, which, by means of a rack adjustment, can be made more or less tense, so as to accelerate or diminish the rapidity of the oscillations. The pillar is of such a height that the cylinder end of the lever, when at rest, is about ⅛in. or 3-16th in. above the end of the bundle of wires in the coil. The mercury cup is capable of being adjusted to any required height, so that the platinum wire just touches the amalgam; over the amalgam is poured some alcohol, which, being less conductive than air, renders the passage of the extra-current spark more difficult. The pillar and the cup are respectively connected with the coil in the same manner as the two sides of the spring break. This form of contact-breaker is chiefly applicable to the larger class of coils, especially when used with great battery power; as before stated, it renders more difficult the passage of the spark of the extra-current, which so rapidly oxidises the platinium of the spring-break; moreover, for the same reason, it elongates the spark of the secondary wire. In a coil I recently made, the spring-break, with 3 Grove's cells (5in. × 3in. of platinum immersed) gives sparks 6in. long; the mercury break, with same battery power, gives sparks 7in. The mercury break is, however, not adapted for illuminating vacuum tubes.—J. D. M.

[2381.]—**FIXING IRON STANDARDS IN STONES.**—The composition generally used for fixing iron standards in stones for wire fencing, railings, &c., is composed of brimstone (crude sulphur) and washed dry sand in about equal parts, poured into the joint in a molten state.—VIVIS SPERANDUM.

[2384.]—**WORK ON ELECTRICITY.**—I should recommend "S. T. P." to purchase either "Noad's Inductorium," price 3s. 6d., or "The Induction Coil, How Made, and How Used," by Dyer, price 1s.—F. RUSSELL.

[2390.]—**INDUCTION COIL.**—Thomas J. O'Connor may safely use a battery consisting of 6 or 8 Grove's or Bunsen cells (pints), or 3 quart bichromate cells.—F. RUSSELL.

[2390.]—**INDUCTION COIL.**—T. J. O'Connor asks what battery power would be suitable for his coil.

If his coil is well insulated, he can use a bichromate battery, presenting a total surface of 48 square inches, or one quart Bunsen's battery, with about 66 square inches. Such a coil with a condenser of 25 sheets, 6 × 4, ought to give ⅜in. spark at the least.—A. E. Tucker.

[2399.]—DIE FROM MEDAL.—The best way for "Medal" to procure a counterpart or die from his medal would be either to make a mould in plaster of Paris and cast it, or else, which is the better way, to reproduce it by means of the electrotype process.—F. Russell.

[2403.]—FLUXES.—In reply to "Dorset," he can obtain fluor spar from any of the mining districts of Cornwall. I get mine from Redruth, though one of the assayers. It can be had in powder from almost all drysalters and dealers in chemicals. J. J. Griffin, 22, Garrick-street, Covent-garden, London, supplies it; white argol may also be had at the same place. White argol is the commercial name for crude bitartrate of potassa; cream of tartar is the same, purified; tartaric acid is also obtained from it. It is chiefly obtained as an incrustation in wine casks.—T. Roskell.

[2404.]—TELESCOPE QUERIES.—I am unable to answer the query addressed to me by "C. S.," page 69, for the following reasons. I do not possess an eyepiece of the power he mentions—the highest I have used is about 300; also my telescope was left behind in Manchester, and I fear that I shall not be able to send for it before the middle of June. One point is worthy of notice, the stand seemed almost perfect on quiet nights, but if not sheltered, the instrument had an unpleasant tendency to come "head to wind," so smoothly and easily did it work. This will be remedied when I get to work again, and I think it will then be the best possible form of stand for an altazimuth.—Arthur W. Blacklock, Newbridge, Aberdeen.

[2407.]—DYEING.—"Mordant" will get the fullest information about chemical dyeing in "Musprat's Chemistry," but it is a very expensive work. "Napier's Handbook on Dyeing" may suit him, it is more mechanical (if I may use the expression) dyeing than chemical, but contains a multitude of recipes for dyeing cotton and silk in all colours.—Vivis Sperandum.

[2414.]—ALGEBRAIC EQUATION. —Let x = greater number $\therefore x - 2$ = less number,
Then

$$x(x-2)(2x-2) = 12$$

or

$$x(x-2)(x-1) = 6$$

or

$$x^3 - 3x^2 + 2x - 6 = 0$$

or

$$(x-3)(x^2+2) = 0$$

whence

$$x - 3 = 0 \text{ and } x^2 + 2 = 0$$

$$\therefore x = 3 \text{ or } \pm\sqrt{-2}$$

and the less number $= x - 2 = 1$
Or

$$\pm\sqrt{-2} - 2 = (\sqrt{-2} - 2) \text{ or } -(\sqrt{-2} + 2)$$

—J. P. P.

[2414.]—ALGEBRAIC EQUATION.—"Pater" will find the following to be a correct solution of his problem:—Let $3x$ = the greater number, and x = the less; then $(3x^2 \times 4x) = 12$; or, $12x^3 = 12$; dividing by 12, $x^3 = 1$; extracting root, $x = 1$; therefore, $3x = 3$ Proof:—$3 - 1 = 2$, the required difference; $(3 \times 1) \times (3 + 1) = 3 \times 4 = 12$.—W. Airey.

[2416.]—ADHESIVE MATERIAL.—A thick mixture of dextrine and water possesses great adhesiveness. Dextrine, or British gum, is made by exposing potato starch to a temperature of 400°. It is a cheap article, and largely used as a substitute for gum.—Beta.

[2420.]—SPRING BOW.—A steel spring bow of given length cannot be weakened except by reducing its substance in thickness, or otherwise.—J. B.

[2423.]—AQUARIUM.—Why does not your correspondent use gas piping? I have used it continuously for several years. My fishes lived and got fat, yet I never fed them, but kept the aquarium well stocked with vegetation. I have found no cement to surpass Portland cement, it hardens under water, and makes a good artificial stone.—Country Grocer.

[2423.]—AQUARIUM.—Gutta-percha does not affect water in any respect, neither fish or any other thing will be therefore injured by water which has passed along pipes of that material. Roman and Portland cement are suitable for uniting rock work, and can be obtained by any mason; but both of these, and the former especially, give off an efflorescence for a time, which is poisonous to fish if the water gets impregnated with it.—J. B.

[2424.]—MICROSCOPICAL.—The Quekett Club publishes a quarterly journal, which is supplied to its members free of charge, and which contains reports of the proceedings of the club, and in which the most important of the papers read at the meetings are published in full, with illustrations, when required. A member unable to attend the meetings could scarcely derive any advantage beyond the perusal of the journal; but any subject he might wish to bring under the notice of the club, with a view to elicit opinions, or otherwise, would receive attention if brought forward through the secretary or any other member. As a regular attendant at the meetings of the club, I should be glad to be of service in this way to any absent member. Nelson's gelatine is largely used, and can be had, I believe, of almost any grocer. With Cox's I am not acquainted, nor have I ever known isinglass to be used for microscopical purposes.—W. H. G.

[2439.]—SLOT CUTTING.—See "J. K. P's" letter elsewhere.—Ed. E. M.

[2442.]—MOUNTING LARGE CYLINDER.—"Woodleigh" had better have wooden caps to fit the ends of his cylinder, with brass bearings screw tight in the centre of the caps, and secured by a lock-nut inside and varnished with sealing wax varnish. I have one that is done the same way, and it answers well.—J. M.

[2448.]—PLANET NEPTUNE.—Adams's calculations and formula first appeared as an extract from the appendix to the "Nautical Almanac" for 1851.—Henry W. Henfrey, M.N.S., &c., &c.

[2450.]—FASTENING PIN TO BROOCH.—In answer to "Yorkshire Bite," he must use shellac to fasten the pin or joint in his brooch; this is what the black ornament makers use in Birmingham. The joint is warmed previously to putting together.—J. M

[2455.]—FRET CUTTING ROLLED BRASS.—"Chip" had better use coarse cut saws to pierce his ¼in. brass with, as the fine ones get hot, and then merely rut, not cut; he must lubricate with a little suet or wax, and not work his saw too quick. I have cut some metal ⅛ thick, for book mounts, and I found fine cut saws of no use whatever. Perhaps he would let me know how he succeeds in his next attempts?—J. M.

[2456.]—OLD COINS.—The first-mentioned pieces of "Shabazadah," are merely Nuremberg tokens or counters, and are of no value. He will find many particulars relating to them in the last volume of the English Mechanic, see pages 309, 537, &c. The following is a description of the "Voce Populi" halfpence. Obverse, a laureated head to the right, the neck being bare. Legend; VOCE POPULI. Reverse, a female seated, looking to the left, holding a branch in the right hand; a spear, pointing backwards, is supported by the left arm, and behind the figure is a harp; HIBERNIA above, and the date, 1760, below. There are a great many minor varieties, which I need not notice here. I extract the following from the "Numismatic Chronicle:"—"For some years prior to 1760, very little copper money was struck for Ireland, which caused such a scarcity of small change that all sorts of base stuff was cast into pieces that passed for halfpence and farthings. This gave an opportunity to a Mr. Roche, of South King-street, Dublin (who struck metal buttons for the army), to issue copper halfpence and farthings, which were generally received in preference to the wretched sort then in circulation. The first sort he sent out was badly finished, and on one side a head laureate, looking to the left, and for inscription, VOX POPULI; reverse, Hibernia sitting on a globe, holding a laurel branch in the right hand and a spear in the left, with HIBERNIA round; in the exergue the date, 1760 (none of these sort are now known to exist). The second sort that he issued was much neater, and better copper, with the inscription on the head side altered to VOCE POPULI. The halfpence were a larger size, and done in the same manner. However, on information being given to the then Lord Mayor of Dublin, the whole apparatus for striking the aforesaid coin was seized and lodged in the tholsel. Roche fled from the same." The most comprehensive account of these curious pieces is by C. Clay, M.D., published in Part III. of the "Proceedings of the Manchester Numismatic Society," 1866. The medals in brass of Admiral Vernon, are very common, not being worth more than 1s. I have two specimens in my cabinet, commemorating the taking of Porto Bello.—Henry W. Henfrey, M.N.S., &c., &c., author of a "Guide to English Coins."

[2456.]—OLD COINS.—The one figured is a Nuremberg token. The words "Hans Krauwinkel, Nur." are very legible.—Bernardin.

[2456.]—OLD COINS.—Is a counter or jetton; made by Hanns Krauwinkel, whose name appears on the coin. If "Shaazadah" will refer to "Snelling's View of the Origin, &c., of Jettons or Counters," or even to the English Mechanic, a few weeks back, he will find all, or as much other information he may require. The "Voce Populi," or "Pretender's halfpenny," as it is sometimes called, was struck in Ireland in 1760. It is rather smaller than an ordinary sized halfpenny of the period. There are conflicting accounts of its appearance as a singular and distinct coinage, and it is singular that its origin should be lost in obscurity, considering its comparatively recent date. The various authorities on the subject are brought together and printed in the "Proceedings of the Manchester Numismatic Society," Part 3. There is a variety with the letter P in the front of the bust, and another with P under the bust. There is also a farthing size. The Vernon medal was probably struck on the taking of Porto Bello, and I dare say some of our medal collectors will send information.—D. T. Batty, Fennell-street, Manchester.

[2457.]—TEA CHESTS.—I would state that it is my opinion that the chests which come from China and Assam are made from the wood commonly called here Indian teak. The country round Assam, south of China, abounds in forests of this tree.—W. Stephenson.

[2459.]—BANKAL WOOD.—Bankal wood, of the Philippine Islands, is the wood of *Nauclea Glaberrima*, of the Peruvian bark order, or *Rubiaceæ*; this wood, of a golden or a greenish yellow, is esteemed for its tenacity and durability, is employed by shipbuilders, coopers, &c.; it is abundant in the Philippine Islands. For more particulars on the woods of these islands, see my notes in the *Technologist*, August, 1864. Some other trees of the Genus *Nauclea* yield also a good timber:—In Senegal, the Koos, *Nauclea Africana*; in Tahiti, the yellow wood of *N. rotundifolia*, hard, and excellent for carpentry purposes; in Ceylon, *N. Coadunata*, Roxb., the Bakmee-gaha of the Singalese, light and tough, used for doors, &c.; *N. cadamba*, Halamba of the natives, and *N. cordifolia*, both used for building purposes; in Java, *N. lanceolata*; Angriet, Malay, brown, hard timber, very difficult for working, nevertheless employed by wheelwrights; and *N. purpurea*, or Tjangtjaratan, light, with rather loose fine fibres, working easily, but having no special use.—Bernardin.

[2461.]—INHALATION OF IRON DUST.—Perhaps "A Turner" had better suspend a horshoe magnet over his lathe. The magnet attracts the small particles of steel that fly off, and prevent much mischief to the workman.—J. M.

[2464.]—TARNISHED SILVER LEAF.—Perhaps you "clear sized" your silver before you covered it with "mastic varnish," in which case it must tarnish. Silver again with fresh silver leaf, and varnish directly with best pale copal or body varnish. Mastic varnish is a spirit of turpentine varnish, and does sometimes become dead and opaque—The Welsh Shepherd.

[2471.]—SUMMER BEVERAGE.—The following is a good recipe for lemonade: Pour ¼oz. of essence of lemon upon 1½lb. of refined sugar, not broken. Put 3oz. of tartaric acid in 2 gallons of cold water, let it stand 12 hours or more, put the sugar which has absorbed the essence of lemon to it, and stir up. When bottled, add a desert spoonful of carbonate of soda in a quart bottle not quite filled.—Minnehaha.

[2481.]—GUANO INJURIOUS TO HEALTH.—*Science Gossip*, September, 1866, quotes the following fact from the *Gazette de Lausanne*:—"A peasant cutting wood was wounded by a splinter, and having afterwards worked in guano, this substance entered the wound and occasioned death by poison after three days' suffering."—X. Y.

[2492.]—BENNETT'S CHUCK.—For reply see "J. K. P.'s" letter on another page.—Ed. E. M.

[2499.]—APPARENT ANOMALY.—Edward Habergham has got fogged by mixing troy and avoirdupois weight together. Pennyweights appear in the former only, which has 12oz. to the pound of 5760 grains. It is well worth bearing in mind that though the troy pound is so much smaller than the avoirdupois pound of 7000gr., yet the troy ounce has 480gr. against the 437½ that go to the avoirdupois one, for if you go to a sale and buy plate at per ounce, as a friend of mine did, and get charged by avoirdupois, you will pay about 11 per cent too much. It must also be remembered that the apothecary's drachm is 60gr., and the drachm, as I think it should always be spelt, though we do not find much distinction made in the dictionaries, is about 27⅓gr., and is what we talk about when we say we put 3dr. of powder into a charge for a small-bore rifle. As regards the weight of water, we commonly see put in books that a gallon is 10lb., also that in a cube-foot there are 6·232 gallons; and should conclude that a cube-foot would weigh 62·32lb., whereas we are always told it is 62½lb. It would reconcile matters, and be just as easy to remember, if it were called 62¼lb., and would be nearer the mark a good deal.—J. K. P.

[2501.]—INDUCTION COIL.—T. J. O'Connor's difficulty would appear to be that no contact is completed. He must not expect an iron screw and steel spring to work to any sort of satisfaction. The metals would be immediately oxidised, and rendered non-conducting, and no doubt this is the case now at the point of actual contact of screw and spring.—Sigma.

NOTES AND QUERIES.

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[2503.]—TOBACCO FUMES—Can any reader inform me of the best mode of deodorising a furnished room containing tobacco fumes?—R. W.

[2504.]—UNIFORM TEMPERATURE.—How can I keep the temperature of a room, and a tank of water in it, at exactly 50° Fahr., both in winter and summer?—Quercus.

[2505.]—WEIGHT OF WATER.—What is the weight of a cubic foot of fresh water and sea water, each at 60° Fahr.?—Quercus.

[2506.]—CAMPHORATED COLZA OIL.—Will C. Ward kindly state what this is, and how prepared? I have a real argand lamp, the cotton in which is raised and lowered by a rack and pinion; it gives an excellent light with sperm oil, but this is far too dear, and the common colza oil will not suit, as it crusts so rapidly, the tubes in the lamp being very close, and the cotton fine. Possibly the camphorated colza oil mentioned by Mr. C. Ward might suit.—S. J. M., Penge.

[2507.]—RECOVERING GOLD.—I see in last week's English Mechanic a plan to recover the silver off of plated ware without dissolving either copper, brass, or German silver, which I consider very useful. Can you or any reader of the Mechanic give the same for recovering gold off plated ware, and also how to recover the gold afterwards in the metallic state, as I have some old spoons that have been gilt pretty thick on the metal that they are made of, which looks like copper?—T. E. D.

[2508.]—FASTENING STENCIL COLOURS ON PAPER.—Can any brother reader inform me of any method of fastening stencil colours on paper that will size and varnish. I have tried vinegar and alum to fasten the ordinary pigments that are ground for paint, but they won't stand the size. I have used stiff colour ground in oil and well diluted with turpentine, but it is apt to make greasy and unclean work?—Painter.

[2509.]—PUMPS.—Many thanks to "C. S." for his private answer to my inquiry about the turbine wheel. I see that it will not do. I would like to know what would be the most advisable plan for to send up about 4000 gallons of water in the shortest time; driving power, 8ft. of a fall, and 50 gallons per minute? In reply to "H. B. M." There has been a ram tried already and found to be insufficient.—Plumber.

[2510.]—PEPPER MOTH.—TO MR. CLIFFORD.—I should esteem it a favour if our friend who writes us those interesting monthly chapters on curious caterpillars, or some other brother reader, would favour me with an answer. What colour is the larva of the pepper moth (*Amphydasis betularia*), and what position found in when feeding; also what it feeds on, and what localities are the most suitable to it? What time of the year does it make its appearance?—Pupa.

[2511.]—BEER.—Would you or some brother reader inform me of a book treating on the benefit to be derived from the moderate use of intoxicating drinks as beverages?—A. L. E.

[We know of no such work, though the benefits derived from moderate drinking have been written on and spoken on again and again. It is, however, our opinion, grounded on a long experience and much observation and inquiry, that the benefits derivable from the habitual use of alcoholic beverages are very small indeed. We do not say this from a teetotal point of view, but as ordinary observers of the habits of men. We have known hundreds of men, some of whom were miners and sailors in Cornwall, spinners in Manchester, agriculturists in Devonshire, and printers in London, who have abstained for years together from all kinds of intoxicating drinks, and then we have known hundreds of others similarly employed and situated, who have used intoxicating drinks as beverages, and our unprejudiced opinion has been and is, that the abstainers were stronger and healthier men.—ED. E. M.]

[2512.]—SODA CRYSTALS.—Thanks for G. E. Davis's able article in No. 201 of your publication, but not having any drying or heating apparatus, I must abandon the idea of commencing the manufacture, and having two pans, both idle, one to contain 120 gallons, and the other about 80, I should like to know how to manufacture an article of simple process, and marketable, to keep them going these bad times. Being no chemist myself, probably G. E. D. would kindly suggest something.—SODA CRYSTALS.

[2513.]—TAR DISTILLING.—TO "FEU FOLLET."—Will "Feu Follet" be so kind as to describe to me the process of tar distilling; how long it is boiled before the pitch is run off; how to separate the articles when the pitch is run off, such as naphtha, oil, benzole, carbolic acid, ammonia, crude anthracene, &c., or where can I procure a book that will tell what I wish to know; the price, and where to be had?—T. BROWN.

[2514.]—SPICE MANUFACTURING.—Would any brother reader tell me where I can get the information how to make spice, or where I can get a book to tell me; also the means to colour it, price of book, and where to be had?—T. BROWN.

[2515.]—BOILER.—A few days ago I was told that if a boiler, the first time it is used is made to get up steam quickly, it will ever afterwards be easy to get up steam. If, on the other hand, the boiler is heated slowly on first using it, a difficulty will always be experienced in generating steam. Is there any truth in this statement, and if so, what is the reason?—W. H. THORPE.

[2516.]—EXPLOSIVE COMPOUND.—Are there any two liquids, inexplosive in themselves, which will, when mixed together, explode directly, or become capable of being exploded; if so, what are they? In what proportion should they be mixed?—E. KENNEDY.

[2517.]—ELECTRIC ENGINE.—Is there such a thing as an engine worked by electricity of one horse power? What is its total size and weight? What the cost, and where could it be bought?—E. KENNEDY.

[2518.]—GAUGE FOR A KITCHEN BOILER.—Would it not be a useful and comparatively inexpensive thing to affix to all common kitchen boilers a small water gauge? It might be secured from fracture by being loosely cased in the manner of spirit levels, and its action having been once explained to the kitchen servants, I feel sure that many a boiler would be saved from cracking and uselessness. Is there any objection to this idea beyond that of cost?—A. C. G.

[2519]—VULCANISING INDIA RUBBER.—Will one of your readers kindly inform me how to vulcanise india rubber? Can the apparatus used by dentists for hardening vulcanite (which I possess) be used for the purpose, and how?—GUMMY.

[2520.]—WATERPROOFING PAPER.—Can any of my brother readers inform me of the best method of making paper waterproof?—A. SPEIGHT.

[2521]—CURIOUS AFFECTION OF THE TEETH.—Can any reader tell me the cause of the following strange affection of my teeth? Some time back a rough deposit began to be deposited on my teeth, till it had accumulated to the thickness of a sixpence, gradually covering the tooth and eating away the gum all round until the tooth fell out without pain, and scarcely any loss of blood. Nine of my teeth have fallen out in this manner. A druggist whom I consulted told me it was canker, and a doctor said it was scurvy; neither of their remedies did me any good. When the lime-like coating, with which the tooth is covered, is scraped away, the tooth beneath appears to be as perfect as ever. Will some one help me, and prevent the loss of the rest of my teeth?—SUBSCRIBER FROM THE FIRST.

[2522.]—SHEET IRON RUDDER.—Will a correspondent kindly say whether a sheet iron rudder for canoes is found efficient and durable; if so, will he kindly state dimensions for a canoe 15ft. long?—H. C. ROGERS.

[2523.]—RUST IN WATER.—BREWING.—Will any of your numerous readers inform me the way to construct a cheap filter, which will separate rust from water; also has water, impregnated with rust, any injurious effect on the brewing of ale, especially as to flavouring it in any way; also the best and cheapest form of attemperator for checking the rise of heat in a fermenting square, dimensions 6ft. square, and 5ft. deep, usual length of brewing 25 barrels, temperature of water direct from the well 53°?—CROMWELL.

[2524.]—LONGITUDE.—Will some reader tell me the difference of time between Belfast and Glasgow?—SCIRE VOLO.

[2525.]—CONTENTS OF PART OF SPHERE.—Will some brother reader inform me how to find the content of part of a sphere greater or less than a ½, the two plane surfaces at right angles?—ANTHONY.

[2526.]—SUBMARINE LAMP.—I have made several fruitless efforts to make a lamp some 3in. diameter by 5 or 6 long, that will burn under water. Could you get me any information on the subject? I want it to burn when submerged some 4 to 6ft. in fresh or salt water. I have tried a candle in a lamp fed with air by india-rubber tubing, but it went out speedily. Information as to the construction of such a lamp would oblige.—W. A. HACKETT.

[2527.]—ROSCOE'S LUBRICATOR.—Will some one of our practical correspondents kindly inform me whether Roscoe's patent lubricator lubricates the slide-valves of a locomotive engine when the engine is running with steam on, or only when the steam is shut off?—G. W. R.

[2528.]—MUSICAL BOX.—Would some kind and competent reader give a full description of a musical-box? I would be particularly obliged if some one would tell me how the uniform motion is obtained.—OMAR.

[2529.]—INVENTOR OF THE MANGANESE BATTERY.—Will "Mr. W. H. Stone," who gave a description of the manganese battery, state the name of the inventor of the same?—X. Y. Z.

[2530.]—THOMSON'S ROAD STEAMER.—The account in your paper of Thomson's road steamer is surprising. Can any of your readers give me any information as to the durability of the india-rubber wheel tires? I have seen on hand-trucks at railway stations similar tires. How do they wear? I should be afraid the rough stoned roads would destroy the tire of the steamer. Also although the tires doubtless will expand under the pressure of the steamer, still the weight must be there, and how can they be prevented sinking on soft land?—AGRICULTURE.

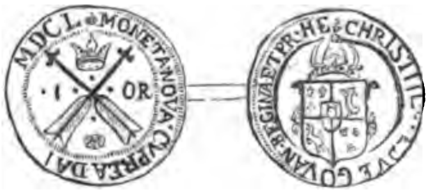
[2531.]—BRAZING CAST IRON.—The impression for April 8th contains an answer to my query from "Blue Ruin;" my best thanks to the correspondent for his kindness. The method of laying the work in moulding sand will not suit my purpose, and pouring melted iron over the joint is not what I should term "brazing." I will define more particularly the information I seek. I very frequently have to repair important bright parts of machinery, cast iron (small pieces generally). The defects are caused by friction. I file a slot in the cast iron, and fit a piece of wrought iron in its place to compensate for wear. My difficulty is this: I cannot get the spelter to unite the cast and the wrought iron—it has an affinity for the wrought iron, but will not take on the cast iron. It can be accomplished I am certain, as I have seen specimens of cast-iron' neatly mended by brazing pieces of wrought iron to compensate for wear. For the information of St. George, I can assert that the process of Mr. Armitage, of Kirkstall, for case-hardening, is not new. I have seen prussiate of potass used in the way described twenty years since. I always use prussiate of potass for hardening my work (wrought iron), if there is much friction, especially bolts and pins.—RECIPROCITY.

[2532.]—LEAD FOR "RELWOT'S" ENGINE.—(To Mr. Baskerville.)—Allow me to congratulate Relwot for obtaining such an excellent and valuable answer from our good-natured correspondent, J. Baskerville. Such an answer is worth pounds in THE ENGLISH MECHANIC, not only to Relwot, but to others as well. I wish to ask J. B. one question—Why would he give so much lead to the valves of the engine in question? I should have thought ¼ in. lead decidedly too much for any stationary engine, except it was a very high piston speed, as in my opinion the piston speed is the main point to be considered when deciding the proper lead for an engine. But I should much like to see the question of lead well argued out in these columns by some one that can fight, for scarcely two engineers seem agreed upon this point. Will J. B. kindly give me a single rule to find the proper weight and size of engine fly wheels?—STEAM SPIRIT.

[2533.]—COCOA-NUT.—Will one of your numerous readers be so good as to account for the milk in the cocoanut?—MINNEHAHA.

[2534.]—SOLUTION WANTED.—The straight lines A D, B E bisecting the sides B C, A C of a triangle intersect at G: show that A G is double of G D.—MINNEHAHA.

[2535.]—OLD COIN.—About 50 years ago I found, in an old quarry, a coin, token, or medal: it is of copper, and about ⅛ of an inch in thickness. Enclosed is a copy, half-size. It is corroded a little, and abraded on one side.



Will Mr. H. W. Henfrey, or any of your readers, kindly inform me what it is, and if it is of any value?—TAFFY.

[2536.]—ELECTRO-PLATING.—About twelve months ago I plated some tea-spoons, and they have a most disagreeable taste and smell when used for eggs, custard puddings, or plain boiled rice; I should be glad if some correspondent would kindly tell me the cause of this, and how it can be remedied.—A. R.

[2537.]—WRITING TELEGRAPH.—Is Meyer's telegraph, consisting of two cylinders having an isochronical motion, a new invention?—THOMAS.

[2538.]—INCRUSTATION ON POROUS CELLS.—Could any brother reader tell me the best way for taking off the copper incrustations on my porous cells, or suggest a good means for preventing them?—ELECTRIC CLOCK.

[2539.]—OKE.—I wish to know the exact value of a Turkish "oke;" a paper said lately it was equal to a kilogramme. Is this not an error?—CALCULATOR.

[2540.]—SMOKE ON WALLS.—I beg to submit the following question to the investigation of the scientific correspondents of our E. M. I observe that, in a kitchen or any other place of which the walls have been whitewashed, the smoke is deposited on the whole surface of the walls and ceiling, with exception of the edges or intersections. What may be the reason of this? Are there at those places currents which prevent the deposition, or is this phenomenon of the same order as the one that is observed with the iodine vapours in presence of a relief or of an engraving?—V. M. BEECHY.

2541.]—GALVANIC BATTERIES.—I have been studying for some time past the problem how to make an economical, constant, energetic, and lasting battery. I tried many substances, and heard afterwards that several had been already tried and had failed; might it not prove very useful to many readers to have a list of all the substances proposed or tried, with the results? This would spare much time and prevent waste; many readers could bring their brick to the building besides learned "Sigma," who has promised, I believe, to give us a note "On Batteries."—V. M. BEECHY.

[2542.]—PHOTOS. OF AUSTRALIAN SCENERY.—Would any kind brother reader tell me where I can procure photographs of an Eucalypt tree, and of an Australian acacia, or of an Australian landscape with those trees?—BERNARDIN.

[2543.]—THE NICOL PRISM.—"The Nicol's prisms, which our readers will have seen mentioned so often in the recent papers of Professor Tyndall, are expensive to obtain of any size. They are made of a crystal of calc-spar, cut across diagonally, the two sections being afterwards joined together by means of Canada balsam. It has recently been discovered that a prism, possessing the same optical properties, may be made by constructing a vessel of glass, inserting a thin plate of calc-spar across the diagonal, the vessel being filled up with bisulphide of carbon. If this be so, Nicol's prisms of considerable size may be made cheaply, since blocks of calc-spar of considerable size are often met with."—*Mechanic's Magazine*, February 26, 1869. I cut the above from a scientific periodical. Has any subscriber met with it, and, if so, I should be glad to obtain further details?—CARTHUSIAN.

[2544.]—HEATING WATER IN BATHS.—Is there not a patent apparatus to be placed in a bath to heat it in a short time?—A. M. M.

[2545.]—EMIGRATION TO NEW ZEALAND.—Will "Josh," "H. Coggins," or any reader, favour me with a few hints, as I am going to emigrate to New Zealand? I have saved £48, and I am a single young man, a Jack of many trades, but master of none.—W. STONE.

[2546.]—PATTERN-MAKING.—Will anyone be kind enough to tell me if there is any work published on "Pattern-making? If so, the price, and where to be had.—GALLOWAY.

[2547.]—PRINTING NAMES ON PLANS.—Will some brother reader be kind enough to inform me of a method of printing the names of fields, trees, &c., on plans of estates? I have lately used a printer's pallet and type, but with not much success.—LAND SURVEYOR.

[2548.]—GILDING BATTERY.—Will any reader lend me a little assistance? I have a gilding battery, Daniell's two cells, and cannot get it to work, as I am in error somewhere. The copper cells are about ⅞ of an inch larger in diameter than the porous pots, which are 3¼ inches across. I have put sulphate of copper round outside of pot nearly half-way up, and banked round at the top on the copper rim, that keeps the pot upright, and filled up with water inside the pot to immerse the poles. I put oil of vitriol and water, one part vitriol and two parts water; but I could get no action on the poles. The wires—one from each—were ordinary stout copper, and I led them into some strong cyanide of potassium dissolved in water, and kept it over a gas-burner, putting a piece of 22-carat gold on one wire, and the article I wished to gild on the other, but I could make nothing of it. If any reader will set me right I shall feel extremely obliged.—ONE IN A FOG.

[2549.]—SCREW STEAMER.—Will one of your readers be kind enough to inform me what horse-power is required for a screw steamer to carry from four to six persons, and whether an ordinary horizontal engine will convert for this purpose?—DOUGLAS M'CARTHY.

[2550.]—ETHEREAL GOLD SOLUTION.—I am very much obliged to "Sigma" for the information he has imparted, but he has not answered the last questions, as to the means of applying it, and whether the steel requires any preparation. If he will do so, he will very greatly oblige.—B. S. BURDEN.

[2551.]—THE SPECTROSCOPE.—It has often occurred to me that some of our numerous brethren who practise with the spectroscope might, if they were asked, give us a paper or two concerning the practical working of the instrument. And if any one has made one of these instruments at a cheaper rate than paid for at an optician's (of course it is not the elaborate construction of the instrument but its efficient working when completed), perhaps he will give a description and probable cost of making the same. If any will do this I think he will receive the hearty thanks of many others besides myself.—A. J. JARMAN.

[2552.]—MOIST COLOURS.—Could any of your kind readers inform me how to make moist colours or cakes of paint, like Winsor and Newton's?—ORANGE.

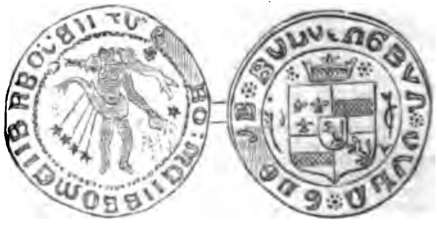
[2553.]—TUNING CONCERTINA.—Will any reader inform me how to tune English concertina reeds, and the best kind of metal? What I want to know most is the tuning after the metal is screwed in.—W. B.

[2554.]—SQUARE GASKETING.—How shall I proceed to plait gasketting or spun yarn to form a solid square, as used in stuffing-box of engines.—LITTLE CHARLEY.

[2555.]—ECHO.—Will any reader kindly inform me how the echo is produced with the cornet?—AN AYRSHIRE AMATEUR.

[2556.]—ENAMEL.—I have tried the recipe for making white enamel that "Iota" kindly gave on page 18, but I find it will not keep together; if "Iota" or some other brother reader will tell me the reason why, and the remedy, he will greatly oblige.—A BURNER.

[2557.]—COPPER COIN.—Could any of your correspondents inform me what the copper coin is, a copy of which I enclose?—FLINT.



[2558.]—SUN DIAL.—I have made a sundial, horizontal, and want to have the meridian line correct. Will some of our brother correspondents be kind enough to tell me the exact declination of the needle for the present time, as I can have access to a compass? I have asked three persons who used the compass in mines, and they all said it pointed north: not one of them knew there was any declination at all, and one would not believe it until he asked an optician, who informed him that it was so.—A. H. Z.

[2550.]—ANTIQUE.—I have in my possession a cornelian ring with an antique head cut on the stone.

The inside of the cutting is beautifully polished, and I have been told that the secret of polishing the engraving is lost; is this so? Perhaps some of your readers, "gem collectors," would kindly inform me, or give me any hint whereby I could judge if the cutting is an antique or a modern one?—VIVIS SPERANDUM.

[2560.]—MICROSCOPIC.—I should feel under obligation to your microscopical readers who would inform me what is the view of first-class observers as to the lenses in the compound eyes of insects—the dragon-fly for instance. Do they consider the hexagonal piece is *all* lens, or that a minuter circular lens is fixed in this hexagonal setting?—F. F.

[2561.]—BOOKS.—I should be glad in reading of the sizes of books to be able to know exactly what is meant, as I am neither in the trade nor otherwise able to learn. My requirements are the sizes in inches of the page of all from imperial 4to to 33mo?—F. F.

[2562.]—HARMONIUM.—I intend to make a harmonium pan according to "Eleve's" instructions to a "Country Amateur," No. 245, page 279, but there are one or two things I should like to know before I begin, that is, the size of the reed hibs in the veneer at top and bottom, and also if the veneer is the very thin kind that is sold in the shops? I should think that the reed veneer at least would require some thickness in order that the reeds may be screwed to it. Perhaps "Eleve" would be so kind as to enlighten me on the subject. I would also take it very kindly if some of your harmonium correspondents would show me the way how two or more rows of reeds are placed in a harmonium—how the channels are connected with one another? I may mention that I have an apparatus under the keys of my harmonium by means of which a tune in any key may be played on the white keys alone, except where an accident occurs, when the black is used. This is done by merely shifting a small knob in front of the key-board, according to the key to be played upon. Perhaps some of your musical correspondents would say whether it is an improvement or not. It must be an advantage to those who would like to play a common tune in as easy a manner as possible, who are not very well versed in the mysteries of sharps or flats, as by this a tune in four or five sharps or flats is as easy to play as one in the key of C.—VALVE.

[2563.]—SMALL COPPER COIN.—Obv., a shield of arms, "A Halfe Penny, 1668;" rev., two men holding a piece of cloth, "For the Poor of Dover." Why was it struck, and by whom?—OLD COIN.

[2564.]—LEADEN COIN SIZE OF A HALFPENNY.—On one side a rude "W," on the other a device probably intended for an anchor. Should like information about it?—OLD COIN.

[2565.]—HERBAL OF THE BIBLE.—Will any reader of the MECHANIC tell me of a book treating of the plants named in the Bible?—IXION.

[2566.]—TOOTH POWDER.—Will some brother subscriber kindly give a good receipe for a tooth powder?—INQUIRER.

[2567.]—CHIMING CLOCK.—I have a chiming clock, the weights of which are so heavy (28lb. each) that whenever a line breaks, the weight, falling from a height of perhaps 5ft, has an unpleasant way of breaking through the floor. Can any reader suggest any means by which this may be prevented? I have *thought of a bag filled with hay, or something similar, to be placed at the bottom of the clock-case, and so act as a buffer.* In that case, what would be the best material to stuff the bag with?—TOODLES.

[2568.]—HARD WATER.—I find the Thames water is soft, but that the same water when it has passed through the water works gets hard. How has this change been brought about? Can anyone explain the mystery?—STEADY HAND.

[2569.]—BAT HANDLES.—Can any of my brother subscribers tell me how to prepare and glue up bat handles?—95, VOL. 4.

[2570.]—GLAZIERS' DIAMOND.—Will any subscriber inform me how to soften the metal for taking out glaziers' diamonds; also, what metal is used, and how to re-fix the diamond?—IGNORANCE.

[2571.]—MATHEMATICAL TABLES.—Will any kind friend inform me in which of the modern cyclopædias is the best and fullest account given of the mathematical tables published to the present time.—W. H., Cinderford.

[2572.]—LARGE FILTER.—Would some person of experience advise me about a filter? I require about 5000 gallons of clean water every 24 hours. My water carries a considerable quantity of sand, insects, vegetable matter, &c., and is often during the day quite turbid. Could I construct a filter, using a large treacle or other cask in the manner described on page 578, Vol. X? Would "W. H. H.", 611, Vol. X., tell me where he got his "moulded carbon filter blocks"? Would common wood charcoal answer?—HYDRO.

[2573.]—ÆOLIAN HARP.—Would someone tell me the best way to make an Æolian harp; also the best materials for same? A small drawing with measurements for one to fit in a common window sill would help me very much.—R. B.

[2574.]—BRONZING MODEL VESSEL.—I am making a small model vessel, which I wish to bronze in imitation of copper on the bottom, and I want to know if the best copal varnish put on will cause the bronze to stick; if not, what will?—ONE IN THE DARK.

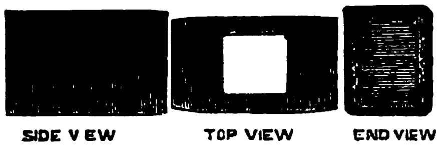
[2575.]—GUTTA PERCHA *v.* ROPE BANDS.—Will any machine worker tell me which bands work best—gutta percha or hemp rope, and which do their work best? I believe rope is affected by the damp or dry weather—I mean round bands.—SUSSEX.

[2576.]—PNEUMATIC PARADOX.—Could any of your ingenious readers give me an explanation of the action of this little instrument?—SWANSEA.

[2577.]—BORING GLASS.—Can any of my fellow-readers inform me how to cut a hole, 3in. in diam., in the centre of a common piece of glass?—C. H.

[2578.]—CONTACT BREAKER.—Will "Tangent" kindly say where I can purcase one of Rhumkorff's double quicksilver contact breakers, and at what price? Are they difficult to make?—THOMAS J O'CONNOR.

[2579.]—MALLET.—The enclosed drawing is a mallet with a metal shell and wooden faces. It is very useful in our trade. We have broken the one we had, and we cannot meet with another. We have tried to get one cast from the old one, but they say they cannot cast one without a model, and it is not worth employing a regular modelmaker, so I want some of my brothers to give me instructions how to make a model for the same.—ANON.



USEFUL AND SCIENTIFIC NOTES.

◆

THE SIZE OF ATOMS.—Sir William Thomson, who contributes an important paper on the "Size of Atoms" to last week's *Nature*, thus sums up:—"The four lines of argument which I have indicated lead all to substantially the same estimate of the dimensions of molecular structure. Jointly they establish, with what we cannot but regard as a very high degree of probability, the conclusion that in any ordinary liquid, transparent solid, or seemingly opaque-solid, the mean distance between the centres of contiguous molecules is less than the hundred-millionth, and greater than the two thousand-millionth, of a centimetre. To form some conception of the degree of coarse grainedness indicated by this conclusion, imagine a raindrop, or a globe of glass as big as a pea, to be magnified up to the size of the earth, each constituent molecule to be magnified in the same proportion. The magnified structure would be coarser grained than a heap of small shot, but probability less coarse grained than a heap of cricket-balls."

THE COLOURING MATTER OF BLOOD.—Herr Hoppe-Seyler of Tubingen, who has for a considerable time been investigating the colouring matter of the blood, and has discovered that the so-called Hæmatin is an essential product of its decomposition, shows that this substance is a product of oxidation formed immediately on contact with the air; and, that, moreover, by decomposition of the colouring matter of the blood, another substance, besides albumen, results, which he calls Hæmochromogen. Both have peculiar effects upon light, which can be recognised by the absorption-bands in the spectrum, and enables them to be distinguished. Both contain iron.

THE LATEST EXCAVATIONS IN POMPEII, &c.—The *Giornale di Napoli*, of March 26, states that on the occasion of a royal visit to Pompeii on the preceding day, some excavations were made in some houses situated on the right of the Via Stabiana, and a variety of treasures were found, viz.: a large number of objects in terra cotta, iron, and bronze, a beautifully-chiselled silver cup, a very rare glass oil lamp, a still rarer and perhaps unique object, consisting of a small terra cotta cup with a metallic cup inside containing a night-lamp like those in modern use, a large gladiator's sword, with the metallic portions of the scabbard; many copper and silver coins of the time of Vespasian, and an amphora full of small onions near the skeleton of a woman. The skeleton of a man was also discovered, holding a pickaxe in one hand, an iron bar in the other, and with many bronze objects scattered at his feet, near a wall which had been partially broken through.

THE LONDON CO-OPERATIVE WATCH MANUFACTURING COMPANY.—On Monday night (11th inst.) a crowded meeting of the workmen engaged in the various branches of the clock and watchmaking trade in Clerkenwell was held at the Amwell-street School-room, Pentonville, for the purpose of considering the advisability of the trade, as a body, supporting the above company, established by operative watchmakers to promote the production of genuine London work. Mr. C. Young, who occupied the chair, opened the proceedings by declaring his conviction that the only way to retrieve the present depressed state of the trade, owing to the large importation of foreign watches duty free, was by the workmen combining together in a co-operative company to produce a watch equal in every respect to the best foreign watches imported, and at as low a price. There were three points upon which he believed there was no difference of opinion—viz., that if the watchmaking trade was to be kept in this country, the whole system of production must be changed; that watches should be of one uniform gauge; and that all foreign watches sold in England should have the maker's name, and thus prevent them being palmed off on the public by unprincipled sellers as English lever watches. The meeting was then addressed by Mr. Ganney, who described the system of watchmaking by machinery as practised in America. It was acknowledged by all that the Clerkenwell watchmakers were the best workmen in the world, and the company were prepared to supply a silver lever ¾-plate watch, jewelled in four holes, for 50s. This watch had been designed and produced by a committee, composed of the very best workmen in every branch of the trade, and every part of the watch would be made in one building, thus effecting a great saving in time and expense upon the present system. Messrs. Newton, Holdsworth, Jones, Hislop, Mead, and others addressed the meeting in support of its objects, and the following resolutions were carried by large majorities:—"That in the opinion of this meeting the union of labour and capital under a well-organised system of co-operation is essential to the maintenance of the watch trade in Clerkenwell." "That watches should be made by a uniform gauge, and that every watch should bear the maker's name." "That this meeting pledges itself to support the London and Clerkenwell Operative Watchmakers' Manufacturing Company." Several objections to the scheme having been replied to, to the apparent satisfaction of the meeting, the proceedidgs concluded with a vote of thanks to the chairman.

A STEAM-ENGINE WITHOUT A CRANK.—The *Milwaukee Daily News* thus describes the performance of an engine, which, however, we fear our readers will read with considerable doubt. The engine is very simple, and consists of a cylinder 12in. long and 6½in. bore (in one already built), with the shaft passing through the centre of it. The cylinder is furnished with a piston at each end, precisely like the pistons of common crank engines; to these pistons are connected short rods, with a friction roller at the outside end working in the inside of an elliptical ring, which passes around the shaft outside of the cylinder; outside of the ellipse is another friction roller, connected to the piston by compensation levers in such a manner that when the pistons are moving towards the cylinder, the rollers act on opposite sides of the ellipse, both pulling directly towards the centre, thus causing them to move forward on the ellipse, and communicating a rotary motion to the shaft. After the rollers have passed forward to the shortest diameter of the ellipse, the steam is exhausted from the ends of the cylinder and let into the middle, between the pistons, pressing them outward, causing the rollers in the ends of the piston rods to act on the inside of the ellipse, and continuing the forward motion of the shaft until they arrive at the long diameter, when the steam is exhausted from the middle of the cylinder, and is again applied at the ends. The results obtained were surprising, and can hardly be credited by believers in the infallibility of the crank motion. The cylinder is about the size of the cylinder of an eight-horse crank engine, with a stroke of 3in. for each piston, and the power evolved was at least 22-horse power, and some present at the trial placed it as high as 25-horse power, with a speed of 100 revolutions per minue, and 50lb of steam, consuming about the amount of fuel required for a 10-horse engine.

THE PULSE.—Dr. Omanza describes a method of registering photographically, the beats of the pulse. The appartus essentially consists of a small inverted funnel, having a long narrow stem and a caoutchouc base. This instrument is filled with mercury to a certain distance and its base is applied to the heart or an artery; the oscillations of the mercurial column are then photographed by well-known processes. It is said that with this apparatus the apparently single stroke of the pulse is shown to consist of three, or even four, in succession.

DIMINUTION OF WEIGHT IN MAN DURING THE COLD MONTHS.—Mr. Milner, of Wakefield (*Am. Jour. of Med. Science*), some years since performed a series of experiments with a view of determining the periodical fluctuations in weight, substance, and form, which the whole body undergoes. He weighed every prisoner upon his entrance into the convict establishment at Wakefield, and subsequently at the end of every calendar month, all of them being subjected to similar conditions of temperature, food, exercise, and ventilation. The number of men weighed exceeded 4000, and the total number of individual weighings was 44,004. From his experiments it was found that there was a progressive loss of weight in January, February, and March, and a gain in April, May, June, July, and August, and a loss in September, October, November, and December; or, in other words, an increase of weight during the hot months, and a diminution during the cold. These results are in accordance with physiological truth, for Dr. E. Smith has shown that the quantity of carbonic acid exhaled in winter is largely in excess of that given out in summer, and the sudden weight in April is found to correspond with an equally abrupt diminution in the quantity of carbonic acid expired.

UNIVERSAL STANDARD OF MEASUREMENT.—According to the *Memorial Diplomatique* the Austrian Government has just signified its assent to a proposal of the French Government for an International Commission to assemble in Paris in order to agree upon a common standard of measurement for all civilised nations. Already 15 European Powers have announced their willingness to take part in the commission. Even England, which hitherto has been disinclined to depart from old customs, will be represented by the Directors of the Observatories of Greenwich and Oxford. The French Government now only awaits replies from the United States, Brazil, and the South American Republics previously to calling together the commission. The Minister of Foreign Affairs would of right be the honorary president, but the proceedings will really be directed by the vice-president, General Morin, Director of the Conservatoire des Arts et Metiers, in whose archives is deposited the official standard of the metre recognised in France.

A CURIOUS DISCOVERY.—Dr. Milio, the celebrated surgeon of Kieff, has recently been at St. Petersburg explaining a means he has invented of illuminating the body by means of the electric light to such an extent that the working of the human machine may be observed, almost as if skin and flesh were transparent. The *Moscow Gazette* asserts that, to demonstrate the feasibility of his process, Dr. Milio placed a bullet inside his mouth and then lighted up his face, upon which the bullet became distinctly visible through his cheek. Dr. Milio does not propose to lay bare all the secrets of the flesh, to explore the recesses of the heart, or to perform any miracles, physical or metaphysical. But he claims to have discovered a new and effective way of dealing with gun-shot wounds; first, by means of electric illumination he discovers the precise situation of the bullet: next, by means of magnetism, he proposes to extract the bullet—provided always that the bullet contain some portion of steel. Against leaden bullets his system is powerless, and he therefore intends to represent to the International Committee, which lately met at Geneva, the desirability of recommending an admixture of steel in the manufacture of all future bullets. Dr. Milio's experiments with bullets containing only a slight admixture of steel are said to have been thoroughly successful.

ANSWERS TO CORRESPONDENTS.

*** All communications should be addressed to the EDITOR of the ENGLISH MECHANIC, 31, Tavistock-street, Covent Garden, W.C.

ENGLISH MECHANIC MUTUAL IMPROVEMENT SOCIETIES.

LAST week we inserted a letter (p. 89) from Mr. D. William Kemp, of Leith, on the formation of "ENGLISH MECHANIC Mutual Improvement Societies." The idea is a good one; in fact, it is in harmony with the structural idea and purpose of this publication under its present management. Our readers and subscribers feel an interest and a pleasure in mutually instructing each other. This they now do through the post. Mr. Kemp suggests that they should also meet together in different localities, cultivate each other's acquaintanceship, and "discuss some of the topics reviewed in the MECHANIC during the past month." The suggestion has already taken root. It will be seen by an advertisement in our first page that a meeting of the subscribers of our journal in Edinburgh is called for the 29th inst., at the New Waverley Hotel. The experiment is a novel one, and we trust it will be successful. We shall be glad to record the result.

THE following are the initials, &c., of letters received up to first post, Thursday, April 14:—

B. Forster, J. M. Proctor, W. W., R. M., J. H., Rev. H. E. G., W. H. C., Capt. Fawcett, W. H. B., Rev. N. W. G., Rev. G. B. G., T. C. and Sons, Rev. E. K., J. Crowther, D. W. K., S. S., E. A. K., J. A. Watt, J. P. J., F. King, F. W. T., B. Edwards, J. A. M., J. A. B. and Co., F. A. M. D., J. H. and Co., J. R. Williams, W. B. H., H. H., A. Granville, J. H., E. W. H., W. A. H., W. H. G., R. F. H., G. R. M., L. and Co., C. Paget, H. C. C., Geo. Luff, C. B. A., Veritas, H. E. G., G. Firth, Casual Observer, Hugo, West Indian, W. Stephenson, Swansea, Anti Egyptian, W. B., C Holday, A Smoker.

J. E. COSTARD.—No. 124, Newgate-street. See our advertisement pages.

CICERO.—Beginners do not get £100 per annum in the Bank of England. Your other queries would take up too much space.

S. W.—Results prove you wrong.

LAMBDA.—We know of no institution in which Greek is taught conversationally.

INQUIRER.—Under the circumstances it would be waste of money for B to patent his invention if it were covered by A's previous patent. We can, however, scarcely give reliable advice as to the course to be pursued with only your general statement to found our opinion on, and should advise you to consult some respectable patent agent.

PAT HAGAN is more than half a fool.

T. S. REYNARD.—No stamps enclosed.

NORTHUMBRIA.—We could not in any case consent to "exchange" articles sent through our office. We know nothing as to the respectability of the *Exchange Mart* alluded to.

W. BOYD.—The inventor of the pedespeed is an American.

THANKS.—"Carthusian" thanks Alexander Hall for the trouble he has taken with the "distance measurer." He thinks it, however, too complicated to be constructed by any but a regular watchmaker.

J. L. T.—Write to the Secretary of the Institute of Surveyors, 12, Great George-street, Westminster.

W. H. W.—Queries really too insignificant.

A WESTHEAD.—We don't know the address.

FLINT.—Third brass Roman coin of Maximinus.

R. J. STUBBS.—Consult some respectable optician. Your query is an advertisement.

W. R.—It is fruitless to kick against the pricks.

J. B.—We don't answer by post.

PHRENOLOGY AND BIG HEADS.—"Saul Rymea" has sent us a long letter exposing the fallacies of "T. D.'s" letter in our last number. The insertion of the letter would lead to a fruitless controversy; at all events we think our space may be better appropriated. Our experience teaches us big heads are no guarantees or even indications that their possessors are wise men.

C. V.—No charge is made for queries.

J. H.—Don't ask such silly questions.

ALFRED ALLEN.—We shall bye-and-bye have a halfpenny post for newspapers. The ENGLISH MECHANIC ought to reach you before Saturday by the ordinary trade channels.

THE EARTH'S MOTION.—Mr. Beardsley says:—"Will you kindly alter the heading to my letters on the 'Figure and Motions of the Earth' to 'The Earth—Its Reputed Figure and Motions?' I make this request as it is more in keeping with the spirit of the contents of those letters, and is in other ways also more applicable."—Mr. Beardsley is quite welcome to the change of title if it will do him or his cause any benefit. We think it right, however, to say that the reason why we have placed at his disposal a certain amount of space is that some one may have an opportunity of refuting his fallacies—fallacies which are being enunciated nightly by Parallaxes, enthusiasts, and charlatans. Perhaps Mr. J. Dyer, the author of the admirable little work "Spherical Form of the Earth," noticed by us a few weeks since, will reply to Mr. Beardsley?

IGNORAMUSES.—Pitman's system, which is the best, can be learnt from his manuals, which are published at cheap rates. We give the preference to drawing, because a knowledge of that art is absolutely necessary to the great majority of our readers, while shorthand could only be useful to a few. We must advise you to become more perfect in spelling and composition before attempting phonography.

LENA.—Search at the Patent Office.

PLEBEIAN.—1. Prices of globes vary; inquire of the makers. 2. By tracing its position on a map or globe. 3. We do not know.

J. BYNG.—It is a Parisian invention, and is patented in England, but whether manufactured or not we cannot tell. Search at the Patent Office for the specification, and write to the inventor or his agent. We do not reply by letter.

THE SIXPENNY SALE COLUMN is the only place in which can appear queries forwarded by A. E. Tucker, "One in the Dark," "Sussex" (2nd query).

DERBY, A. O. Z.—Search at the Patent Office.

GEORGE GASKELL.—Both your queries have been answered—the latter very recently.

95, VOL 4.—Buy one of our cases.

A. MORRIS.—On page 87, under the heading "China Grass."

PAINFUL.—Your disorder would seem from your description to be some neuralgic affection; but it would be exceedingly unsafe to advise. Consult a medical man.

HUMANE MAN.—It is a question we cannot well treat of in these pages. Tell your friend to discontinue his evil practices *at once*, or he will die early or become insane. He has debilitated his constitution by vice; he can only restore it—or partially restore it—by virtue.

JAMES BELL Douglas, Isle of Man, writes us that he does not agree with M. Somner's opinion on the cause of sleep. J. B. says, "My opinion is that the heart continues to strike less the pericardium when the person continues to sit or rest; hence the constant current of blood which flows from the heart is not so strong." We opine "J. B.'s" opinion is conclusive.

W. H. GOSS.—The numbers *were* forwarded. We cannot be responsible for postal irregularities.

THE BRICK FROM LIVERPOOL.—Not the sort asked for; the shape of the parcel betrayed its contents. We returned it to the railway company unopened without paying the carriage.

THE *ENGLISH MECHANIC* LIFE-BOAT FUND

Subscriptions to be forwarded to the EDITOR, at 31, Tavistock-street, Covent-garden, W.C.

Amount previously acknowledged	£164	18	10
W. H. Thorp	0	1	0
Per E. Hurst—			
Proceeds of a concert given in aid of the ENGLISH MECHANIC Life-Boat Fund, at Head Quarters of the 1st Essex Engineer Volunteers, Heybridge, near Malden, Essex; and promoted by Messrs. Mulley, Andrews, and Hurst, in the employ of E. H. Bentall, Esq., M.P., Heybridge Iron Works	3	6	0
Orange	0	0	6
Collected at the King's Arms Hotel, Kensington, by H. Cowan—			
Mr. Pettit	0	0	6
Mr. Leete	0	0	6
A. B. P.	0	1	0
Pell Huckle	0	1	0
H. Cowan	0	1	0
Mr. Nock	0	0	6
Mr. Wilson	0	0	6
Mrs. Cowan	0	0	6
Mr. Lye	0	1	0
Mr. Andrew	0	0	6
Mr. Hall	0	5	0
E. J. B.	0	1	0
	168	19	4

THE INVENTOR.

IN obedience to the suggestions of a number of readers, we have decided on appropriating a portion of our space to a condensed list of patents as nearly as possible up to the date of our issue.

APPLICATIONS FOR LETTERS PATENT DURING THE WEEK ENDING APRIL 12, 1870.

989 J. Winter, Wardour-street, Soho, apparatus for filling glass bottles and jars with soups, jellies, and other edibles

990 H. W. Hammond, Manchester, improvements in the manufacture of iron

991 H. A. Dufrené, 10, Rue de la Fidélité, Paris, improved machine for winding yarns or threads on bobbins—A communication

992 T. Smith, Leigh, looms for weaving

993 J. Pickup, Tong, York, improvements in machinery to be employed in drawing, spinning, and twisting fibres

994 A. M. Clark, Chancery-lane, improvements in apparatus for washing and treating pulps—A communication

995 J. Pickering, Glasgow, forming holes in iron castings

996 J. More, and W. L. G. Wright, Glasgow, apparatus for forcing and projecting liquids

997 T. Rose, Oxton, and R. Emerson Gibson, New Brighton, utilisation of a certain material obtained in treating cotton seed

998 C. J. Busk, Pancras-lane, London, treating cements for the purpose of rendering them applicable for the production of artificial stone—A communication

999 E. Green, Phœnix Works, Wakefield, apparatus for removing soot from the tubes of steam boilers

1000 J. Parker, Woodstock, improvements in dry earth closets

1001 E. Lever, Haughton, improvements in signals and name plates to be used with letter boxes

1002 J. McNaught and W. McNaught, St George's Foundry, Rochdale, steam boiler furnaces

1003 D. M. Childs, 16, Mark-lane, London, improvements in sash fasteners—A communication

1004 T. Horridge, Bolton, means of communicating between the passengers and guard

1005 T. Ford, Birmingham, improvements in gas lamps

1006 I. Baggs, High Holborn, improvements in making carbonates of ammonia

1007 E. J. Hill, Victoria Railway Station, Pimlico, slipping and depositing parcels and packages or other objects

1008 A. H. Brandon, 13, Rue Gaillon, Paris, an improved strap fastener—A communication

1009 R. Jones, Botolph-lane, London, merchant, improvements in the preservation of animal and vegetable substances to be used as food

1010 J. Mayer, 59, Great Portland-street, improvements in specula for surgical purposes

1011 J. Sharrock, Rochdale, improvements applicable to winding engines

1012 F. J. Sweeting, Clyde Dry Dock, Rotherhithe, apparatus for indicating the distance travelled by vehicles

1013 G. H. James and J. James, 11, Newgate-street, improvements in cases for cigars

1014 W. Young, Magdalen-bridge, Midlothian, and P. Brash, Leith, manufacture of illuminating gas

1015 C. H. Wight, Baltimore, U.S., improved inkstand

1016 C. H. Wight, Baltimore, U.S., an improved stand for containing stationery, in combination with a thermometer

1017 W. Henley and D. Spill, North Woolwich, non-explosive compounds forming the material for the manufacture of collodion

1018 A. B. Brown, Birkenhead, improvements in steering gear, and in machinery for starting, stopping, and reversing heavy steam engines

1019 M. J. Roberts, Pendarren, near Crickhowell, Brecon, propelling apparatus for ships and other vessels

1020 C. Crossley and R. Whipp, Manchester, and T. Crossley, Rochdale, improvements in the manufacture of size

1021 T. Adams, 14, Little Tower-street, London, stationer, a spring clip file or binder—A communication

1022 T. Adams, 14, Little Tower-street, London, binding music, pamphlets, and other papers—A communication

1023 H. A. Bonneville, 18, Chaussée d'Antin, Paris, astronomical instrument called the "Heliade"—A communication

1024 L. A. Brode, Glasgow, fibre suitable for making paper and a brown colouring matter

1025 C. H. Gardner, West Harding-street, Fetter-lane, London, improvement in typographic, lithographic, and zincographic printing machines

1026 C. Montague, Cannon-street, London, improvement in the manufacture of overcoats and other garments

1027 J. Shackleton, Bradford, York, improvements in apparatus for heating or warming rooms

1028 T. Robinson, Widnes, apparatus for skimming cast iron during the process of casting

1029 C. Clinch, Witney, apparatus for "cleansing" beer and other fermentable liquids

1030 E. Daniel, Bapeaumetown, near Rouen, apparatus for indicating the water level in steam boilers

1031 F. Taylor, Manchester, improvements in the construction of paper collars

1032 A. Watkins, 435, Strand, and R. Cory Harrott, 5, Gray's-inn-square, apparatus for winding and setting watches

1033 J. Edmondson, W. Edmonson, and F. W. Edmonson, Manchester, improvements in machinery for etching or engraving cylinders

1034 W. H. Carson and J. V. Toone, Warminster, improved automatic lamp-creep

1035 H. J. Kirkman, 3, Soho-square, improvements in the construction of pianofortes

1036 G. Baker, Bridge-street, Norwich, improvements in the manufacture of tacks

1037 T. Aveling, Rochester, improvements in the construction of agricultural, road, traction, and portable steam engines

1038 C. F. Andersen, Abbey-wood, an improved apparatus to be used in window cleaning

1039 A. Etienne, Charlotte-street, Fitzroy-square, construction of carriages, vehicles, and velocipedes

1040 W. Cooper, Bradford, York, improvements in sliver or cotton cans

1041 J. B. Blythe, St. Mary-axe, London, apparatus for seasoning, injecting, and preserving wood

1042 J. Fairclough, Warrington, an improved mill stone dress—A communication

1043 A. Craig, 12, May-terrace, Renfrew, improvements in mills

1044 C. F. Varley, Beckenham, improvements in electric telegraphs

1045 W. Nelson, Bolton, manufacture of quilts, toilettings, and other figured fabrics

1046 H. Mallet and C. Russell, New Basford, twist lace machines

1047 W. E. Newton, 66, Chancery-lane, improved machinery applicable for inland navigation—A communication

1048 A. H. Brandon, 13, Rue Gaillon, Paris, improvements in looms—A communication

1049 A. Mosley, Old Radford, improvements in the jacquard

1050 P. C. Thamsen, Copenhagen, improvements in finishing linen, cotton, and other fabrics—A communication

1051 J. Henderson, New York, an improvement in the manufacture of wrought iron and steel

1052 W. R. Lake, Southampton-buildings, London, improvements in the construction of steam vessels—A communication

1053 A. Parkes, Birmingham, improvements in the manufacture of steel

1054 S. C. Lister, Bradford, improvements in looms for weaving

1055 L. Weber, 104, Rue Royale, Brussels, improvements in galvanic cells and batteries

1056 G. H. Ellis, 91, Gracechurch-street, improvements in rotary engines and pumps

1057 W. Higgins, 11, Great New-street, Fetter-lane, Middlesex, improvements in the manufacture of hackney carriage and other lamps

1058 A. Brown, Lanark, improvements in ornamenting wood, leather, and other materials

1059 J. B. Booth, Preston, improvements in apparatus for lubricating and covering spindles employed preparing, spinning, doubling, and winding fibrous materials

1060 R. Adams, 16, Gladstone-terrace, Battersea-park, improvements in spring hinges

1061 T. J. Smith, 166 Fleet-street, improvements in treating excremental matters—A communication

PATENTS SEALED.

2936 W. Kelsey, improvements in driving drums or pulleys

2937 D. Sowden and R. C. Stephenson, improvements in looms for weaving

2951 G. A. Middlemiss, Sunderland, apparatus for withdrawing water or other fluids in as pure a condition as possible from wells, cisterns, and other places

2959 E. A. Snuggs, improvements in cocks, taps, and valves

2950 R. L. Hattersley, improvements in looms for weaving

2962 J. B. Blyth, improvements in the mode of and apparatus for vaporising and burning liquid hydro-carbons for the production of heat in furnaces and for generating steam

2965 E. Farrington, improvements in breech-loading fire-arms

2970 J. H. Selwyn, improvements in fire-arms, parts of which are applicable for use as a digging tool

2977 S. Osborn, improvements for reaping and mowing machines

2980 J. Hartley, apparatus for registering billiards or other games

2981 R. J. Ellis, improvements in apparatus for desiccating animal and vegetable matters

2994 J. Hudson, J. Hudson, and C. Hudson, improvements in machinery for the manufacture of paper

3079 W. J. Rivington, improvements in counting and registering apparatus

3080 C. D. Abel, a new or improved manufacture of metallic tiles or slates for roofing

3098 G. Ireland, improvements in nutcrackers

3255 J. Mason, an improvement or improvements in metallic pens

3557 W. Tranter, improvements in fire arms

178 C. A. Calvert, an improved apparatus for self-registering and checking the money taken for admissions to public entertainments

400 F. T. Ferguson, an improved jug or pitcher

2972 L. M. Casella, apparatus to be employed in lighting gas burners

2975 R. Scholefield, improvements in pumps or apparatus for raising or forcing water or other liquids or fluids

2982 W. J. Bonser, apparatus to be used for feeding and watering cattle in railway trucks

2989 L. A. Lesage, improvements in closing and securing vessels containing alimentary substances

3007 S. Barber, apparatus for the propulsion and steering of navigable vessels

3015 W. E. Gedge, an improved elastic horse shoe

3023 W. H. H. McNeight, venetian and other blinds

3057 J. F. Crease, an improved method of attaching cements to iron or other substances

3059 W. Firth, wheels of traction carriages for use on common roads and tramways

3071 F. Jenkin, improvements in bridges

3078 J. Bignall, improvements in reaping machines

3119 W. A. Ross, improvements in preserving the surface of iron, steel, copper, brass, and other metals

3156 R. Marsden, pulley blocks or apparatus for raising heavy weights

3159 A. Minton, improvements in electro coating iron and other metals

3160 B. de Lagillardaie, producing condensations and evaporations in vacuum

3247 J. P. Budd, improvements in the manufacture of iron

3768 R. Derham, an improved machine or apparatus for washing potatoes

3776 J. A. Johnson, improvements in the manufacture of iron and steel—A communication

153 J. H. Johnson, improvements in the treatment of acid tars obtained from boghead, mineral schist, or petroleum—A communication

202 H. M. Whitehead, improvements in preparing blocks of animal and vegetable materials for making soup or other liquid food

353 J. Hanson, improvements in breech-loading fire arms

401 W. R. Lake, improvements in looms for weaving—A communication

570 A. Wingard, an improved paddle-wheel for propelling vessels in the water

The English Mechanic
AND
MIRROR OF SCIENCE AND ART.
FRIDAY, APRIL 29, 1870.

THE ROYAL MICROSCOPICAL SOCIETY.
THE ANNUAL SOIREE.

ON Wednesday, the 20th inst., while nearly all London was intent upon what it conceived to be great things, a select company of sage gentlemen were equally intent upon the smallest of small things, in the precincts of King's College. At an early hour on that day the secretaries and chief members of the Royal Microscopical Society were at full preparatory work in their rooms. Cabs arrived every half-hour laden with microscopes, and the great *savants* were hastening about, some with coats off, placing and numbering the instruments. Several hundreds pounds' worth of microscopes arrived during the morning, and it was no slight proof of public scientific spirit that all them were delivered and located without difficulty and without expense. Our own humble microscope gained its place amidst a crowd of flaunting competitors which were gloriously bright in highly polished brass, and beautiful in appearance, but not a whit more useful for all practical microscopic science. A rich man may readily spend £120 with Mr. Ross for a first-class instrument, but we are confident that our own, at a cost of about £20, will do as much and as good work, though less to look at and lighter to move.

On this occasion, for the first time since its establishment, the Royal Microscopical Society attempted to inaugurate a new style of exhibition, Hitherto these displays have been of a very miscellaneous and heterogeneous character. The several makers of microscopes had seized the freely-accorded opportunity of showing their craft and skill to the great visiting public, and, in truth, the annual soireés have been theatres for the performances of Messrs. Ross, Smith and Beck, Powell and Lealand, Swift, Baker, Crouch, Murray and Heath, Stewart and Co., and other well-known makers. These soireés have really been manufacturers' bazaars, and greatly, it is understood, have they profited by them. During five or six of the latest of such displays the student will have observed many gradual improvements in the form and in the accessories of the instrument, and will have noted each step in advance in concurrence with the year of exhibition.

Still this was not fulfilling the highest purposes of Microscopic science. It showed what was profitable, but not always what was scientific. To obtain results in the simplest and cheapest form is the desideratum of the student; to show them in the costlier form is perhaps that of the maker, not that the makers are without merit, for they have met the spirit of discovery and research—nor can they be blamed if they also look for a tangible profit.

The Royal Microscopical Society has gradually gathered, by bequests and by purchase, a very considerable number of objects, chiefly indeed by gifts. The late Dr. Wallich, Mr. Richard Beck, and several others have given a most valuable series of objects to the Society, and the question has naturally arisen—how, and when, shall these be exhibited? No occasion can be so good as the annual soirée. But, then, the instrument makers have nearly shut out the gentry of science. Well, let the gentry of science, for once, claim space with the makers; now such has really been the result. The Microscopical Society resolved to display its treasures, and never did they come to a worthier resolution. They printed a list of desirable objects, circulated it amongst the members, and thus contrived to offer a somewhat more systematic and really useful exhibition than aforetime. It was less showy to ladies, but far more instructive to men. For the first time, in fact, the soirée has been less miscellaneous, and more truly illustrative of particular classes of objects.

There was, indeed, no time for a leisurely study of the various objects, and those who had no previous knowledge of them, of course failed to reap the full benefit of the display; but those who were acquainted with the elements of natural history and microscopy, and who came to see and not to be seen, found it possible to gain good results even in the heat, bustle, and jostling of the crowd of fair and unfair visitors. The makers of microscopes were there, and had their tables richly garnished as aforetime, with burnished brass and glaring lamps. They showed, too, many highly attractive objects, but little or nothing new to the advanced microscopist, though much that was interesting to the passing gazer. But why should they make great efforts continually? They have had their day, or their nights, and all the microscopic-loving world has admired their craft and landed their ingenuity.

Amongst the objects shown by makers were some very fine sections of coal and coal-like fossil wood. We noted also a particularly fine Podura scale, shown by Beck and Beck, and a few fine objects under some instruments by Mr. Ross and by Mr. Swift. The Society displayed a very good series of educational microscopes, with their prices attached, and beginners would be delighted to see such a series. The most straightened in means may be comforted by such a show; for the small outlay of three, four, or five guineas a neat and useful little instrument may be had.

Dr. Carpenter was the lion of the evening, if the name of so large an animal is allowable in connexion with the smallest of creatures. On a raised platform at one end of the large room, he exhibited a very interesting series of objects from deep-sea dredgings. It is impossible to do any descriptive justice to them in a brief space—in fact, some considerable previous knowledge was necessary to appreciate them at their true value. The wonder was not so much in the structure of a particular object as in its profound extraction. To gaze at little spindle-shaped "tests," or shell-like coverings, which were brought up from depths of 300, and 540, and 640 fathoms of sea-water, was no slight pleasure; while to examine them in connection with the useful little descriptive catalogue printed by the Society, and also in the clever enlarged drawings overhead, was full of instruction and entertainment. One object, a small complete specimen of *Orbitolites* was most attractive, for in it we studied the nucleus of the disc formed by a spire of several turns, and the approach to a cyclical arrangement, showing that the whole subsequent growth takes its course on a cyclical plan. Then there were a series of *Cristellariæ*, showing every gradation from the straight to the nautiloid form, which next to the *Globigerinæ* and *Orbulinæ* are the most common inhabitants of the abyssal waters. Beautifully constructed are their finely-tubular shells, while under another microscope was visible the animal itself of *Cristellaria*, which was obtained by dissolving the shell of a fresh specimen in dilute acid.

What could be a greater intellectual luxury than this bringing up, as it were, from the silent abyss of waters, some of its choicest and tiniest inhabitants, into the very heart of noisy and populous London, and displaying them easily and pleasantly to the curious eye of every privileged visitor to King's College on this Spring night? Here were some 1200 sightseers; many brought in commodious vehicles, all spared every kind of drudgery and dredging labour, provided with fine instrumental aids to observation, in every respect duly facilitated, and to crown all, with Dr. Carpenter himself at hand, ready to answer any intelligent questioner, and sufficiently tolerant even of the bore and the bungler. In the upper rooms were the usual smaller displays, and relatively smaller, though by no means absolutely small, people of microscopic science. How pleasant on these occasions to meet old friends and ever to see old sights! On no account would we miss that amiable elderly enthusiast in polarised light, who though literally one of the "nation of shopkeepers," is a valued co-operator with the friends of his science. Ask him any question about polarised light, and you may count on a good and useful reply. Long may we live in light! and and probably he would himself utter the prayer of one of the famous Homeric heroes, "Let me die in light,"—if we ventured to add one word to that prayer it would be "polarised."

To the great, tumultuous, busy, or idle world of London, such sights as we have attempted to describe are unknown. Even the scientific world in other branches of study, scarcely know of their occurrence. Let us hope that the attention we have directed to them will bear fruits in a newly-awakened interest in microscopy, and an inquiry as to the society represented, and other kindred ones in London. One thing should strike every visitor to such a display as that of Wednesday night last—viz., the amount of freely offered service devoted to the getting up and successful conduct of these soirées. Such service amply proves the zeal of truly scientific men, and when we learn that previous days of careful attention are essential to the success of these exhibitions, we ought to be grateful to the officers and members of the Royal Microscopical Society, and to others on like occasions. May all these societies find many new friends, ample funds, and a thankful public to appreciate and applaud their zeal!

COLOURS, AND COLOUR BLINDNESS.

By "Omicron."

IT is very evident to those who thoughtfully consider the earth as the residence of man, that the beneficent Creator has provided it not only with the materials that are essential to the existence of mankind, but He has provided much that only contributes to his enjoyment. He has not only considered the needful, He has considered the beautiful. Enter the woods, and the ear is gratified by the songs of birds and the hum of insects; the eye is pleased by the thousand beauties of the landscape, and the variation of light and shade; all around is seen a tinted mass that speaks of the glory and goodness of the Creator. And among the various examples of the care bestowed by Providence on man, one of the most striking is the lovely mantle of colour that is everywhere spread round about him; and yet what man has long and commonly enjoyed, he often undervalues. To appreciate the full effect of this gorgeous robe of colour, it is necessary to conceive a blind man suddenly restored to sight. With what pleasure would he welcome this new sense! With what delight would he drink in this new source of enjoyment! With what interest would he survey the scene before him, in its gay apparel! How long couldhe gaze upon the far-reaching expanse of lively green below him, and the calm deep azure above him without tiring of its loveliness. And after he had enjoyed the view of Nature in its marvellous assemblage of tints and colours, with what delight would he consider the details of the scene, how tenderly he would touch the flowers, and, above all, how thankful would he be in the possession of a sense which affords him such intense gratification! Very few value colour at its true worth; and many often speak disparagingly of it, and consider other forms of beauty far preferable; and many speak slightingly, because They really do not appreciate it, and are not sensitive to any kind of beauty. "Such expressions," says Mr. Ruskin, "are used for the most part in thoughtlessness, and if such disparagers of colour, would only take the pains to imagine what the world and their own existence would become if the blue were taken from the sky, and the gold from the sunshine, and the verdure from the leaves, and the crimson from the blood, which is the life of man, the flush from the cheek, the darkness from the eye, the radiance from the hair—if they could but see for an instant white human creatures living in a white world, they would soon feel what they owe to colour. The fact is, that of all God's gifts to the sight of man, colour is the holiest, the most divine, the most solemn."

The investigation of the cause of colour has been attempted by several philosophers, though we can give here little more than the names of the more celebrated. Among the ancients, the hypotheses to account for the phenomenon of colour are sufficiently vague, and colour blindness, or chromato-pseudopsis does not seem to have in any way engaged their attention. With the Pythagorean school, colour was the superficies of body; and Plato considered it as a flame issuing from bodies. Aristotle's notions were equally mysterious and inaccurate. After the long interval of the Dark Ages, when culture began to settle among the inhabitants of the West, modern philosophers promulgated their hypotheses. Des Cartes, the ingenious founder of the system of vortices, imagined colour to be a modification of light, and the difference of colour was produced by the rotatory motion of the particles that composed light. From this date all the students of physics connected colour with the phenomena of light, accounting for it by the rays of light entering the eye at different angles with the optical axis. The experiments of Sir Isaac Newton, however, began a new era in the history of chromatics. By passing the solar ray through a glass prism, it was plainly proved that light was not homogeneous, but that it was composed of a bundle of varied-coloured rays, some of which were more refrangible than others. These coloured rays were not capable of being subdivided into others; hence they were considered primary, and the property of colour was supposed to be occasioned by different substances reflecting certain particular rays more copiously than others. This theory was so simply deduced from the observed facts, that it immediately obtained universal belief, and all former theories died out and were remembered only as matters of history. An object that appears white, reflects all the rays indiscriminately, or does not sufficiently separate them to make the distinction obvious, while a body that appears black, absorbs, instead of reflects, the rays that fall upon it. Simple as this theory of Sir Isaac Newton's is, it must be evident that it advances but a very little way towards settling the troublesome question of difference of colour; for it still remains to be shown why it is that certain bodies can reflect certain rays more abundantly than others. Sir Isaac attributes this effect to the density of the bodies. He had observed while pressing together the surfaces of two prisms which were slightly curved, that at the point of juncture the prisms were perfectly transparent, like one piece of glass; but that round that point appeared concentric rings of different colours, sensibly separated from each other. To make the experiment more completely and perfectly, he took the object glasses, one plano-convex, belonging to a 14ft. refracting telescope, and the other a large double convex, that belonged to a telescope of 50ft. focal length. On bringing the two object glasses into contact, the same peculiarity manifested itself; at the point of contact the two lenses appeared colourless, and this spot was surrounded by a circle of blue, white yellow, and red; the blue being small, and apparently possessing no trace of violet; the yellow and red were far more prominent. This was succeeded by another circuit, consisting of violet, blue, green, yellow and red, all in about equal proportions, excepting the green, which was less predominant than the other colours. The third circle was composed of purple, blue, green, yellow and red. In this circle the green was more noticeable, and vied in brilliancy with any of the other colours, except the yellow. The next circle was composed of green and red; the green being very vivid. After this the colours grew more and more faint, and incapable of being detected, till, after a few more bands of colour, they finally terminated in complete whiteness. Since the distance that the glass plates were separated produced corresponding variations of colour, Sir Isaac Newton concluded that colours proceeded from the thickness of the plate of air intercepted between the glasses; that is, that the different colours were transmitted or reflected according as the segment between the lenses was thicker or thinner; and the general law deduced by Sir Isaac Newton was, that the colour of all natural bodies depended on the density of the body, or the size of the component particles.

The experiment of the decomposition of light into its various component rays, is so simple and beautiful, and, above all, so excellent a test for colour blindness on the one hand, and a delicate perception of colour on the other, that we trust many of our readers may be induced to try it. Let a prism be procured whose sides contain an angle of about 55° (and the more perfect is the prism, the more successful will be the experiment), and held in such a manner that a ray of light may fall upon it from a small perforation in the shutter of a darkened room. The ray of light will be refracted from its original direction, and be bent upward; at some distance from the prism must be placed a sheet of paper, to receive the ray of light in its new course. On the screen will be perceived an oblong spectrum containing all the primary colours, at the bottom the least refracted colour, red, of a most brilliant tone, more vivid than can be produced by any other means, or than any substance in nature presents. This dies away into an orange, which by insensible degrees gives way to a pale straw colour, which in its turn is succeeded by a green of the most intense purity, followed by a blue, which, though at first its purity is affected by the green, subsequently becomes of the purest indigo tinge, though the illumination is more feeble than in the yellow and earlier portions of the spectrum, and the luminosity is finally extinct in the violet rays. In experimenting on the ray of light it should be as nearly as possible a mathematical ray. If the perforation be of about ¼in., and the distance from the screen to the prism, say, 18ft., the spectrum will be 10in. long and 2in. wide, and show all the phenomena distinctly, and if the sun's rays can be collected by a lens of short focus the purity of the colours will be much enhanced. Should the spectrum present the appearance we have described, the experimenter may congratulate himself on being free from any strongly marked form of chromato-pseudopsis, which is the expression that colour blindness is usually known by in this country, and which means a false vision. On the Continent this peculiarity has received the appellation of Daltonism,* from the celebrated John Dalton, the founder of the Atomic theory, who suffered in a most marked degree from colour blindness, and who has described his own peculiarity with great care, in the "Proceedings of the Manchester Philosophical Society," and has proposed a theory to account for the phenomenon, of which we shall say more hereafter.

To return to our experiments on light and colour, and to completely establish the analysis of light, it will be necessary to form the solar ray again in its integrity, from the many-coloured bands, in which it has been divided by the prism. It will be seen that the distance from the prism to the screen, has nothing to do with the formation of the spectrum. However near the paper is brought to the prism, the spectrum is still visible, though reduced in size, whence it necessarily follows that the ray has undergone division, immediately on leaving the prism. Let another prism of a similar angle be placed in a reversed position (with reference to the first prism) very near the first prism, and the ray of light will be perceived emitted in a direct line from the second prism, unaltered and undeviated, as if no prism had intercepted the ray. To effect the confusion of the different coloured bands, a similarly constructed prism is not indispensable, for a double convex lens employed in a similar manner equally well effects the purpose. White light can only be produced by the assemblage of the entire pencil of rays, for if any portion be intercepted before it falls upon the lens, white light is not the result. If the violet end of the spectrum be intercepted, the light will have a tinge of yellow, and if the blue and green portion of the spectrum be obstructed, the resulting combination of the other lines will be more and more red, till when only the least refracted portion of the spectrum is allowed to fall upon the screen, a brilliant red is the result. If the rays at the other end of the spectrum—namely, the red extremity—be cut off, the resulting light will pass through shades of green, blue green, blue, and at last, violet. By intercepting intermediate portions of the spectrum, the resulting light will exhibit every variety of shade and colour that is to be met with in nature. Now, if we consider that all these shades are produced on paper, which we usually term white, that is when exhibited to the full light of the sun, and all the solar rays are equally refracted, and that this same paper when placed in the red, green, or blue portion of the spectrum, appears indifferently red, green, or blue, and that this phenomenon takes place whatever colour the body that receives the spectrum may appear in white light, we are forced to conclude with Newton, that "the colours of natural bodies are not qualities inherent in the bodies themselves, by which they immediately affect our sense, but are consequences of that peculiar disposition of the particles of each body, by which it is enabled more copiously to reflect the rays of one particular colour, and to transmit or stifle, or as it is called in optics, absorb the others."

Mayer, in an essay "De Affinitale Colorum," objects to seven colours being received as primary, and regards all colours as being produced from three primary ones, red, yellow, and blue, regarding white as a neutral mixture of rays of all colours, and black as a mere negation of white. Without departing from Mayer's doctrine, any other three prismatic rays may be assumed as the fundamental colours, for Dr. Young has assumed red, green, and violet, and states as an experimental fact in support of this doctrine, that the perfect sensations of yellow and blue may be produced, the former by a mixture of red and green, and the latter by green and violet.* Mr. Hay, in his work on the "Laws of Harmonious Colouring," reports on some experiments he had attempted with three primary colours, and he says "that he could not by analysis prove that there were only three colours, but that he succeeded in proving it to his own satisfaction, synthetically in the following manner:—After having tried every colour in succession, and finding that no one could be separated into two, I next made a hole in the first screen in the centre of the blue of the spectrum, and another in that of the red. I had by this means a spot of each of these colours on the second screen; I then by means of another prism directed the blue spot to the same part of the screen on which the red appeared, where they united and produced violet, as pure and intense as that of the spectrum. I did the same with the blue and yellow, and produced the prismatic green, as also with the red and yellow, and orange was the result. I tried in the same manner to mix a simple with what I called a compound colour, but they did not unite, for no sooner was the red spot thrown upon the green than it disappeared. I tried the same experiment with two spectra, the one behind and of course a little above the other, and passed a spot of each colour successively over the spectrum, which was furthest from the window, and a similar result occurred. It therefore appeared to me that these three colours had an affinity to one another that did not exist in the others, and that they could not be the same in other respects, except colour and refrangibility, as had hitherto been taught."†

(To be continued.)

STRENGTH OF MATERIALS.‡

By A. Tolhausen, Jun.

(Continued from page 97.)

THE table given last week shows us that iron wire seems to possess the property of tenacity in the greatest, and leaden wire in the least degree. The tenacity of cast iron is taken advantage of in the most scientific manner in the construction of the Britannia Tubular Bridge. It will be of some interest to those readers who do not intend to study the subject in its details, to have some particulars respecting this bridge, and for these the following is inserted:—The design of the bridge was made by the well-known engineer R. Stephenson, and forms one of the most wonderful structures in the world. It spans the Menai Straits on the line of the Chester and Holyhead Railway, within sight of Telford's chain suspension bridge, and was begun April 18, 1846, completed, July 25, 1850, and opened for traffic, October 21, 1850; total cost, £601,865. It is made of cast iron, of a tubular form, in the tube of which the trains pass. Four of these tubes span the strait, two of which are 250ft. and the other two 470ft. long. The weight of malleable iron in the tubes is 10,000 tons, of cast iron 1400 tons. In the middle of the strait is the Britannia Rock, from which it has taken its name. The tubes are supported by piles of masonry; that on the Anglesea side is 143ft. 6in. high, and from the front to the end of the wing walls is 173ft. These wing walls terminate in pedestals, on which repose colossal lions of Egyptian character, and for each of these 2000 cubic feet of stone were required, each weighing 80 tons, and being 250ft. 6in. long, 12ft. 6in. high, and 8ft. wide. The total quantity of stone in the bridge is 1,400,000 cubic feet.

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* In fact, scientific men have been sorely puzzled to suggest a convenient appellation that shall accurately express the peculiarity generally known by the term "colour blindness." Mr. Whewell suggested "Idipots" to designate the sufferers, which, however accurate in its derivation, is too much like "Idiots" to receive any general favour, and Sir John Herschel proposes "Dichromic Vision" to mark the cause of suffering. This term (as its derivation implies) supposes that only two, and combinations of two colours can be seen by some eyes, while three, and combinations of three are visible to a normal eye. Mr. Pole, who describes with great care the affection of his eyes, in the volume of the "Philosophical Transactions for 1859," adopts this expression, and thinks it fully explains his inability to detect certain colours.

* Young's "Lectures on Natural Philosophy."

† Ray "On the Laws of Harmonious Colouring."

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Ere it was opened for traffic it had to undergo severe tests to ensure stability and permanence. The first and principal experiment consisted in passing two locomotive engines through the tube, and resting them at intervals in the centre of the sections. Another trial was a train of 28 waggons and two locomotives, with 280 tons of coal, drawn into all four tubes. The deflections caused by these loads were ascertained to be exactly three-fourths of an inch over the immense mass and area of iron.

With the aid of Table I. and the rule, "the tensive strength of a uniform body is directly proportional to its transverse section," we are almost able to determine the tenacity of all materials with which engineers have to deal.

All problems connected with the tensive strength of bodies are reduced to two, or, speaking more concisely, to one, for one is the mere converse operation to the other. They are :—

1. Required the tensive strength, or the constant load, a body will safely bear when the dimensions of the transverse area are given?

2. Required the dimensions of the tranverse area of a body when the tensive strength of the same material is known per square inch of sectional area?

The rule for—

1. is—Multiply the strength of an inch bar (as in the table) of the body required by the transverse area of square and rectangular bars, or by the square of the diameter* of round bars, and the product will be the ultimate cohesive strength.

Examples based on this rule :—

1. What is the cohesive power of a bar of cast steel 2·5in. broad and ⅝in. thick?

Area of transverse area = 2·5 × ⅝ = 2·5 × 0·625 = 1·5625.

1 sq. in. bar of cast steel has a tenacity = 19·9 tons.

1·56 sq. in. „ „ „ „ „ = ?
= 31·044.

19·9 × 1·56 tons = 31·044 tons = total cohesive strength.

II. What is the cohesive power of a round bar of cast steel 2·5in. in diameter.

$(2·5)^2 = 6·25$ sq. in.

1 circ. sq. in. bar of cast steel has a tenacity = 15·7 tons.

6·25 circ. sq. in. „ „ „ „ = ?

(15·7 × 6·25) tons = 98·125 tons = total cohesive strength.

We could have found the total cohesive strength without making use of col. 3 in the table, as follows :—

The area of a circle whose diameter is equal to 2·5in. is $\frac{(\text{diameter})^2}{4} \times$ ludophine $= \frac{2·5^2}{4}\pi = \frac{6·25}{4} \times 3·141 := 4·898$ sq. in. 1 sq. in. bar of cast steel has a tenacity = 19·9 tons

4·808 sq. in. „ „ „ „ „ = ?

(19·9 × 4·898) tons = 98 tons nearly

That this 2nd answer is not quite the same as the first is merely because in our calculation the decimal fractions have not been sufficiently extended.

III. Required the cohesive power of a bar of Swedish iron of a tranverse section, and dimensions as shown in fig. The upper part of the figure is a trapezoid, and the lower portion is a rectangle; the sum therefore of these two reas gives us the whole transverse section.

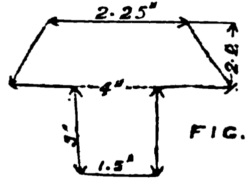


FIG. 1.

Area of a trapezoid = add together the two parallel sides, multiply their sum by their breadth or height, and half the product is the

area $= \frac{2·25 \times 4}{2}$ 2·2 = 6·875 sq. in.

Area of rectangle = product of two adjoining side = 1·5 × 3 = 4·5 sq. in.

Total area = 11·375 sq. in.

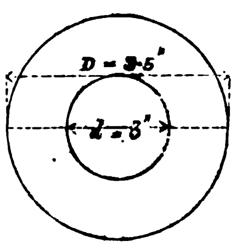
1 sq. in. bar of Swedish iron has a tenacity = 9·7 tons

11·375 sq. in. „ „ „ „ = ?

Tensive strength = (11·375 × 9·7) sq. in. = 110·3375 tons say 110 tons.

IV. Required the tensive strength of a circular brass tube whose outer diameter = D = 3·5in. and whose inner diam = d = 3 in.

FIG. 2.



Area of outer circle $= \frac{D^2}{4}\pi = \frac{3·5^2}{4} 3·14 =$ 9·55 sq. in.

„ „ inner „ $= \frac{d^2}{4}\pi = \frac{9}{4} 3·14 =$ 7·06 sq. in.

Area or space contained between them = 2·49 sq. in.

1 sq. in. bar of brass tube has a tenacity = 2·7 tons.

2·06 sq. in. „ „ „ „ „ = ?

Total tensive strength = (2·06 × 2·7) = 5·562 tons, say 5 tons.

By aid of the above examples the student will find no difficulty in ascertaining the tenacity of any material having a given sectional area, or conversely in finding the dimensions of a piece of material to bear a certain load, so that we may now proceed to

THE TENACITY OF CHAINS AND ROPES.

Metals when drawn into wire become stronger in respect to tensive strain, (see Table I.), owing to the wire-drawing process, causing the particles to arrange themselves in continuous fibres. Numerous experiments show that iron wire up to one inch diameter attains a strength of about 30 per cent. greater than that of iron bar; so that while the strength of wrought iron wire may be taken at 8 tons per sq. in., that of iron wire may be taken at 11 tons per sq. in. nearly.

Chains are now so well and so accurately made, and their soundness and quality so readily ascertained by means of the testing machine, that they are much used in crane work on ships, &c., instead of ropes, especially for outdoor work; but as there are many circumstances in which it may be requisite to use ropes, it will be proper to show the strength of both.

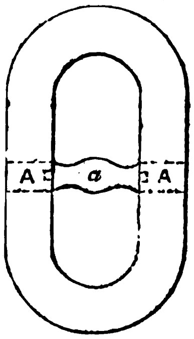


FIG. 5.

The strength of a chain is determined by ascertaining the diameters—all are equal to each other—of the metal constituting the links; thus the chain which has a diameter of an inch at A is called an inch chain, and so on.

Within certain limits the strengths of chains may be estimated in proportion to the squares of the iron's diameter of which they are made; but it is obvious that when they are made very large or very small, neither the quality nor the workmanship can be so well relied upon. Iron of large diameter is less fibrous and more crystalline in the fracture, and the welding is more perfect in links of intermediate size. Mr. Glynn for this reason recommends that chains above an inch in diameter should not be employed for crane work, as he prefers chains of smaller dimensions, say ⅝, ¾, or ⅞ of an inch, and reducing the strain upon the chain by increasing the number of the parts that bear it, by means of blocks and pulleys.

Chains for crane work, are commonly made with short links of an oval form, the links being no longer than is necessary to permit the smith to use his tools for soundly welding the iron. Chain cables for ships, or for raising sunken ships are made with the links somewhat longer, and a stud (see Fig. *a*) or stay is inserted in the link across its least diameter, to support the sides and prevent their collapse under heavy strains, thus giving great additional strength to the chains. The latter are nowadays more or less done away with, and are replaced by a method patented by Austin in the year 1837, which consists in fastening empty gutta percha vessels or balloons to the ship's sides, and filling these by means of an air-pump with air.

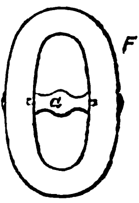


FIG. 4

Since studded chains used for cables are stronger than short linked chains without studs, it is not prudent to subject both kinds to the same proof, when the tenacity of the chains is tested.

The proportions existing between short linked chains to a studded chain is as 7 is to 9, or a simple chain able to sustain a "proof weight" equal to 14 tons—being the proof strain of one inch chains—will when studded be able to carry 18 tons, which is the Navy proof for iron cables. Both kinds may be safely worked to half the strain to which they have been proved.

The tenacity of chains is generally tried at a mean temperature, the strain being steady, and the vibration caused by the blows of the hammer, given in order to detect imperfect welding of a link, is by no means equivalent to the live load—*i.e.*, one that is put on suddenly—it will have to sustain, when exposed, perhaps to a temperature below the freezing point, affecting the strength of iron, as it does that of all crystalline bodies.

The following are the two practical rules for calculating the diameter, or working load of an iron chain, for computing the tenacity of chains, being calculated at a lower rate than they are generally stated, as it is best to be on the safe side, when we consider what great damages often result from the breaking of a chain, and what is still more carefully to be guarded against, serious injury to life and limb, is inflicted.

1. Extract the square root of 8 times the safe load, and the result will give the diameter in eighths of an inch, or in symbols, if d = diam. in eighths of an inch, W = safe load in tons, then $d = \sqrt{8\,W}$; or

2. Multiply the weight (tons) to be carried by 30; the product will be the square of the diam. of the chains reckoned in sixteenths of an inch.

Where long chains required to lift heavy loads are used, it is best to work out the diam. after the first rule, as it gives a little larger diameter to the chaih.

Example: Required the diam. of a simple chain to bear a safe load of 14 tons.

a (by rule I.)

$d = \sqrt{8·14} - \sqrt{112} = 10.\tfrac{5}{8}$ of an in. = 1¼ in.
·2

b (by rule II.)

$d = \sqrt{30·14} = \sqrt{420} = 20\frac{}{16}$ of an in. = 1¼ in.

N.B.—To find the diamater of a chain-cable with studs we have the proposition: $\frac{5}{4} : d. = 9 : 7$, or diameter = 0·9in., from which the diameter would only require to be :

For the converse operation namely to find the weight which a chain of given diameter will carry we have :—

1. The quotient of the square of the diameter given in eighths of an inch. divided by 8 gives the safe load in tons, or symbolically $\frac{d^2}{2} = W$.

2. Divide the the square of the diameter (reckoned in 16ths) by 30, the quotient will be the number of tons carried.

Example: What safe load will a chain (simple) bear having a diameter = ¾in.

a (by rule I.)

$$\frac{6^2}{8} = \frac{36}{8} = 4\tfrac{1}{2} \text{ tons: say 4 tons.}$$

b (by rule II.)

$$\frac{12^2}{30} = \frac{144}{30} = 4\frac{4}{5} \text{ tons: say 4 tons.}$$

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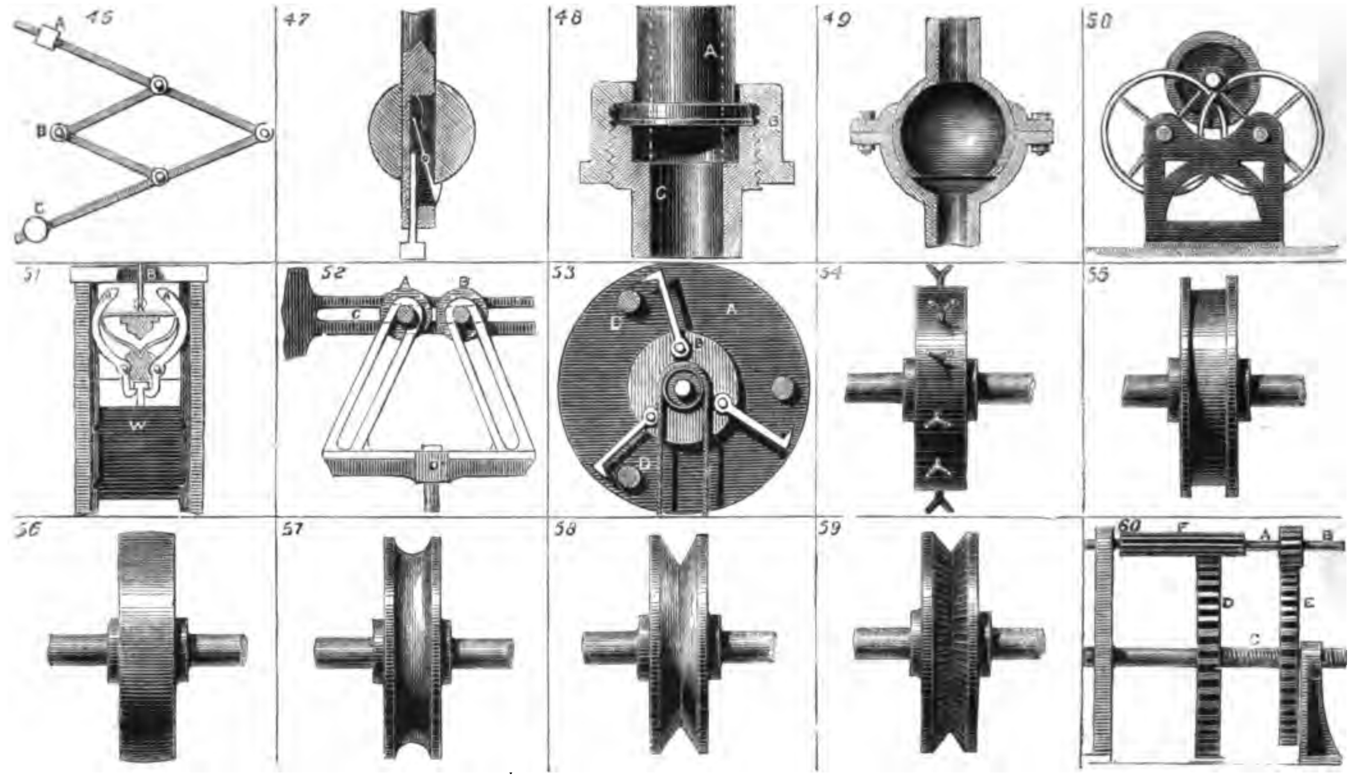
* According to Euclid, the areas of circles are directly proportional to the square of their diameters, and the product will be the ultimate cohesive strength.

MECHANICAL MOVEMENTS.



N.B.—A studded chain would therefore bear $\frac{24\cdot 9}{5\cdot 7}$ tons = $6\frac{1}{6}$: say 6 tons.

TABLE II.

STRENGTH AND WEIGHT OF IRON CHAINS.

Size of the chains	Weigh. in lb. per fathom.	Proof strain in tons.
$\frac{5}{16}$ in.	6	¾
⅜	8¼	1¼
$\frac{7}{16}$	11	2¼
½	14	3¼
$\frac{9}{16}$	18	4½
⅝	24	5¼
$\frac{11}{16}$	28	6¼
¾	32	7¾
$\frac{13}{16}$	36	9¼
⅞	44	10¼
$\frac{15}{16}$	50	12¼
1	56	14

The tenacity of ropes depends, as a rule, on the number of threads they are composed of, and are only employed in those cases where the greatest flexibility is required, and the weight of chains would have been inconvenient.

Ropes are now mostly made by machinery, as in this process every yarn is made to bear its part of the strain exerted on the whole. There is a considerable difference in the weight and strength of ropes made by hand, and those made by the register, for practice, shows that although the girths—*i.e.*, the circumference—and number of yarns is the same in both, large ropes made by the old method weigh about 7½ per cent. more than those made by the register, and are not even as strong. The strength of ropes also depends very much on the quality of hemp, while the durability of the rope, and, consequently, its trustworthiness in use, are greatly affected by the quality of tar, some of which contains an acid destructive to the hemp, so that it may be rendered unsafe in 3 years time.

Mons. Du Hamel says that it is a decided fact by experience that white cordage in continued service is one-third more durable than tarred; secondly it retains its force much longer while kept in store; thirdly it resists the ordinary injuries of the weather ¼ longer.

The following experiments were made by the same at Rochfort on cordage 3 French inches circumferences made of the best Riga hemp.

August 8, 1741.
Broke with strn. of 4500lb. (white) & 3400 when tarred
" " 4000 " 3300 "
" " 4800 " 3258 "
August 25, 1743.
" " 4600 " 3500 "
" " 5000 " 3400 "
" " 6000 " 3400 "
September 23, 1746.
" " 3880 " 3000 "
" " 4000 " 2700 "
" " 4200 " 2800 "

(*To be continued.*)

MECHANICAL MOVEMENTS.*

(*Continued from page* 105.)

46. REPRESENTS a pantograph for copying, enlarging, and reducing plans, &c. One arm is attached to and turns on the fixed point C. B is an ivory tracing point, and A the pencil. Arranged as shown, if we trace the lines of a plan with the point, B, the pencil will reproduce it double the size. By shifting the slide attached to the fixed point, C, and the slide carrying the pencil along their respective arms, the proportion to which the plan is traced will be varied.

47. A mode of releasing a sounding-weight. When the piece projecting from the bottom of the rod strikes the bottom of the sea, it is forced upwards relatively to the rod, and withdraws the catch from under the weight, which drops off and allows the rod to be lifted without it.

48. Union coupling. A is a pipe with a small flange abutting against the pipe, C, with a screwed end; B a nut which holds them together.

49. Ball-and-socket joint, arranged for tubing.

50. Anti-friction bearing. Instead of a shaft revolving in an ordinary bearing, it is sometimes supported on the circumference of wheels. The friction is thus reduced to the least amount.

51. Releasing-hook, used in pile-driving machines. When the weight, W, is sufficiently raised, the upper ends of the hook, A, by which it is suspended, are pressed inwards by the sides of the slot, B, in the top of the frame; the weight is thus suddenly released, and falls with accumulating force on to the pile-head.

52. A and B are two rollers which require to be equally moved to and fro in the slot, C. This is accomplished by moving the piece, D, with oblique slotted arms, up and down.

53. Centrifugal check-hooks, for preventing accidents in case of the breakage of machinery which raises and lowers workmen, ores, etc., in mines. A is a frame-work fixed to the sides of the mine, and having fixed studs, D, attached. The drum on which the rope is wound is provided with a flange, B, to which the check-hooks are attached. If the drum acquires a dangerously rapid motion, the hooks fly out by centrifugal force, and one or other or all of them catch hold of the studs, D, and arrest the drum and stop the descent of whatever is attached to the rope. The drum ought besides this to have a spring applied to it, otherwise the jerk arising from the sudden stoppage of the rope might produce worse effects than its rapid motion.

54. A sprocket-wheel to drive or to be driven by a chain.

55. A flanged pulley to drive or be driven by a flat belt.

56. A plain pulley for a flat belt.

57. A concave-grooved pulley for a round band.

58. A smooth-surface V-grooved pulley for a round band.

59. A V-grooved pulley having its groove notched to increase the adhesion of the band.

60. A differential movement. The screw, C, works in a nut secured to the hub of the wheel, E, the nut being free to turn in a bearing in the shorter standard, but prevented by the bearing from any lateral motion. The screw-shaft is secured in the wheel D. The driving-shaft, A, carries two pinions, F, and B. If these pinions were of such size as to turn the two wheels, D, and E, with an equal velocity, the screw would remain at rest; but the said wheels being driven at unequal velocities, the screw travels according to the difference of velocity.

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* Extracted from a compilation by Mr. H. J. Brown, Editor of the *American Artisan*.

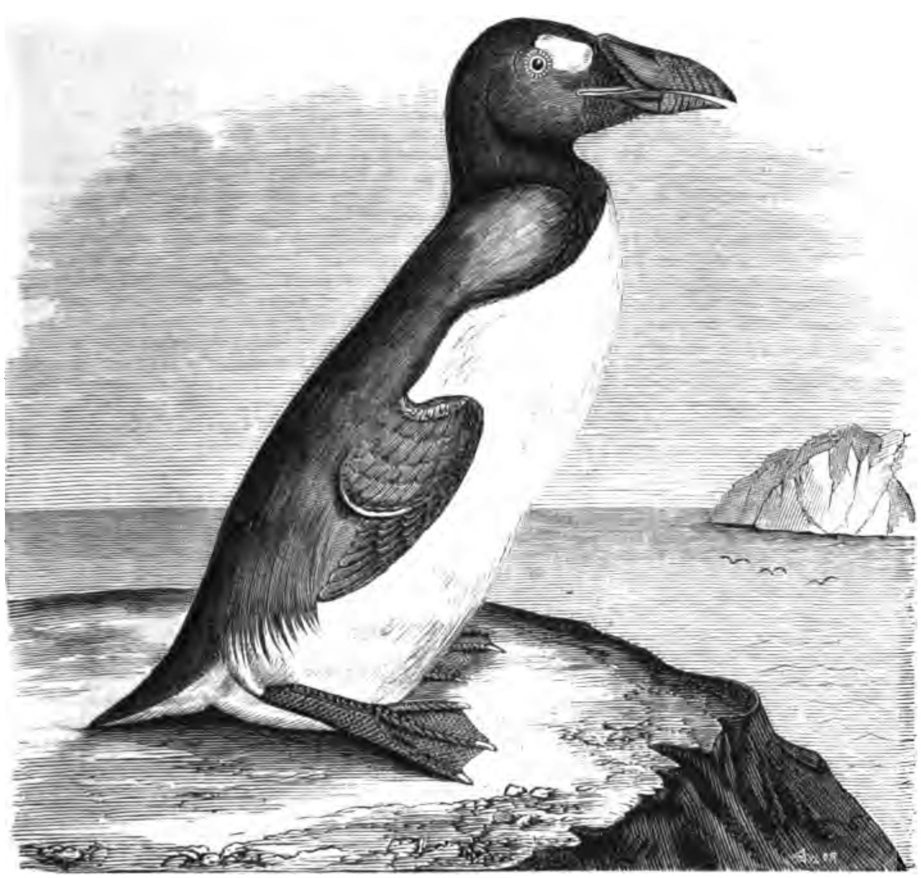
THE GREAT AUK.

BY PROFESSOR JAMES ORTON, IN THE "AMERICAN NATURALIST."

THE recent addition of a specimen of this rare bird to the Smithsonian Museum is an event worthy of record. There are now three specimens in the United States; the one just mentioned, another in the Academy of Natural Sciences, Philadelphia, and a third in the Giraud cabinet in Vassar College. The last is the most perfect specimen, and certainly possesses the greatest historical value, as it is the one from which Audubon made his drawing and description. It was caught on the banks of Newfoundland.

The Great Auk or Gare-fowl, fortunately for itself, did not live long enough to receive more than one scientific name—*Alca impennis.* It was about the size of a goose, with a large head, a curved, grooved, and laterally flattened bill; wings rudimental, adapted to swimming only, approaching in this respect the penguins of the

THE GREAT AUK.



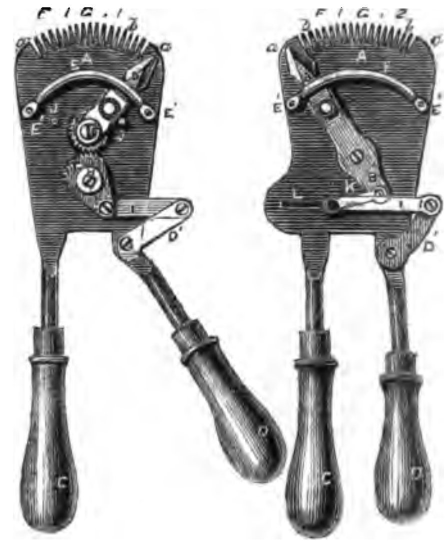
southern hemisphere. The toes are fully webbed, the hind one wanting ; the plumage is black, excepting the under parts, the tips of the wings, and an oval spot in front of each eye, which are white. It was an arctic bird, dwelling in the Faroe Islands, Iceland, Greenland, and Newfoundland. "Degraded as it were from the feathered rank (said Nuttall), and almost numbered with the amphibious monsters of the deep, the auk seems condemned to dwell alone in those desolate and forsaken regions of the earth." But it was an unrivalled diver, and swam with great velocity. One chased by Mr. Bullock among the Northern Isles left a six-oared boat far behind. It was undoubtedly a match for the Oxfords. It was finally shot, however, and is now in the British Museum. "It is observed by seamen," wrote Buffon a hundred years ago, "that it is never seen out of soundings, so that its appearance serves as an infallible direction to the land." It fed on fishes and marine plants, and laid either in the clefts of the rocks or in deep burrows a solitary egg, five inches long, with curious markings, resembling Chinese characters. The only noise it was known to utter was a gurgling sound. Once very abundant on both shores of the North Atlantic, it is now believed to be entirely extinct, none having been seen or heard of alive since 1844, when two were taken near Iceland.

The death of a species is a more remarkable event than the end of an imperial dynasty. In the words of Darwin, "no fact in the long history of the world is so startling as the wide and repeated extermination of its inhabitants." What an epoch will that moment be when the last man shall give up the ghost ! The upheaval or subsidence of strata, the encroachments of other animals, and climatal revolutions—by which of these great causes of extinction now slowly but incessantly at work in the organic world, the Great Auk departed this life, we cannot say. We know of no changes on our northern coast sufficient to affect the conditions necessary to the existence of this oceanic bird. It has not been hunted down like the Dodo and Dinornis. The numerous bones on the shores of Greenland, Newfoundland, Iceland and Norway, attests its former abundance ; but within the last century it has gradually become more and more scarce, and finally extinct. There is no better physical reason why some species perish than why man does not live forever. We can only say with Buffon, "It died out because time fought against it." From the *Lingula prima* to the Auk, genera have been constantly losing species, and species varieties ; types and links are disappearing.

SHEARING OR CLIPPING ANIMALS AND SKINS.

THIS invention, patented by E. H. Rawlings, of Paris, relates to a shearing apparatus of the class in which the hair or wool is cut by a reciprocating knife working upon the surface of a comb, and consists, 1st. In the peculiar formation of the comb ; 2nd. In the employment in combination with the comb and knife of a novel device for keeping the knife properly and evenly in contact with the comb ; and 3rd. In the mechanism for imparting motion to the said knife. Fig. 1 is a top view ; Fig. 2 is a similar view of a modification of the same. A is the comb or toothed plate, and B is the knife which has two cutting edges ; C and D are the handles whereby the apparatus is held and operated ; E is a bridle or bridge which is placed over the knife, and is so formed and arranged that the knife works in contact with its under surface, and is thereby kept evenly in contact with the comb throughout the extent of its course ; F is a toothed segment pinion to which the knife is fitted and secured by the screw F , the latter is secured in the plate A, and may be readily removed when it is desired to change the knife. The pinion F is geared into the segment G, which is attached to the plate A by the screw H, whereon it is fitted to work freely. To the segment G is connected one end of the rod I, whose other end is attached to the elbow lever D¹, on which is fixed the handle D. The bridle or bridge E is secured at each end to the plate A by screws E¹, between whose heads and the bridle are spring washers, and the pressure of the said bridle upon the knife may be regulated by adjusting these screws. The stroke of the knife is limited in each direction by the stops J fixed in the plate A. By means of the comb or toothed plate A the hair or wool of the animal to be sheared is raised, and the toothed part *b* of the said plate is so formed and arranged that the knife at the commencement and end of its course in each direction lies entirely beyond such toothed portion, as shown, so that the hair or wool may be taken up without obstruction between all the teeth from one end to the other thereof, and so that no hair will remain caught between the teeth and the knife when in the operation of shearing the apparatus is raised or moved backward or forward. The handle C serves as a the means for holding and guiding the apparatus with the left hand, while motion is imparted to the knife through the connecting rod I by the lever D¹ and handle D. Pressure of the knife upon the comb is produced by means of a spring washer placed at the axis or centre thereof, which pressure is augmented and equalised by means of the bridle E, as above described.

In the modification of this invention, illustrated in Fig 2, the toothed segments F and G are dispensed with, and replaced by a parallel motion the connecting rod I being attached to the arm B of the knife by the link K, and guided in a slot L in the plate A, in which slot it is retained by means of a pin, having a head or button at the back or under side of the plate A.



CHAPTERS ON CURIOUS CATERPILLARS.

MAY.

By J. R. S. Clifford.

MAKING due allowance for the difference between early and late seasons, we shall find that caterpillars generally are more abundant during May than at any time during the spring and summer season. These, having attained maturity, pass into the chrysalis state, and undergo one of two destinies—they either appear, as perfect insects some time during the autumn or put in an appearance in the early spring ; or, almost, perhaps, before we can say it is spring, though an occasional twitter of a bird, or the swelling buds on shrub or tree hint to us that the vernal time is approaching. Of this latter class is the moth of which the transformations are now described, its time of appearance being February, or the beginning of March. During the month of May, in those places where the species occurs, the caterpillars are sufficiently conspicuous from their mode of life to attract the notice of observers who are not entomologically inclined. The small Egger Moth (*Eriogaster lanestris*), to which we have been alluding, deposits its eggs on the twigs of the hawthorn, and it would appear as if usually the whole number of eggs which each female is possessed of are placed in ones pot. These eggs are covered with down, which the parent strips off the abdomen, its hue being blackish, or smoke-coloured. This, serves to protect the eggs from the rain and cold of the season, and when April arrives, the young caterpillars begin to hatch out, having sometimes a difficulty in disengaging themselves from their downy envelopment. In habit they are gregarious nearly throughout their life, constructing a nest or web, in which they repose, and devour the leaves around it, extending their excursions by degrees to some distance from this home. As they increase in size, with successive changes of skin, they remove from place to place, constructing new abodes, until the tiny nest, which at first might have been hidden in the palm of the hand, gives place to a structure of some size, which the insect hunter pounces upon with satisfaction should he come across it. In this common nest they generally contrive to include one or two largish branches, on which they cluster when not eating, lying extended at full length. If one of these caterpillars is alarmed, he suddenly raises the head and the front segments, assuming somewhat of the attitude of the Hawk Moth Caterpillars, and if still further disturbed, then falls compacted into a ring. After the last change of skin, the caterpillars of the Small Egger separate and feed alone, but it would seem as if this were not invariably the case. The general colour is velvety black; along each side there runs a narrowish yellow stripe, from which, on each segment, a slender branch goes off at a right angle; the body is clothed with hairs of two different lengths, the shorter hairs being rich brown, the longer paler, with greyish tips. The legs and the hindmost pair of claspers are black, the rest of the claspers being red. The cocoon formed by this caterpillar has given its name to the moth; it is egg-shaped and compact, and so small, as compared with the size of the caterpillar, that it is difficult, when the two are placed together, to imagine how it can be constructed, as the caterpillar must, of course, work at it from the inside. Not only, however, does it complete this cocoon in the most perfect manner, but it leaves, with great dexterity, two or three small holes in this encasement, the purpose of which is doubtful.

Another interesting Egger caterpillar may be discovered at this season by those on the sea coast, especially in the south of England. Some time in August, the female moths of the Grass Egger (*Bombyx trifolii*) drop their pale brown eggs at random amongst the herbage. These produce caterpillars in the course of a week or two, not easily to be found during the autumn, since they keep close to the ground. Feeding again in the spring, they are of some size in May, being full-grown at the beginning of June. When found on grasses they are generally observed to eat from the tip downwards. Though known as the Grass Egger, an observer who has bred many, states that they thrive on the birds' foot trefoil, and will also eat oak, willow, bramble, and furze. Mr. Newman, on the contrary, found that all the individuals he had in his cages refused to eat anything but grasses. Like the preceding species, the ground colour is an intense black; though in this caterpillar there is a triple series of very small white spots along the back, which are best seen when the caterpillar is rolled into a ring, as is its habit when annoyed. On the third and fourth segments is an orange mark in the form of a crescent. The body is covered densely with soft hairs. The cocoon is usually placed amongst the sand (for the species occurs on the very margin of the sea), being attached slightly to the roots of the grass; it is brown and compact.

One of the largest British moths belonging to the family of the *Bombyces* is that known as the Lappet (*Lasiocampa quercifolia*), and this name is taken from the curious appendages or "lappets" which adorn the body of the caterpillar. This creature lives through the winter, being then only about an inch in length, but in May it has usually attained its full proportions. It occurs on blackthorn, willow, and sometimes on oak, being rather easy to detect from its size, though not by any means common, as far as our experience goes. The Rev. J. L. Wood, however, asserts that he has no difficulty in getting either caterpillar or moth whenever he requires it; but he leaves the *modus operandi* for the ingenuity of his readers to discover. Different specimens of this caterpillar vary much from each other in colour, being various shades of grey and brown; on the twelfth segment there is a distinct hump, and along the sides the protuberances which give it its rather fanciful name; between the second and fourth segments are two broad stripes of a bluish purple. The cocoon is placed by the caterpillar low down amongst the herbage; it is not egg-shaped, being long and blackish, and within it is swung the chrysalis, which is also black and smooth. The moth is sluggish, and when at rest very much resembles a dry and faded leaf. When fresh from the chrysalis, it has a beautiful bloom upon the wings, which fades in a few hours.

Amongst the butterfly caterpillars, which, found at all, are most likely to turn up in goodly numbers from their peculiar habits, are those of the three smaller Fritillaries belonging to the genus *Melitæa*. These are mostly full-grown about the beginning of May. The commonest is the Greasy Fritillary (*M. Artemis*), which occurs in damp, low-lying meadows. A year or two ago, as an entomological friend reports, these caterpillars occurred by the thousand in a certain part of Ireland, and were looked upon as a phenomenon by the country folks. They feed by preference on the plantain, sometimes also on the "devil's-bit scabious." The winter is passed by them in a state of hybernation, under the protection of a silken covering; in the spring, however, they feed exposed, and seem even to delight in the rays of the sun. The caterpillars of the Greasy Fritillary are black, or deep brown, with reddish-brown claspers, the surface of the body is sprinkled with white dots, and is also covered with spines rather thickly set. In the "good old times," this insect occurred at Chelsea, in the immediate vicinity of London; it must now be sought in localities remote from the metropolis. The butterfly flies very tardily, and may be easily caught with the hand.

Mr. Newman has described with great acumen the history of the Heath Fritillary (*M. Athalia*)—so called because it is most partial to heathy spots in or bordering upon woods. The eggs are laid by the parent butterflies in June and July on the narrow and broad-leaved plantain, and the young caterpillars after feeding a short time, hybernate early close to the roots. As soon as their food plants are in leaf they feed again, and continue to feed until the plantain is in flower, which flower, Mr. Newman notes, they much resemble in colour, and thus escape some of the assaults of birds, so frequently destructive to caterpillar life. These caterpillars, like those of all the Fritillaries, are studded with spines, some of which are orange and white, and others pure white with black tips; the ground colour being black, on which some snow-white dots show conspicuously, the under surface is of smoky hue. The chrysalis is short and stout, and attached by hooks to a little web of silk previously spun by the caterpillar. The Glanville Fritillary (*M. Cinxia*) resembles the preceding in its habits, and occurs in tolerably plenty on the Undercliff, in the Isle of Wight, appearing to have a preference for rough ground. Mr. Dawson remarks that, by natural instinct, the caterpillars of this species, when young, feed low down on the banks, where the growth is most luxuriant, and they are sheltered from rough weather; and as they increase in size they advance higher up the slope, attacking the older plants, to the stems of which they attach themselves, and become chrysalides.

Amongst the crowd of caterpillars which may be beaten from the hawthorn hedges this month, we are almost sure to find the small, but singularly-formed caterpillar of the Chinese character (*Cilix spinula*), the perfect insect being adorned with silvery scales, supposed to resemble Chinese letters—hence the name. The head of this little caterpillar has a crown, which is cleft in the middle; the body is of a dull brown colour, wrinkled, and having a stripe down the back, and some wavy markings. There are also numerous warts, some largish, some minute; a hump on the eleventh segment, and at the extremity of the body a terminal spike, the hindmost claspers being wanting. This spike is raised in the air, and carried much in the position in which the Puss Moth caterpillar raises its horns. When full-grown, the caterpillar of the Chinese character constructs a small gummy cocoon, which is ingeniously hidden in the angle of a branch or twig. There are two annual broods, and the second usually appears in August or September, remaining as a chrysalis through the winter.

Notable among the insects haunting the vicinity of the metropolis of England, and especially abundant in its northern suburbs, is the moth rather absurdly called the Willow Beauty (*Boarmia rhomboidaria*), which may be seen sitting quietly in the daytime with expanded wings on walls or old palings. The caterpillars which produce this species are usually adult in May, feeding on the ivy, and giving preference to the large-leaved kind, known as Irish ivy. The eggs are deposited in the summer in little clusters, and the young caterpillars, when newly hatched, eat only partially through the leaves, and, keeping on the underside, are thus protected from the weather. In about a fortnight they begin to nibble holes in the leaves, but long before winter approaches they conceal themselves amongst the recesses of the ivy, spinning a slight web, to which they fix themselves firmly. These caterpillars feed again in April, and when of full size enter the earth, and change to chrysalides just beneath the surface. The colour of the body is brown, darker or lighter, in different specimens; there are four black dots on each segment, the head is rather darker than the body, notched on the crown with two pale marks, which look like eyebrows. When touched, one of these caterpillars falls at first by a silken thread, and then descends to the ground, feigning death. When resting, the body is extended in a stick-like position.

One of our most active moths is that appropriately called the July Highflyer (*Ypsipites elutata*), and the habits of the caterpillar producing it contrast singularly with those of the mature insect. This lives through the winter, and feeds up in the spring, being full-grown in May. It lives upon the sallow, generally hiding during the day in the masses of seed-down, and coming forth at night. It is slow in its movements, and falls at once, as if inanimate, when it is touched. The colour is pale brown or smoky brown, the body being marked with white stripes, some of which are indistinct, and it is slightly attenuated towards the head, which is clear brown, with blackish cheeks, and slightly notched above. The chrysalis is placed in a cell constructed in the seed pods of the sallow, from which the moth appears in July and August, and flies at times briskly in the sunshine.

GEOGRAPHICAL INFORMATION.

INTRODUCTORY.

THESE notes, articles, or whatever name my readers like to give them—do not profess to be original. They will be simply compilations condensations from more elaborate treatises. Of course I have an aim; and it is this—to give our superabundant population, our intending emigrants, some *bonâ fide* knowledge of the different lands at the present moment open to settlement. THE ENGLISH MECHANIC having an immense circulation, and being read by that class to which geographical information seems all-important, I have determined, with the Editor's sanction, to extend far and wide such facts relating to this subject as are at present known to a select few. The peculiar information required by intending emigrants cannot be gathered from any existing text-books, but is contained either in the minds of returned settlers and travellers, or scattered throughout a number of costly volumes beyond the reach of any but the rich. The so-called guide books are often terribly inaccurate, as will be best seen from the sensible remarks made in he following extract:—

"I greatly doubt," said P——, as we strolled away, "the advisability of glossing over all drawbacks (many, very many of which exist) to the intending emigrant. Better far to place the colouring in a fair light, to speak freely of the difficulties he must encounter in soil and climate, and suggest a remedy. A poetical description of scenery in a guide-book may serve to cover over poverty of soil; but the truth is, that the emigrant *can't see* the poetry of the thing when his crops fail, and then he becomes disgusted with the land of his choice."

The colony is generally represented in an ideal light, as one would wish it to be, but not as it really is. Guide-books, as a rule, *omit* the failures, giving only one side of the question. This is not the place nor the time to write a dissertation upon emigration; it is a fact that our fellow citizens *are* emigrating; many have already gone, more are preparing to go. Hard it is to leave old associations, to leave home, kindred, all that is dear, in order to fight the battle of life in a far-off country; but necessity knows no law. Starvation stares us in the face here; affluence, or at least plenty and prosperity are promised there. Nevertheless, an emigrant who would fail to gain a livlihood in one place may become rich in another. Different men are adapted to different countries, and although the Caucasian seems to flourish everywhere, yet it is not so. In India, part of Africa, the "workers" are not the sons of previous workers, but fresh arrivals from the Old Country. An Englishman's childrens' children would soon imbibe and be enervated by the peculiar climatic influences of these regions, but other parts have a climate very similar to our own, and here it is that the race is perpetuated. America, Australia, New Zealand, the Cape, &c., all testify to this fact. Following the example, therefore, of "F.R.A.S.," I shall be glad to answer, when possible, any questions, directed to the Editor in the usual manner. This, I think, will be the best course to pursue, as although many readers would enjoy a descriptive narrative of the journey of Mr. Freshfield amidst Caucasian mountains, or Mr. Williamson in Marchuria, &c., yet the specific object at which I aim would not be gained.

F.R.G.S.

EXHAUSTED TEA LEAVES.

UNDER any circumstances, it is a misnomer to call infused tea leaves "exhausted," as they still contain a large proportion of such material as we every day consume in the form of bread, beef, and vegetables—viz., in Souchong, 4·6 per cent., and in Gunpowder, 4·40 per cent. of nitrogen. It needs but a glance to see that, apart from any putrefactive decomposition which may be discovered in re-dried tea leaves, they are not unfit for human food, if consumed as a vegetable.

The use of leaves which had "passed through the pot," as a means of increasing the bulk of tea retailed by certain grocers of "easy virtue," was conspicuously brought before the public by Mr. Phillips, of the Inland Revenue Office, twenty-six years ago. He then remarked :—"In the year 1843 there were many cases of re-dried tea leaves, which were prosecuted with vigour by the board, and the result was, so far as we could ascertain at the time, the suppression of the trade. It was supposed, in 1843, that there were eight manufactories for the purpose of re-drying exhausted tea leaves in London alone, besides several others in various parts of the country. The practice pursued was as follows :—Persons were employed to buy up the exhausted leaves at hotels, coffee-houses, and other places, at 2½d. and 3d. per lb. These were taken to the factories, mixed with a solution of gum, and re-dried. After this, the dried leaves, if for black tea, were mixed with rose-pink and black lead, to 'face' them, as it is termed."

In those days, it will be remembered, owing to the enormously-increasing consumption arising from various causes, the inducement to adulterate was much greater than it is now, and the duty levied was 2s. 2½d. per lb. Coming to a more recent period, we find that on the 18th December, 1850, the excise authorities seized a quantity of material in Liverpool, expressly prepared for tea adulteration, which possessed the negative merit of containing no tea at all. It consisted of broken sycamore and horse-chestnut leaves, stuck together and rendered astringent with catechu. During the following year another pleasant little episode in the way of sophistication came to light in the classical region of Clerkenwell. The *Times* of May, 1851, gives a description, which we abreviate :—"Edward South, and Louisa his wife, were charged with being concerned in the manufacture of spurious tea. The officers had been to their house, where they found the prisoners engaged in the operations. There was an extensive furnace, before which was suspended an iron pan, containing sloe leaves and exhausted tea leaves, which they were in the practice of purchasing from coffee-shop keepers. On searching the place, they found an immense quantity of used tea, bay leaves, etc., for the purpose of manufacturing illicit tea, and these were mixed with a solution of gum and a quantity of copperas. The heat was so excessive that the officers could scarcely remain, but the prisoners did not seem at all oppressed. The woman was employed stirring the bay leaves and other materials with a solution of gum in the pan; and in one part of the room there was a large quantity of spurious stuff, the exact imitation of genuine tea. In a back room, were found nearly 100lb. weight of re-dried tea leaves, bay leaves, and sloe leaves, spread on the floor, drying. The prisoners had pursued their nefarious traffic extensively, and where in the habit of dealing largely with grocers, chandlers, and others, especially in the country."

That such vile practices are by no means obsolete, we observed from one of the occasional notes in the first number of this journal ; but it is to be hoped that public indignation, once more aroused, will have the effect, through judicious legislation and the continual employment of analytical chemistry, of curbing, if not altogether eradicating, tea adulteration.

Already the community feels the sting, and it is a significant fact that the 7,000,000lb. of trashy tea, alluded to in Dr. Letheby's report as being under the ban of the City authorities, almost exactly correspond with the quantity of good tea short last year in the imports from China, as compared with those of 1868.

It must be evident from the foregoing, that the time has passed away when we need hold up our hands and roll our eyes in holy horror at the iniquity of the Chinese. Surely it were better to mingle our frugal Congou with Maloo mixture, over which the nimble Shanghai pigs had gyrated, and China dogs gambolled, rather then return to the days of slow poisoning by arsenite of copper, chromate of lead, bay leaves, sloe leaves, and catechu.—*Food Journal.*

DRESSING MILLSTONES WITH THE DIAMOND OR "BORT."

OUR readers have observed that for some weeks past an interesting controversy has been sustained in our columns on dressing millstones. Who would have thought that the ENGLISH MECHANIC would have become an organ for millers ? Judging from what several correspondents have said, such is the case. As the question is an important one, not only to millers, but to all interested in the cheapness and purity of flour, we will transcribe from the *Engineer* a paper on the subject.

A remarkable revolution has been in progress during the last two years in a department of the mechanical operations connected with the manufacture of flour, and various facts associated therewith are worthy of record, not only on account of the importance of the manufacture, as supplying the "staff of life" for our daily wants, but also because they possess considerable interest from a mechanical point of view. We do not propose to enter very minutely into detail, nor to deal very largely with technicalities which could interest the miller only : at the same time we may have to mention some facts that are most probably known to all our readers.

The character of the grinding surfaces of the millstones has a great deal to do with the quality of the flour produced. After the grinding operation, the flour is separated by "dressing" or sifting, into different qualities, and from the same grain one pair of stones will produce a much larger proportion of the first and finest quality than another pair. This depends on the "dress" or surface condition of the stones. The face of each stone has a number of grooves or "roads" formed upon it, the surfaces or "lands" between these grooves being the parts which effect the grinding operation. It has hitherto been the practice to produce on the lands the roughness necessary for grinding entirely by hand, by means of a steel chisel, pick, or bill; and considerable skill is required by the operator or "stoneman," who strikes in a peculiar manner and so as to just crack the surface of the stone. The roads of the stone are arranged in sectors, all in one sector being parallel to each other, and the "master" or longest road in each sector being in a radial position. This arrangement is, however, sometimes departed from. The cracking or dressing is generally done in lines which are parallel to the roads, and at minute distances apart.

Millstones when grinding night and day are usually re-dressed by the handbill once in six days. In large mills the stonemen are kept exclusively at the work of dressing, and in consequence attain as great efficiency as is possible at this description of work. In small mills, however, such as are scattered over country districts, this is not possible, as the men cannot wholly occupy themselves with dressing, but have to attend to all sorts of work, and cannot attain the same proficiency. With the best and most careful hand-dressing possible, the millstones, for from thirty to forty hours after being dressed, cut up the wheat very much, making the meal rough and unequal,—the flour being in consequence specky and irregular, the bran small and badly cleaned, and the proportion of flour-sharps, middlings, or second quality, large ; and in proportion as the millstones are less perfectly dressed these evils increase. In addition to the importance of the dress or cracking being well done, it is also of great importance to have the millstone face, or grinding surface, absolutely true and level ; much difficulty, however is experienced in keeping the millstones true—the tendency being for a portion or section of the grinding surface to get out of truth with the rest. Indeed, under the system of hand-dressing it has been found impossible to prevent this evil from arising, more or less, notwithstanding the most careful use of the proving-staff. The application of the staff to the surface of the stone is the only means hitherto in use for testing or indicating the truth or level of millstones, and it has long been felt to be imperfect, a more thorough and accurate method being much wanted. Many practical and careful millers consider the truth and level of the millstones as of more importance even than the quality or perfection of the cracking or dress, and recent experience with improved arrangements has very much tended to confirm this opinion. We feel sure that every miller who has given the matter consideration will agree with us that these two defects are all but inseparable from the system of dressing by hand—namely, an imperfect dress and a want of truth and level in the millstone face.

It is roughly estimated that there are 80,000 pairs of millstones in the United Kingdom, so that the importance cannot be over-estimated of any sound improvement so essentially affecting their use and action as one relating to the "dressing" of their grinding surfaces. The subject has not failed to attract the attention of inventors and patentees, and a great variety of appliances have been proposed from time to time. Amongst these there have been various combinations of mechanism which, in imitation of the ordinary hand-dressing, have been designed to actuate a steel bill or pick, the objects of such mechanism being to render the action more uniform and regular, and to dispense with extreme skill on the part of the operator. Some of these combinations have comprised arrangements for making the lines of the cracking accurately parallel and at uniform distances apart ; but in none of those designed for using the steel tool is there any provision for, or arrangement conducive to, the maintenance of the truth and level of the stone ; and as none of them have come into use, it may be safely assumed that they have not satisfied the requirements of the case.

No attempted improvement in dressing millstones has as yet attained any practical success that has not comprised the use of "bort" for the cutting tool ; at the same time, it may be interesting to refer to one of the machines proposed for operating with a steel bill, as not only was it anterior to any proposal to use the diamond or bort, but it also contained various mechanical appliances, which, with suitable modications, have been adopted in the successful bort machines, and its designer may, therefore, justly claim to have contributed something towards the ultimate success. The machine to which we refer is the invention of a Parisian miller, P. J. Morisseau, patented in this country in the name of G. Davies, of Serle-street, on the 9th April, 1861, No. 865, and is shown in vertical section in Fig. 1, and in plan in Fig. 2. The following description is from the specification :—

"The machine rests by its own weight upon that part of the millstone A, which it is desired to operate upon, and it may be moved with ease on to any portion or division of the circumference of the stone, being guided in this movement or alteration of position by means of two gudgeons or pins fixed at two extreme points of the frame B, and sliding in a circular groove a, made in the iron ring C, which embraces the circumference of the millstone, and is adjusted and fixed thereto by set screws.

"Each of the longitudinal sides of the machine is provided with a long screw rod b, upon which is mounted a bevel wheel c. These wheels have bosses screwed internally, and work between two projecting pieces forming part of the frame or carriage D. This carriage also supports a long ratchet or grooved cylinder E, extending the whole width of the machine, and to the extremities of which are keyed bevel pinions e gearing respectively with the wheels c on the screws b. It results from this arrangement that by the rotation of the cylinder E the carriage D can be caused to travel the whole length of the screws b, and consequently of the machine itself. On the carriage D are two brackets or supports carrying a shaft f, which is grooved throughout its entire length so as to receive a key connecting a cam g thereto, which cam is intended to communicate motion to the cylinder E, as hereafter described. This cam is held between two projections or bosses g_1 fixed on a second carriage F, which carries the cutting tool or hammer m, and also serves as its guide. This carriage, which is mounted on V slides on the carriage D, is moved by hand by the workman by the aid of a lever h, and can be slidden from end to end of the machine, and arrested at any point desired. The tool carrier k moves vertically in V slides formed in front of the carriage F for that purpose ; to this piece are attached jaws which hold the cutting tool or hammer m, the position of which latter can be regulated to any height desired above the sur

FIG I

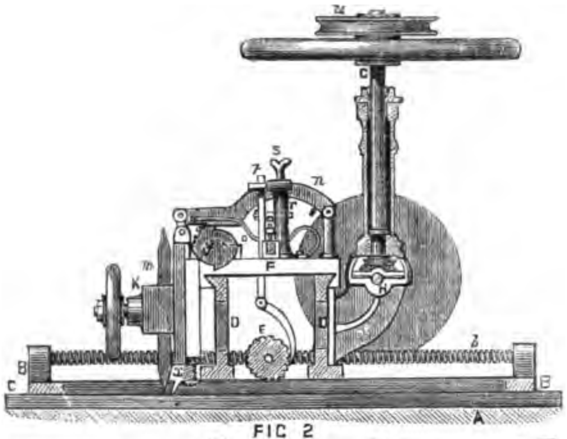


FIG 2

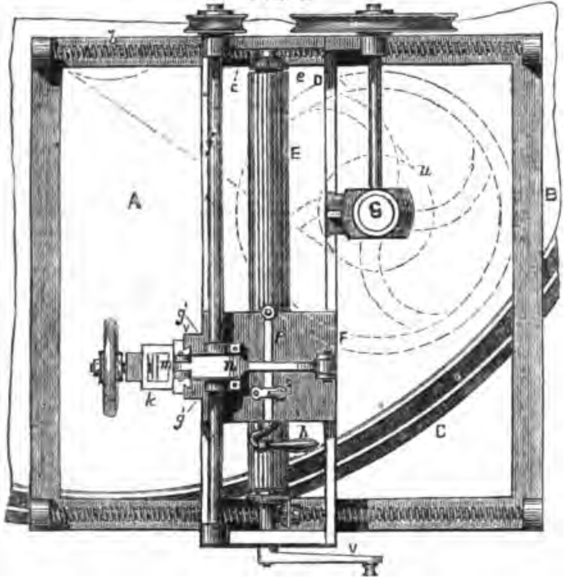
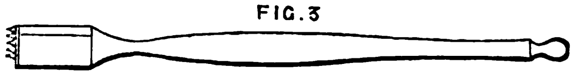


FIG. 3



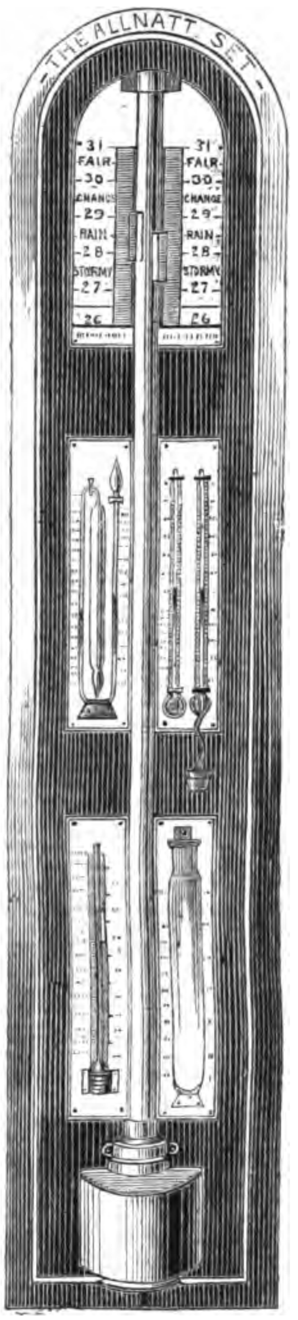
face of the stone upon which it is intended to operate. The tool carrier *k* is connected by a joint to a lever *n*, actuated by the cam, the abrupt projections of which give an increased action to the hammer. This lever *n* is thrust away from the said cam by a spring *o* fixed to the carriage F in such a manner that contact only takes place in proportion as the spring is compressed by the pressure of the lever *h*. The action of this mechanism is rendered more sensitive by the combination of several spring levers all controlled by the same handle *h*. It will hence be perceived that the more the lever *h* is pressed down the more action the cam *g* has on the lever *n*, the ascent and descent of which is communicated exactly to the hammer, and in this case the latter acts on the stone to a correspondingly greater depth, the reverse of which will evidently take place if the lever *h* is moved in the reverse direction. When this lever is raised it comes in contact with a lever *p*, the extremity of which works in a fork *r*, and acts against a screw *s*, which can be raised or lowered to any desired degree to limit the ascent of the said lever *p*. To this latter is joined a vertical rod carrying a ratchet or catch *t*, which gears into the grooves or teeth of the ratchet cylinder E. In this manner the greater the ascent of the lever *p* the further the catch *t* will cause the cylinder E to rotate, and the more the carriage D will be displaced on the screw rod *b*.

"It now remains to explain the driving gear and the transmission of movement to the various parts of the machine. The pulley *u*, mounted on the vertical fly-wheel shaft G, receives motion directly from the driving power; this shaft communicates movement by the aid of a pair of bevel wheels to the horizontal shaft H, the end of which carries a grooved pulley round which passes a cord, passing also round a similar pulley on the shaft *f*, carrying the cam *g*, which actuates the double bevelled hammer or tool *m*, as above described. The workman directs the tool carriage F by hand to any point of the width or depth of the machine, whilst, by raising the handle *h*, he also determines at will the movement of the lower carriage D, and causes it to act successively by means of the ratchet cylinder E and screwed rods *b*, on every point lengthwise of the machine. Thus the attendant operative can not only move the tool or hammer *m* instantly to any possible point of the millstone A, and cause it to attack the surface with any force or to any depth required, but he can also had the tool fixed upon one particular point as long as he thinks fit. When the carriage D is at the end of its course it is taken back to the starting point by means of a crank *v*, which acts directly upon the ratchet cylinder E. The wheels then slide upon the screw *b*, which remain fixed. To keep the driving-strap or band on the pulley *u* at its necessary tension, whatever may be the position of the carriage D on the frame B, an elastic cord or band must be used for that purpose. The sand or dust produced during the work on that part of the stone under operation is constantly expelled by a small bellows *x*, actuated by each upward movement of the tool carrier *k*."

We have in this machine a horizontal rectilinear sliding movement, which causes the cracking to be done in straight lines, and a screw-feed motion at right angles thereto, by which those lines are made at regular distances apart. Any arrangement for securing the truth and level of the stone is, however, wholly absent; the frame, resting on the stone, covers too small a surface, and the inner corner of it being over the central part of the stone, which is always somewhat depressed below the outer part, must be held up by a special support, the adjustment of which would always be uncertain; otherwise the frame would rock on the two corners which rest on the outer part of the stone.

(To be continued.)

SOLOMONS' NEW PATENT "COMPOUND SET."



IN 1868 Dr. Allnatt wrote to the editor of the *Times* suggesting the great advantage that would accrue to meteorological observers from the possession of a complete set of instruments. He, however, lamented that the cost of the complete set—consisting of barometer, thermometer, hygrometer, rain gauge, anemometer, and zone cage, when constructed with tolerable accuracy, prevented the majority of observers from obtaining them. He suggested the construction of a combined set of all the required instruments (except of course the rain-gauge), mounted on a solid mahogany frame, which should exhibit at a glance all the existing physical elemental conditions. The Messrs. Solomons, of 39, Albemarle-street, Piccadilly, speedily responded to Dr. Allnatt's suggestion by the construction of het compound set herewith illustrated, and which het Doctor in a second letter to the *Times* characterised as "indeed a *multum in parvo*." The set is indeed the best and cheapest we know of, its price, £2 12s. 6d., being so low as almost to inspire distrust. Its accuracy, however, is guaranteed by the testimonials of numerous purchasers who have hastened to avail themselves of an opportunity hitherto afforded by no other meteorological instrument maker.

The set consists of a barometer, with double vernier, maximum and minimum thermometer, Mason's hygrometer, thermometer with centigrade and Fahrenheit's scales, and storm-glass The tubes, enamelled, are of best quality; the scales, of stout polished boxwood firmly screwed to a solid walnut, oak, or mahogany board, measuring 3ft. 3in. long, by 8in. wide.

Messrs. Solomons recommend the addition of their patent vernier thermometer, which, at the slight extra cost of 12s. 6d., renders the set complete.

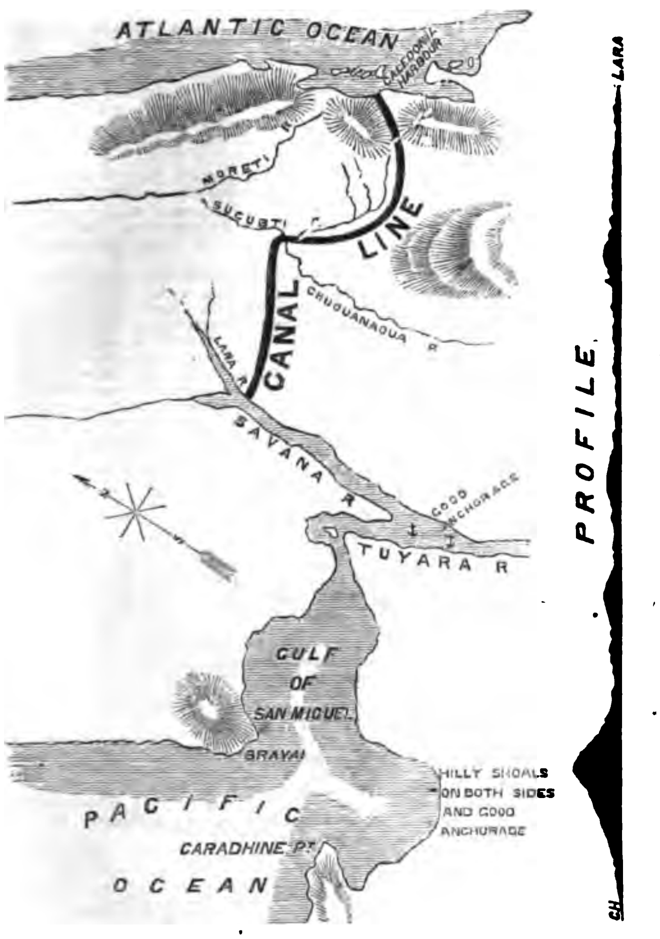
The scales and two verniers of the barometer are engine divided, and allowance is made for capacity and capillarity; so that it approximates in accuracy the nearest to the Kew standard. The storm or camphor glass, though much consulted by the late Admiral Fitzroy, is probably of little real use. Still it is attended with great interest, and being made by Messrs. Solomons exactly in accordance with the Admiral's receipe and with the glass tube of a larger size than usually sold is rendered, which prevents in a great degree the attraction of the crystals to the sides, it is rendered as useful as possible. The hygrometer is a most important part of the set. Its aid to the physician is invaluable in the regulation of the degree of moisture or dryness necessary in the air breathed by his patients; to the householder who wishes to keep the air of his rooms in its proper condition; and to the horticulturist whom it enables to determine at will the climate of his conservatory. We think Messrs. Solomons fairly entitled to the credit of having produced the best and cheapest set of meteorological instruments yet introduced.

THE PROPOSED DARIEN CANAL.

THE Isthmus of Darien appears to be regarded by the majority of American scientific opinion as the most suitable site for the proposed inter-oceanic canal.

Dr. Cullen, an Englishman, claims to have made the most complete reconnoissance of the Isthmus of Darien. He claims to have found a practicable route, with an elevation of not over 190 feet, and he thinks even less may be found. We submit his map.

It will be seen from the map that he has a canal of 21 miles, and deepens the Sucubti 12 miles, then navigates the deep streams, Lara, Savana, and Tuyara, 14 miles more, in all 47, with one or two tidal locks—no other. He estimates this to cost about 34,000,000 dols., but his estimates are only for a canal 24ft. deep and 150ft. wide through the mountain or deep cuttings. It would be folly to dig such a small canal at the present day. The harbours at each end will accommodate ships of the largest class now known, and at low tide the depth of water at the mouth of the Lara is 50ft. The tide rises there 12 to 14ft.



The canal, to meet the requirements of modern commerce of all characters, should, the *Scientific American* thinks, be 50ft. deep its entire distance, and 500ft. wide at top, throughout the earth or valley cutting, and at least 150ft. through the mountain section. Without the most wasteful extravagance such a canal would not cost near 100,000,000 dols. The actual mountain section is not over three miles long, the rock is soft dolomite, and coralline, limestone, and gravel. The climate, unlike that of Panama, is comparatively healthy, and there need be no such mortality as was witnessed in the construction of the railroad. 10,000 Chinese labourers would in five years add another to the great works of modern engineering skill.

The Suez Canal has cost over 80,000,000 dols., and it is estimated to cost 20,000,000 dols. more to make it what was originally intended—that is, 100 yards wide at top and 26ft. deep. With its present imperfection they have taken nearly 100,000 dols. of tolls. The Darien Canal, costing, say, 75,000,000 dols., would at least pay 10 per cent. profit, and Dr. Cullen estimates the actual saving to the commerce of the world in 1857 would have been 48,130,208 dols.—nearly enough to have built it.

THE GERM THEORY OF DISEASE.

IN a letter to the *Times*, Dr. Tyndall combats, as follows, some of the arguments against his germ theory of disease :—

Amid the morass of wordy discussion and contradictory argument in which the germ theory of disease and the question of spontaneous generation are entangled, the fact and inference brought forward by Professor Lister regarding the putrefaction of wounds appeared to me to present a spot of perfectly firm ground. They by no means involved the demonstration of the germ theory of disease in all its generality, and I thought that even those who are most hostile to the theory in its wider claims and bearings would be willing to concede that the origin of putrefaction, at least, was placed beyond dispute. Dr. Bastian's letter in the *Times* of last Wednesday causes me to fear that this admission on the part of those whom he represents is still distant, and that it was a delusion on my part to hope that it was near.

A similar delusion may cleave to my judgment when I say that in a letter which fills nearly a whole column of the *Times*, Dr. Bastian has not, so far as I can see, brought forward anything beyond an opinion affecting, in one way or the other, the position of Professor Lister. He deprecates "indirect evidence," and speaks of the ambiguous experiments of Pasteur; he refers to the virtues of turnip infusions and to the killing of germs by heat; he expresses amazement, and protests against laxity; he exhorts, he warns, he promises results "which will go very far towards the settlement of the much-vexed question as to the possibility of spontaneous generation." But he successfully avoids offering the shadow of an argument calculated to influence either affirmatively or negatively the distinct issue raised in my letter of Thursday week. Will Dr. Bastian forgive me for expressing the opinion that irrelevant writing has done, and is likely to do, more damage to the cause of exact medicine than the distinct statement of even erroneous views? In the one case we have a definite error on which to place the iron heel of logic or of fact; in the other we are met by a phantom which eludes both. The question raised by my letter lies in a nutshell. Either Dr. Bastian denies the inability of lung filtered air to produce putrefaction, or he admits it; if the former, he can state his denial in three words; if the latter, I ask him to explain the fact.

Philosophical physicians have before now rendered immortal service to the cause of physical science; and, should the opportunity arise of making some small return for this service, it is not the philosophical physician who will scorn our offered aid. The germ theory of disease, says Dr. Bastian, "appertains most to the biologist and the physician." Granted. But it is, nevertheless, true that the very best modern work connected with this subject has been executed, not by a biologist, not by a physician, but by a chemist. This is not the opinion of chemists only. Some of the most eminent biologists of the present time speak with no uncertain voice of the demonstrative force of the experiments of Pasteur.

I quite agree with Dr. Bastian that there is no proof that the organic matter of London air is all germinal matter. I do not believe it to be such. In fact, I have twice or thrice written down what the researches of others make the floating matter of London air to be, but tenderness for the public has withheld the description from the press. In the lecture, a report of which you did me the honour to publish, it is stated that "there is no respite from this contact with dirt, and the wonder is, not that we should from time to time suffer from its presence, but that so small a portion of it would appear to be deadly to man." It is with reference to this "small portion" that I described the germ theory of disease. The really important point here is that the germs which are mixed up with the floating matter disappear when it disappears. Permit me to place in a connected form before the readers of the *Times* the "indirect evidence" on which, to the surprise of Dr. Bastian, I rely. Schrœder and Pasteur have demonstrated that air filtered through cotton wool is deprived wholly or in part of its power to produce animalcular life. Why? Experiment with a beam of light answers the question; for while it proves our ordinary air to be charged with floating matter, the beam pronounces air which air which has been carefully filtered through cotton wool to be visibly pure. There are no germs afloat in it; hence its impotence as a generator of life.

Again, Pasteur prepared 21 flasks, each containing a decoction of yeast, which he boiled, in order to destroy whatever germs it might contain. While the space above the liquid was filled with pure steam he sealed the necks of his flasks with a blow-pipe. He opened ten of them in the damp still caves of the Paris Observatory, and 11 of them in the courtyard of the same establishment. Of the former only one showed signs of life subsequently. In nine out of the ten flasks no organisms of any kind were developed. In all the others organisms speedily appeared. Pasteur ascribed this unexpected result to the subsidence of the germs in the motionless air of the caves. Is his surmise correct?

The beam of light enables us to answer this question also. I have had a chamber constructed, the lower half of which is of wood, and the upper half of glass. On the 6th of February this chamber was closed, and every crevice that could admit dust or cause a disturbance of the air was carefully stopped. The electric beam, when sent through the glass, showed the air at the outset to be loaded with floating matter. The chamber was examined almost daily, and a gradual diminution of the floating matter was observed. At the end of a week the chamber was optically empty. The floating matters, germs included, had wholly subsided, and the air held nothing in suspension. Here again the ocular demonstration furnished by the luminous beam goes hand in hand with the experimental result of Pasteur.

Next comes Professor Lister's observation regarding the filtering power of the lungs. Turning once more to the luminous beam, we find that it declares air so filtered to be free from floating germs. Hence its inability to produce putrefaction, and the accompanying manifestation of animalcular life. Finally, as if to clinch the purely scientific experiments by a practical result, we find Professor Lister actually employing cotton wool to ward off the atmospheric germs, and, by its agency, keeping a large class of wounds sweet and pure. It is this intimate welding together of two independent series of observations that Dr. Bastian calls indirect evidence; it is my reliance on such evidence that fills him with "amazement." In matters of science I always sacrifice the emotions, otherwise I might permit myself a little amazement too.

NEW LUBRICATING APPARATUS FOR MACHINERY.—For nearly two years an invention has been practically tested on the Lancashire and Yorkshire Railway, from which a considerable saving in lubricating material is secured. The peculiarity of the invention, which has been patented by Messrs. Bauer and Co., of Manchester, consists in the construction, in connection with the axle-box, of a chamber or receptacle for oil, underneath the axle journal, in which a disc, supported on elastic or yielding bearings, is partially immersed. This disc, owing to the periphery of its upper surface being pressed against the axle journal, is made to rotate when the axle is in motion, and a continuous supply of oil is thus transmitted to the journal and its bearings, the amount being governed by a doctor or plate, provided with a slot that embraces the disc, placed above the level of the oil. By this means a constant supply of the lubricant being insured, the possibility of the bearings getting hot, which often happens when the salve lubricant is employed, is prevented.

LETTERS TO THE EDITOR.

[We do not hold ourselves responsible for the opinions of our correspondents. The EDITOR respectfully requests that all communications should be drawn up as briefly as possible.]

⁂ All communications should be addressed to the EDITOR of the ENGLISH MECHANIC, 31, Tavistock-street, Covent Garden, W.C.

All cheques and Post Office Orders to be made payable to J. PASSMORE EDWARDS.

I would have every one write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that, as to other things, knows no more than what everybody does, and yet to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks: a vice from whence great inconveniences derive their original.—*Montaigne's Essays.*

THE TELESCOPE.

SIR.—"Amateur" (2451) is confusing angular and linear magnitude, in a way nothing short of marvellous. In its existing form his question admits of no answer; but the following considerations may possibly tend to help him out of his difficulty. The disc of the Sun subtends an angle of about 32′, and 32′ (as "Amateur" may discover by reference to a table of Natural Sines in the first set of mathematical tables he can lay his hands on), or the sine of 32′, which practically coincides with the arc, is ·0093 of the radius of the circle on which it is measured, be that of what size it may. Now in most books on Optics, 10in. is taken as the standard distance of distinct vision; multiplying, then, ·0093 by 10· we get ·093in. as the length of a line subtending an angle of 32′ at 10in. from the eye. In other words, if your correspondent will cut out a little disc of card, ·093in. or roughly ·1in. in diameter, and interpose it between his eye and the Sun at a distance of 10in. from the former, he will find that it will just hide the Sun from his view. If, then, we multiply, ·093 by 40· we shall get, 3·72in.; or by 60, 5·58in. as the apparent diameter of the Sun with the powers he specifies. This is however only true *at the one specific distance of 10in. from the eye;* since, for example, the 3·72in. image would apparently coincide with one of 16·32in., or the 5·58in. one with another of 33·48in. if the latter were removed to a distance of 5ft.; and, so far as "Amateur's" query, in any shape, admits of a response at all, this must be my reply to it.

"α Ursæ Minoris" (2487), same page, is very much less difficult to answer, inasmuch as "a partially silvered speculum," and "a single plano-convex lens for an eyepiece" supply all the conditions needful for the production of any amount of fog, glare, or indistinctness. "α Ursæ" omits to say whether the plane or the convex surface of the single eye lens is turned towards the mirror; but under any circumstances, his friend ought to get some good Huyghenian eyepieces forthwith, always supposing that his speculum is worth them, and have that properly silvered into the bargain.

I may inform Mr. Baguley (2498), p. 95, that any optician whatever, would make him a Ramsden's eyepiece. Slater, of 138, Euston-road, London, would be a very good man to go to, were he a little less dilatory; or Baker, of 243, High Holborn; or Murrell, of 5A, Mitchell-street, St. Luke's, both in London, might be depended on. From 12s. to 15s. would be a fair price to pay for it. Two ways only occur to me in which Mr. B. could deepen the colour of his sun shade. The one is to have a piece of green glass cemented on to his present red one; the other is to smoke its internal surface over a candle. The latter is the more feasible, as the first would render the eyecap inconveniently thick. It is impossible to re-colour the glass, but Baker would take it out and replace it with another of any tint your correspondent chose for about a shilling.

A FELLOW OF THE ROYAL ASTRONOMICAL SOCIETY.

ASTRONOMICAL.

SIR,—"Gimel" (2448), p. 94, speaks as though Le Verrier had both computed the mass and distance of Neptune, and made the optical discovery of it as well in his own person; at least so I interpret the words "by calculation and observation," which he employs in connection with the name of the great French geometer. Le Verrier computed the hitherto unknown planet's place in the Heavens, as did Adams too; but the former communicated the result of his calculations as soon as he obtained them, to Dr. Galle, of Berlin, and he, searching in the indicated region, at once found Neptune; so that Dr. G. was what would be vulgarly called the discoverer of the new planet. "Gimel" may get some idea of Adams's process from Vol. 16 of the "Memoirs of the Royal Astronomical Society," and from the "Supplement to the Nautical Almanac for 1851."

Did it never occur to "H. A. C." (2452), p. 94, that the very circumstance of his pseudo Satellite of Venus disappearing with a change of eyepiece was, in itself, a very suspicious one? The probability is, that had he only turned the 240 eyepiece round in the tube, while watching the planet, he would have seen his supposititious moon describe a complete orbit about its primary, and so have convinced himself that it had its origin and existence within the eyepiece itself, and nowhere else.

A FELLOW OF THE ROYAL ASTRONOMICAL SOCIETY.

DARK LINES IN SOLAR SPECTRUM.

SIR,—"T. A." should state his evidence. All I can at present say is that his view is opposed to all the evidence I know of. There are certain characteristics we should expect to find in dark lines, caused by our own atmosphere; certain others we should expect to find in dark lines really belonging to the solar spectrum. We find accordingly that the dark lines may be divided into two classes—the atmospheric and the solar. Has "T. A." any reason to show why the latter dark lines (all or any of them) should be placed in the same category with the former?

R. A. PROCTOR.

JUMPING FROM A TRAIN IN MOTION.

SIR,—A friendly correspondent points out what he holds to be a mistake in my remarks on this subject. On looking at my letter, I find there *is* room for misconception. I was not referring to the case of one who wishes (evil-disposed man !) to leave a carriage "while the train is still in motion," against the laws made and provided by the authorities, but to one who wished to leap from a rapidly moving train. Whenever it is possible, it is always well (as every one knows) to move in the same direction on *terra firma* as in the train. Even then, however, the motion with which one leaves the train is only forward with respect to *terra firma*, not with respect to the train; but where one has to spring from a train in rapid motion, and is quite sure of a fall, one may escape broken limbs by leaping strongly in a direction contrary to that in which the train is moving. Unfortunately, one cannot very easily do this. It is, however, useful to learn that when one is in an open carriage and the horses run away, one may effect an almost certain escape by springing sharply from the back of the carriage (supposing its construction suitable). I do not speak without having tried the experiment—not, indeed, in the case of a runaway trap, but from the back of a truck moving with considerable swiftness.

One can easily establish the general principle on which the matter depends. If any one will amuse himself by throwing stones from the back of a carriage, he will find that after a little practice he can so throw a stone in that direction, that the stone will fall dead still on the spot where it first touches the ground.

I see by your "Replies to Correspondents" that you think Mr. Beardsley should be answered. With all respect, I confess I am of another opinion. I think no student of science who values his reputation could seriously enter into discussion over such puerilities as those with which Mr. Beardsley has filled nearly a column of your space.

It is one thing to exhibit the evidence on which the earth's figure, &c., depends, and quite another to take up the challenge which "charlatans and enthusiasts" are ever ready to throw down. Surely your readers must all see for themselves that Mr. Beardsley's letter needs no answer. If we spring from the floor of a railway carriage, we are not forthwith flung against the rear seats. A passenger on a rear seat would not find it more difficult to throw a ball to a passenger on a front seat than the latter would find it to return the compliment; yet for Mr. Beardsley's argument these and all the thousand evidences derived from daily experience must be forgotten. The real fact is, that it is not with the teachings of astronomy he contends, but with the familiar principle known as the second law of motion. It would be absurd to reason with him.

If he were to point out any flaw in the reasonings in my paper on the earth, I should feel bound to set matters straight; but as a matter of fact, he has gone out of his way to deal with things I have not touched on in my paper, conceiving as I did that to explain such matters to those for whom the ENGLISH MECHANIC is primarily intended would be to carry coals to Newcastle.

R. A. PROCTOR.

ENGLISH MECHANIC MUTUAL IMPROVEMENT SOCIETIES.

SIR,—The letter in last issue but one, on ENGLISH MECHANIC Mutual Improvement Societies has given, no doubt, great satisfaction to many subscribers of our paper besides myself. The same thought which has been so vividly depicted was also in my mind, but true, in a dormant state, waiting, like the worm for the spring, to emerge from its cover. Will you therefore allow me to take a part in the movement, and propose to the subscribers living in Manchester to assemble one night this week, to discuss the subject—namely, the formation of a Manchestrian ENGLISH MECHANIC Mutual Improvement Society. I feel convinced that much benefit would be derived from such a society, and would in some measure be a reward to our indefatigable editor, in effecting prosaically the truth in the editorial article, "Ourselves and Our Subscribers."

Having been fortunate enough to make arrangements with the landlord of the Dog and Partridge Hotel, I suggest that we meet there on Friday evening, 29th April, at 7 o'clock, when I hope to meet many subscribers.

A. TOLHAUSEN, Manchester.

WORKMEN'S INTERNATIONAL EXHIBITION, 1870.

SIR,—As the interest in the Workmen's International Exhibition is daily increasing, a few words upon the subject may be acceptable, and perhaps useful, to many of your readers. The following despatch, which has been received by the council through the Foreign Office, will give an idea of how warmly the subject has been taken up upon the Continent:—

"The council of this exhibition have received the following despatch through the Foreign Office from Signor Visconti Venosta, one of the Italian Ministers:—

"Florence, February 26th, 1870.

'Sir,—His Majesty's Government took care to give the greatest possible publicity to the notices contained in your notes of the 20th June, 8th of October, and 22nd of December, 1869, relative to the Workmen's International Exhibition, which is to be opened in London next June.

'I am glad to inform you that the idea of that exhibition has been most favourably received in Ital[illegible] that in the most important cities of the king[illegible] delay has taken place in constituting local co[illegible] which have spontaneously assumed the [illegible] encouraging it.

'The King's Government, on its part, has in a spec[illegible] manner requested the Consultative Committee [illegible] Provident Institutions and Labour to prepare [illegible] solicit the participation of our country in that exhibition, and its Executive Committee has just publish[illegible] a code of regulations, copy of which is enclo[illegible], explaining the course to be followed by Italian exhibitors.

'You will perceive that independently of the subsidies which may be voted by the provinces, communes, and Chamber of Commerce, or accorded by private individuals, the exhibitors are entitled to gratuitous transport by sea of the articles for exhibition, and to the reductions usually granted in similar cases by the railway companies.

'I must add that the King's Government intend instituting an Italian commission in London, which will provide for the reception and placing of the articles and for their reconveyance to Italy.

'I am convinced that this commission will receive the support of the British authorities charged with the direction and regulation of the exhibition, and in this conviction I avail myself, &c.,

"(Signed) VISCONTI VENOSTA.'"

The following reprint from the *Daily News* will give a good idea of the intentions of this exhibition:—

"It is intended, as no doubt most of our readers are aware, to hold a Workmen's International Exhibition in London, in July, 1870. The distinguishing features of the scheme are—

"1. All articles exhibited will be signed with the name of the workman by whom they are made.

"2. In those manufactures in which division of labour prevails, workmen will be invited to exhibit specimens of that particular branch of work in which they are severally engaged. Thus, for instance, a watch or a piano might be exhibited, showing in a complete series the various parts on which workmen are severally employed, and the various steps by which it approaches completion. Each workman will thus have the opportunity of showing his skill in his own special department, or of calling attention to any improvement in the manner of manufacture he may wish to introduce, and the public will better understand the whole process of construction through which the completed article has passed. 3. Workmen are invited to combine for the production of the same article. In all cases the article will bear the workman's signature. 4. To show the various processes of manufacture, and to arrange these in such a manner that the English and the foreign process may be compared with each other, and lectures given in explanation of the relative advantages possessed by the different methods. 5. In the same way, for the purpose of comparison, when the manufacturing process is of such a character that it cannot be seen in operation, an endeavour will be made to show, side by side, by means of drawings and models, some important variations in the methods pursued in different countries.

"The Right Hon. W. E. Gladstone, M.P., is the president, supported by noblemen and gentlemen of all parties as vice-presidents; the executive committee consists both of men of position and artisans, assisted by a handsome guarantee fund and good list of subscriptions. An agreement has been made with the Agricultural Hall Company for the use of their hall at Islington, in which there is ample room for exhibits, and which will contain 30,000 visitors. Very considerable progress has been made not only in this country, but in foreign countries. Side by side with the contributions of our own country will be the productions of the French artisan, of the thoughtful German, of the artistic Italian, of the persevering Dane, and of our American cousins.

"Local committees have been formed at Venice, Verona, Florence, Turin, and Genoa. The Syndic of Palermo has announced that the artisans of that city shall have their contributions forwarded to London at the expense of the commune. In the Italian cities subscriptions have been raised to pay the expenses of transit, &c. The exhibition has the hearty support of General Garibaldi. The secretary of the local committee at Florence was the general's intimate friend and companion, Signor Dolfi, who continued his efforts until his lamented death. He has been succeeded by Signor Dassi, the president of many workmen's institutions. Through the hearty exertions of the Right Hon. A. H. Layard, the chairman of the committee at Venice, and Hon. Secretary Dr. Errara, twenty picked Italian artisans will be sent to London to visit the exhibition, and the committee in London will endeavour to extend their visit to Manchester, Leeds, Birmingham, and the other great centres of manufactures in this country. In Germany committees are being formed at Berlin, Frankfort-on-the-Maine, Mayence, Darmstadt, Offenbach, Stutgard, Carlsruhe, and Munich, at Pesth in Hungary, and at Warsaw in Poland. The Baden contributions will be collected at Carlsruhe, and there exhibited, and then forwarded to London at the expense of the State. The Wurtemburg Government has voted 10,000 florins for the use of the committee at Stutgard, for the expense of transit, and to give subscriptions to workmen desirous of visiting the exhibition. Committees are also formed at Copenhagen, Hamburg, Rouen, and Brussels. A very active and energetic committee is formed at New Orleans, and contributions are promised, and the manufacture of sugar will be exhibited, as the makers of this article claim to have reached a great degree of perfection. The South Carolina State Agricultural and Mechanical Society have placed themselves at the head of the movement in the Southern States of America. The Earl of Clarendon, her Majesty's Secretary of State for

Foreign Affairs, addressed a circular letter to all her Majesty's ministers, envoys, and consuls abroad, requesting them to give publicity to the exhibition, and to promote the formation of committees, and to assist with all their influence the objects of the council of the exhibition. The principal effect of this circular has been to convince the council that many places would have been entirely excluded unless agricultural produce and raw material used in manufactures were admitted. The council, therefore, have decided not to exclude those articles, and through the energetic help of our consuls, agricultural produce, &c., will be exhibited from Patras (Greece), Algiers, Naples, Cagliari (Sardinia), New Orleans, Lisbon, San Francisco, Corfu, Madeira, Galveston (Texas), Rio de Janeiro, Mobile, Lima (Peru), San Jose, Costa Rica, Norway, Havana, Para, Rosario, Bogota, and Monte Video. To meet the views of the Russian Government the council will endeavour to make arrangements so that the articles exhibited in the Workmen's Exhibition at St. Petersburg in May next may have place in the London Exhibition. The council also have been in communication with the French Government, and they have every reason to hope that an admirable display of French workmanship will be exhibited. The Duke of Argyll, her Majesty's Secretary of State for India, has announced that a selection representing Indian art manufactures shall be exhibited, and the expense of fitting shall be defrayed by the department.

"To meet these very energetic efforts made in foreign countries, seventy local committees have been formed in the United Kingdom. As an example, the city of Belfast has a very active committee, of which Mr. W. Kirkpatrick (of the *Northern Whig* office) is the able and efficient secretary. A very ample subscription has been raised to meet the current expenses, and to pay part, or the whole, if possible, of the carriage of articles to London. The committee has also received the countenance and support of the leading manufacturers, who have promised to give every facility to workmen in their employment who may express a desire to produce articles for the exhibition. It is hoped that the artisans of this country will make a most determined effort, so that the Workmen's International Exhibition of 1870 will not only be a display of the best foreign workmanship, but an exposition of the talent, industry, and manipulative skill of the British workman.

"To further the objects of this exhibition, the King of Wurtemburg has directed that his name be added to the list of guarantors for the amount of £100. The President of the Republic of Peru has directed that all the expenses of transit of articles to the exhibition, with the expenses of the Central Committee at Lima, such as printing, postage duties, &c., shall be defrayed by the State. A handsome subscription has been forwarded to the hon. secretaries of the exhibition by the British residents at Buenos Ayres."

It has also been proposed to open workshops in the exhibition building, and to give prizes for the highest skill shown in the use of various tools.

In the scholarships, so generously given by Mr. Whitworth for mechanical science and practice, about an equal amount of marks are to be given for theoretical knowledge and for manual skill.

The examination for these scholarships, which is to test the manual proficiency of the candidate, consists of two parts. In the first part the candidate is required to produce certificates, to exhibit work specially executed for the occasion, &c.; in the second part he is required to show a knowledge of various tools, by the performance of one or more of the following pieces of work:—

The Axe.

a. To square up a block of wood 1ft. long and 6in. in diameter.
b. To make a spoke for a cart wheel.
c. To shaft an axe.
d. To cut out wheel spokes ready for fitting into nave.

The Saw and Plane.

a. To saw from a plank two pieces of timber 3ft. long and 3in. square and plane them up true.
b. To make a box 18" long × 9" wide × 9" deep planed up true and the joints dove-tailed together.
c. To saw out and plane up two parallel strips 2' 6" × 2" 2" × ⅜".

The Hammer and Chisel.

a. To chip a piece of cast-iron 6in. square over on one of its surfaces ready for filing.
b. To cut out of sheet iron (any gauge) a figure or letter of any size from 1" to 6".

The File.

a. To file two sides of a cast-iron inch cube as flat as possible with a Stubbs' 12in. second cut file, the stroke of the file not being less than 9in.
b. A wrought iron hexagonal nut ½" or 1" to be filed up true.
c. To file up two parallel strips, iron or steel.
d. To file up pocket square as true as possible.

The Forge.

a. To weld or join together two pieces of iron ⅞in. square.
b. To make a pair of smith's tongs.
c. To make the head of a hammer.
d. To make a pick.
e. To make 2ft. ⅜in. chain with hook and ring.
f. To make a horse-shoe complete.
g. To cut off and draw out chipping chisel or drill, and afterwards harden.
h. To make a pair of small callipers.
i. To make a pocket square.

It is with this part of the examination that we are here concerned. We are impressed with the soundness of judgment which has led Mr. Whitworth to give weight to manual as well as to theoretical proficiency in the examination, and it seems to us that the forthcoming exhibition would offer to workmen of different countries an interesting opportunity of competing in the skilful use of the most important tools.

Besides the tasks of work required from candidates for Mr. Whitworth's scholarships, many others may be suggested, such as:—Joining—The putting together a door. Turnery—To turn in ivory seven balls, one within the other, the outer one not to be more than 1½" in diameter. Engraving—To engrave on glass and stone and metal; the engraver working from a copy or inventing the design, which would be required to suit certain circumstances, to be made known at the time. Modelling—In wax, clay, leather, &c., the designs to be original and from copies. Carving—In wood and stone. Inlaying—In metal, wood, and stone. Designing—Of articles belonging to the textile trades, the glass trade, the porcelain trade; the designs to be original, and to suit special circumstances to be made known at the time.

The rules to be observed by exhibitors are as follows:—

1. The exhibition to be opened on the 7th July, 1870, at the Agricultural Hall, Islington, London.
2. No charge will be made for space.
3. Space will be allotted to exhibitors by the council of the exhibition.
4. All articles must be brought, exhibited, and removed at the risk and expense of the exhibitors.
5. All packages arriving at the exhibition in the absence of the exhibitors or their agents, will be opened by the servants of the council with the greatest care, but at the risk of the exhibitors.
6. Articles once exhibited must not be removed during the continuance of the exhibition, except by permission of the council.
7. All property not removed within seven days after the close of the exhibition will be dealt with as the council may direct.
8. Exhibitors may appoint persons, subject to the council's approval, to take care of articles exhibited by them, or to explain them to visitors.
9. The council will supply counter, wall, and floor space, but any special fittings must be furnished at the exhibitor's expense.
10. In cases where a number of workmen combine to produce any object, the name of each workman must be given, and the portion executed by each specified. The same rule will apply to all articles exhibited by manufacturers and employers, which will be admitted subject to this regulation.
11. All articles intended for exhibition must be approved by the council, or such officers as they may appoint, the council reserving to themselves the right of rejecting any articles which may be unsuitable.
12. All articles must be delivered at the Agricultural Hall, Islington, between the 20th of May and the 25th of June, 1870.

The Board of Trade are preparing a bill for the protection of inventions shown at the exhibition, so that inventors need entertain no fear of their inventions being pirated without their being able to help themselves, as the mere fact of the invention being exhibited in this exhibition will be a provisional patent in itself without further expense or trouble of any kind whatever.

The space allotted to English exhibits is being rapidly taken up, and the last day for receiving applications is April 25th, so that intending exhibitors will do well to make early application to the hon. secretaries of the Workmen's International Exhibition, 150, Strand, between 10 and 4. Every information, space forms, &c., can also be had on personal application to the St. Mark's Club, 11, Brown-street, Duke-street, W., London, between 7 and 10 p.m.; or by letter enclosing *stamped directed* envelope to

Robert Burgess, Local Secretary, 22, George-street,
Oxford-street, W., London.

EQUATIONS.

Sir,—We have had several queries lately upon quadratic and other equations. I beg to forward solutions of equations reducible to quadratics. "Todhunter," p. 171.

$$(1.)\ 3x + 2\sqrt{x} - 1 = 0$$

$$3x - 1 = -2\sqrt{x}\ \text{(squaring)}$$

$$= 9x^2 - 6x + x = 4x$$

$$9x^2 - 10x = -1$$

$$x^2 - \frac{10x}{9} + \left(\frac{10}{18}\right)^2 = -1 + \left(\frac{10}{18}\right)^2 = -1$$

$$+ \frac{100}{324} = \frac{100 - 36}{324} = \frac{64}{324}$$

$$x - \frac{10}{18} = \pm\frac{8}{18}$$

$$x = \pm\frac{8}{18} + \frac{10}{18} = 1, \text{ or } \frac{1}{9}$$

$$(2.)\ x^{10} + 31x^5 = 32.$$

$$x^{10} + 31x^5 + \left(\frac{31}{2}\right)^2 = 32 + \frac{961}{4} = \frac{128 + 96}{4}$$

$$= \frac{1089}{4}$$

$$x^5 + \frac{31}{2} = \pm\frac{33}{2}.$$

$$x^5 = \pm\frac{33}{2} - \frac{31}{2} = 1, \text{ or } -32.$$

$$x = 1, \text{ or } -2$$

$$(3.)\ 3x^3 + 42x^{\frac{3}{2}} = 332$$

$$x^3 + 14x^{\frac{3}{2}} = 1107$$

$$x^3 + 14x^{\frac{3}{2}} + (7)^2 = 1107 + 49 = 1156$$

$$x^{\frac{3}{2}} + 7 = \pm 34$$

$$x^{\frac{3}{2}} = \pm 34 - 7 = -41, \text{ or } 27$$

$$x = (-41)^{\frac{3}{2}} \text{ or } 9$$

$$(4.)\ x^{\frac{1}{n}} - 13x^{\frac{1}{2n}} = 32$$

$$x - 13x^{\frac{1}{2n}} + \left(\frac{13}{2}\right)^2 = 32 + \frac{169}{4} = \frac{225}{4}$$

$$x^{\frac{1}{2n}} - \frac{13}{2} = \pm\frac{15}{4}$$

$$x^{\frac{1}{}} = \pm\frac{15}{2} + \frac{13}{2} = 14, \text{ or } -1$$

$$x = 14^{2n} \text{ or } (-1)^{2n}$$

C. H. W. B.

(*To be continued.*)

VELOCIPEDES.

Sir,—The many erroneous notions that prevail among inventors in regard to this form of locomotion will ever prevent its general adoption, the foremost of which is, that speed cannot be obtained without great expenditure of the moving power, an axiom true in regard to stationary mechanics, but one that has no place with locomotive vehicles.

The great obstacle of rough roads is best overcome by excessive speeds, not by slow motion and main force, especially as muscular strength will endure for a far longer period with slow than rapid motion

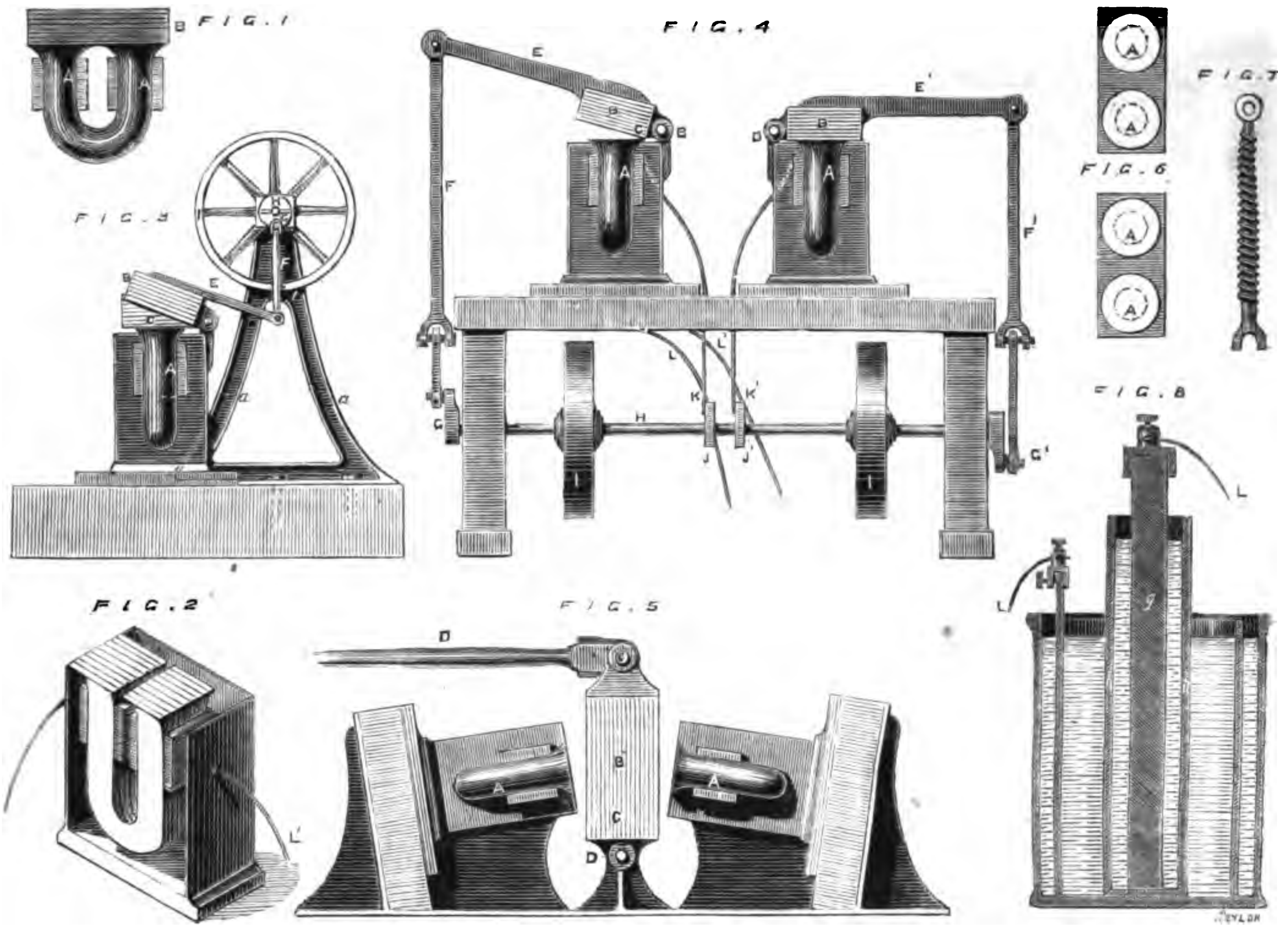
In all the velocipedes and bicycles now in use, the only gain in speed over an ordinary walking pace is the difference between the circumference of the driving wheel and the walking tread, so that in order to gain a speed of more than 7 or 8 miles an hour an impossible rapidity of muscular action is required, and until from 15 to 20 miles and upwards be possible, velocipede riding will never become generally a mode of locomotion. Fortunately, we are now in possession of a means of obtaining any rate of speed, limited only by the resistance of the atmosphere at high velocities, with slow muscular action. By the use of india-rubber tires all carriages are rendered independent of bad roads. The tires must not, however, be in the form of thin plates, as proposed by the "Phantom" Wheel Company, but must have a depth of between two or three inches in order to be effectual. Also in multiplying the motion of the treadles by a wheel and pinion in the proportion of four or six to one, stout india-rubber tires to both wheel and pinion will prevent all clatter and friction, when with 4ft. driving wheels, loose on their axles, 30 miles may be readily attained, while the muscular motion of the drivers' legs will only be equal to that of walking at the rate of two or three miles in the same period. The universal up and down vertical tread is also a great mistake, for it can only be compared to running up the Monument stairs with half-a-hundred on one's back; whereas, if the strength of the legs be used in the horizontal position it is found to be equal to a one-horse power. For a strong man, such as Topham of the last century, and many others, have successfully withstood the pull of a brewer's dray horse. Some inventors put forward the absurd idea that the weight alone of the driver should actuate the propulsion. Others again would use both legs and arms; in fact all the muscles of the body at the same time, rapidly producing an exhaustion that no human frame could endure for many minutes.

It is scarcely necessary to allude to the trotting velocipede, or that most glaring absurdity of propulsion by means of a spiral spring, patented by M. Ferdinand Constant Colney, of Paris, who makes the additional blunder of after having obtained circular motion, introducing the crank system. His spiral spring would require a considerably greater power to wind it up than would be required to propel the carriage direct. A light carriage for 30 miles an hour with slow treadle movement is figured and described in a former number of the English Mechanic, under the title of the "Velocifere."

Henry W. Reveley, Reading.

SLATER'S ELECTRO-MAGNETIC MACHINES.

Sir,—A description of Mr. Slater's newly-patented electro-magnetic machine may probably interest your readers, so I send an abstract of the specification. The said invention relates more particularly to various improvements in the construction of electro-magnetic machines as motors, and in the construction and mode of exciting batteries, and in the application of such motors and batteries to various useful purposes. These improvements consist, firstly, in the construction and arrangement of electro-magnetic machines, and in transmitting the force obtained through these improved batteries and magnets, and rendering such force available for useful purposes either through a reciprocating or rotative movement. Mr. Slater constructs his magnet of the form shown in Figs. 1 or 2; Fig. 1 is of the horse-shoe form, circular in section, but swelled out at the poles of the magnet at the end of each limb, so as to give a greater surface for the armature to work on, and otherwise for the increasing of the surface of the armature and power of the magnet. A, A^1, is the magnet, either made of solid wrought iron and circular in section, or as in Fig. 2 built of sections of flat soft wrought-iron plates, but also swelled out at the poles of the magnet. Either one magnet is used, as in Fig. 3, or more than one (in a series) as in Fig. 4, increasing substance so as to obtain a greater attractive force for the armature to be attracted against by the "moment of force" alternately. B is the armature of a compound form built up of a series of wrought-iron plates, as shown in section, Figs. 1, 3, 4, 5. The outer edge of the arma-



SLATER'S ELECTRO-MAGNETIC MACHINES.—(See previous page.)

ture works on the outer edge of the poles, or nearly so, of the magnet, and not absolutely in contact when raised from the poles, as shown at C, Figs. 3, 4, and 5; each end of the armature having journals D to work on, to keep it always in its proper position, so that the heel of the armature may be nearly into contact at all times with the poles when raised from the magnet. Attached to each of the armatures are levers E and E^1, to communicate the electro-galvanic force from the armature to the connecting rods F, F^1, thence to the cranks G, G^1. which are attached to the running shaft H, on to which is affixed fly wheels I, so as to maintain the momentum of the machine. There is an arrangement on the main shaft or on a separate shaft driven by the former, on which is placed "commutators" of metal J, J^1, which revolve with the shaft, and on which the conducting wires K, K^1, form the battery work, or in other words are in contact; but on these revolving discs or commutators are inserted pieces of ivory or any non-conductor, so that as the "commutators" or "discs" revolve the force from the battery is laid on to the magnet when the armature is raised to the angle required, and when attracted downwards the wire passes on to the non-conducting surface and releases the armature, when it is raised to the position C again, and so on in succession for any number of strokes per minute. By this repeated laying on and taking off the force, the armature B rocks up and down, the faces of the armature coming into contact alternately with the faces or poles of the magnet, producing the reciprocating movement as described. The power of the machine is increased in a ratio not yet ascertained in practice by the introduction of the compound armature. but it has been found to be so material that the solid iron armature has been abandoned in consequence. In transmitting motion to the crank shaft from the armature B through the lever E and connecting rods F and F^1, it will be readily seen that the crank is in its worst position for the transmission of dynamic force to the rotative shaft at the time when the armature is receiving in greatest attractive force from the magnet, but in order to obviate this difficulty the connecting rods are made of an elastic material, either of caoutchouc, or of helical springs of steel wire, as shown in Fig. 7, but supported with extending sleeves in the inside in sections like a telescope slide, so that when the armature closes on the magnet and the force is disconnected, the connecting rod will assume its normal length again before passing, or at the time of passing the lower centre of the angle of 90°. The branches of the magnet are coiled left and right with its equivalent of insulated copper wire, so that each end of the horse-shoe may have its opposite polarity, the ends of these wires L, L^1 are attached with the negative and positive poles of the improved battery. Electro-magnetic force in electro-magnets of this kind is due to the induction current, which the development and disappearance of the magnetism of an iron core indicated by the insulated spiral surrounding it, which is termed excited magnetism. Much depends also on the area of the section and faces of the two ends of the limbs of the horse-shoe, which are the poles. In his improved magnet Mr. Slater swells out the end of such limb of the magnet at the poles, as shown in Figs. 1, 2, 3, 4 and 5, so as to increase the surface of the poles, and also allow more attractive force and surface for the armature to work against. He also constructs a single machine, as shown in Fig. 3, where *a*, *a*, is the frame or support of the machine, A the magnet, B the armature, and lever E, the connecting rod F. and the fly wheel I. The commutator, or disc, for laying on and off the fluid from the battery, may be placed on any convenient part of the machine.

Another form of working a double compound armature is shown in Fig. 5, where the magnets A, A, are placed horizontal, or nearly so, and the armature B works between them, and the leverage for the connecting rod *d* to transmit the power is taken off at the point *e*, so that the armature would rock on the bearing or journal D.

In regulating the action and velocity of such machines to suit various loads, a governor of very simple construction is used, by placing a small plunger "cataract" governor between the battery and the magnet or magnets, such machine to have a valve at the bottom as the plunger ascends to let in fluid from the small cistern, the regulator being a valve or tap to let the water out slow or fast, as the case may require. This will act on a small mercury bath in which the conducting wire is immersed, the immersion being regulated by the governor as before described, which regulates the speed in proportion to the load on the machine at the time.

In his improved battery, and also improvements in the manner of using such batteries with one or more cells, as shown in section Fig. 8, Mr. Slater uses excitants different from those commonly used, especially when a uniform current is required. As the Bunsen battery is of similar construction, it will be necessary here to explain the difference between his improved battery and that of the former. Instead of using zincs in the outer cells and carbon in the inner cells, he uses soft iron plates or cylinders in the outer cells in combination with his improved method of exciting such metals as described. At the same time he uses the carbon in the inner cells, but with a difference also in his exciting solution as described. The excitant he prefers is a saturated solution of nitrate of soda or nitrate of potash. The former is found best and cheapest. In this solution the plates of iron (if a battery of flat plates), or cylinder of iron (if for cylindrical cells) are placed in the outer solution, as in section Fig. 8. Then the carbon or graphite *g* is placed within the porous cell *h*, which cell contains nitrous acid of the specific gravity of 1·60, or any weaker fluid containing in solution nitrous or nitric acid; but the stronger acid is preferable. The acid in the porous cells *h* should be about 1in. higher than the solution in the outer cells in which the iron cylinders are placed. The infiltration, or exos, or endosmosis process through the porous tubes or cells *h* keeps the outer solution containing nitrate of soda constantly supplied with acid, preventing it from becoming alkaline. When the iron and carbon are properly excited in their cells, the constant action of the battery can be maintained by adding about one-sixth to one-third of fresh nitric or nitrous acid daily. This partly exhausted acid solution is mixed with the nitrate of soda and used for exciting the iron in the outer cells, adding a small quantity daily in accordance with the amount of work done.

Another method of compounding a useful excitant is by using nitrous and muriatic acids, the former of the specific gravity of 1·60, and the latter about 1·200, in equal proportions (by measure) to be used in the carbon cells, and the nitrate of soda as before described in the outer cells. Or a very powerful current is generated when nitric or nitrous acids are used alone or combined with sulphuric or muriatic acids in small proportions in the cells with the carbon, and dilute nitric acid is used in the outer cell with the iron. When the nitrate salts are not used, nitric acid is used in the outer cells. The filtration through the porous cells will keep the outer excitants for the iron nearly uniform in strength until the iron solution is almost of a pasty consistency. Where great intensity is required in batteries, especially for telegraphic purposes, the saturated solution of nitrate of soda or potash only is used both inside and outside of the porous cells. Furthermore, if an increase of power is required without adding to the number of cells in the process of working in any especial case, then to the nitrate of soda solution in the porous cells is added about one-tenth part of weak acetic acid or common vinegar.

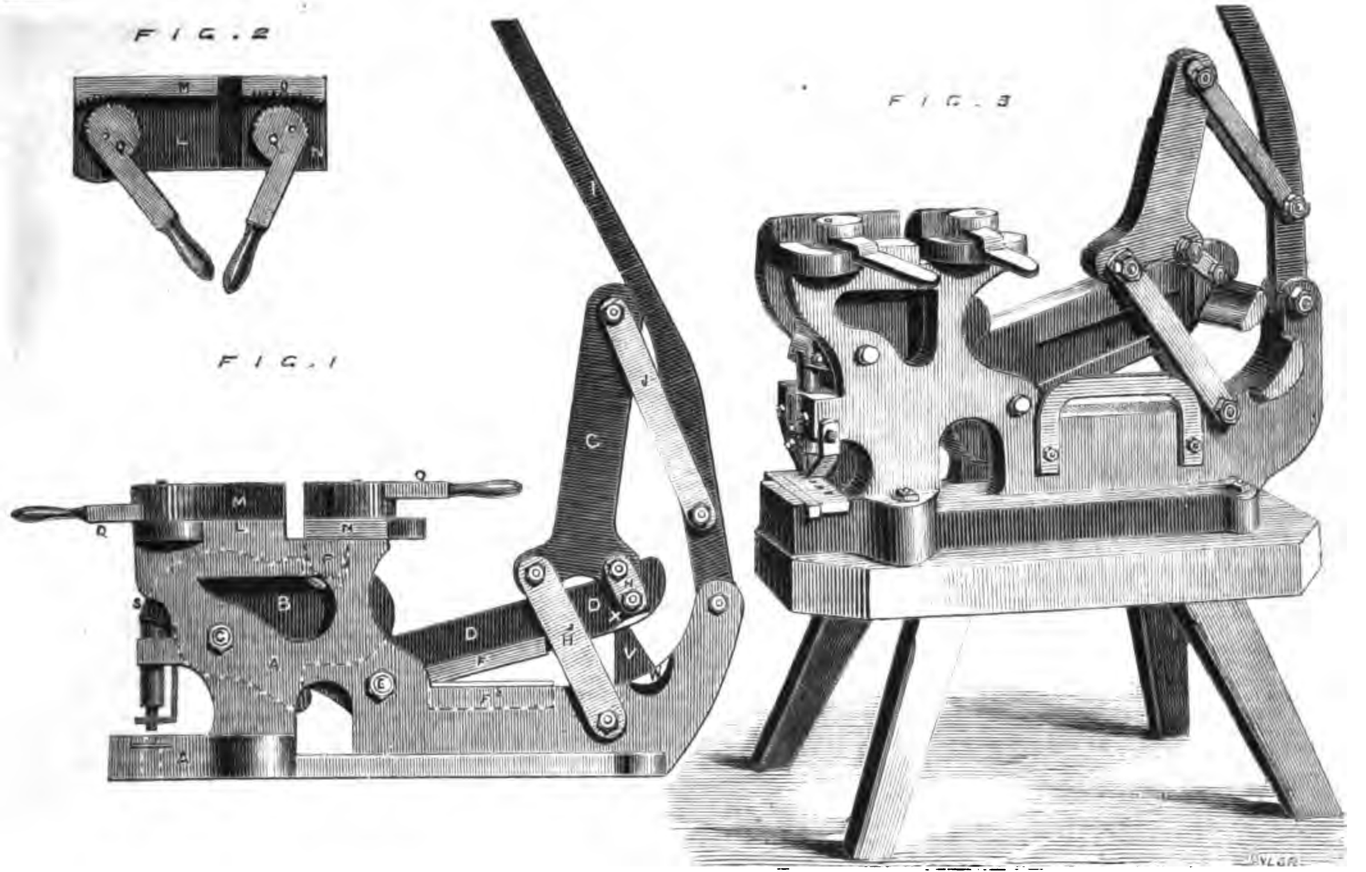
D. F. K.

COMBINED PUNCHING, SHEARING, UPSETTING, AND STRETCHING MACHINE.

SIR,—I send you drawings of a very ingenious and useful little machine of American origin, which has been lately introduced into this country by Messrs. Towle and Harding, of 98, Newgate-street. This machine, which is constructed by Messrs. Reed and Bowen, of Boston, U.S., is intended for shearing, punching, bending, and shrinking or stretching tires or hoops, and when constructed in the form we illustrate is adapted for being worked by hand power. The machine, in fact, although capable, when worked by one man, of cutting easily bar iron 2¼in. by ⅝in. or 4in. by ⅜in., weighs only 350lb.

Referring to Fig. 1, it will be seen that the main frame A of the machine, consisting of the two sides and the top and bottom is cast in one piece, the cam B being placed between the two sides and hung on the pin C. The first lever D works into this cam, and is hung on the pin E, the knife F, for shearing, being attached to this lever and the knife F^2 to the main frame A. The second lever G is connected to the first lever D by the straps H, and to the main frame A by the straps H^2. The third or hand lever I is connected to the lever G by the straps J, and also to the main frame A by the bolt K. This forms a very powerful arrangement of levers, giving with 100lb. on the hand lever a pressure of over 52,000lb. on the shears and 72,000lb. on the punch. The straps H, H^2, and J are in pairs, one on each side of the machine.

The operation of shearing is performed by placing the metal to be cut between the knives F and F^2, and then bearing down on the hand lever I. The tire shrinker and stretcher consist of a block L, which is part of the main frame A. On the back of this block there is a projection M, against which the tire rests, and which is provided with teeth at the end so as to



COMBINED PUNCHING, SHEARING, UPSETTING, AND STRETCHING MACHINE.

keep the tire from slipping; there is also a movable block N, which has a similar projection O, and which is also provided with teeth in the same manner as the other. The movable block N has a tooth P on the under side working down into the cam B, and is moved in the operation of shrinking a tire by the hand lever I. Upon each of the blocks L and N is a toothed eccentric Q, for the purpose of holding the tire while the block N is being carried towards the block L. The operation of stretching a tire is performed by reversing the eccentrics Q, and carrying the lever the other way.

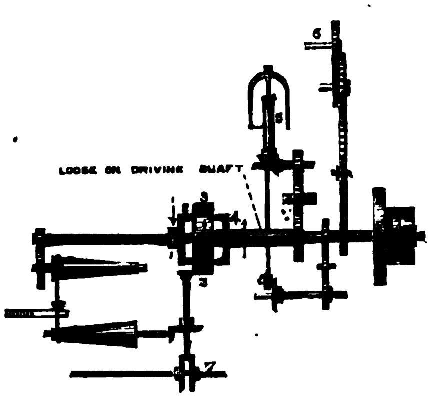
The punch socket R is connected to the cam B by the pin S, and passes through the guide T, the die being confined in the main frame A. The operation of "gumming," or cutting between the teeth of saws, is performed by a punch and die made especially for that purpose. A guide V is cast on the main frame A, so as to keep the lever D from being forced off in the operation of cutting. Finally, a concave projection W, which is cast on the main frame A, projects about 3in., and a corresponding convex projection X is cast on the lever D. These parts are used for bending iron into any required form, and they form, according to *Engineering*, a useful addition to a very useful machine.

B. G.

COTTON SPINNING.

Sir,—As no one has taken the trouble to enlighten "Excelsior," p. 1927, March 4, I will, with your permission, endeavour to do so. He asks for an explanation of the sun and planet wheels, cone, and reversing motion of Higgins's roving frame. The object of the cone, or what is better, cones, is to give to the bobbins a constant circumferential speed, or velocity of periphery, so that they may "lap" up the roving yarn at the same rate as the rollers deliver it, as the diameter of the bobbins is constantly increasing from "empty" to "full." I suppose he will know that the yarn is "lapped" around the bobbins by the "flys;" if so, he will see that if the bobbins "lead" the flys, as they are now generally made to do, their speed of revolution must be retarded in proportion as their diameter is increased, but if they lap it up by "dragging" behind the flys, then their speed must be increased in the same ratio. Now as the cones have their extremes, in proportion to the bobbin, empty and full, I dare say "Excelsior" has wondered what the sun and planet wheels were for, as at first sight it appears that a properly adjusted motion might be given to the bobbins directly from the cones—*i.e.*, by the cones being made to drive the bobbins, and their speed adjusted by a "strap rack." However, a little more consideration, or what will teach a man far more positively, a little experience, will soon show that if the speed of the bobbins be not very exactly and positively adjusted to that of the rollers, the quality of the roving will suffer, on one hand from attenuation, on the other from "lagging" around the fly-top. It was formerly a matter of great difficulty to regulate the speed of the bobbins of the roving frame, as it was done by what was called a "differential rack and friction-plate," the results of the adjustments being generally rather too differential. But this difficulty was at last overcome by the introduction of the "cone, and sun and planet wheels," the working and object of which I will now try to make "Excelsior" understand. He will see that if motion could be given by positive gearing to the spindles, bobbins, and rollers from one strap, the irregularities of speed from "slipping" would be only an ordinary evil, but as, obviously, this cannot be done by any direct action of gearing, since the bobbins require a varying speed, and the spindles and rollers an unvarying one, some sort of mechanical contrivance must intervene betwixt the gearing of the spindles and the bobbins, that will give to the bobbins the varying speed they require with the necessary truthfulness. This contrivance, then, is the sun and planet wheels, regulated by the cones and strap-rack. Let "Excelsior" look at the sketch, and he will see that the spindles, bobbins, and rollers are all driven by positive gears from the driving shaft. The wheel 1 (sun wheel) gives motion to the wheel 2 (internal wheel), this carries it to 4 (boss wheel), and so on it goes to the bobbins, 5. Now comes the disc wheel 3, which carries the internal wheel; if this wheel be held stationary, the velocities of 1, 2, and 4 must evidently be equal, but, on the other hand, if motion be given to the disc wheel 3 in an opposite direction to that of the sun wheel 1, then the internal wheel will be driven just as much faster, so also the "boss wheel" 4, and the bobbins. This opposite direction is given to the disc wheel when the bobbins "lap up" by "leading," but when they do so by "dragging," then the direction of the disc is the same as that of the sun wheel, and the result is a subtraction of velocity from the internal wheel, &c. Suppose the rollers "turn out" 3in. of yarn while the spindles make 9 revolutions. If the bobbins be 3in. in circumference it is evident they will require to make 10 revolutions in the same time as the spindles make 9, in order that they may lap up the 3in. of yarn delivered from the rollers. Suppose this to be the condition, then, that is required at the commencement of the "set," and that the "disc wheel" gives this one extra turn to the bobbins, either by one revolution of its own, or whatever part of one the arrangement of gears may require. With the cone strap driving at the fastest end of the cone, it will be evident to "Excelsior," if the extremes of the cones, as I said before, correspond to those of the bobbin empty and full, that the speed of the bobbin can be regulated with greatest nicety by causing the strap to move forward a proper distance for each layer of yarn that adds to the diameter of the bobbin, as the real weight of driving the bobbin is given directly by the gears 1, 2, and 4 from the driving shaft, so that the small amount of power required from the cone strap by this arrangement renders it as near a positive in its action as needs be. The reversing motion comes from the same source, it regulates the up and down motion of the "lifter," upon which the bobbins rest, in order that the yarn may be coiled upon them in a proper manner—*i.e.*, the coils laid side by side. The changes of direction are given by the bevel wheels 7, the one being thrown out of gear as the other is thrown in, and is brought about by means of a lever, one end of which is lifted up or pressed down by a slotted fixture attached to the "lifter," which is also connected in a suitable manner to the strap rack, so that its fulcrum is brought nearer the end at every change, and by this means it causes the "lifter's" direction to be changed a little earlier for every layer of yarn that goes on the bobbins, and so gives the required taper to the ends. I hope now that I have given "Excelsior" such information as will enable him after a little further inspection of the frame itself, whilst working, to understand that very ingenious device, the sun and planet motion. I have tried to be as plain as I could, so that what I have said may be understood by the numerous young cotton workers who are readers of our wonderful Mechanic, and if it meets with the approbation of our Editor, I will gladly add a "few bricks" to our "institution" for the benefit of those who seek such information as I can give, so that factory lads may not have to complain of the paucity of matter in the Mechanic in which they can take an especial interest. With respect to "Excelsior's" last question, I know no such work. I should just like to say in conclusion that I think the space taken up sometimes by "straw splitting," such as that a week or two ago about what a "devil" is or isn't, would be much better filled up by charity, as all the writers were to some extent both right and wrong, and the mere local name of a machine does not effect its proper working, that I am aware of.

E. Slater, Burnley.



TO MILLERS.

Sir,—I will endeavour to review this correspondence as briefly as possible. Some few weeks ago I forwarded to you, Sir, a diagram of a modification of the universal joint, which is a decided improvement on the old plan, and left it at your option to insert it in the English Mechanic for the benefit of my brother readers, or otherwise consign it to the waste-paper basket. However, it made its appearance in due time, under the somewhat indefinite heading, "Something New for Millers." I have no fault to find with this, though they are not my words, and not what I intended it should be called. The name I gave it was "Universal Balance Rynd," accompanying which was also forwarded a few words descriptive of its construction. This *meets* the eye of Mr. Sharpe, who writes to say that he has had the *same* working in his mill since 1856, and proceeds to give a "vague" description of what now *proves* to be something else, respecting which I wrote for an explanation, and how we were to reconcile those contradictory statements. This, to all appearance, he is unable to do, but resorts to abuse and misrepresentation. I never said that I was the inventor of the universal joint as such, but of the same as per diagram; and any ordinary intellect would have so understood it. If the description given was not sufficiently clear to him, surely the diagram ought to be. He says that the only part that I can lay claim to is the outward ring. Let me tell him I never said I did, because I knew perfectly well that it was in use long before in England and Scotland, and he says it is common in Ireland, too, the stone being built around it; so also may mine be; and does not occupy the eye of the stone any more than his. He now proceeds to answer, unwittingly, my query, by describing his scheme, which is simply two separate boxes let into the sides of the eye of the stone, which must be cut away to admit them; and this he says is an improvement upon the solid ring, *built* in, which he also says does away with the necessity of making one of the rings oval. Just so, and is tantamount to what I expected, which goes directly to prove the fallacy of his assertions. For why should he make a ring oval if there were no necessity for it? He tries to overcome this by saying that the sliding steps are common to Templeogue, while the oval, or unnecessary shape, is confined to himself, probably in the shape of a crony. And of course, as he says, our motives for adopting this shape are quite different. It is, therefore, quite evident that he knows nothing about the utility of my scheme or invention, to form a correct judgment.

THOS. EVANS.

[We have thought best to draw our pen through some personal remarks in Mr. Evans' letter, to render unnecessary a keen reply from Mr. Sharpe.]

SIR,—In the ENGLISH MECHANIC (No. 264) there are two replies to my letter in No. 262, on "Millstone Balancing." Mr. Sharpe supports my opinion; I thank him for his reply. I also thank Mr. Evans for his criticism of my "notions." He is the first that has attempted to explain the matter to me. I have asked many millers for their opinion, but till now could get no direct reply. I honestly assure Mr. Evans if I do not see with his eyes, my blindness is the result not of obstinacy, but misfortune—or ignorance, if he think proper so to term it.

I try, and have long tried, to take Mr. Evans' view of millstone balancing, but the more I study the subject, and the more experience I get, the more sceptical I become; for I too have ideas—probably very vague ones—of something called gravitation, centrifugal force, &c., and of the unequal distribution of the former over a millstone. I have had considerable experience as a millstone builder, and have new backed, put in fresh burrs, and broken up many a stone; so am slightly acquainted with a millstone's composition, &c.

I have seen Mr. Smith's diagram (referred to), but confess I am too unenlightened to understand why, when a millstone's gravitation has been equalised when standing, it should be disturbed when running. It seems to me the faster a stone runs, the greater tendency it should have to equalise its gravitation.

Mr. Evans objects to my "notion" that a level bedstone has anything to do with balancing. I acknowledge when giving a running balance it would not matter were the bedstone 45 degrees out of level, or vertical, or away altogether, providing the spindle was held steady and a rest furnished for the chip; but will he say it is not necessary for a standing balance? If it is not, then I am indeed under a delusion, and have been these last 23 years.

As to millers looking to the face of the stone for the fault, could he tell, if a stone had a good standing balance, if it had a high side to it?

I have had the opportunity in many mills to test my "notion," and, as I remarked in my first letter, have invariably found when a stone's standing and running balance did not coincide, that either face, level, irons, or cogs were untrue. Either of the above faults would cause a dragging, or apparent dragging, causing a back-lash, and disturbing the neck.

With respect to length of spindle disturbing the neck, as asserted by some of your correspondents, I will offer no opinion, but merely say I have one stone 16in. thick at eye, 14in. at skirt, on "centre irons," with the pivot 8¼in. from the face of the stone, and another pair on faulty "universal irons," 13½in. at eye, 11½in. at skirt, with cups only 2⅝in. from face. Each pair works well. There is but little difference in their speed of grinding and per centage.

I suppose Mr. Evans does not pretend to lay claim to the invention of the "universal irons," but their oval form and set screws. His outside ring has been in use some years; so has that described by Mr. Sharpe.

With respect to your correspondent "Charles's" balance, good as it might be, I believe it got the inventor of it into trouble, he having been prosecuted for infringing on the rights of Messrs. Clarke and Dunham. I think the above patentees will tell us the "sliding" or "running" balance is their property, and any one using a substitute for theirs is infringing their patent.

But to return to my "notion." Until I get more light, I must still run the risk of being thought ignorant and unpractical by holding to the opinion that if the face of a stone be true, the bedstone level, the irons and pitch of cogs correct, a "standing" and "running" balance are the same; and if the above conditions are not observed, they are not the same.

A STONEMAN.

SIR,—Without doubting Thomas Evans' statement respecting the capabilities of the "patent flour machine" he refers to, perhaps it may not be uninteresting to some of your readers to endeavour to explain the probable cause of the difference of the quantity dressed by it and mine.

His machine dressed through 5 sheets of wire, mine only had 3½ (the half was seldom used). He took 15ft. of flour out of 20ft. of meal, I only took 12½ft. His machine had 6in. to the foot fall, and therefore had to be driven at 520 revolutions per minute, mine only went at 400, so that when the speed, the power, the length of wire devoted to fine flour, number of wire, and allowance for a little exaggeration taken into consideration, I don't think the modest amount of 6 sacks per hour will appear so insignificant as at first sight. With reference to the relative advantages of silk *v.* wire, I should recommend the silk less on account of its superior work than for its saving of flour, wear and tear, and attendance. The power required for a wire machine such as Thos. Evans describes would exceed 4h.p., while the power the silk requires is hardly observable. I have improved French flour by dressing it through wire, yet for the above reasons I prefer the silk, but should anything occur to necessitate a return to the wire, the patent machine is the last I would adopt.

JAS. SHARPE.

A THEORY OF THE CAUSE OF THE TIDES.

SIR,—According to Newton, it is of the principle of gravitation that two globes placed at a distance from each other, stationary, but free to move, must with an increasing speed move to their common centre of gravity; but if propelled in a direction not in line with their common centre of gravity, they will each revolve round that centre of gravity in a certain period of time. I propose that the earth being about fifty times greater in bulk and density than the moon, their common centre of gravity will be within the mass of the earth, and at a certain distance from its centre; that the earth revolves on this centre of gravity or combined axis in the same period of time as the moon, about twenty-eight days; that the earth, revolving on this combined axis, has an eccentric motion, and that the part of the earth's surface farthest from the moon, and in line with the two centres, is subject to an increase of centrifugal force that the dense matter of the earth, in its revolution on its central axis, is not at liberty to accommodate itself to; that it is otherwise with the air and water; that the waters are raised by this centrifugal force in a ridge or wave on or near the equator, at that point most distant from the moon, which will also be the part of the earth's equator most distant from the combined axis; that this force in excess only extends to a few degrees on either side of the equator; that the open waters outside of these lines towards the poles merely obey the law of the displacement of fluids flowing towards the equator, to temporarily occupy the place of that raised in a ridge or wave on or near the equator by the excess of centrifugal force produced by the eccentric revolution of the earth on its combined axis; so that a lake outside of these lines, or a large bay with its inlet towards the nearest pole, would not be affected by the force that produces the ridge or wave on or near the equator, or the flow that the open waters are subject to, and so would have no tide; that the revolution of the earth on its central axis once in about twenty-four hours will cause every part of its equator to come under the influence of this excess of force produced by its eccentric revolution on its combined axis in that period of time. So that with the moon's attraction in the opposite direction, we have the ebb and flow of the tide twice in about twenty-four hours, omitting secondary and local interferences.

G. H. OGILVY, Birmingham.

THE EARTH'S ROTATION.

SIR,—With your kind permission I will make one or two remarks on a letter appearing on p. 89, on the above subject, signed by John Beardsley. Now although I can lay claim to no scientific attainments, yet my own common sense seems to me to detect some very fallacious reasoning on the part of the writer of the letter referred to, if I am correct in presuming that Mr. Beardsley makes *centrifugal force* a basis for disputing the fact of the earth's revolution on its axis. In the first place, I beg to submit that Mr. Beardsley's ideas of "centrifugal force" are, to say the least of it, very vague; he appears to think that objects on the earth's equator, because they have a surface speed of 17 miles or so, per minute, must, therefore, have a tremendous tendency to fly off. Now with all due deference to the "godfather," I think the very term "centrifugal" is calculated to mislead, for this reason—an object projected from a surface in rapid rotation, does not pursue a direction of flight directly in a line with the centre of the body from which it has taken its departure. On the contrary, the line of flight, if produced backwards, as it were, would, I imagine, be found to be a tangent touching the circumference of the rotating mass, and it takes this direction merely in obedience to the law of nature, that bodies set in motion in any given direction endeavour to continue their motion in that same direction. Now my idea with regard to objects on the equator is this (and I invite anyone to administer to me a good hearty whack if I am talking nonsense), that they—the objects—pursuing a surface speed of 17 miles a minute, have no more tendency to fly off from centrifugal force than would little iron filings on the surface of a globe of magnetised iron, say 8ft. diameter, revolving on its axis once in 24 hours. The magnetism is of course to represent gravity; this globe would have a surface speed at its equator of about 1ft. per hour, which may be taken to represent the 1000 miles traversed by a point on our earth's equator; the arc of the circle described would be identical in each case. Now the 24th of a circle, when drawn on paper, looks like a very slight deviation from a straight line; it is just as slight a deviation in the case of the earth, and does Mr. Beardsley mean to say that a body would have any perceptible tendency to fly off from "centrifugal force" when, after an hour's flight, it had only departed from a straight line by so small a curve as this arc represents? I will bring forward another case for Mr. Beardsley's consideration. Conceive a huge locomotive, with driving wheels 100ft. diameter, cylinders, boiler, and gauge of rails to match—fancy this monster tearing along due north and south (I mention this direction that it may not interfere with the earth's motion) on a line of rails laid, say 6ft. above sea level all the way from pole to pole, rushing along at a speed of 1000 miles an hour, does Mr. Beardsley for a moment think that such a speed would cause the engine to launch itself into space from centrifugal force? I can scarcely think he would form such an opinion; and yet this engine would be travelling over the same curve, pursuing a precisely similar line of flight, at precisely the same speed as objects at rest on our equator; in fact, the earth's revolution is only comparatively rapid because we (little insignificant atoms) are not accustomed to view in our everyday life movements on such a gigantic scale, but looking at the earth simply as a globe, its motion is in reality very slow indeed, and quite incapable of any perceptible tendency to cast bodies off by centrifugal force; at least, this is my opinion, and I am open to correction, and shall be only too glad if anyone will kindly show me where my judgment is at fault.

I cannot take up any more of your valuable space in discussing the other portions of Mr. Beardsley's letter, relative to the wind, &c., but it appears to me to be ——well, never mind.

C. R. O., Hants.

THE BELTS OF JUPITER.

SIR,—As Mr. Grover expresses a wish not to enter into a long discussion on the above subject, I assure him that I also am quite willing that it should be cut short as quickly as possible; but as his letter is such a string of misconception, I feel bound again to reply. In the first place, Mr. Grover's quotation from my letter as to "delicate gradations," &c., is a mistake when applied to light and shade; I applied that term to colour only. The words I used were, "*broad masses*" of light and shade, which are quite different things, and which I believe are affected relatively and proportionally the same with every-sized aperture; but Mr. Grover implies that the reverse of this is abundantly proved by the amount of detail which a large aperture reveals when compared with a small aperture. I really cannot see how this affects the question of broad masses of light and shade. As to the professed impossibility of getting pigments suitable to express planetary markings, Mr. G. brings an instance to support his argument, of a lily, which, though really a white flower, had to be painted grey to express shadow. In what way this supports his argument as to the impossibility of getting pigments pure and bright enough I am at a loss to conceive. Such an instance evidently does not touch the point at issue. Again. Mr. Grover says: "Mr. Purkiss thinks I am in error in stating that Mr. Browning's drawing is overcoloured." Certainly not. Had Mr. G. said so at first, I should have perfectly agreed with him; but he did not say so, but remarked that the drawing referred to was *too vivid* in colour. The term "overcoloured" implies that there is too much colour, or that it is too heavily coloured; whereas *vividity* implies brilliancy and light. Mr. Grover may perhaps think I am splitting hairs, but such distinctions are absolutely necessary to prevent misunderstanding. My remarks with reference to Mr. Denning's letter therefore do not, that I am aware of, offer any contradictions. The next paragraph contains a singular misconception. Could Mr. Grover really suppose that I ventured for one moment to compare a painted sunset with a real sunset? Such would evidence a degree of insanity which I hope I do not possess at present. Truly, I spoke of a sky, and I spoke of a landscape, but only as they might exist on canvas, and so could be compared with each other; and it still remains for Mr. Grover to justify his plea for the need of exaggeration by the simile I then used. In the concluding paragraph Mr. Grover descends to personalities, which certainly do not lend any dignity to his preceding remarks. Does he expect me to blow my own trumpet as a draughtsman, or to spout about the performance of my mirrors? However, for the general satisfaction of your readers, some of those gentlemen for whom I am now making specula (thanks to the pages of the MECHANIC) will perhaps shortly be prepared to let you know the merits or demerits of my work, which they have my free permission to do; and then Mr. Grover can judge for himself.

W. PURKISS.

THE REPUTED FIGURE AND MOTIONS OF THE EARTH.—THE EARTH'S ROTATION.

SIR,—I am aware that it is held that as the motion is steady, this (the centrifugal force in connection with the earth's rotation) becomes possible, because "motion without shaking is as easy as rest. We carry the air with us, as in a railway carriage, and therefore feel no wind."* I must confess I never saw lamer reasoning, or a more complete failure to give a reasonable explanation to a theory. No one, I think, will dispute the fact that "motion without shaking" is as easy as rest" under the condition named; but how is it made to appear that we, on the earth's surface, exposed to its rotation, are in a similar position to being in a railway carriage, where, of course, the frame and substance of the carriage protect us from the effects of the rush through the air?

If our author will take his seat outside a railway carriage, on an express train proceeding at a speed of 60 miles per hour, he will find he is more exposed than is desirable, and he will then be able to form some idea of the sensation he would experience if whirled through space at a speed 17 times as fast. On the other hand, if the air carried with us is meant the air inside the carriage only, where is the comparison? In the one case we are exposed outside a rotating sphere, in the other boxed up in a carriage.

Also if he will put water on to a flywheel, connected with any piece of machinery in motion, indoors, and under the same conditions as if inside a railway carriage, he will find the water thrown off in proportion to the size and speed of the wheel, which proves the assertion to be entirely unfounded in fact.

Again, if there is any such thing as a truly vertical position for objects on the earth's surface, how is it that if the earth is globular that such a thing as a vertical line is to be found everywhere, as we approach the poles, and also at the equator? The answer, I am aware, is dependent upon the theory of gravity, as producing vertical lines as straight ones, pointing to the centre of the earth, and that force is required to divert the motion of anything from such line. But what proof have we that a really vertical line has no existence? I am not aware of a single argument in proof of this, except that of necessity (gravity), for if a plumb line be let fall at the equator, and the true vertical line points to the centre of the earth, would it not require a greater force to form a correct and straight line at one portion of the 24 hours (it takes to form this rotation) than at the other portion of the same 24 hours?

Astronomers agree as to the existence of a zenith, or place directly overhead; or, in other words, a true perpendicular. This zenith, or perpendicular, from the centre of the earth, they give, as at a point to the left of the North Pole, as it would be shown in a diagram. Now, from this we conclude, that by a universal law there must be a correct horizontal to all perpendiculars, and which are at exactly right angles the one to the other—and it is also an established fact, that all bodies, or everything that has weight, and is unobstructed, has a tendency to fall in a straight line downwards from its point of suspension, if not influenced by attraction or force. I am aware that weight has been, and is generally described as the "measure of force," but to this definition I object, as it depends solely for proof on the theory of gravitative attraction; a theory (so far as I know) which has not a single argument (confirmed by positive fact) for its support.

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* "Astronomy without Mathematics," page 27.

The true vertical line is said to be from the point of suspension *c*, or in a straight line for the centre, as in the annexed diagram (or ϕ) that the earth's rotation causes any body let fall at A to fall somewhat towards D, to the said centre ϕ, and the experiments of Dr. Hook, Guglielmini, and of Benzenberg, and with all the care which the last-named philosopher brought to bear, he found a deviation in his experiments on falling bodies, towards all four points of the compass, so that he had to be satisfied with a "balance of deviation," a term, and a fact, which plainly shows that some other principle than the earth's rotation had control over these balls through 235ft. of vertical space.

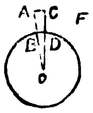


FIG. 1.

Now we will put aside as much as possible the mathematical terms which are puzzling to some readers, and show that this speed of 17 miles per minute, which the surface of the earth performs during its rotation, being close upon 1500ft. in one second of time, is simply incredible; because when we find that a body falling from a position of rest falls through 16ft. in one second of time, this "balance of deviation" of a few *lines* to the east, is more incredible still; for if we divide the height of the tower (235ft.) by rule, we shall find that the ball would occupy nearly 4 seconds in falling, and, consequently, that the earth should have passed in that time for the space of 5900 to 6000ft. from the true vertical, past towards the east. So that it is not a question of lines, but of thousands of feet It may be said that the speed at which the earth rotates will cause the ball to be carried with it to a great extent, reducing the difference of distance traversed during the 4 seconds. But if this rotation is a fact, and this forward force applicable to the falling ball, why does it not bound onwards in the same direction as the rotation, the same as any body will do let fall from a railway train? The question of the body's falling down a mine, for such a depth, under such circumstances, is simply absurd.

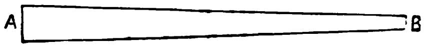
I come now to consider the diurnal motion of the sun, as a proof of the spherical figure of the earth. I might easily set out by giving a few diagrams, proving that the earth is a vast plain. I do not advance this assertion as true. I do not argue that the earth is a vast irregular surface, behind which the sun rises and sets. What I have to say is, that the apparently convex surface of our world is not owing to any real convexity of the surface, but to optical illusion, or the principle of vision, combined with the refraction of the atmosphere; indeed, these two principles are the foundation of all our errors as to parallax, measure, and distance, the first and fundamental error upon which a host of others have been grafted.

Now, as to the proof that the earth really moves, the simple fact that a small rotating semicircle* may be made to keep pace with the sun, and to cast a uniform shadow, is no proof at all. It of course is altered and moved, until the different parts are adjusted, so as to show their exact relation and position one to another, and then the principle is said to be complete by way of illustration, whereas the construction, and the position intended to be illustrated, may be as foreign to each other as possible. In proof of this I may say that Mr. Proctor admits (ENGLISH MECHANIC, Vol x, p. 598) the system of Tycho Brahe may be illustrated just as easily. This being so, I surely shall not be called upon to enlarge much upon this part of the subject.

We will then at once proceed to inquire into the principles which actually exists, and which may throw some light upon the cause of light and darkness, and illustrate the subject in hand. Mr. Hampden has offered to stake £500 on the proof of the convexity of a river, a canal, &c., and which you notice in your present volume, pages 79 and 95. I can regard this matter in no other light than as truly extraordinary that man should be so wedded to system, as to be blind to proof they witness nearly every day of their lives. I hope I shall be able to prove that the apparent greater height of an object, in the centre of 6 miles of water, than objects at either end of this distance, is not owing at all to convexity, but to an entirely different principle in nature, but which principle does not appear to be universal.

It seems almost incredible that philosophers will not call things by their right names. If they had said visual illusion so much, whether it be by refraction or otherwise, I could have understood them. Any ploughboy can testify to the changeable appearance in width of the land he has marked out, and not quite finished (if the same is of *equal width throughout*. When he is at the end A, Fig. 2, the part unfinished, appears as in the figure at B, and when he is at B the end A appears narrowest, and so on; the end he stands upon invariably appears widest. A railway servant can testify to the changeable appearance of each line of rails. A town street assumes the same appearance, *laterally* and *vertically*; indeed, the principle is almost universal.

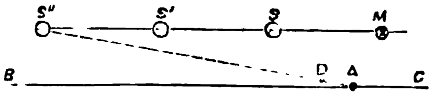
FIG. 2



Although this principle will be more fully dealt with when I come to the question of parallax, I may say here that the rising and setting sun and moon, and the appearance attending their journey through space, are illustrated by a consideration of this principle of visual illusion, which we may define as the apparent lateral and vertical contraction of space in distance, or, scientifically, lateral and vertical perspective.

It has commonly been held that the earth is speeding round the sun with inconceivable velocity, and that the appearance of a rising and setting sun could not be accounted for in any other way than by the rotation of the earth about its axis.

FIG. 3.



We will suppose A B to be a plain on the earth's surface, and M the moon, and *s s′ s″* the rising sun at apparently different altitudes, and we will suppose, for the sake of easy illustration, that the observer stands at A, and that *s* and M are at equal angles to the right and left, and supposing *s s′ s″* and M are at equal height, the question arises, would the sun *s′* appear as shown in the diagram, before the vanishing point is marked? I contend that it would, for the simple reason that the visional illusion, called in all engineering works "curvature" (but which is neither more nor less than optical deception), accounts for it.

There is in all sights a vanishing point, or a converging of the rays to a point at various distances, and we will suppose D in the above figure to be the vanishing point of a person stationed at A. This point, then, will be the observer's *horizon*, because of the converging of the bottom and top rays to a point at D, and fixes the object above the horizon, at an apparently less altitude than it is in reality, and if we carry a straight line from D to *s″* we shall witness a rising sun, and *vice versa* a setting sun.

I will take the table of curvature as it stands in Baker's "Land and Engineering Surveying," and by rule, which agrees (refraction deducted) with the late experiments, and apply it to Fig. 3. The difference in altitude, given as the difference between the "apparent and true level," supposing *s′* to be 30 miles distant from A, will be 600ft. Or D will be 600ft. above the line A B, and supposing *s″* to be 60 miles distant, the difference between the apparent and true level will be 2400ft. Or if we suit the altitude to the distance, it will vanish entirely, because it is below the observer's horizon D, really in the same altitude as *s*. So that it is plain that instead of curvature (considering the line *c* B to be a perfectly true level), that an object is really higher than it *appears* to be when *beyond* the observer's horizon. But when within the range of vision, objects *appear higher* than they *really are*, as is shown by the apparently higher position of the middle object viewed from either end, in the experiments in connection with Mr. Hampden's challenge. That is, from A to D objects apparently rise, but when the limit of vision is reached, any independent object beyond it appears from A to be lower than it really is. JOHN BEARDSLEY.

(*To be continued.*)

[We admit we owe an apology to many of our readers for devoting space to letters like the above, and if similar arguments and illustrations were not used nightly in lectures, as we said last week in our "Notices to Correspondents," by "Parallaxes, enthusiasts, and charlatans," we would not do so. These lectures, as Mr. Dyer, in his little work on the "Form of the Earth," says, are unsettling the minds of many people who have not studied the subject. We therefore give Mr. Beardsley space, so that he may be triumphantly answered.—Ed. E. M.]

TIME.

Sir,—Absence from home has prevented an earlier acknowledgment of the reply which "F.R.A.S." has kindly given (p. 86) to my query No. 2425.

The question proposed was, how to obtain G. M. T. from local S. T., at a place whose longitude is 8m. 7s. West: having regard to the following "explanation" of the Nautical Almanac. "If the place of observation be not on the meridian of Greenwich, the sideral time" (*i.e.*, at G. M. N.) "must be corrected by the addition of 9·8565s. for each hour of west longitude, but by its subtraction if east."

Where longitude is expressed in time, I have understood it to mean sidereal time, at the rate of 15° for one hour. The specified longitude, 8m. 7s., was deducted by scale measurement from an ordnance map, and the longitude in the proposed question was consequently expressed in sidereal time.

The example which "F.R.A.S." has been good enough to give, should therefore be read thus:—Required the G. M. T. corresponding to 6h. 14m. 50·39s. local S. T., on 15 April at a place whose longitude is $2^\circ\ 1'\ 45''$ west (= 8m. 7s. of S. T.) And his calculation, slightly condensed, is as follows:—

	h.	m.	s.
S. T. at G. M. N. 15 April	1	33	46·06
Add prop. part of 9·8565	0	0	1·33
S. T. at local M. N.	1	33	47·39
Then, from the given local S. T.	6	14	50·39
Take above corrected S. T. ..	1	33	47·39
Sideral interval since M. N. ..	4	41	3
whose corresponding equivalent in Mean Time, is found to be ..	4	40	16·96
Add long., expressed in M. T.	0	8	5·67
G. M. T. required..	4	48	22·63

Now here "F.R.A.S." has adopted a method formerly practised by myself, but condemned as erroneous by authorities no less eminent than Mr. Baxendell, and the late Mr. Dawes. In No. 35 of the "Astronomical Register," Aug. 1865 (Vol. III., pp. 191, 208). are letters from those gentlemen in reply to one from myself signed "Aicitinens": and in that from Mr. Dawes an example in given which is transposed, as follows, into the case in question.

	h.	m.	s.
Local S. T., 1870, April 15 ..	6	14	50·39
Add long. west.	0	8	7
G. S. T...	6	22	57·39
Sub. S. T. at preceding G. M. N.	1	33	46·06
Sidereal interval since G. M. N.	4	49	11·33
Sub. retardation of M. T. on S.T.	0	0	47·37
Mean interval since G. M. N... or, G. M. T. required	4	48	23·96

It will be observed that the two answers to the question differ by 1·33., the connection applied by "F.R.A.S." (in accordance with what certainly seen to be the directions of the "Nautical Almanac"), to the S. T. at G. M. N. If the 8m. 7s. finally added by "F.R.A.S." were allowed to stand for Sidereal time, the same result would be obtained as is found by Mr. Dawes' method; but of course sidereal and mean time cannot be added together. Is the Nautical Almanac "Explanation" right or wrong: and is the G. M. T. at the time and place proposed, 4h. 48m. 22·63s. or 4h. 48m. 23·96s.? NOT A F.R.A.S.

PARABOLISING SPECULA.

Sir,—I did not anticipate that the difficulty expressed by "Novice" was of so simple a nature, or I would willingly have answered his question before; but now such answer is, I suppose, superfluous, if Mr. Blacklock's explanation met his difficulty. It is, of course, easy to see that if we have a spherical mirror whose *central* rays meet, say, in a focus of 60 inches, while its marginal rays meet in a focus of 59½ inches, it is just as practicable to make the centre of the mirror more hollow, so as to give a focus ½in. shorter, as it would be to flatten the margin, and so lengthen the outer rays to suit the central; it simply reverses the order of procedure, the only difference in result being that when the centre is depressed, the focus of the mirror would be a trifle shorter than if corrected by the other method. W. PURKISS.

REFRACTING TELESCOPE.

Sir,—It appears to me that it is quite possible, from the data supplied by "Neptune," 2444, page 23, to give him a set of curves sufficiently accurate for practical purposes, though our friend, "A Fellow of the Royal Astronomical Society," does not seem to be of that opinion. I do not find also, that "Neptune's" flint disc is of "abnormally high dispersive power," as our friend imagines, but that it is quite an ordinary piece of glass—at least as far as dispersion is concerned. Though "Neptune" does not give the actual dispersive powers of his glass, all that is absolutely required—*i.e.*, their ratio, may be easily ascertained from his query. This is evidently 1 : 1·6, very nearly.

I have adopted Herschel's curves for glass of this description to the foci required by "Neptune," and I find the radii of the curves of his crown lens must be for the outer surface 137·50in., and for the inner 62·51in., both faces of the lens to be convex; of the flint, the inner surface 60·21in., concave, and the outer surface 280·87in., convex. These curves will give a correct result only for glass whose refractive indices are 1·524 and 1·585, and will then produce foci such as "Neptune" requires—viz., 6ft. 10in. for the crown, 10ft. 11in. for the flint, and 18ft. 3in. for the focus of the telescope. Of course if the indices of "Neptune's" glass are not as above, he will not get a perfect correction for colour. If he finds this to be the case, when his object-glass is in a sufficiently forward state to be tested, he can produce the required correction by altering the curves slightly. I think he will find in practice that he needs only to alter either the outer surface of the crown or the inner surface of the flint. He may by this means arrive at a perfect correction.

If "Neptune" is a practised workman, and perfectly sure of giving the curvative he intends, I shall be happy to compute a set of exact curves for him. In that case he must furnish me with the respective indices of his glasses, and their diameter. He had better also give me the radii of any tools he may purpose using.

HENRY T. VIVIAN.

POWERS OF SUBSTANCES TO RESIST THE PASSAGE OF THE ELECTRIC SPARK.—OPERA GLASS LENSES.

Sir,—I thank Mr. Russell for his letter relating to this question. What I wanted more particularly to direct attention to was the powers of substances to resist the passage of the spark. For instance, if the interior tube of an induction coil be formed of gutta percha, shellac, glass, or ebonite, what would be the relative thickness required in each case depending on the power to resist perforation. It is evident that in this case an air space would not offer so much resistance as the above-named substances. Perhaps

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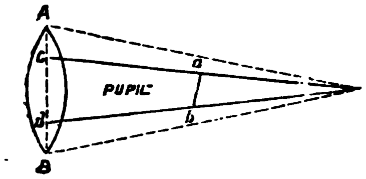
* Mr. Proctor, in ENGLISH MECHANIC, Vol. X, page 144.

"Sigma," or some one of your readers would give their opinion. Lastly, allow me shortly to call attention to an optical question. According to the theory of the telescope, the aperture of an object glass, in order to grasp all available light, should have a diameter as much greater than the pupil of the eye as the magnifying power of the instrument exceeds unity. Many opera glasses with a power of two diameters have an aperture of 1in. or more. The annexed diagram



shows this to be apparently useless, as the extreme rays of the pencil evidently do not enter the eye at all. I should be glad to see this matter criticised, as many matters of this kind are ventilated through your journal. A B object glass, *a b* pupil,

c d : *a b* : : 2 : 1, available aperture = *c d*.

S. T. Preston.

P S.—Taking the extreme diameter of the pupil at ¼in., the above considerations show that for a power of two diameters any aperture of object glass above ½in. is of no advantage. Hence the uselessness of object glasses of large diameter for opera glasses.

COTTON SPINNING.

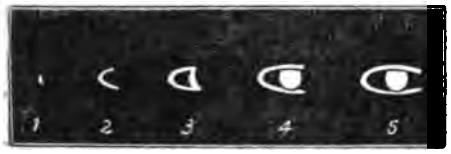
Sir,—I am glad that my letter on p. 59 has succeeded in opening the subject of cotton spinning, and if we can only enlist a few more correspondents, I have no doubt much information may be obtained by an exchange of views through the Mechanic. I shall be glad if "B. W. R.," or any one else will give their opinion on the following point—viz., Suppose a drawing frame to have 4 lines of rollers, with a total draught of 7, what draught ought there to be between the 1st and 2nd, 2nd and 3rd, and 3rd and 4th rollers?

"Mutual Improvement's" rule for ascertaining the draught of a carding engine is correct, though it appears as if his callenders "took up" took quickly

Factory Lad.

OCCULTATION OF SATURN

Sir,—Possibly some of your readers who did not sit up on the morning of April 20, till 3 and 4 o'clock may like to know what was seen of the occultation of Saturn with so unpretending an instrument as a 3in. achromatic by Slater. The disappearance taking place on the bright side of the moon, with light clouds about, the planet looked very dull, and I lost it before occultation was complete; but when it re-appeared, an hour after, on the moon's dark side, the sky having meanwhile cleared, a very good view was obtained. Commencing as a strangely-shaped star, Saturn presented a very odd appearance, with only a portion of his well-known figure visible, and apparently the dark sky all round. A mountainous projection was seen on the moon's dark limb as it passed over the body of the planet.



G. Guyon.

CALCULATING DISTANCES.

Sir,—I beg to submit that it would be very desirable to establish a "harmonious" system of calculation as to the mean parallax of the sun.

The following facts do not argue in favour of that system, by

	Professor Encke.	E. J. Stone. "F.R.S."	P. Daval, Esq. "R. H." 1762	"Veritas."
Mean heat Parallax Sun.	8"·58	8"·91	8"·65	8"·760988

Referring to the letter of "F.R.A.S." on "personal" matters, on page 80 of the English Mechanic, 15th April, 1870, he says "Veritas" has been "preaching" from that text "Venus on the Sun's Face," as given in Vol. X., No. 247. Well, I admit the soft impeachment, without, apparently, obtaining many converts, but to change the metaphor, I considered the production of a "F.R.A.S." a fair subject of criticism, especially as the data ere so circumstantially given, "as 277: 723 : : 7000": 18271 miles," &c. But he adds, "None of these figures are *precisely* correct, because we have never gone beyond one place of decimals."

I do not, nor never did, hold "F.R.A.S." to a "rigid accuracy in figures;" but I do hold that the eccentricity of the orbit of the earth, as given by Sir J. Herschel at 0·01679, as measured by unity, the mean distance ought to be a guide, to which, when unity is added, equals 1·01679, this is the ratio between the mean and aphelion distance, and also the mean distance divided by the perihelion distance.

"To have gone into all the details and refinements of calculation," and thereby deduced or obtained the correct mean diameter and distance of the Sun, would have been considered ample satisfaction by

Veritas.

FIG. 1 VERTICAL SECTION

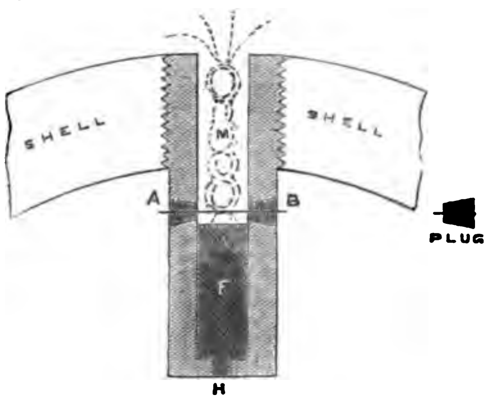


FIG. 2 VERTICAL SECTION

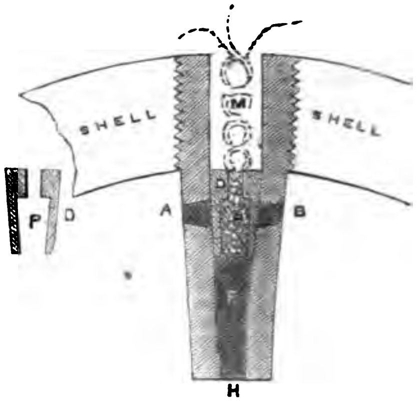


FIG. 1 HORIZONTAL SECTION

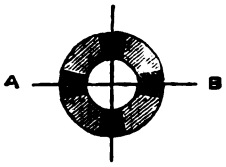
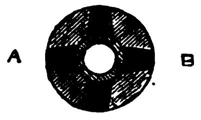


FIG. 2 HORIZONTAL SECTION



FUSES FOR CONCUSSION SHELLS.

Sir,—I beg to send sketches of fuses for concussion shells, which I have invented.

The sketches above show the fuses as fixed in shells.

The number of holes for the escape of flame may be increased either vertically or laterally.

J = Common fuze composition.
M = " quick match.
A B = Sections of plugs of lead or other metal.

In Fig. 1 the plugs are retained in their places by a thin wire A B of *fusible* metal, which is destroyed when the gun is fired, and the plugs are set free to tumble *outwards* when the shell strikes the ground.

In Fig. 2 the plugs tumble *inwards* as soon as the plug of cardboard or papier mache *D* is removed. In order to effect the displacement of D, it is filled with rifle powder P, and becomes blown out when the gun is fired.

These fuses are *not similar to Freeburn's*, or any fuse that has been invented prior to 1852.

Oliver Haldane Stokes.

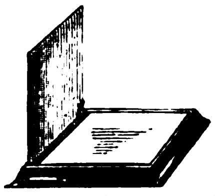
BACK-WHEEL BICYCLE.

Sir,—It may be only practice. Mr. Preston (2463) wants to ride the "back-wheel" bicycle he has made. The pressure on the treadles being of a different nature to that of the ordinary machine, requires to be learnt afresh, even though he may ride them. He ought to have 6" cranks, though, for a 38" wheel (ordinary bicycles require 6½" for a 36" wheel); the wheels are only 6" apart, not a foot, and if he has got a roller I advise him to take it off. The swinging bars are of such a length as to make the treadles about 1ft. 6in. below the level of the spring, when they are at their lowest point, this suits most persons, but as they can easily be lengthened or shortened, it is best to adjust them till you get the size you find most comfortable. The swing bars are made of the shape shown in the sketch. Leg rests can be put on to the projection in front, these do not interfere with the working. Persevere with it, and you will soon "make it go" fast enough. On the 2nd of April, I travelled on mine from Hampstead to Hendon, 3 *miles in* 15 *minutes, with great ease*. I have reason to believe it to be the *easiest working* velocipede I have yet heard of. Certainly the "lever" principle is the best driving action.

S. James, Kentish Town-road.

MOISTENING LABELS.

Sir,—Some time ago I observed a query in our Mechanic in reference to moistening labels and postage stamps, without being subjected to the—not always either pleasant or safe—operation of passing them through the mouth. The best reply I can make, is to forward for your kind acceptance a neat litte apparatus, that most efficiently (I think) accomplishes the object in view, without the drawback of *clumsiness* that attaches to so many of the contrivances extant — lately brought out by Messrs. Savage and Son, Brighton. If you think this ingenious and natty device worth an illustration in your columns—so devoted to original ideas—it is at your service.



They are made in several sizes, to suit the various forms of label in use. The one I send is, you will observe, nearly square, and intended chiefly for wetting postage stamps; the *modus operandi* is as follows. Pour a little water upon the pad, so as *thoroughly* to saturate it; place the label with the adhesive side upon the pad, then press down the lid with the fingers; the brass spiral spring inside the box—which constitutes the chief merit of the invention—will raise the cover again when relieved from pressure, when the label or stamp may be removed and applied in the ordinary way. Edmund M. T. Tydeman, Brighton.

DRAUGHT IN A CARDING ENGINE.

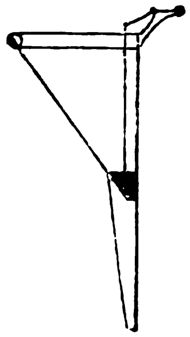
Sir,—"Mutual Improvement" asks if the rule he gives, p. 111, for the draught in a carding engine "is strictly correct." If he means for the whole of the draught in the engine, I answer, No!

The rule is correct so far as it goes, but it only gives the draught between the doffer and the feed rollers; to get at the whole draught we must take into account also, the draught between feed rollers and lap roller, and also between doffer and callenders. The draught of a carding engine, or any other machine, is simply the ratio between the surface speeds of the first, or taking-in roller, and the last, or delivering-roller. If the surface speed of first roller be always taken as equal to 1, then the surface speed of last roller will be always = the ratio of their speeds, which ratio is the whole draught in the machine.

B. W., Rochdale.

COMBINED FUNNEL AND MEASURE.

Sir,—Enclosed I send you a sketch of a funnel and measure combined, which I made some time ago, and



which answers the purpose first-rate for all kinds of liquors, and which I think will be useful to many of your readers. I made them in different sizes, and got them stamped.

Seacombe.

CHEMICAL.

Sir,—Whilst reading an old book several years ago, I met with the following, which I wish to lay before your chemical readers:—"Sow some cress-seed in flour of sulphur, watering it with distilled water, in order to prevent the introduction of any foreign element. The seeds germinate, and push forth into a centre, nourished alone by principles known by analysis. Cut the stem into several pieces, so that you may have sufficient quantity to operate upon, and by burning it you may obtain some heaps of ashes. In analysing these ashes you will find acid of silica and of alumine, of phosphate and carbonate of lime, of potassium and oxide of iron—as if the cress had wandered or come from the sea-shore. Now, these substances exist neither in the sulphur which served as soil for the plant, nor in the water that was used; we can only explain their presence by supposing some element common to the bodies contained in the cress, and in those which surrounded it. Thus, the air, the distilled water, the flour of sulphur, and the substances contained in the cress—that is, potassa, magnesia, and alumine—have one common principle. From this irrefrigable experiment we deduce the existence of the *absolute*—a substance common to all natures, modified by a simple force."

The idea contained in the above, which is, as I understand it, that *all* bodies are formed of precisely the same substance, only modified variously by some force or agent, is certainly a grand one. But I wish to ask our chemical friends if the result of the experiment is actually as above stated, and if so, what is the modern explanation? A. J. Smart.

FIG. 1
10/4/70, 21h 30m

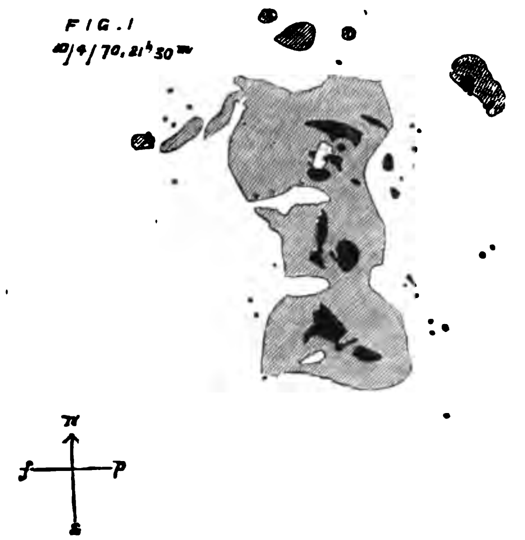
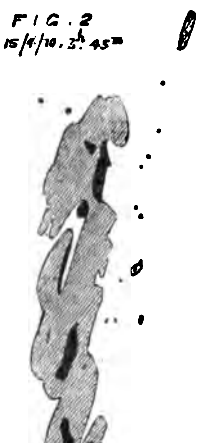


FIG. 2
15/4/70, 3h 45m



THE SUPPOSED PLANET VULCAN.

Sir,—The observations of the sun, made with the view to rediscover the above planet in transit, concluded on April 10, and the observers agree in stating that during the time they have watched the solar disc no planetary body has been visible. The spots (*maculæ*) have continued to be exceedingly large and numerous, and have presented some very interesting appearances. The larger group, which appeared on the E.N.E. edge, on the 4th inst., and to which I called the attention of your readers in my last letter, continued to be visible until the 16th. It was seen by many observers without telescopic aid, and I have numerous sketches of its appearance when examined with a high magnifying power. I enclose two, made by Mr. J. W. Backhouse, of Sunderland, with a 4¼in. refracting telescope. Mr. Backhouse also obtained some measures of the size of the penumbra, and found that on the 6th April, at 4h. 20m., it was 83,009 miles long, and 64,000 miles wide. Its umbræ were, however, small in proportion, the largest being but 13,000 miles long. On the 8th, the penumbra was reduced to 67,000 miles in length, and 48,000 miles in width. On the 14th, at 3h. 20m., its greatest length was 58,000 miles, and its greatest width 36,000 miles. On the 15th, at 21h. 15m., the length of the penumbra was 60,000 miles.

In addition to the immense cluster referred to above, numerous others were visible on various parts of the disc, and the following are the numbers noticed by Mr. J. G. E. Elger, on several days :—

		No. of Groups.			No. of Groups.
March	20	7	April	2	10
,,	21	9	,,	3	9
,,	23	11	,,	4	7
,,	25	8	,,	5	7
,,	27	6	,,	6	8
,,	29	10	,,	7	8
,,	31	9	,,	10	8
April	....	11			

Mr. Elger, in referring to the large spot visible on the 7th, says, "The most rapid changes were remarked in the long straggling umbræ of this spot. There were evident traces of cyclonic action going on, shown by the spiral streaks, and markings within the penumbra. I have been in the habit, during the last ten years, of constantly observing large solar spots, but I never witnessed such a changeable group before."

Mr. W. R. Birt, F.R.A.S., in speaking of a small group visible on the 6th, says:—"April 7. This group has become enlarged still more, assuming the character of two other conspicuous clusters, one in the S. the other in the N. hemisphere, consisting of two spots, one preceding and the other following the central portion, or apparent focus of disturbance; a feature which I constantly noticed in my sun spot observations, nine or ten years ago. The group in question, of which I noticed the earliest formation, has now become extended by appendages of spots, N. of the two terminal ones."

Mr. Birt also says :—"Between March 29 and April 7, the spots, which have been very numerous, may be divided into two classes, large isolated spots, or pairs of such spots, attended with comparatively small penumbra, and preserving from day to day their distinguishing characteristics; also large groups of insignificant proportions, containing numerous umbræ, and a large extent of penumbra, the disposition of which has altered from day to day."

Throughout nearly the entire period selected for the observations, the weather was very fine, but definition was not good, and it was frequently found impossible to obtain good views of the spots, when employing high magnifying powers. In a future series of observations, it is proposed to obtain the co-operation of observers at more distant stations.

William F. Denning, Hon. Sec. Observing Astronomical Society, Ashley-road, Bristol, April 18.

THE "PHANTOM."—"OVER SIXTY."

Sir,—In further reference to the "Phantom" wheel, I have just had my attention called to an article under the heading "Wheel," in the "Penny Encyclopedia," whereby it appears that so early as 1838, wheels for railway trucks were constructed upon the "suspensory" principle, and though immensely strong, were not found sufficiently elastic to answer the purposes of good carriage wheels. I also remember, within the last twelvemonth, to have seen, either in the English Mechanic, or some other scientific journal, a notice of a wheel of similar construction, in use (as a gig wheel) by a gentleman in London; but in this case the spokes were formed of steel chains passing over pulleys attached to the felloes or rim of the wheel; this would, I think, be less objectionable than spokes of steel wire, as, although the so-called chain spokes might be a trifle heavier, they would not be so liable to fracture from an accidental blow, as the wire ones, and would, moreover, not prove so rigid and inelastic, thus two of the most serious objections would be overcome. I may observe, that the idea was suggested to my mind by seeing a boy's hoop, with a ring tied in the centre by pieces of string for spokes. The wheel and velocipede referred to in my previous letter will doubtless be remembered by many persons in the neighbourhood of Rochfort and Rayleigh, in Essex, in 1864-5; as will also a first experimental wheel constructed with a solid brass rim with very fine wire spokes passing through in a precisely similar manner to the one illustrated by The "Phantom" Company.

I must also in all fairness add that I have never either tried or seen any of their wheels; but no one will rejoice more than myself, or be more ready to congratulate the "Phantom" Veloce Company if they have—in anyway yet unexplained—succeeded in surmounting the very obvious difficulties in constructing a really strong, light, and useful wheel, on the "suspensory" principle.

In reply to "Over Sixty," page 115. I very much dislike anything having the appearance of "blowing my own trumpet," but as it is not a matter of trade to me, and appears to be a matter of some importance to him, I can with confidence inform him that I know of nothing—and my experience is pretty extensive—more suitable for getting along in a hilly country, or indeed any other, than the velocipede I fully illustrated and described under the *nom de plume* of "Leo," in Vol. IX., April or May last year of our Mechanic. (3 of my vols. are now being bound, so I cannot refer), and of which the Editor said it was the only one he had seen that really deserved a patent. But I preferred to make our readers a present of it.

Edmund M. T. Tydeman.

NINETY MILES A DAY ON A BICYCLE.

Sir,—I have rested contented with reading only the opinions, suggestions, and experiences of your numerous correspondents on the construction, use, and progress of the velocipede, and have been very much interested with the ingenuity exhibited by some, surprised at the wonders told by others, and amused at the ridiculous nonsense of that class of your correspondents who are endeavouring to show how to gain power and speed by the various magic contrivances of long levers, cranks, &c. It is, however, useless dilating further on these absurdities. I saw an account in your valuable paper of April 9, 1869, of some gentlemen going from Liverpool to London in four days. This then appeared to me a great feat, and I considered the riders had done four days' hard work, as my notion of the velocipede has differed very much from many of my friends, for I have always held that it is the rider who takes the machine with him, and not the machine the rider.

This opinion was very nicely explained by your correspondent "W." in your issue of Sept. 17, 1869, in his letter headed "The Bicycle Tested and Condemned," which some of your subscribers would do well to study. I must say, that although "W.'s" sentiments have exactly concurred with mine till now, I begin to vary a little (though not materially) from him, since seeing the account in last week's paper, which I know is true, being intimately acquainted with the two performers, who were both at their post at the usual business hour the next morning.

Extract from *Birmingham Gazette*, April 16, 1870 :—

"On Monday last two young gentlemen, residents of Smethwick, performed a journey each on a bicycle from this place to the town of Derby and back, being a distance of 90 miles, within the day, partaking at the last-named town on arrival of a substantial dinner provided by mine host at the well-known hostelry, Shakspeare Inn, Bell-lane, returning the same evening on their vehicles in excellent order. We believe this is the longest stretch performed within the time by any of our amateurs in the Midlands."

I would add that they were ordinary bicycles, with 36in. wheels and 6in. cranks.

A Regular Subscriber.

COCHINEAL.

Sir,—As cochineal is an article largely used in trade, a few words about it may interest some readers, and furnish a text for others better acquainted with the subject than I am to enlarge upon.

For many years it was thought to be some kind of seed, and retains the name "grain" at the present day among dyers, &c. Naturalists ascertained it to be the female of a hemipterous insect. It was found by the Spaniards in 1518, on their first entry into Mexico, where it was being used by the natives to colour ornaments, &c., &c., and is now extensively *cultivated* there, in Teneriffe, and Algiers. A Spanish priest introduced it into Teneriffe in 1826. In 1840 M. Simounet, a Frenchman (evading the Spanish law, which threatened any one found exporting the insect from their dominions with death), introduced it into Algiers, thereby rendering a great service to his country; for France was paying 9 or 10 millions of francs annually for the cochineals she used.

FIG. 1

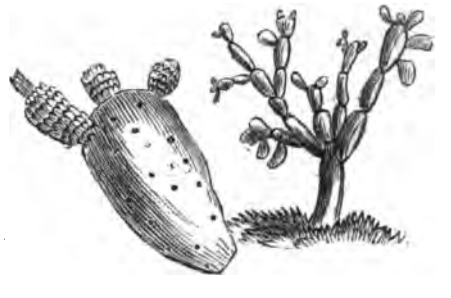


Fig. 1 represents the nopal plant, one of those peculiar succulent shrubs belonging to the natural order *Cactæ*, called by botanists *Opuntia Coccinillifera*. "On this the impregnated females are placed. Young ones are shortly developed, and about three or four months afterwards, when the females have become fecundated and enlarged, the harvest commences. The insects are removed and killed, either by immersing in hot water or by the heat of a stove." They are collected three times in the year, a few being preserved for breeding the following year.

The male only is supplied with wings; the female has none (Figs. 2 and 3), and remains always attached to the leaf of the nopal. They are small, irregular, ovoid bodies, of a greyish red colour on the outside, and a bright purple red within. They are used chiefly for the sake of the fine colour which they produce, and are principally consumed by the scarlet dyers. Alcohol, water, and solution of ammonia readily extract their colour.

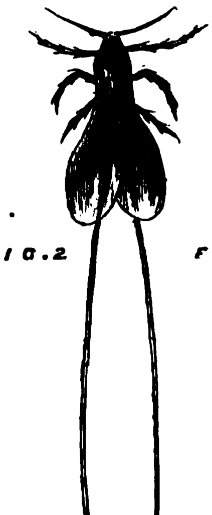


FIG. 2

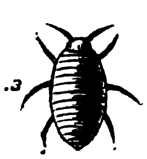


FIG. 3

Carmine is prepared from cochineal by decoction in water and the addition of a precipitant, such as bichloride of tin. What is thrown down, when collected and dried, constitutes carmine, six drms. of which is yielded by 1oz. of cochineal.

H. E. Godfrey.

THE DETERMINATION OF THE PERCENTAGE OF SULPHUR IN IRONS.

Sir,—As this subject is of great importance to those connected with the metallurgy of iron, I shall feel obliged if you will allow me space for a few words on the process described under this heading by Mr. Hamilton in your paper of the 8th inst. The method of separating the sulphur from the iron as sulphuretted hydrogen gas, which is absorbed by the solution of potash, and the oxidation of the sulphide of potassium thus produced, by passing chlorine gas into the alkaline liquid, as suggested by Mr. Hamilton, is ingenious; but the process is objectionable for several reasons, which I think will prevent its coming into general use. 1st. It requires great care in the preparation of the apparatus, and strict attention during the evolution of the gas. 2nd. The unpleasant odours, first of the hydrocarbon gases, and subsequently of the chlorine gas, are even more disagreeable to the analyst than the nitrous fumes evolved during the nitrohydrochloric acid process. 3rd. It is not so rapid as the nitrohydrochloric acid process. 4th. The results do not exhibit a greater accuracy than is obtainable by solution of the iron in nitrohydrochloric acid.

Mr. Hamilton, in his article, says: "I have analysed several specimens of pig-iron according to the solution in the nitrochloric acid method, with all due precautions, which, although exceedingly important, are often omitted in explanations of the process." As Mr. Hamilton has also omitted to mention the precautions necessary to observe in carrying out the nitrohydrochloric acid process, I will describe in detail the manner in which I estimate sulphur in iron and steel by that method, having always found the results trustworthy and accurate.

A weighed quantity (about 3 grammes) of iron is placed in a beaker of about 800 cubic centimetres' capacity, and having a clock-glass cover. 20 cubic centimetres of strong hydrochloric acid are mixed with 10 cubic centimetres of strong nitric acid in a small beaker, and gently heated until the acid liquid assumes a slightly yellowish tint. The acid is then poured, little at a time, into the beaker containing the iron, the glass cover being moved just sufficient to allow of the acid being poured into the beaker. A very strong reaction takes place, and great heat is generated; but the capacity of the beaker, and the large cooling surface presented by it prevents any loss by effervescence. The solution of the iron is thus effected in two or three minutes, and the whole of the sulphur is oxidised to sulphuric acid. The sides of the beaker and the clock-glass cover are now rinsed by means of the wash-bottle, and the liquid is evaporated nearly to dryness over the water-bath, or on the steam-chest, to remove excess of acid. A few drops of hydrochloric acid are poured on to the residue when nearly dry, and water is added, a gentle heat being applied to hasten the solution. The liquid is then filtered in the ordinary way, the filter paper washed with cold water, and the filtrate diluted to about 100 or 150 cubic centimetres. A solution of chloride of barium is added in excess to the filtrate, which is allowed to stand in a warm place for several hours. The precipitate soon makes its appearance, and settles down at the bottom of the beaker, leaving the liquid above it quite clear. The liquid is now filtered, and the precipitated sulphate of barium collected on the filter paper; but it is important to note that the filter paper must not be washed with *hot* water until the whole of the yellow solution of iron has been removed from it by washing with *cold* water. I mention this particularly, as Mr. Hamilton in his paper says:—"After filtering and washing it well with boiling water, it is seldom, if ever, possible to render it white, which is objectionable to a careful chemist." This statement and the context would lead one to infer that washing with boiling water is necessary to render the precipitate white, whereas the reverse is the case. After the liquid has passed through the filter paper, the latter should be washed with cold water, and if a trace of yellow colour remains in any part of the paper, a few drops of hydrochloric acid added, and further washing with cold water, will entirely remove it; the washing may then be continued with hot water. With proper care, and the observance of those precautions, the precipitate, when dried, ignited, and weighed, will be obtained perfectly white. On the other hand, if the paper be washed at first with boiling water, it will assume a brown coloration, owing to the precipitation of oxide of iron, the complete removal of which from the paper is very difficult.

In estimating the sulphur in steel and wrought iron, it is advisable to use a larger quantity, say 5 grammes of the metal and 50 cubic centimetres of the mixed acids. The weighings must be made on a balance capable of weighing accurately to the tenth part of a milligramme. I use one of Ladd and Oertling's balances, furnished with supports for the scale pans, and having agate plane and knife edges.

The acids sometimes contain a trace of sulphurous acid, which during the solution of the iron becomes oxidised to sulphuric acid. Before making any estimation of sulphate in iron, it is therefore necessary to estimate the weight of sulphate of barium obtained from a given volume of the mixed acids. Thus, if 60 cubic centimetres be the volume experimented on, and four milligrammes of sulphate of barium be obtained, then in a determination of sulphur in iron, using 3 grammes of iron and 30 cubic centimetres of acid, a deduction of two milligrammes from the sulphate of barium obtained will be necessary on account of the impurity in the acid. The following are some of the results which I have obtained by solution in nitrohydrochloric acid. In my opinion they are sufficient evidence of the accuracy of the method, and the difference between the results of the first and second analyses is in each case less than the differences obtained by Mr. Hamilton in his experiments:—

PIG IRON.

		1st Analysis.	2nd Analysis.	Diffrnce
1.	Percentage of sulphur.	0·044	0·046	0·002
2.	,, ,,	0·047	0·042	0·005
3.	,, ,,	0·060	0·069	0·009
4.	,, ,,	0·067	0·064	0·003
5.	,, ,,	0·080	0·085	0·005
6.	,, ,,	0·118	0·118	0·000
7.	,, ,,	0·119	0·125	0·006
8.	,, ,,	0·128	0·116	0·012
9.	,, ,,	0·124	0·122	0·002
10.	,, ,,	0·421	0·424	0·003

WROUGHT IRON AND STEEL.

		1st Analysis.	2nd Analysis.	Diffrnce
11.	Percentage of sulphur	0·014	0·018	0·004
12.	,, ,,	0·023	0·015	0·008
13.	,, ,,	0·036	0·038	0·002
14.	,, ,,	0·042	0·040	0·002
15.	,, ,,	0·048	0·041	0·007
16.	,, ,,	0·073	0·061	0·012

Edward Richards, Analytical Chemist to the
Barrow Hæmatite Iron and Steel Co.,
Barrow-in-Furness.

THE SOPER RIFLE.

Sir,—Some readers may recollect a description of a rifle invented by Mr. Soper, in Vol. VII., p. 339. Certainly our inventor must be credited with no small amount of ingenuity and perseverance in being able to produce to the world another and a far superior arm than the previous one. The former was rejected by the Small-Arms Committee for its *seeming*—I say seemingly intentionally—complication. The one I am about to describe is simplicity itself. By a very unfortunate decision, however, of the Government, the gun of which I give diagrams, has not been considered in the competition, as it could not by any possible means be got ready by the day stated as the last when new inventions would be received. Therefore, for the moment, it has the cold shoulder, but if rival inventors, experienced mechanicians, the most eminent engineers of England, France, Germany, and the United States, give, as they have given, their opinion that this new gun is the best in the world, how long will it be before Government is compelled to admit it in competition with others? The requirements of a breech-loader are simplicity, strength, and certainty of action. We will consider for a moment how far the gun we are discussing answers to these requirements. Its constituent parts are reduced to a minimum, and therefore, of necessity we get simplicity. "The cocking of the piece, the opening of the breech, and the extracting of the empty cartridge shells are simultaneously effected by *one* movement of the hand without changing the position of the piece. The breech is closed by a block which is hinged or pivotted at one side of the rear of the barrel, and which is raised and turned laterally on its pivot to open the breech" (specification). Fig 1, A, the breech-block is perforated to allow the insertion of the striker, Fig. 1, B, by means of which the blow of the hammer is transmitted to the cartridge. The movements above-mentioned are caused by the motive power being applied to a lever, Fig. 1, D, mounted on the right side, moving in a circular direction, but only to the extent of 53°. The ease of the operation will explain the marvellous rapidity with which this gun has been fired. At the late Basingstoke Exhibition no less than 60 rounds were fired by Mr. Warwick in *one minute*, work which has never yet been equalled. The only springs used in the mechanism are the ordinary mainspring taken from an Enfield rifle, and a flat trigger spring. Regarding strength, which is properly of the utmost importance, the gun has many times been fired with a charge of 200 grains of powder and 530 grains of lead. Lastly, respecting certainty of action, so simple and so certain is it that misfires are unknown in the vocabulary of its inventor. The ordinary sand clogging has been tried without effect, the base of the cartridge has been sawn asunder, but still no failure, it has been left for a fortnight under water, and during the next two weeks left out in the open air, recollect this was done during foggy November, and still when tried, of course before being cleaned, its action was perfect.

FIG. 1

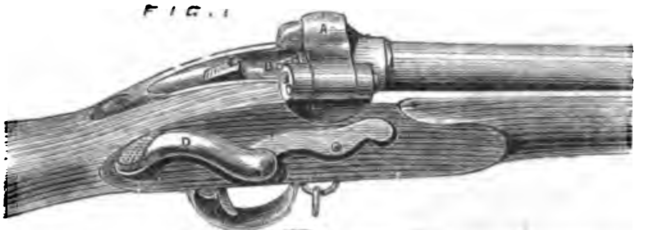


FIG. 2

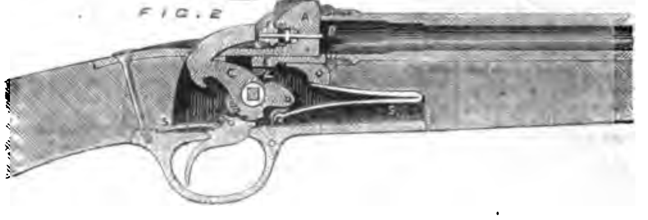


FIG. 5

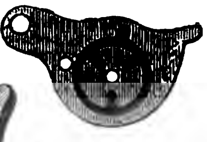


FIG. 3

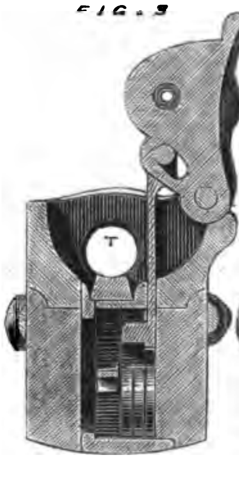
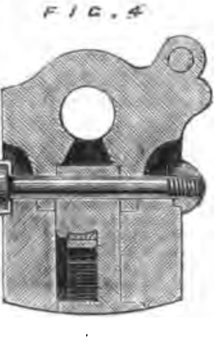


FIG. 4



The whole mechanism will however be understood much better by reference to the following diagrams. I have given references to the peculiar parts only; the others, as the barrel, cock, &c., are similar to the ordinary rifle.

Fig. 1 represents a side view; Fig. 2 a longitudinal section; Figs. 3 and 4 are end views, with the breech-block raised and closed respectively; Fig. 5 shows the breech block.

It may be necessary to say a few words regarding the extractor, E, Fig. 2. By the diagram it will be seen the end of the extractor is raised, and it is this part which catches the rim of the cartridge. The extractor is moved by means of a lever, and by a peculiar formation of the hammer it is started back with a slow motion, which is gradually accelerated, and finished with a jerk. By this peculiar motion great force may be exerted upon the cartridge shell in starting it from the barrel, which is necessary when the explosion of the cartridge, or some other means, has caused to stick tightly in the barrel. One screw secures the whole. The stock of the gun is in one, and, therefore, very strong.

C. H. W. B.

P.S.—Just at the moment of writing I hear another trial is to be made as regards rapidity of firing, which I hope to witness, and if more than 60 rounds per minute are fired, the Editor shall be duly informed.

INGREDIENTS FOR GOOD PAINT.

Sir,—In answer to "Surveyor," (qy. 2500), I may tell him the ingredients necessary to form a good paint are as follows:—

1st. A genuine well ground material or paint proper for the body.

2nd. Siccaline or boiled linseed oil, as a vehicle for the convenient retention of the paint itself.

3rd. "Patent" or other dryers, to assist the paint in hardening and drying.

4th. Turpentine or petroleum spirit, to give sufficient fluidity to the above mixture, so that it will work readily under the brush. It also acts as a dryer.

The proportions of the above vary, (1) according to the nature of the paint, (2) according to the kind of surface to be covered, and (3) according to the weather.

Speaking generally, and taking best ground white lead as an example, 1cwt. lead, 6gal. boiled oil, 21lb. patent dryers, and 1½gal. turpentine, would make a paint suitable for second coat work. For priming or first coat, say 1gal. oil less, 1gal. turpentine more; this would cause the work to dry "dead" or flat, as is required.

Pale oak varnish is the best for grained woodwork. If the work is exposed to the weather, ask for *outside* oak varnish. Unless you buy from a good house you will get varnish made with softer and cheaper gums; this is only fit for inside work.

You cannot well detect adulterated paints unless the adulteration is unmistakably apparent, or you have pure paint by you to serve as a standard. In this latter case, and taking ground white lead again as an example, you may detect adulteration in this way: Take, say, 50 parts lead to 1 part ground Prussian blue or vegetable black, mix together with a given quantity of oil and turpentine, and observe the shade of blue or grey. Proceed in the same manner with the sample to be tested. If this latter test gives you a darker blue or grey than the former, you may be sure that the latter is the most adulterated. By repeating the tests and diminishing the quantities of lead in the first sample, you may make both shades coincide. Note then the difference in the number of parts of lead to the one part of blue or black, and that will be your estimate as to the superiority of one sample over the other. This method may be adopted with most colours. The writer makes an oxide of iron paint that will stand this test favourably against any other he meets with. It is the method he adopts with every sample that comes within his reach, and by it he can test each maker's assertions with tolerable accuracy.

As to the last clause of the inquiry, I should think petroleum or other oils would certainly spoil any paint. Petroleum spirit, or mineral turpentine, as it is sometimes called, will answer very well for common outdoor purposes, but at the present price of good turpentine there is very little saving in the use of petroleum spirit. Consumers usually buy paint in the ground or stiff state, and thin it themselves. If bought ready for use (a mode the writer would not generally recommend), the smell of it would determine whether petroleum spirit, or spirits of turpentine, had been used. If "Surveyor" will insert his address in the advertisement columns, I shall be happy to forward him further details. Being in the trade I do not wish further to speak of this subject, as it would make an advertisement of this reply.

Llah.

THE ORGAN.—SOUNDBOARD, OR BELLOWS.

Sir,—Having made the acquaintance of the English Mechanic some three months ago, being introduced to him by a friend who referred me to one of his articles in elucidation of some mechanical contrivances in which we were mutually interested, I need scarcely say that I have derived much pleasure in availing myself of a copy of his weekly visits ever since. I have felt much gratified in the perusal of his pages generally, and more particularly of late by an article on organ pipe construction, by "An Adept," whose very simple, clear, and minute instructions gave me encouragement to proceed at once in the construction of an instrument which, for a long period, I have been very anxious to commence. I have followed his instructions in making several experimental pipes (and very satisfactorily, as open ones), but, unfortunately, like another of your inquirers, am totally at a loss how to construct stopped pipes; and, taking a hint from "Adept's" reply to "Inquirer," on page 609. No. 258, I had made up my mind to shelve the pipe operations for the present, and proceed with soundboard, or bellows. But here again I find myself in a fix; for, not knowing the scale or relative sizes of the pipes, I connot set out my soundboard: and again, as I wish the bellows to be just as large as my soundboard and windchest will conveniently admit, I am consequently brought to a stand. I am desirous that the instrument should comprise—1, stopped diapason, CC to F in alt. or G (medium scale), wood; 2, principal; 3, fifteenth; and 4, trumpet metal. And to this end I should esteem as a particular favour, answers to the following queries:—1. In what number of the English Mechanic can I find "Adept's" wind-chest and soundboard instructions? 2. Would soundboard 4ft. 6in. by 2ft. be sufficiently large (placing the largest octave of pipes in front and at sides)? 3. What should be the sizes of blocks and thickness of stuff for the diapason CC to F or G? Simplex.

WOOD PIPES *VERSUS* ORGAN METAL PIPES.

Dear "Harmonious B.,"—Glad to find the "gout" has not suppressed your defiant crow. I always hoped wood pipes would come to the fore. "Adept" must be convinced by this time that metal is not a *sine qua non* for an organ. His communications, as *original* experiments, are of the highest value, and I hope he will arrive at speedy convalescence, and be allowed to complete them. There must be men capable of doing this work, and some don't care much for the trammels of the "practical organ builders." I even think the tones of the American organ may be rivalled in *delicious wood*, and I like to hear the tone and smell the fragrance of the goodly cedar. We can judge of good tone without the aid of the organ builders, just as we may pronounce upon a vintage of the "real thing" without the intervention of the licensed victualler. After all "Adept" has done and said, the difficulty ought to vanish.

Henry Ussher, B.A., M.B., Surgeon.

EXTRACTS FROM CORRESPONDENCE.

AMATEUR FARMING.—"A Country Vet." writes:—"Seeing a paragraph in your valuable journal whether it would not be advisable to give a column to questions and answers respecting the breeding, keeping, and rearing of horses, &c. I think myself it would be a good idea; but would it not be advisable to add to the abovementioned list that of dogs and poultry, especially as dog and poultry shows are becoming so extremely fashionable; and a few hints occasionally on the different diseases in the said animals would not be amiss. I shall be only too happy at any time in my humble position to render anything towards its advancement."

BLUE MAHOE WOOD.—"Joe" says:—"I enclose you a splint of the so-much-praised wood for our humerous friend, 'The H. Blacksmith.' It looks to me very like mahogany in texture. The price I was asked for a rod of it was about 75 per cent. over what I can procure first-class fishing-rods for in hickory, lance, or greenheart. Will the 'H. B.' kindly favour me with length and weight of his rods without reel or bag? I might be of service to him if he is in the market for fly rods. I have given up bait fishing."

ELECTRICAL PSYCHOLOGY.—"B. Q." writes:—"T. D. Workington says that a positive person can control the will of one who is negative. Now, Sir, I once proposed to a young lady, and was very positive, and found her equally negative; and, notwithstanding, utterly failed to control her will! 'T. D.' also says that Dr. Dods 'showed the sighing lover how to choose a congenial partner for life.' The 'sighing lover,' I suppose, was like the Irishman of the Irish tales, who first fell in love, and then began to consider who he should be in love with! On re-reading 'T. D.'s' letter, I find I have made a slight mistake. He says that the positive person either 'paralyses' or 'causes motion' in the negative individual. I did both in my own affecting case. The young lady was first paralysed with astonishment, and then —— vanished with truly electrical rapidity!"

THE SPHERICAL FORM OF THE EARTH.—E. M. T. Tydeman says:—"There is one argument in support of the spherical form of the earth, of an eminently practical character that I have never yet seen insisted on, but have repeatedly put to the test from the cliffs and shores. If looking towards the sea on a clear day, a perfectly straight edge be held some distance from the eye, and then be gently lowered down so as just to graze the horizon (where the sea and sky appear to meet), it will be readily perceived that the waterline is not straight, but convex, and that the rule and the sea, if the former is held perfectly level and steady, first touch in the centre of the straight edge. This, I think, is occular demonstration, and is almost as good a proof of the earth's rotundity as its shadow on the moon.

USEFUL WORK.—"Bernardin" writes: "To my brother readers who may understand German, I recommend the following work (printed in Latin type) *Chemisch-technisches Repertorium*, herausgegeben von *Dr. Emil Jacobsen*, Berlin, R. Gaertner, 150 p., in 8vo. It issues every 6 months, and contains extracts, recipes, &c., from 105 foreign reviews, on bleaching, building materials, dyeing, oils, varnishes, textile fabrics, leather preparing, metallurgy, photography, chemicals, &c., and, moreover, a bibliographical index of all that has been published on these matters in those reviews; to be obtained, I think, at every German bookseller's in London.

REPLIES TO QUERIES.

[1935.]—**EQUATION.**—

$$x + y + z = a + b + c$$

$$bx + cy + az = cx + ay ; ay + bz = a^2 + b^2 + c^2$$

this problem has been duly solved. I beg to add a few observations which might extend its utility: I remark that these equations solve the problem: a circle being inscribed in a triangle, the sides of which are $2a$, $2b$, $2c$, to find the segments x, y, z, formed on the sides by the circle, the relations between these segments are expressed by the given equations.—Gregory.

[2007.]—**TEMPERING DRILLS.**—"S. T." is obliged for the loop hole "J. B." has so confiderately left him to leap through, but is not disposed to take the leap, or make use of the printer's shoulders, as his way out of the suggested difficulty. Tempering, be it that of a drill, or anything else, is the art of bringing the metal to a certain condition by the application of heat, and by sudden cooling causing it to retain such characteristics as are thus developed. The condition of the metal is known by a superficial oxidation producing the colours before named; this may be effected in two ways, by hardening and letting down the temper, or by softening, and then raising it. The both systems are adopted, the preference being given to the latter, especially for new tools, as all the finish of surface can be better obtained in the soft condition of the metal, which finish is uninterfered with by the process advocated, that of laying it on a lump of iron heated to a sufficiently strong heat in the forge or other fire. The desired temper may be thus secured with the greatest facility and exactitude, as the clean bright metal shows the degrees of oxidation from the blue upwards most distinctly, which oxidation can be arrested at will. Cleanliness—*i.e.*, brightness of surface, is a *sine qua non*. Smoke, scale, or other obliterative media, prevent the manipulator satisfactorily judging of the stages of the process, and failure is frequently the result. The criticism of "J. B." had escaped my notice, or I should have replied in the next issue.—S. T.

[2223.]—**WATER POWER.**—In my reply to "G. P.," 2323, there is an error in the number of cubic feet. "G. P." stated 200 and not "203" cubic feet, and at the former I calculated his available power for a turbine. I am the more desirous to be accurate, because the "astounding machine" (I can call it no other) of Mr. J. C. Shewan (which immediately follows my own reply), upsets all practice of hydraulic engineering. All I can say is, that if Mr. Shewan can produce a "machine" as given in his reply, I, as an engineer in good practice, can make his fortune. His statement that "pressure is no object," I do not understand; but let that pass.—Senex.

[2234.]—**COLOURED OBJECT GLASS.—SOLOMON'S TELESCOPE.**—Whether this is your printer's error or mine, I certainly did not intend to write such nonsense; of course it is the *eye-glass* I refer to. I may here mention, that to each of the day eye-pieces I have pancratic tubes made, which vastly increases their power, both for earth and sky. By merely pulling out this tube, a change can at once be made, from viewing the sun or moon in their entirety, to an inspection of a highly-magnified portion of their surfaces.—Amateur.

[2270.]—**MOTION OF WATER.**—I refer to "Q. Q. R.'s" answer, April 15th, who states that 929 cubic feet per hour, or nearly 15·5 cubic feet per minute, would pass the orifice; but "Mirabile Dictu," "Anthony" (April 22) states that 25·7 cubic feet would be discharged! (The latter's calculation by his own figures is wrong also).—Senex.

[2280.]—**CHINA GRASS SEED.**—The seed of *Urtica nivea*, of which China grass is a variety, is quoted 6 francs a loth, in the catalogue of MM. Haage and Schmitz, seedsmen, at Erfurth, Prussia, correspondents, I think, of the great London seedsmen.—Bernardin.

[2286.]—**GENEVA CYLINDER.**—This is bought, as shown in Fig. 1. In selecting, the measurement is taken from the height of the lip or pallet E (I, Fig. 1). If there is a very slight difference it is of no importance, as it will only make the part A a little thicker or thinner. Further on will be shown how to get the height when there are no broken pieces to guide. The diameter is taken by placing a tooth of the 'scape wheel inside the cylinder, and then the cylinder between two of the teeth; when the play the tooth has inside the cylinder, and the cylinder between the two teeth, ought to be equal, taking care not to put them too far into each other, or else the measurement will be false, but just inside the roundings of the lips. It is best tried (and a second measurement is usual) in a depthing tool, increasing the depth till the tooth falls fairly outside and inside, and fails to turn the cylinder. Proceeding to turn it in, the broken piece is placed at 2, Fig. 1, so that the end of its pivot is level with the lower edge of the lip E, when the corresponding part of the old piece will show how much to shorten the arbor D. Remember always in shortening the arbors to allow for the point to be flattened in finishing the pivots, and a slight wear in the process of turning in; and taking as much into account in every measurement. Place the part A (3 Fig. 1) on the point of the shortened arbor, and the end of the pivot will show how much to turn away for the shoulder the balance is to rest on. 4, Fig. 1 shews how to proceed with the lower position. Before rivetting on the balance, the point marked on its rim ought to be in a position to correspond with the centre one of the three marked on the plate, when the wheel is acting in the cylinder; which can be effected by turning the balance round on the cylinder till it does so. Fig. 2 shows how to proceed in "new work." The balance cock, centre wheel and cock, and 'scape wheel and cock being screwed on the plate, invert the cylinder to be turned in; placing the surface of the lower plug on the surface G of the balance cock, shorten the arbor till the point comes just below the 'scape wheel. (The cylinder turned in complete is shown merely to facilitate.) Since the bottom of the 'scape wheel occupies exactly

FIG. 1

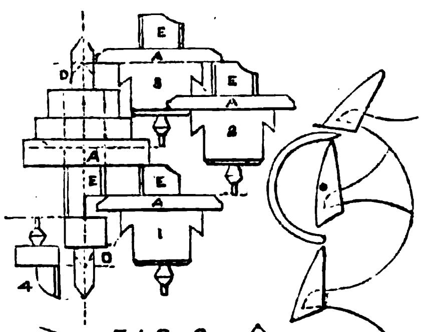
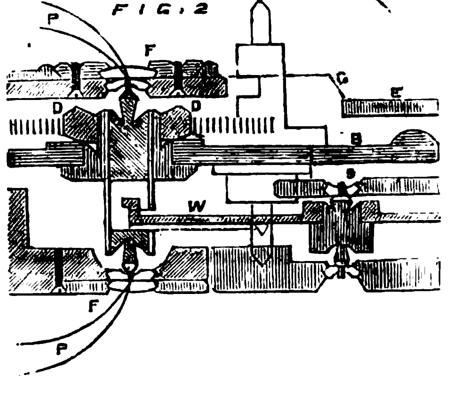
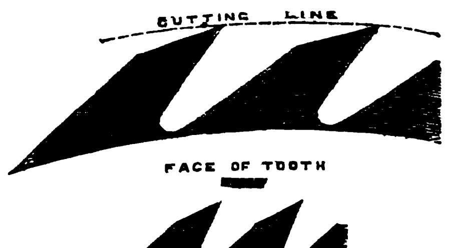


FIG. 2



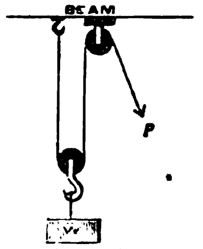
the middle of the notch in the cylinder, by placing the shortened point on one of the spokes (allowing for flattening and the thickness of the spoke), it can be seen if the surface G comes exactly in the middle of the notch. Here the adjustments for the balance and hairspring collet may be safely turned away (but after the other arbor is shortened and before its pivot is turned in), roughly taking the height by placing the point of the shortened arbor in the middle of the space between the 'scape cock S and the centre wheel E, and seeing where the surface G comes on the collet. With a callipers P P, the upper and lower endstones F F being off, take the height from hole to hole; shorten the other arbor and pivot it in. Placing the pivot in its hole, the lower endstone being screwed on again, and the balance cock slipped on to keep the cylinder upright, see if the notch is too high for the 'scape wheel; in which case shorten the pivot with piece of oilstone or very smooth file to *nearly* the proper height. Finish fitting on the balance, letting it down till it occupies exactly the middle of the space between the centre wheel E and the 'scape cock S; taking care that it fits pretty tightly in its hole, as this is essential to its turning true when rivetted on. Press it well down all round on the shoulder before trying for the height. Fit on the hairspring-collet D D also pretty tightly, and turn in the top pivot. Screw on the balance cock without the endstone, and if the pivot projects through the hole, shorten it flush with the top. Then try again with the index and endstone screwed on, and if the cylinder is bound, just free it. See that the balance clears the curb-key or pins and stud for the hairspring. Round up and polish the ends of the pivots, which will give the proper endshake, and rivet on the balance.—Nobody.

[2338.]—**SAW TEETH.**—In answer to "R. T. S." I send him a sketch of my favourite form of circular and deal frame saw teeth, the segment of C saw teeth are drawn half size for 30″ C saw, the deal saw teeth are the proper size and depth for A speed saw table of 150 or 170, both are sharpened with the flat file, both top and gullet, with about as much lead as is shown in the drawing. If "R. T. S." has a less speed than 700 or 750 he must not carry so much hook on C, saw teeth. The way I get so much hook on my saw teeth is by means of thin grindstones, which I put on the saw spindle. I grind on the back of the stone, the saw being laid flat on the table, having a small jet of water running on the point of contact. The operation requires tact and care, as the stones are easily broken.—Mill Sawyer.



[2370.]—**PEPPER MOTH.**—The following answer will perhaps satisfy "Pupa." The caterpillar of the *Phalæna Bitularia* is of a pale colour, and has at the back two black spots. It feeds and is found on the elms, birch, rose, and the willow.—A. Tolhausen.

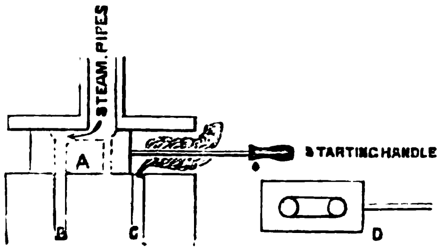
[2426.]—**PIG IRON.**—"Ironworker" will find that pig iron, after having been stocked for the length of time he mentions, has little or no sand on it, whereas new iron is generally well covered with this substance. I scarcely need tell him that that the sand (silica) excites a scouring action in the furnace, and that it causes the iron to melt thin; no doubt he has observed, that after putting clay on the bridge, in the jambs, or elsewhere, in the furnace, if it (the clay) has got on the bottom, or into the iron in any way, the heat has been harder to work than usual. This arises from the presence of too much silica, as in the case of the new iron, and, as in the process subsequent to puddling, it cannot be eliminated; the result is, a hard and brittle finished iron.—CINDER.



[2376.]—LIFTING SACKS.—I think the following arrangement of pulleys will suit "Rusticus." A power of 125lb. applied at P will keep 250lb. at W in equilibrio, and if the power be increased it will lift it.—W. H. THORPE, Reading.

[2374.]—BREWING.—"A Reader of Old Books" gives "New Subscriber," incorrect information respecting works on Brewing. "Levesque on Brewing," is published at 21s., and Donovan's work can be had in one vol. for 3s. 6d. If New Subscriber is in London, and will call at No. 20, Hop Exchange, Southwark-street, he can see copies of all the works in print on the subject.—W. L.

[2382.]—STARTING VALVE.—I think the following form of starting valve will suit "A. W. T." It was designed by myself some time ago. It combines a reversing apparatus and starting valve in one. When the slide A is in the position shown in the engraving, the steam flows from the steam-pipe, through the hole in the slide, and through the hole B in the block to the cylinder. Now if the slide be brought forward so that the other hole in it is opposite the hole C, the engine will be reversed. But if the slide is put in the middle the steam will be shut off. D is a plan of the face of slide, next the steam-pipe. I have made two holes in it, so that it shall not have to slide far either way, and consequently take up less room. If "A. W. T." adopts this plan, I should like to know if he makes it answer.—W. H. THORPE, Reading.



[2480.]—FROM MR. G. BATES.—It would hardly become me, as Messrs. Hopkinson and Co's agent, to answer your Leamside correspondent's questions in the manner suggested by him. The best answer I can give is, that several of the valves are now in working operation at Leamside, which place I pass through weekly, and if he will be good enough to send me his address I shall be glad to explain the working of the valve personally to him, and also fix him one on approval free of cost, which is our usual way of doing business.—GEORGE BATES, Engineer, Eastbourne, Darlington.

[2435.]—PROJECTION.—Proceed as in No. 2376, up to finding the line *a* N; then on any line take *m k* and *n k*, equal to A N and *a* M, and draw *k l* perpendicular to *m k* and equal to *a a′*; join *m l* and *n l*, and set off *l o*, *p l*, and *a′ e′*, equal to 1, the side of the cube. Draw *o q* and *p r* parallel to *l k*, and set off *b a* = *q k* and *d a* equal to *v k*; then a projector from *e′* will mark off *a e* on the plan, and projectors from *c* and *d* on the plan, will mark off *c′* and *d′* on the elevation. A few parallel lines will then, in the usual manner, complete the plan and elevation of the cube. I have given this solution and that to No. 2376, because it contains all the lines of construction necessary, and they are simpler, and I have always found them more readily understood than the more general form given by "Bernardin;" indeed I believe these are about the shortest and simplest solutions that can be given to these problems.—T. BROWN.

[2442.]—MOUNTING LARGE CYLINDER.—Mr. Woodleigh can mount his electrical cylinder in the following manner. The caps should be made of metal, as they are neater and stronger than wood, and they should fit *over* the necks of the cylinder, which should be slightly roughened with an old file and a little emery and water. The caps should fit loosely, and the easiest way to make them is out of brass tube, with the axis soldered into it. The cement which I have found to answer best for fixing the caps on to a cylinder is made of a mixture of about 1lb. of resin, 3oz. beeswax, and a small quantity of red ochre.—HENRY CHAPMAN.

[2442.]—MOUNTING LARGE CYLINDERS.—Cylinders for electrical machines are generally mounted on wood axles, never metal ones, and as the hole in the centre is generally truer than the rim round the same, the wooden axis is inserted in the hole, and secured by an electrical cement, made of 4 parts rosin, 4 parts beeswax, and 1 part red ochre, all melted together and applied hot. Care must be taken that the mixture is not so hot as to crack the cylinder, and for this purpose it would be as well to warm the latter before applying the former.—T. S. CONISBEE.

[2446.]—MEAT PRESERVING.—The simplest way of preserving meat in tins for a long voyage, consists in placing the required commodity in a tin case, soldering on the lid, leaving merely a small orifice unsoldered. When a sufficient number of tins have been thus prepared (a small quantity of water is sometimes added), they are placed in a tray or vessel, containg water which is gradually raised to a temperature of 212°, which converts all, or I should say, a portion of the water into steam, which displaces the air previously contained in the case and in the pores of the meat; when this is done, the hole is closed with solder, and the meat will keep for a very lengthened period.—T. S. CONISBEE.

[2450.]—FASTENING PIN TO BROOCH.—I find that shellac answers very well. The way that I fasten pins on brooches is to melt the shellac on the brooch with a small rod of iron made red-hot, then heat the pin in the flame of a candle or gas-light, then stick the pin when hot in the melted shellac on the brooch. Care to be taken not to handle it until the shellac sets.—J. O.

[2451.]—DIAMETERS.—TO "AMATEUR."—'Amateur" is not right in the way in which he set about finding the size of the sun. The proper way would be to estimate its size as seen by the naked eye, and then to multiply it by the power he has applied. Say the sun appears as 1ft. in diameter to the naked eye, then with a power of 60 it will appear to be 60ft. in diameter.—SCORPIO.

[2465.]—COIL.—"Induction" asks, is an inch spark from a coil containing 2lb. of wire as much as he can expect? This is not near a proportionate result; he ought to get about double that length, and as the faults of coils generally lie in the bad insulation of the secondary, I should advise him instead of adding more wire, to make perfect what he has done by winding the wire again, and taking greater care with the insulation. In such a coil the wire ought not to be brought nearer the vulcanite ends than ¾in. Also the farther he works out from the centre the more insulating material he must use between each layer of wire. He can overcome the second grievance by using a solution of bichromate of potash as a substitute for his enemy, filling both the porous and earthenware pots with it, thus converting a Grove's into a bichromate battery; it will not be quite so energetic in action, but at the same time there will not be the least smell.—A. E. TUCKER.

[2465.]—COIL—The length of primary coil—viz., two layers No. 16, is rather vague, as given by "Induction," as he does not give either the length or the diameter. If the primary wire bears the proper proportion to the secondary coil, he ought to obtain at least a 2in. spark, or supposing a slight fault to have been made in the insulation of two or three of the layers, 1½in. It is a point often lost sight of in making coils, that their action (as their name denotes) depends on the principle of induction, and when this is taken into account, it is evident that the ultimate result of the secondary coil must be in exact ratio to the cause, —*i.e.*, the primary coil and core. If the proportions are right, I do not think it would be of the slightest use to add more wire, but I should be better able to judge if I had the length of the primary wire given. I have recently been favoured by M. Faurr, with one of his newly invented batteries, which I hear has been tested in competition with one of Groves's. In the former case, the galvanometer needle was deflected 39°, and in the latter 40°, while the permanency was in favour of the former by some hours. Its construction is as follows:—In place of a platinum plate, we have a vessel made like an ordinary ginger beer bottle, but instead of earthenware, it is made of some plumbago composition, this is filled with nitric acid, and the mouth is stopped with a carbon plug, into which is screwed a binding screw of ordinary construction; the bottle is placed inside a zinc plate, bent to encircle it, and the whole is placed in an ordinary round battery jar. The fluid used in the outer cell is common salt and water. In use, this battery gives off little if any fumes, is cheap to work, and may be obtained at Elliott, Brothers, Charing-cross. I do not find the fumes from Groves' battery at all inconvenient, as it can generally be easily placed outside a window, and the connecting wires covered with gutta percha, carried through a small crack left between it and the sill into the room to the coil. The bichromate battery gives a very powerful current, no fumes, and lasts a very short time. It is practically useless, at least I have found it so, for lectures, or where it is required for any lengthened period.—T. S. CONISBEE.

[2466.]—SHEATHING IRON SHIPS WITH COPPER.—I think our friend, "The Harmonious Blacksmith," is misinformed about the Admiralty having adopted permanently, any plan of sheathing iron ships with wood, and afterwards coppering or zincing them. Many patents have been taken out with this view, but, so far, none have come into use, from the difficulty of making complete adherence, also perfect insulation, and cost of working. Muntz's Metal Company brought before the Society of Civil Engineers, in June 1863, the following plan—viz., a large number of holes, of small diameter, are drilled in the plates of the ship's sides, a sheet of india-rubber is then so applied, that it not only covers the holes, but completely fills them up, the sheathing is then applied and fixed with suitable nails, ebonised. The cost of working the above would be a bar to its general adoption. Another patent leaves out bolts at certain distances, to be afterwards filled up with the bolts fastening the wooden sheathing; here the difficulty, as in many others, is so to cover the heads of the iron bolts with some composition as to prevent galvanic action. Zinc sheathing is not a good detergent from fouling, and was introduced some years since to cover the bottom of colonial built vessels, iron fastened; were it efficacious in preventing fouling, it would be easy to galvanise the iron of vessels; but galvanised iron rapidly fouls, and vessels using it require constant clearing. Copper and Muntz metal seem to be the only preventives so far known, and many compositions having copper, &c. for their base, have been tried with varying success; the latest, and I believe the most successful is a thick coating of some adhesive material, painted on hot, and copper in minute particles, dredged on and rolled to make a smooth surface. Arsenious acid has also been tried, but it soon destroys the plates; so does the red lead paints, and so far the right thing has yet to be discovered. Several patents have also been advertised to clean the bottoms of vessels by brushes, &c., while afloat, but the tenacious adherence of barnacles, seaweed, and slime, renders all such efforts futile.—PATIENCE AND PERSEVERANCE.

[2471.]—SUMMER BEVERAGE.—LEMONADE.—Pour one pint of boiling water on 1½lb. loaf sugar, ½oz. citric acid, two pennyworth essence of lemon, dissolve the acid in a little of the liquor in a teacup, drop the essence of lemon on a piece or two of the loaf sugar, and drop them in the liquor, stir it well; when all dissolved, strain through a piece of muslin or a wire strainer into a decanter; it will keep for a long time; mix it as you would grog. If a little more water is used it will not matter; it will not be quite so strong. Tried and approved. Some think a dash of wine or brandy is an improvement.—GROCER.

[2474.]—APPOLD PUMP.—The makers publish the sizes of the pumps, and the particulars of the quantity of water thrown; sizes of pipes required, &c., but they do not give the number of revolutions the pump requires to make, which I believe they keep to themselves, for what reason I do not know; I have adduced the following formula from experience. For instance: class 1, 6″ diameter, class 2, 8″ dia., class 3, 12″ diameter, and so on:

R = revolutions of pump
D = dia. of pump in feet
H = head of water in feet

Hence

$$R = \frac{550 + (500 \sqrt{H})}{D \; 3{\cdot}1416}.$$

The useful effect is said to average about 70 per cent. Molesworth's formula is very incomplete, and requires the divisional number as above to suit the different sizes or diameters of the pumps.—SENEX.

[2479.]—MUSIC.—"Clerk" having engraved music plates, had better send them to some litho music printer, who would transfer copy of same on to stone. This process is much cheaper than printing from the plate, and far better in appearance.—ZETUS.

[2482.]—FUEL FOR PORTABLE ENGINE.—I have never found that coke of ordinary quality injured the fire-box of a portable engine more than coal, in fact, from the relative cheapness of the two fuels, coke is more economical, even supposing that the fire-box were more rapidly deteriorated by its use. "Subscriber" will, however, find his tubes require cleaning out more frequently when using coke, owing to the quantity of fine dust caused by its combustion. With the worst samples of coke (those containing the most sulphur), the wear and tear is very slight indeed, and the difference between coal and coke would be so small, as hardly to admit of being described as a percentage.—T. S. CONISBEE.

[2485.]—GALVANIC ENGINE.—I beg to inform "Old Salt" that the electro magnetic engine which he wishes for information about was invented by Professor Jacobi, of St. Petersburg. That engine is said to have propelled a boat carrying 12 persons against the stream on the river Neva. The construction was as follows:—There were 8 electro magnets fixed on to 2 discs of wood; the one disc stationary, and the other movable. The faces of the poles of the magnets were made to pass almost, but not quite, in contact with each other. The commutators of the engine were so arranged that as the moveable disc revolved, and its magnets were approaching those on the fixed discs, the poles were of the opposite kind, therefore they were attracted towards each other; but as soon as the momentum of the machine had carried it so far that the centres of the magnets had passed each other, the current was changed, so that the poles became of the same kind; and therefore they repelled each other, and thus rotation was produced. I never saw a detailed account of the above invention, and this account which I send is mainly taken from Lardner's "Electricity and Magnetism." My own opinion is that in such an engine, there would be very little power, as of course you only get the effect of the lateral pull of the magnet. I have had some experience in electro magnetic engines, and the more I know of the matter, the less probability I see of any practicable application of electro motive power as a substitute for steam.—HENRY CHAPMAN.

[2497.]—FROM "A THINKER."—In answer to "Constant Subscriber," the width of frame at seat is 20in., the width between the centres of tiers of grinding wheels, 2ft. 7½in.; length of cranks, 7½in.; distance of bar (on which the front levers work) from the seat, 16in.; height of said bar from the ground, 2ft.; length of levers below fulcrum to centre of working joint, 18½in.; length above fulcrum, 22in.; length of connecting rods from centre to centre, 3ft. 9in.; distance between centres of levers, 13in.; distance of axle of driving wheel from axle of guiding ditto, 2ft. 5in.; height of top of seat board, above axle of guiding wheels, 9½in.; a vertical line from front edge of seat board would be 2½in. from axle of guiding wheels; the lower board 1½in. less; the box lid slopes and turns downwards; extreme width of seat board, 19in.; extreme breadth of ditto, 11½in.; foot treadle from fulcrum of levers, 16in.; length of guiding levers, 2ft.; distance of their connecting rods from fulcrum, 7in. The connecting rods run in an horizontal line from the axle, and their working joints are rather large, so as to give some play room when in use; the guiding levers are enclosed at each end of the lower board, in a light iron rail to support them; the above dimensions are for an average-sized man. The form and composition of the frame may be judged objectionable, but with the addition of only about 5lb. to the weight, I have at once firmness and steadiness, also durability and lightness in appearance.—A THINKER.

[2499.]—APPARENT ANOMALY.—My inquiring friend is quite correct in stating that the avoirdupois weight contains 7000 grains troy, but the 24 grains to the dwt. does not belong to avoirdupois, but to troy weight, which contains 5760 grains, the ounce troy being quite different to the ounce avoirdupois.—H. STEPHENSON.

[2505.]—WEIGHT OF WATER.—A cubic foot of rain water, when the barometer stands at 29·5 metres, weighs 1000oz., or 62·5lb. Sea water = 64·14lb.—SENEX.

09.]—PUMPS.—You cannot raise 4000 gallons of er (or 64 cubic feet per minute) with a fall of er 8ft., and only 60 gallons per minute (or 8 cubic t). The ram would be quite inadequate.—SENEX.

[2510.]—PEPPER MOTH.—The caterpillar of *A. Betularia* is ground colour various from almost putty colour, some with green tinge and some tinge of red brown. On each side of 5th, 6th, 7th, 8th, 10th, and 11th segment is a reddish-raised spot, and there are two such spots on back of 9th and 12th segments. It feeds in August on acacia, lime-birch, oak, and many other trees. It turns to a chrysalis in the ground in September, the moth comes out in May; not common. The above is taken from Newman's "Illustrated History of British Moths." £1. The best work I ever saw.—A. NIOBE.

[2519.]—VULCANISING INDIA RUBBER.—The apparatus used by dentists will do for vulcanising of any kind. The smaller the proportions of sulphur in the rubber, and the lower the temperature used, the softer and more elastic will be the india rubber. About 10 or 15 per cent. of sulphur, and a temperature of 270° or 275° for 4 hours, will make an elastic rubber. 30 per cent. of sulphur and a temperature of 315° for 2 hours will make a hard vulcanite like ivory.—A DENTIST.

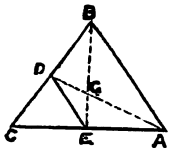
[252[illegible]]—WATERPROOFING PAPER.—To waterproof packing paper, dissolve 1lb. of white soap in 1 quart of water. In another quart of water [illegible] 1 ounce of gum nitric, and 6 ounces of glue; [illegible] two solutions, heat them and soak the paper [illegible] liquid then hang it up to dry. From "The Best of [illegible]ything."—BUSY BEE.

[illegible]—CURIOUS AFFECTION OF THE TEETH.—[illegible] is only a deposit of tartar from want of cleaning. [illegible] is on the teeth at present must be carefully chipped off with a fine thin-edged instrument, but at an angle near the joint to enable it to be got into any crevice with ease, and the teeth must be kept clean afterwards with a strong rough tooth brush and camphorated chalk and water. If the tartar is chipped clean away and the teeth kept clean the gum will grow up again in a week or two.—A DENTIST.

[2524.]—LONGITUDE.—Difference in time between Belfast and Glasgow, 6 min. 40 sec.—D. B.

[2526.]—SUBMARINE LAMP.—No lamp could be "fed" with air by a single tube. Every miner knows that to obtain a proper supply, a current must be established by means of a "down cast" and "up cast" shaft. This could be effected without much difficulty in the case of Mr. W. A. Hackett's lamp, which may be taken to represent a mine on a small scale. But common india-rubber tubing will not do, as it would be throttled by the pressure of the water. "H" must get some tubing kept disturbed by a coil of wire inside, such as the divers use. This is enough on the general question; but if Mr. Hackett has any practical object in view, I shall be happy to supply him with further details.—THICLORIUS.

[2534.]—SOLUTION WANTED.—If "Minnehaha" will draw the figure of his problem, using the same letters as in his query, and join D E, he will find that, since A C = 2 E C, and B C = 2 C D, and the angle A C B is common to the two triangles A B C, D C E, A B = 2 E D, and the angles C E D, C D E = C A B, C B A, respectively; therefore D E is parallel to A B; therefore the angles B E D, A D E = A B E, B A D respectively; therefore the triangles A B G D G E are similar; and A G : D G :: A B : D E :: 2 : 1 so that A G = 2 D G.—HUGO.



[2534.]—SOLUTION WANTED.—Join D with E, then by similar triangles A B G and E D G we have

$$AG : DG = AB : DE = AC : CE = 2 : 1$$

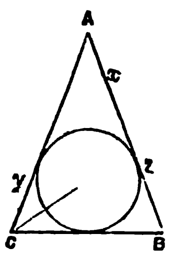
(by construction) therefore

$$AG = 2DG.$$

G is the centre of gravity of the plane A B C.

A. TOLHAUSEN.

[2534.]—SOLUTION WANTED.—The straight lines A D, B E bisecting the sides of B C, A C of a triangle,



intersect at G: show that A G is double of G D—making figure. I have

triangle C D E sim. to C B A (Euc. vi. 6)

$$\therefore AB = 2DE$$

triangle D G E sim. to B G A (Euc. vi. 4)

$$\therefore AG = 2GD.$$

FRANCK.

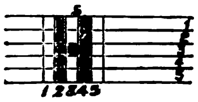
[2535.]—COIN.—Is a coin of Christina, Queen of Sweden, struck, I think, for the province of Dalekarlen: DAL. . . . .—BERNARDIN.

[2539.]—OKE.—A Turkish oke is as nearly as possible equal to 2lb. 12oz. avoirdupois. A kilogramme is about 1⅜lb., so there is not much difference.—EDARDUM A.

[2539.]—OKE.—A Turkish oke = 1278·48 grammes = 2,8286lb. avoirdupois. Local okes vary sometimes.—BERNARDIN.

[2541.]—GALVANIC BATTERIES.—Mr. V. M. Beechey asks for information on the above subject, and suggests that we (your readers) should bring our "bricks," and I therefore venture to contribute mine. I have always considered the study of galvanic batteries, with a view to economy and constancy, together with intensity, as most interesting and most important to science in many directions, and I shall endeavour to describe (briefly) those batteries which I consider the most useful. They will be mentioned under two heads, first, single fluid batteries, and second, double fluid ones; amongst the first there are Cruikshank's, which consists of plates of copper and zinc, cemented into a wooden trough and excited by a weak solution of sulphuric acid and water. This battery, although a most important improvement at the time it was invented, is now entirely superseded. Smee's battery is a very useful arrangement for experimental use if it is not wanted to be very constant, or to be kept in action for a long time. The construction of it is as follows: There is an earthenware vessel to contain the exciting solution, which consists of one part sulphuric acid to about 7 of water. The negative plate is made of platinised silver, and that is held in a wooden or gutta percha frame between the two positive plates, which are made of zinc. By far the most powerful battery that I have seen or used is one invented about 1852 by Mr. Martyn, J. Roberts, both as regards constancy, intensity, and quantity. It consists of an earthenware pot to hold the exciting solution, undiluted nitrous acid, the positive plate is made out of pure tin, and it is placed between the two negative plates, which are made of pure platinum. I have used a battery of that kind continually for many consecutive hours, for the electric light, without being able to detect the slightest variation in the current. The disadvantages are the cost of construction and working, and the large quantity of fumes evolved from the nitrous acid. There are several other kinds of single fluid batteries, but those I have mentioned I think are the most important of them, and I now pass on to the double fluid kind. Daniel's constant battery consists of a copper vessel, which at one and the same time holds one of the fluids (a saturated solution of sulphate of copper), and forms the negative plate. Within the copper vessel is placed the porous cell, and in that is placed the positive plate, made of a thick rod of zinc, and the other fluid, 1 of sulphuric acid to 6 of water. This battery is a very convenient one from the constancy of its action and the absence of fumes. The Maynooth battery, invented by Professor Callan, is a very powerful, but a very unpleasant one to work with, on account of the nitrous fumes given off from it. It is arranged as follows:—There is an outer vessel made of cast iron, which forms the negative plate, and holds the one fluid (undiluted nitrous acid), in other respects the arrangement is the same as the preceding one. Groves's battery is one of the most useful, I think the most. It is made as follows:—An outer cell of earthenware and an inner porous cell; the negative plate is made of platinum, and the two positives are zinc, the fluids used are, for the negative plate in the porous cell pure nitric acid, although I think nitro-sulphuric is better. The fluid for the positive plate is 1 of sulphuric acid to 6 or 7 of water. Bunsen's battery is similar to Groves's, excepting that the negative plate is made of carbon cut from the graphite deposited in gas retorts. Some years since (with a view to economy) I tried aluminium instead of platinum for a negative plate, but although I got a fair current from it, I did not consider it at all equal to Groves's, and one thing fatal to it was that the aluminium was slowly dissolved by the nitric acid, and I therefore discontinued to use it. In all the above arrangements the zinc is amalgamated with mercury.—HENRY CHAPMAN.

[2547.]—PRINTING NAMES ON PLANS.—A very pretty and easy method of printing the names on plans, &c., is by drawing out a square according to size of type required, and dividing it in to 25 equal squares, as figure shows, representing the so-called Block-printing. If "Land Surveyor" will try he will not find much difficulty to contend against.—A. TOLHAUSEN.



[2549.]—SCREW STEAMER.—I consider that an engine of one horse power would be ample for such a boat as Mr. Douglass M'Carthy mentions, but a vertical direct acting engine would be better than a horizontal one.—HENRY CHAPMAN.

[2555.]—ECHO.—An Ayrshire amateur can produce an echo on the cornet by simply putting a silk handkerchief up the bell, but it is usually done by putting a mute (to be had at any music warehouse) into the bell. Some cornets have a special arrangement for producing the above effect.—HENRY CHAPMAN.

[2557.]—COPPER COIN.—A German counter, I believe, I have several varieties of it, all thin and with badly engraved inscriptions. No value.—BERNARDIN.

[2561.]—BOOKS.—The following dimensions are, I believe, correct:—Imperial 8vo., 11 by 7½; super, royal 8vo., 10¼ by 6⅞; royal 8vo., 10 by 6¼; demy 8vo. 8¾ by 5⅝; post 8vo., 7½ by 2; crown 8vo., 7½ by 5; demy 12mo., 7½ by 4⅛; royal 18mo., 6½ by 4¼; foolscap 8vo., 6¾ by 4¼; imperial 32mo., 5¼ by 3⅞; demy 18mo., 5¾ by 3¾; foolscap, 12mo., 5½ by 3¼; royal 32mo., 5 by 3⅛ demy 32mo., 4⅝ by 2⅞; demy 48mo., 3⅝ by 2⅝in.; edges uncut.—BUSY BEE.

[2561.]—SIZES OF BOOKS.—It is almost impossible to give "F. F." the exact sizes of books, because papers are not made "true;" but I will endeavour to explain the matter to him. When a book is described as being crown 8vo, or fcap 8vo, it is meant that the "sheet" is folded so as to print, on the two sides, 16 pages. In the same way 12mo means that the sheet is so folded as to contain 12 pages on each side, *i.e.*, 24 pages. 18mo would therefore be 36 pages to the sheet; 32mo. 64 pages. When no description of the paper is given, demy is usually the size meant; but in this particular the wording of advertisements is very arbitrary. The size of the last volume of "our" MECHANIC was demy 4to, though to suit the exigencies of printing the 32 pages were printed on one sheet, equal to four sheets of demy. As "F. F." is doubtless aware, there are various names given to different sized sheets of paper, the dimensions of which I give, and he has merely to fold a sheet to take in either 8, 16, 24, 32, 36, or 64 pages to get at the measurement of any sized book he is likely to meet in the ordinary course of life. If I had a rule and the books handy I would give the dimensions he asks for; but I think I have made it sufficiently plain. A slight reduction should of course be made for "trimming" edges, but that again is compensated for by the covers of the book. Sizes of sheets of paper:—Imperial, 30 by 22; super-royal, 28 by 20; royal, 24½ by 19¼; medium, 33, by 18; demy, 22 by 17½; large post, 21 by 16; post, 19 by 15; foolscap, 17 by 13½in. With these dimensions given it will be easy to fold up a sheet to any required size of page and the measurement will then be plain enough. But if "F. F." cannot understand, and will let me know, I will "try again."—SAUL RYMEA.

[2563.]—SMALL COPPER COIN.—The great scarcity of halfpennies and farthings, coined by government, led to the issue, about 1648, of the small copper and brass pieces called "tradesmen's tokens." They were struck, as their name indicates, by private tradesmen, for the use of their customers; and also, but more rarely, for the use of a whole village, borough, town, or city. These latter were usually called "town pieces," and your correspondent's coin is one of them. It is engraved in Snelling's "Copper Coinage," plate 1, No. 32, and is most likely a halfpenny struck by the corporation of Dover.—HENRY W. HENFREY, M.N.S., &c., &c., Markham-house, Brighton.

[2563.]—SMALL COPPER COIN.—This copper coin was probably issued by the town authorities of Dover, such coins, or tokens as they are more correctly termed, being very numerous at that period. The design on the rev. is described by Boyne in his list of the 17th century tokens, p. 130, No. 160, "St. Martin on horseback, dividing his cloak with a beggar, who is following him." To which is appended the following note:—St. Martin in Roman Catholic times was patron, Saints of Dover, and the Church of St. Martin-le-Grand the mother-church. Amongst its other privileges was that of beginning service before all the other churches and chapels in the district. The church was destroyed at the time of the Reformation, Dover Fair is still called St. Martin's Fair. The same device is on the tokens on the Borough Counter-seal which dates as far back as the year 1305. This has been described by Browne Willis as "a highwayman robbing a man on foot."—D. T. BATTY.

[2564.]—LEADEN COIN.—Is *probably* a token of the time of Elizabeth. I possess similar ones *reputed* to be of that period, but cannot bring any authority to bear. I shall be equally obliged with "Old Coin" for any *authoritative* information upon it.—D. T. BATTY, 9, Fennell-street, Manchester.

[2566.]—TOOTH-POWDER.—Camphorated chalk is very good, and economical as well. The following is also recommended:—Orris root, ½ ounce; gum myrrh, ½ ounce; nutmeg, finely powdered, 1 scruple; chalk 1 ounce; mix. Proved.—BUSY BEE.

[2566.]—TOOTH POWDER.—Prepared chalk ¼lb., camphor 1dr. The camphor must be finely powdered by moistening it with a little spirits of wine, and then intimately mixed with the chalk. Extracted.—MINNEHAHA.

[2577.]—BORING GLASS.—"C. H." can bore a hole in his glass sheet, in the following way: Let him mark or scratch a ring, of the size and in the place required on each side of the sheet. These rings will, of course, exactly correspond. Then let him mark out a series of points pretty near each other, round the circumference of the rings, taking care that these points shall also, in every respect, exactly correspond with each other. He should then fix uprightly in a vice a smooth pointed steel punch, and arming himself with a similar punch and small hammer, get some assistant to hold the glass sheet horizontally with one of the circumferential points, steadily resting upon the upright punch. Applying his own punch to the same point on the upper surface of the glass, and using gentle blows of the hammer, he will soon work his way down through the sheet, until the two punches meet, leaving a small perforation without causing the slightest "star" (unless he is clumsy). Repeating the process at other points, all round the circle, he will find at last that the included disc can be readily knocked out by a slight tap, leaving the required hole; where rough edge, can be smoothed off by a file.—MECHANICUS.

FILES SHARPENED BY GALVANIC CURRENT.—A very interesting and economical process for re-sharpening files has been exhibited before the Société d' Encouragement of Paris by M. Werdermann. Well-worn files are first carefully cleaned by means of hot water and soda; they are then placed in connection with the positive pole of a battery, in a bath composed of 40 parts of sulphuric acid, 80 parts of nitric acid, and 1000 parts of water. The negative pole is formed of a copper spiral surrounding the files, but not touching them; the coil terminates in a wire which rises towards the surface. This arrangement is the result of practical experience. When the files have been ten minutes in the bath they are taken out, washed, and dried, when the whole of the hollows will be found to have been attacked in a very sensible manner; but should the effect not be sufficient, they are replaced for the same period as before.

RESTORING LIFE.—In consequence of the experiments of M. Labordette, the National Lifeboat Institution has decided on omitting from its new instructions the statement that among the appearances which generally accompany death the "jaws are clenched and the fingers semi-contracted." Dr. Labordette's experiments on animals, have clearly proved that in nine of twelve cases, after clenching of the jaws, &c., had been observed, life had been restored; and has given several instances of human beings having been resuscitated under similar circumstances. He has also in the strongest manner expressed his opinion, founded on these facts, that the clenching of the jaws and contraction of the fingers, after short immersion, indicated remaining vitality, and that the same should encourage perseverance in the efforts to restore life.

NOTES AND QUERIES.

◆

[2580.]—LARGE TELESCOPES.—I would ask some correspondent who can give a reply, if he knows where it is possible for a working man like myself, who cannot afford to purchase a large telescope, to obtain the privilege of occasionally looking at some of the wonders of the heavens with a powerful instrument. I have a small, but beautiful defining telescope, of 1⅝in. aperture, which will divide double stars as close as 3½"; for instance, κ and ξ Boötis, ζ Aquarii, ε Pegasi, but when I read the accounts of astronomers, and what they have seen with their gigantic telescapes, I long to see some of the wonders they describe. Some years ago, I believe, Mr. Slater, the optician, used to exhibit a large Equatoreal at his house in the Euston-road, but it has now disappeared. Two or three street telescopes, of 4in. or 5in. aperture, I have looked through, but not one of them was of any account?—G. F.

[2581.]—GUTTA PERCHA SHOES.—Will some of the obliging correspondents of our journal, favour me with information on the following queries? 1. Are gutta percha shoes injurious for the eyesight, if so, why? 2. Which way shall I proceed to re-sole an old pair of gutta percha shoes? If possible, state price of the material (gutta percha), and how sold?—D. E. WILLIAMS.

[2582.]—WEIGHT OF FRUSTRUM, &c.—A frustrum of an iron cone has a height of 12ft., the diameter at the smaller end is 2ft., and at the larger end 4ft. A cubic foot of iron = 440lb.; what will the weight of the frustrum be, and supposing that 4 tons weight be cut off the lesser end of the frustrum, what will be the diameter at the plane of section, and the height of the frustrum left?—O. H. S.

[2583.]—THE "ENGLISH" VELOCIPEDE.—Will "A Thinker" oblige me with a further description of the steerage of the "English" velocipede, (a description of which occurs in the ENGLISH MECHANIC of April 8th), as I think of making one on his principle, but cannot quite understand how he guides it, whether from the front or hind wheels? Likewise, will some reader inform me if it is best, previous to driving in the spokes, to soak the wooden nave of a wheel in hot water, or not?—C. T. W.

[2584.]—SULPHATE OF LEAD BATTERY.—I should feel obliged if "A Good Boy" will send full directions for charging the battery, also if the zinc should be amalgamated, and how much lead should be put into a 6n. porous pot; by so doing, he will much oblige, as I have the materials ready, according to directions given in Query 2184?—CARFAX.

[2585.]—FLOCK PAPERHANGINGS.—I should be obliged by any one practically acquainted with the manufacture of paperhangings, to inform me how "flock" paper is made; also, if the gold patterns on same are printed on the paper *before* or *after* the flock is laid on? Information in detail is sought.—ZETUS.

[2586.]—WHEEL MAKING.—Will some brother mechanic give me information relative to the best kind of machinery for forming carriage or cart wheel spokes, and any other part of wheels?—INQUIRER.

[2587.]—CHINA GRASS.—Can any of my fellow subscribers inform me where I can get a small quantity of China grass?—C. KATKA.

[2588.]—EQUATOREAL MOUNTING.—I should feel obliged if "Hyperion" would answer my query respecting his mounting, No. 1792, in No. 256, Vol. X.—NEPTUNE, No. 1.

[2589.]—RAISING WATER.—With respect to my former query, respecting raising water, as "Machinator" did not seem to understand me, I will try to explain myself more fully. I do not want the water raised to the dam above, as he seems to think, but to supply a cistern with fresh water. It is not needful to be a continuous stream. I want it from a mill tail, so as not in any way to interfere with the working of the water-wheel. It will require to be raised 8 or 10ft. high, but no particular quantity.—NEPTUNE, No. 1.

[2590.]—BOOKS WANTED.—Can any of my fellow-readers tell me the names and prices of any works now published, on the construction and details of small engines, from 1 to 3 horse power, either vertical or horizontal?—E. B.

[2591.]—FLYING MACHINE.—I wish to make a model of a flying machine; could some kind brother reader give me the following information? How much gas in a bladder would it require to raise 3oz.? What kind of bladder would be the best to contain the gas, also size of same, and also what kind of gas? Would the common coal gas do?—CASUAL OBSERVER.

[2592.]—DEW-CAPS TO TELESCOPES.—Would Mr. Blacklock or Mr. Purkiss, be so kind as to say whether it is necessary to use a dew-cap with a reflecting telescope (aperture 6in.), in order to prevent the condensation of moisture on the plane mirror; if so, what length should it be, or if there be any other method of protecting the plane?—HUGO.

[2593.]—DEFECTIVE BATTERY.—For a number of years I have been unable to labour through ill health. For several months I have been using one of Smee's electric machines, and feel slightly better. It went well for a time, but of late has been going very feebly, the vibrating often stopping. Occasionally it would go a few minutes or seconds, if the finger were gently pressed on the screw above the vibrator. Recently, when trying to discover what was wrong with it, two of the zinc plates got loose when in the acid, and in trying to tighten the screw, the silver plate bent and touched one of the former, producing a hissing sound, whitening and thickening the acid. I removed it as quickly as possible, and straightened and fastened it properly. Since then I can get no vibratory action, whether from the above cause or not, I cannot say. The zinc plates were amalgamated immediately before it stopped. I put in fresh acid (1 to 8 of water), but this brought no improvement. Perhaps the silver plates require platinising. May I ask if they are done with the same material (mercury), and in the same way, as the zinc plates? I would be truly obliged to any reader of the MECHANIC, who may have the knowledge and experience, for any hints which would enable me to get the machine into working order?—G. F. L.

[2594.]—BORING WOODEN HANDLES IN LATHE.—Will some reader tell me how to bore wooden handles in the lathe, after they are turned ready for driving the tool in. There was a query on this subject December 17th, but I have seen no answer. Perhaps "J. K. P." will oblige by recommending a method of doing it?—A. B.

[2595.]—PROJECTION.—TO "BERNARDIN."—Your able reply on this subject on page 93, induces me to ask if you would inform me of any work that explains the whole subject thoroughly. I have gone nearly through Davidson's book in Cassell's series, but there is evidently much beyond what that book teaches?—J. H. YEWDALL.

[2596.]—BUSY BEE.—Could some of my fellow subscribers kindly reply to a few queries contained in the last dozen back numbers, bearing the above signature? One answer to 12 or 14 queries!—BUSY BEE.

[2597.]—BEESWAX.—I shall feel much obliged if some contributor will kindly give a recipe for making beeswax, common, only sold in th oil and colour shops, the principal ingredient of which is yellow resin, or could any one name a book, where I could find a recipe for making it?—HOMO.

[2598.]—ELECTRIC.—Will "Sigma," or some other electrical correspondent, kindly state if a Leyden jar may be charged by a glass tube, excited by being rubbed with flannel, sufficiently to give shocks, &c., and if so, what ought to be the length and diameter of the tube?—SLASHER.

[2599.]—HANDRAILING.—Can any brother reader inform me of a cheap work on handrailing and staircasing, or whether there is an American work out, and the price of it?—PATELEY BRIDGE.

[2600.]—CLEANING OF DIATOMS.—Will any of your readers have the kindness to give a little information how to overcome the following difficulty? I have tried two or three times to prepare diatoms for the microscope, but with only partial success—not those found in guano and other earths, but the living diatoms. I can succeed, by the aid of muriatic and nitric acids, in getting the diatoms quite clean, and to show the markings very well; but I cannot get rid of a fine filamentous sort of network, which appears to be some sort of vegetable remains. I have boiled them in nitric acid till the diatoms have been injured or destroyed, but the result has been the same. I should feel truly obliged to any one who will tell me how to vanquish this enemy to a neat and perfect slide. I have read several books on the subject, but can get no information on this particular point. What I now seek for is, some brother reader's practical experience.—BEATEN.

[2601.]—VENUS.—On the 1st of November, 1871, Venus will be at her greatest brilliancy; will "Omicron," or some other clever astronomer, please to show how the computation is to be made, according to the formula given at page 509, Vol. X., viz.:—

$$\frac{(r + \Delta + R)(r + \Delta - R)}{r^3 \Delta^3}$$

Where

R = radius vector of the earth = ·9919, its log. = 9·9965.

Δ = log. dist. of Venus from the earth = 9·6234.

r = radius vector of Venus = ·7215, its log. 9·8583.

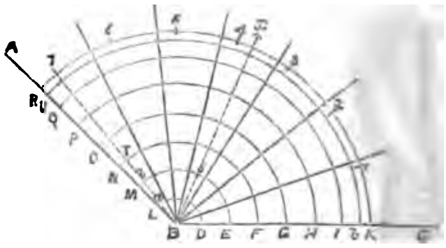
G. FIRTH.

[2602.]—LOSS OF TASTE.—Can any reader inform me of a preparation, medical or other, for restoring smell and taste, lost for some months, from a bad cold?—W. P.

[2603.]—BOOK WANTED.—I am in want of a practical work upon the duties of a rail mill manager, with instructions as to the various calculations which enter into that business. If such a work is in existance, will some fellow subscriber give publisher's name and address, and title of book?—J. JONES.

[2604.]—PROBLEM.—I beg to thank Mr. Tolhausen and Mr. Biggs for their replies to my query (2180), in last week's and this week's MECHANIC. Would some of your mathematical correspondents kindly give me a few hints as to the solution of the following, which I extract from the Science and Art Department Examination papers a year or two ago? "Two points are 2 and 2·5in. from the centre of a circle of 1in. radius, and 3in. from each other. Draw the circle which, passing through these two points, shall touch the given circle."—Y. P. W.

[2605.]—TRISECTION OF AN ANGLE.—I have tried the method recommended by "Vibrator," in this week's ENGLISH MECHANIC, and have found it to act as described in the case of the obtuse angle, but in the case of the acute angle, does not the point O (page 89), fall on the outside of B A? I make it so. In that case I suppose the distance F P would be added to B D, and the arc described from B with B D + D 2 as radius. Would not the same principle apply to the division of angles into any number of equal parts, with this difference—viz., Suppose the angle A B C (page 89), to be divided into five equal parts; on B C mark off five equal distances, proceed as before; mark off the distance H L on the fifth arc, join the fifth point with B, and where this straight line cuts the arc E H (say in the point *x*), mark off E *x* from the fifth point on B C, and proceed as in the other case. Again, suppose the angle A B C is to be divided into seven equal parts; on B C mark off any seven equal distances, B D, D E ……I K, draw the arcs L D, M E, N F, O G, P H, 2 I, and R K, bisect the angle A B C by the line B X, cutting M E in S, mark off the distance S E on the arc R K from the point K—viz., the points 1, 2, 3, 4, 5, 6, and 7; join 7 B, cutting the arc N F in the point T, from the point K mark off K V, equal to N T, and from B with B V as radius, describe the arc V U, and the distance S E will divide the arc U V into seven equal parts, whence the angle A B C is divided into seven equal parts as required. On seeing the article on the "Trisection of an Angle," in this number of the MECHANIC, it struck me that by a somewhat similar method, an angle might be divided into any number of equal parts, and I have thus attempted it in the case of dividing the angle into five and seven equal parts. Perhaps some other person could say why, in



trisecting the angle, L *a* is marked off from F on B F. In dividing the angle into five equal parts, M *f* is marked off from H on B H, and in dividing the angle into seven equal parts, N T is marked off from K on B K, &c., &c., whilst the distance S E, marked on the last arc, remains the same for all divisions of the angle.—Y. P. W.

[2606.]—DAWN, &c.—What countries have the longest dawn and twilight, and why?—DAVID E. WILLIAMS.

[2607.]—HEATING GREENHOUSES.—W any reader give me some practical instructions for heating a small greenhouse, say 10 × 4? I have read all the notes recently inserted, but they do not contain anything sufficiently detailed. I want particulars of cost of the various methods. The small amount of attention requisite, economy, and durability, are essential desiderata. Does any one know anything of Messett's system? Information will be useful to many besides.—SAUL RYMEA.

[2608.]—SULPHATE OF ATROPIA.—Sometimes sulphate of atropia, however neutral, irritates the skin; could any kind brother reader tell me the reason?—OCULUS.

[2609.]—OLD COIN.—While digging in the garden a short time ago, I found an old brass coin, about the size of a halfpenny. On one side is a head and some letters; all I can make out are, VES-ASIANVS…… AVC; on the other side is represented a tree, with a human figure on each side, one in a sitting and one in a standing posture; under these are the letters S C, and round it, —VDAEA CAPTA. Will some brother reader tell me what coin it is, and if of any value?—X. L. D.

[2610.]—ANILINE DYES FOR FEATHERS.—Will some subscriber to your excellent journal, inform me of the method for obtaining the colour known as Bismarck brown, for feathers? Detailed particulars of the process, or any other useful information on the subject, will be thankfully received.—AN AMATEUR DYER.

[2611.]—RE-GILDING BANNER.—Can any of your readers inform me how to gild or re-gild a silk banner, such as used by Sunday schools in processions. I have tried by marking out the letters with gold size, and then laying on the gold leaf, but the size penetrates through the silk, and makes the other side of the banner look anything but neat. I have seen several banners, and the impression of the letters does not penetrate through the silk, so I think I must have got hold of the wrong process, although the person I got it from was a professional gilder?—INQUIRER.

[2612.]—NEWARK'S CEMENT.—Would any one be so kind as to give me some information about the above cement, used very much at New York for concrete building; how is it made (if not a secret); if it has been, or is used in this country, and how is it sold? Any information would oblige.—JOHN HUDSON, Sunderland.

[2613.]—SOCIAL SCIENCE.—Will some brother reader kindly let me know if I could procure the pamphlets which are printed after the Social Science meetings, and if so, to whom should I write? Could I become a member without being present at the meetings?—THOMAS J. O'CONNOR.

[2614.]—WRITING ON GLASS.—What acid must I use, so as to have the letters white when burned in? Perhaps "Engraver" will kindly assist.—THOMAS J. O'CONNOR.

[2615.]—BICYCLE WHEEL.—I should feel much obliged if some of your numerous correspondents would say whether if the rim were made of one piece of American elm, it would be stronger than if made in separate bits? If it would not be thought too much trouble, a drawing would be much prized.—SEMPER VIGILANS.

[2616.]—WET RAGS.—Would one of your correspondents supply me with a simple and cheap indoor method for drying wet rags, say to the extent of one ton per diem?—DRYER.

[2617.]—GLYCERINE AND OLEIC ACID.—Can any of my fellow readers tell me how glycerine and oleic acid are made?—EXPERIMENT.

[2618.]—TO "F.R.A.S."—I feel obliged to "F.R.A.S." for his answers to my inquiries. I am sorry I did not describe my telescope sufficiently; it is an 8½in. silvered glass, reflecting instrument, equatoreally mounted. I wished to know how to set it absolutely level, N *r*, S. *r*, E *r*, S, so that I should find the declination of a star right according to Mr. Webb's book, in whatever point of the heavens the instrument was pointed. It has all the motions necessary, but I do not know how to set about it, or where to begin?—H. A. C.

[2619.]—TO "TANGENT."—Will "Tangent" oblige by giving a drawing and description of Rhumkorff's double mercury contact breaker for induction coil, and also say if I can use anything better than about five layers of gutta percha tissue to insulate the layers of secondary wire, the amount about 1½lb. of No. 35. I find a difficulty in getting the tissue to lay flat and smooth; would a solution of gutta percha in bisulphide of carbon, laid on in several coats, answer as well as the tissue?—VACUUM TUBE.

[2620.]—BARTON'S BUTTONS.—Diffraction, say Sir J. Herschel's ("Familiar Lectures on Scientific Sub jects,' p. 317), is exemplefied . . . in the colours exhibited where a bright point is seen reflected on or refracted through a surface regularly striated or scratched across with fine equidistant lines, as beautifully exhibited in the so called "Barton's Buttons' (from the name of the ingenious and skilful amateur mechanist, who first executed them), brass or steel buttons delicately cross lined by engine work." Are these buttons now procurable, and where?—G. J. W.

[2621.]—"D. H. G.'S" CUTTER BAR.—In looking at "D. H. G.'s" working drawing of his cutter bar, given at page 306 of the ENGLISH MECHANIC of December 10, 1869, it struck me that the patterns given had one fault—viz., that the top of the cutting edges of the cutter, stands above the centre of flexure of the bar. Perhaps "D. H. G.," or some one of your able contributors, will kindly take the trouble, either to point out where my error lies, or should I by chance be right, to suggest a method by which the defect can be remedied, otherwise than by lengthening the already somewhat long crank, by increasing the thickness of the bar, or by altering the position of the parts in such manner, as will render it difficult to adjust the strap truly to its work?—FOREIGNER.

[2622.]—TO "F.R.A.S."—May I be allowed to ask a few questions of our learned and ever-obliging "F.R.A.S." 1. How can I, when I know the foci of the constituent lenses of a Huyghenian eye-piece, calculate the power thereof? 2. What does he consider the smallest achromatic refracting aperture with which five stars of the trapezium θ^1 Orionis can be seen? Would he think a 3in. good, that would show them? 3. Some time ago, "F.R.A.S." said, that a 2¼in. would not divorce stars less than 2″·5 apart, but according to Dallmeyer's formula (as given last week by the Rev. T. W. Webb), it should divorce a 6 mag. pair, only 1″·92 apart. Does "F.R.A.S." think that it would not do this? 4. Are the eye-pieces used in reflecting and refracting telescopes the same? 5. In viewing a star, say a 7·33in. achromatic, and power 700, would it not present a disc *larger apparently* than in a 3in., and power 250? Allow me to congratulate you on your improved appearance and size.—SCORPIO.

[2623.]—SCIENCE QUESTIONS.—Our Science Department put some examination papers before us last year, which leave, I think, about 9) per cent. of our teachers in the fog. As our ENGLISH MECHANIC does not like to see nor leave, any one in the fog, may I ask the following questions. 1st. In the plane geometry honours paper, show how to construct a triangle A B C, the base A B being 2·5in., its height 1·75, and the sum of the sides A C + B C = 4·5. 2nd. In the building construction, the advanced paper contains some ancient specimens, which are very little known at the present time; at least the correct dimensions are not known, nor are our teachers or students in possession of any books which give the requisite knowledge, and therefore I should be much obliged if you inform me whether a student is expected to show his knowledge in making a design similar to those given, or is he to show his acquaintance with the structures of which they give sketches. The latter is, I think, impossible, as the dimensions given are not sufficient, nor do they correspond with the sketch. For instance, in the sketch of St. Thomas's Church at Charlton (*a*), in the span of the roof two lines are given, which appear equal on the sketch, but one is said to be 15ft. 8in., and the other 6ft. 9in.—STUDENT IN A FOG.

[2624.]—PROPORTIONS OF SPACE.—Can any brother reader tell me the proportion between the space occupied by any substance solid and when in balls? Or, to vary the question, if 6 cubic feet of lead weigh say 1000lb., what weight of lead shot can be packed in a case of similar dimensions?—MECHANICUS.

[2625.]—BIRDS' EGGS.—I have a good collection of birds' eggs. How can I best preserve them, so that they may last as long as possible?—RUSTIC.

[2626.]—ARCHIMEDES' LEVER.—Some weeks agy I noticed a paragraph in our MECHANIC, describing a machine said to possess the same properties as Archimedes' lever, invented by a working man. Though stated to be very simple in construction, the working, as shown by description, was altogether unintelligible to my dull brain, and I could make nothing of it. Could any of your talented contributors give a short description of the real Archimedes' lever, and what wonders it was supposed to perform; also, if anything else has come to light about this new invention, which took nigh unto 40 years, according to report, to bring to perfection? Is it registered? A drawing would be very acceptable.—RUSTIC.

[2627.]—STEAM AND WATER QUERY.—My boiler water is heated by a patent economiser 280°, driven into boiler by a force pump. Now, the steam in boiler is much stronger than in economiser, consequently it forces the water and steam back from the boiler. Can any of your very able correspondents give a panacea for this?—MANCHESTRIAN.

[2628.]—DIMENSIONS OF ENGINE.—Will any of your numerous correspondents kindly set me right? I want a steam engine, 6in. stroke and 4in. bore, to make 100 revolutions a minute with 50lb. pressure. What I want to know is, what size the steamways ought to be, and what size the exhaust way ought to be; what size the steam pipe and what size the exhaust pipe to work economically and right. Shall be thankful for practical information.—CAM.

[2629.]—THE QUEKETT CLUB.—Will "W. H. G.," who answered a correspondent in reference to the Quekett Microscopical Society, kindly inform me if I can obtain the *Quekett Journal* regularly in Bristol, where I reside? I take the *Microscopic Journal* (monthly) now, but should like the *Quekett Journal* also.—ED. H. JONES.

[2630.]—CANOE STRAKES.—The strakes of a canoe being of pine ¼in. thick, how should they be fastened together? With rivets and washers, copper nails, or brass screws? Are the edges chamfered at all, or left square, and how much lap is necessary? Also, what caulking or composition is used to render the canoe water-tight?—THREE INQUIRERS.

[2631.]—SPHERICAL FORM OF THE EARTH.—Will any reader answer me the following query?—Suppose we have a cistern half a mile long and 2ft. deep filled with water, would the water be affected by the gravitation of the earth and form a sweep, or would it keep perfectly straight in the cistern, and at the same depth all the length?—AJAX.

[2632.]—BLOTCHY FACE.—If "Fortunatus" will be kind enough to say in what quantity and how often the mixture (for which he gives the recipe at bottom of page 66 of No. 263 of the MECHANIC) is to be taken he will oblige—T. B.

[2633.]—RAISING WATER.—Thanks to "Senex" for his answer to my question, but his plan does not meet my case. If any brother reader has any knowledge of the rope pump, and would give information of its advantages or disadvantages over the ordinary suction pump for deep wells, he would oblige.—W. S. O.

[2634.]—PAPER-HANGING.—Will any brother subscriber be kind enough to give a brief description of machinery for printing paper-hangings, with their probable cost?—A. R. K.

[2635.]—UNNOTICED QUERY.—PUMP FOR MODEL STEAM ENGINE.—Will any kind reader please favour me by answering the query (2129) in No. 260—HYDRAULICAN.

[2636.]—CEMENT FOR JOINING BOARDS.—There is a cement in use at present for joining boards together. Could any of your readers say where I could get it, or how to make it? Or is it possible to make glue resist water? If so, by what means?—ONE IN A FIX.

USEFUL AND SCIENTIFIC NOTES.

INTERESTING FACTS, p. 62.—GERMAN MILE—The "Almanach de Gotha," edited at the well-known geographical Institute of Justus Perthes, gives the following reductions:—

1 kilometer = 0·1347629 geographical miles
1 geographical mile = 7 kilom. ·420438
1 English mile = 1 kilom. ·609315 = 0·216876 geog. mile
1 Russian verste = 1 kilom. 066781 = 0·1437625 geog. mile.—BERNARDIN.

BALLOONING.—Mr. Coxwell has commenced his aerial voyages somewhat earlier this than he did last year. On the 12th inst. he ascended from the Gas Works at Hornsey, and travelled 35 miles in an hour and a half—descending some miles beyond Chelmsford. On the 7th ult. the aeronaut and his pupils made the first ascent of the season from the neighbourhood of Tottenham, the descent taking place four miles north of Bishop Stortford. The famous "Nassau" balloon, built by the late Mr. Green, has during the winter undergone a thorough restoration by its present proprietor, Mr. Coxwell, who purchased it last July. This celebrated balloon was made at a cost of £2100, being composed of the best Italian silk, manufactured by Mr. H. Soper, of Spital-square. Mr. Coxwell has recently had a fresh quantity made by the same firm at 18s. a yard, and the "Nassau" balloon will be soon available for further explorations. This was the balloon in which Mr. Green made his remarkable trip to Germany, and also the one employed to take up Cocking's parachute. After its completion it will be inflated for exhibition. The veteran Green, who died recently, had determined, although 85 years of age, to accompany Mr. Coxwell in his first ascent this season, and he declared that the repairs and additions made by Mr. Coxwell would render the "Nassau" as good and safe as ever.

SOMETHING NEW ON SILVERING PAPER.—We find the following in the last number of the *Canadian Journal of Photography*:—"Always ready to lay before our customers anything new or valuable in photographic manufacture, we should not be doing our duty to them did we not describe a mode of silvering the paper which we have found of very great value; indeed, we have no hesitation in stating that anyone trying the plan will be very much pleased with the result. Provide a board slightly larger than the largest piece of paper you intend silvering; cut pieces of white blotting paper of the size of the board. When about to silver your paper, place the board in a convenient position near the silver bath, with one end elevated to an angle of say 30 degrees. Float your first sheet on the bath, and then place a piece of blotting paper on your board. When the sheet is ready to lift from the silver solution, lift it by the two corners nearest you, and draw the wet albumen surface against the end of the bath; lift the sheet of paper very slowly, and allow it to cling with its wet side tight to the end of the tray. This it will easily do if you are careful to lift the paper perpendicularly over the end of the dish. You will thus wipe off, as it were, nearly every drop of the free nitrate from the face of the paper, saving waste. The only precaution necessary at this stage is to lift the paper slowly and straight up, so that it clings to the inside of the end of the disc. Now lay your sheet face up on the blotting paper on your sloping board, taking care that the end of the sheet that came last off the bath is laid on the highest end of the board. Prepare a second sheet, and when nearly ready to lift off the bath, cover the sheet first prepared, and now partially dry, with another piece of clean blotting paper, and lay the second sheet on top of this, as before. Proceed in like manner with the rest, and when finished put another board on top of all, and allow to dry. The advantages of this mode of proceeding are numerous—saving of silver, no messing and dropping round, perfect equality of sensitising, absence of measles, mealiness, spottiness, and all defects inherent to imperfect silvering; beautiful, brilliant surface when printed, and your paper is always flat. If you try this plan you will find it cleaner, surer, simpler and better than any other plan with which we are acquainted."

METHOD FOR OBTAINING A CONTINUOUS CURRENT OF AIR OR GAS UNDER PRESSURE, FOR BLOWPIPE AND OTHER PURPOSES.—Mr. T. L. Patterson, in a recent paper read before the Glasgow Philosophical Society, explained how a continuous current of air or gas is obtained under ordinary circumstances by the mouth blowpipe or the foot-bellows, and then mentioned the chief objections to those two methods, and proceeded to describe a method which he had found to be free from those objections. He said that it was well adapted to blowpipe work, and that he could easily obtain a pressure equal to half an atmosphere by means of it. The principle involved is the same as the Catalan blowpipe of Sprengel, and is wrought in connection with a Bunsen filter-pump, although it may be erected separately. The air-tap of a Bunsen pump being opened, the water is turned off, and air passes with the water down a long pipe, of 30 to 35ft., in a continuous stream of bubbles. By receiving the stream into a bottle or other vessel, made air-tight with a cork, through which two tubes are passed, one nearly to the bottom of the vessel, and the other just through the cork, the water will flow off by the deep tube, and air escape by the upper; and, by placing a stopcock on the upper tube, to regulate the escape of the air, the pressure in the vessel may be made equal to the height of the water tube. The apparatus as used by Mr. Patterson is made of sheet-lead and "compo" pipes. A liquid may be boiled under the constant pressure of the apparatus by placing it in a strong flask, and connecting the latter (air-tight) by means of a flexible tube, with the pressure stopcock; or it may be distilled by connecting the receiver (made air-tight to the retort or distilling vessel) with the pressure stopcock, as before. It will also be found useful for increasing filtration, by applying the pressure on the surface of the liquor to be filtered, when it is not desirable to use, or convenient to obtain, suction from beneath. Probably the most useful application of this air-current is to the blowpipe. With a Herapath lamp it is easy, by means of the stopcocks, to obtain a small oxidising or reducing flame suitable for chemical experiments, or the strong and powerful jet for glass-blowing and crucible operations. The author had not tried the apparatus with a Griffin's blast gasburner; but, from calculations made, he had no doubt that, with a Herapath's lamp, he could get a blast quite as strong as that obtained by using the Griffin lamp. He stated that it would be desirable to have a float-valve at the mouth of the air-pipe, in the accumulator, to prevent the access of water into it, in the event of the apparatus at any time becoming deranged or over-taxed. In conclusion, the author explained how the apparatus might be used for delivering a steady current of any other gas not very soluble in water. The cost of Mr. Patterson's apparatus, as fitted in connection with a Bunsen pump, is about 30s.

ANSWERS TO CORRESPONDENTS.

*** All communications should be addressed to the EDITOR of the ENGLISH MECHANIC, 31, Tavistock-street, Covent Garden, W.C.

GEO. RYLAND, BIRMINGHAM.

On the 1st of April last we considered it writ down in our duty to caution the public against a Mr. Howard Ryland, of Birmingham, by printing the following letter:—

> "Borough of Birmingham Police Office, 1st February, 1870.
>
> "SIR,—Sergeant Jeans reports that H. Ryland has an office at High-street, Birmingham, but has not been there for six weeks. The last time we heard from him was from Hereford. His letters are called for by his father. *There is no doubt but that they are swindlers.*—Yours truly,
>
> "G. GLOSSOP, Chf. Supt., J.A., C.C.
>
> "Mr. ———."

As the father of Howard Ryland naturally feels aggrieved at being called a swindler, and as we had no intention whatever of so designating him, we beg to express our sorrow for having accidentally mixed up his name in the caution we gave to the public. We therefore unhesitatingly offer our apologies to him and to the public for any pain we may have given him, or for any injury he may have sustained by our inadvertently linking his name with the statement made by the Birmingham police authorities. We therefore cheerfully withdraw all imputations affecting his character.

ENGLISH MECHANIC MUTUAL IMPROVEMENT SOCIETIES.

It will be seen by advertisements on our front page, that two meetings, one in Manchester, and the other in Edinburgh, are called for Friday, the 29th, to consider the propriety of establishing ENGLISH MECHANIC Mutual Improvement Societies. If anything were wanted to show the wide-reaching circulation and influence of this publication, it might be seen in this movement. In our opening address, at the commencement of the present volume, we stated that our subscribers and correspondents were in one sense members of a national mutual improvement society; whereupon Mr. D. W. KEMP, of Leith, and Mr. A. TOLHAUSEN, of Manchester, simultaneously, without any concert with each other or communication from us, call meetings, at their own expense, of our subscribers in Edinburgh and Manchester, to embody in practice a suggestion made by one of our correspondents. It is only natural that we should regard with interest these initiatory meetings, and at the same time express an ardent hope that they may issue in success.

The following are the initials, &c., of letters received up to first post, Friday April 22:—

W. Taylor, J. M. G., F. King, W. R. B., J. H., J. N., Col. S., J. B. Yonge, J. T. S., G. Green, W. Williams, "Live and Let Live," A. Tolhausen, T. C. and Sons, Geo. Luff, G. and B, W. H. Cock, Jos. James, Capt. C., Rev. H. E., J. W. B., "On the Look-out," "An Old Friend," Rev. E.

Kernan with two rolls of MS., T. Brown, W. Farnwall, G. F. S., J. H. P., J. W. & Co, T. H., Jas. Wigan, T. J. W. B., Ed. Youll, A Middletonian, Anti-Discord, W. B. B., Unlearned Man, J. Linton, Sun-Dial, Young Toxopholite, J. K. P., P. France, R. D., Ignoramus No. 2, Vigie, C. Ward, R. F. D., An Old Subscriber, Fidus Achates, Aghalei, Amator Scientiæ, A. A. Jones, W. F., E. C. D., Edwardum A., C D. R., W. P., D. H. Thomas, W. P., J. P. S., R. W. H., Expectant, Spring-time, G. R. M., C. C. R., Hugh V. Krolow, S. F., W. H. B., S. W. & S., J. H. W. B., A Competitor, Nothing but Leaves, Francis Kingdom, J. H., Thos. Evans, A. Bros., T. C. & Sons, Whitley Partners, Clark & Hunt, John Evans, T.M., T. J. O'C., A Young Tyke, A Reader, T. F. C., J. A. Mayo, The Hermit, W. & B., Rattle-brain, J. Crowe, W. H. C., J. A. M., B. W., Col. S., J. P. S., J. B. A., E. M., A Practical Man, E. Wedlake, W. R., J. P.

S. Kent.—Can't your friend, being at Reading, inquire about the School of Art there for himself?

J. H. Chambers asks us whether the character of a man may be traced in his handwriting. No doubt a man's character is exhibited more or less in everything he says or does, and particularly in the manner in which he speaks or dresses. A fop or a swell may be seen in the way in which he adjusts his hat or twists his moustaches. We never knew a man, for instance, with anything worth having in his head who wore his hat on one side. We don't pretend to decipher J. H. C.'s character in his writing; if we ventured an opinion we should say that he was somewhat pedantic and precise, and that he paid more attention to the manner of saying a thing than to the matter it might contain.

R. W. Wilson.—The numbers can be forwarded on receipt of 24 stamps.

J. W. P. Edwards.—The charge is the same for any number of insertions in the Sixpenny Sale Column.

Ennuye.—There is no such paper. It is, as you observe, to be regretted that the greater number of the weekly journals give so much space to records of crime. Of course they profess to only give them as intelligence, and not with the direct view of pandering to the low passions of their readers.

T. H. S.—See recent back numbers.

Henry Allen, or Robert Cossens.—We did *not* receive the stamps.

A Friend to Improvement.—We can give you no information. The English Government are not at present likely to take in hand any invention for the prevention of railway accidents.

A Smoker.—Answered recently.

Rabbit.—Scarcely within the range of a scientific journal.

Electro.—Described frequently in back numbers.

Contributor.—Yes there has; but don't waste your money on such trash.

J. W. Purdue.—Your questions should be put to a respectable London patent agent, who would answer them properly at a moderate cost. You cannot expect us to do so. Write to some of those who advertise in our columns for one of their handbooks.

H. James.—We cannot.

Caloric.—There are such stoves. We noticed and illustrated one a few weeks back.

Wilfrid Hodgson.—Your idea is old.

George Freeman.—We cannot advise you. There are just now too many patentees of velocipedes seeking the assistance of capitalists.

A Constant Reader, (Thurgoland)—You are unreasonable. Your query was inserted as early as possible, page 119. The last remark in your present letter is uncalled for.

G. B. A. M.—Yes, during certain hours.

B. J. Williams.—The new newspaper postage regulations do not come into operation this year. Your query can only appear in the Sixpenny Sale Column.

W. Barber.—If you read our answers you would have seen that we *did* reply to you. Your query can only appear in the Sixpenny Sale Column.

George Bates.—We do not see why you could not have given the information. Your present reply is somewhat of an advertisement.

F. R. Smith.—"Prie Dieu" wished to know where *he* could get the designs.

R. Woodward.—Send a letter embodying a description of Titanic steel, and we will insert it.

W. H. L. thinks Mr. Proctor "is too hard on poor Mr. Beardsley, and that it would be better if Mr. P. would argue with his opponent instead of abusing him." W. H. L. should remember that Mr. Proctor has recently written an elaborate series of articles on the earth in this publication.

Marine Bicycle.—G. Edwards.—Your drawing is not good enough for the engraver, and your description is not clear.

The Sender of the Brick.—You are mortified at your non-success, and ashamed to state your name.

J. B.—We do not insert quack advertisements.

J. H.—Your reply is purely an advertisement.

F. F. C. suggests that Mr. Beardsley should less frequently use the terms "absurd, erroneous, and impossible as applied to theories received by our greatest and wisest of men."

D. Hitch.—No stamps enclosed.

J. Wigginton.—We do not answer by post.

A Constant Reader says he sent a query which has not been inserted, and he supposes it was because the sender did not write well, or because he could not put F.R.A.S. to his name. Probably the query did not come to hand, or some notice would have been taken of it, however humble the writer might have been. We assure "Constant Reader" that no partiality is shown to correspondents. If a peasant sent to us a suitable query it would be inserted, and if a peer sent us an unsuitable one it would be unceremoniously dropped into the waste basket.

J. H. R.—The query appeared a fortnight since.

W. Ayton (Sydney, N. S. Wales) has sent us four threepenny pieces for four numbers of the English Mechanic, out of which we have had to pay 6d. W. Ayton is probably not aware that the Post Office has authority to register a letter which "unquestionably contains coin," and to compel the receiver to pay the double fee, in the same way that an unstamped letter is charged double.

Kappa.—Consult your dignity, and discontinue the correspondence. The insertion of your letter would most likely elicit a vulgar retort. In ability, education, manners, and antecedents, this foeman is altogether unworthy of your steel. Some men—fortunately only a few—prefer notoriety to obscurity, and the one in question would no doubt like to advertise himself in holding a controversy with you.

"Science for the Young."—Fourth portion next week.

"What Stripes the Sunbeam,' by "F.R.A.S.," next week.

J. R. T.—A series of articles on Levelling, which proves the rotundity of the earth, has just appeared in the *Building News*.

O. H. S.—The scientific paper referred to may have the use of the blocks.

The Sixpenny Sale Column is the only place in which can appear queries sent by Fireclay, One who Wants a Tricycle, W. Jones (Barnstaple), T. Thorpe, A Yorkite, Swithin.

THE *ENGLISH MECHANIC* LIFE-BOAT FUND

Subscriptions to be forwarded to the Editor, at 31, Tavistock-street, Covent-garden, W.C.

Amount previously acknowledged	£168	19	4
Aaron Brown	0	1	0
Veritas	1	0	0
W. H. Cock, Monte Video	0	5	0
Experiment	0	1	0
A. O. C.	0	2	6
P. W. D.	0	1	0
	170	9	10

THE INVENTOR.

In obedience to the suggestions of a number of readers, we have decided on appropriating a portion of our space to a condensed list of patents as nearly as possible up to the date of our issue.

APPLICATIONS FOR LETTERS PATENT DURING THE WEEK ENDING APRIL 19, 1870.

1062 O. H. Newman, Brentford End, Brentford, producing an unfermenting and unintoxicating malt liquor

1063 R. Wilson, Patricroft, near Manchester, improvements in steam and other elastic fluid engines

1064 O. C. Walker and W. T. Walker, Midland Iron Works, Donnington, centre valves for gas purifiers and other apparatus

1065 T. Turner, 204, West George-street, Glasgow, bricks or blocks

1066 W. B. Haigh, Oldham, improvements in vertical saw frames

1067 L. W. Thomas, Dover, improvements applicable to fireplaces, stoves, and grates

1068 I. Adams, Boston, Massachusetts, treatment of metal surfaces coated by electro deposition with nickel

1069 J. Kirk, S. Shelmerdine, and C. Froggatt, Stockport, apparatus for felting or "planking" the bodies of hats

1070 J. H. Johnson, 47, Lincoln's-inn-fields, improvements in structures for the preservation of fruits.—A communication

1071 J. Howard, Bedford, improvements in ploughs

1072 M. Henry, 68, Fleet-street, improvements in telegraphic apparatus.—A communication

1073 W. Lake, Southampton-buildings, London, improvements in brakes and starting apparatus for railway carriages.—A communication.

1074 W. R. Lake, Southampton-buildings, improvements in whiffle-trees.—A communication

1075 W. S. Coon, Rochester, New York, applying power to the running of machinery and tools, whereby such machinery or tools may be adjusted to any desired angle in use.

1076 G. A J. Schott, Bradford, manufacture of yarns or threads

1077 B. Baugh and B. Walters, Birmingham, door knobs

1078 E. Lord, Todmorden, cleaning, preparing, and spinning cotton substances

1079 E. Weare, Stonehouse, using the waste threads of condensing carding engines

1080 W. Angus, Fraserburgh, mast-head and other hoisting blocks

1081 M. Bailey, Islington, and W. J. Almond, Cheapside, apparatus for spinning, doubling, and throwing silk, cotton, &c.

1082 C. Joseph, South-place, Kennington-park, improvements in filters.—A communication.

1083 W. Spence, 8, Quality-court, machines for shaping staves for casks and barrels.—A communication.

1084 A. V. Newton, 66, Chancery-lane, improved means for working railroad switches.—A communication.

1085 C. Hamilton, Stratford, improvements in bedsteads, whereby they may be rendered available as an escape in case of fire.

1086 R. Marchant, Torrington-square, perpetual motion

1087 J. Philipson, Newcastle-upon-Tyne, improving the windows of carriages

1088 F. W. Brooksbank, Nottingham, twist lace machines

1089 W. R. Lake, Southampton-buildings, an improved mode of utilising cotton waste.—A communication.

1090.—F. Pattison, Glasgow, a new or improved metal-founder's blacking

1091 T. Dale, Kingston upon-Hull, apparatus for extinguishing fires

1092 A. Taylor, Lydbury, improvements in guns and projectiles

1093 W. R. Lake, Southampton-buildings, improvements in looms for weaving.—A communication.

1094 J. Plaskitt, Lincoln's-inn, improvements in velocipedes.—A communication.

1095 L. Stewart, Edinburgh, improvements in wheels

1096 W. Jesty, Gosport, improvements in compositions for coating ships

1097 G. Spencer, 77, Cannon-street, London, patterns on the surface of kamptulicon or other similar substances

1098 W. Simpson and A. Gardner, Ilford, improvements in the construction of engines

1099 R. J. Everett, West Ham, utilising waste products from gasworks

1100 A. V. Newton, 66, Chancery-lane, improvements in the production of metallic alloys of manganese.—A communication

1101 W. R. Lake, Southampton-buildings, improvements in knitting machines

1102 A. A. Wilbaux, Paris, engraving on glass, metals, wood, and other substances

1103 P. N. J. Macabies, Paris, water-feeding apparatus for boilers

1104 W. R. Lake, Southampton-building, drilling or boring rocks.—A communication

1105 W. Cotton, Loughborough, improvements in the manufacture of looped or knitted fabrics

1106 C. Beard, Bury St. Edmunds, construction of partitions of walls

1107 B. De La Rue, Cranford, improvements in croquet mallets

1108 E. P. Sheldon, Carlisle, improvements in water meters, and in apparatus for boring cylinders

1109 H. Brooks, 31, Cumberland-market, Regent's-park, receptacles for containing liquids

1110 T. White, Birmingham, covers for dishes and plates

1111 I. Baggs, High Holborn, improvements in making white lead

1112 T. Dickins, Middleton, machinery for spinning, twisting, doubling, and throwing silk

1113 A. Borgnet, Swansea, construction of retorts, muffles, pots, and furnaces

1114 H. E. Newton, 66, Chancery-lane, apparatus to be employed in the performance of gymnastic exercises.—A communication

1115 J. Craven, Wakefield, apparatus for raising and lowering heavy bodies

1116 T. Wood, Manchester, omnibuses and apparatus for indicating the number of passengers entering therein

1117 N. Murphy, Norwood, Ireland, securing more effectually the duty upon spirits in distilleries

1118 A. L. Dowie, Glasgow, improvements in treating copper, zinc, tin, and their compounds

1119 P. J. X. Gunther and J. A. C De Latouche, Paris, revolvers

1120 J. L. Norton, Belle Sauvage Yard, Ludgate-hill, dressing and furrowing millstones

1121 W. H. Delamare, Deptford, machinery for treating cotton seeds

1122 J. Barrow, West Gorton, treatment of napthalene, and of hydrocarbon bodies containing napthalene.

1123 P. Toepler, Gracechurch-street, cleaning wool

1124 J. Townsend, Glasgow, applying heat in various chemical operations

1125 A. M. Strathern, Coatbridge, and D. G. Morrison, Glasgow safety apparatus for steam boilers

1126 W. F. Murray and T. D. McFarlane, Glasgow, apparatus for shaping plastic materials

1127 T. McIsaac, Putney, folding bed table

1128 W. Spence, 8, Quality-court, Chancery-lane, manufacture of hats

1129 G. C. Cooke, Woodford, apparatus for scoring or recording numbers

All persons having an interest in opposing any one of such applications are at liberty to leave particulars in writing of their objections to such application at the office of the Commissioners before the 11th of April, 1870.

PATENTS SEALED.

3024 J. Raper, improvements in looms for weaving

3031 J. Bottomley and W. Bottomley, fulling or milling woollen and other woven or felted fabrics

3037 M. Ker, improvements in curtains

3041 W. Lake, improved nut for screw bolts

3044 A. Forder, velocipedes

3047 A. Clegg, improvements in sewing machines

3049 F. R. Window, producing photographs in pigments

3053 A. Munro, cutlery, edge tools, agricultural and other implements

3055 B. Sulman, stamping and cancelling press

3058 A. Brady, improvements in purifying iron or any other metal.—A communication

3064 H. Brooks, metallic cap or cover to glass or other bottles or vessels

3065 J. Becker, apparatus for stopping bottles

3067 W. R. Lake, improvements in rotary blowing engines.—A communication

3091 P. Walker, apparatus for rendering coal mines less injurious

3115 O. L. Hopson, apparatus for reducing the diameter of wire or rods for wire drawing

3150 C. Sacré, improvements in the manufacture of wrought iron

3200 C. De Ville Wells, improvements for regulating the speed of marine steam engines

3256 W. Harris, locks and latches

3323 J. Woodward, liquid meters

3509 J. F. Kent, mortising, tenoning, and sawing machine

3593 P. Koch, manufacturing untapped nuts intended for screw bolts

1011 E. Pilling, looms for weaving

1013 J. Petrie, washing wools and other fibrous materials

1015 J. M. Kilner, apparatus for laying submarine telegraph cables

3056 W. Heywood, improvements in carriages

3066 G. M. Ashforth, applying motive power applicable to working sewing machines

3073 R. J. Goodbody and R. E. Donovan, apparatus for roasting tobacco for snuff

3074 T. Gibb and C. Gelstharp, furnaces for calcining ores

3076 J. R. Grayson, apparatus for clipping or shearing horses

3084 R. Scott and W. McIvor, sulphuric acid residues utilised and employed for the production of sulphate of soda

3087 T. Hydes, J. Bennett, and J. E. Bennett, propelling ships

3101 T. Hoey, improvements in fire places

3102 D. Spill, preparation and use of solvents of xyloidine

3108 T. Dunn, improvements in locomotive steam engines

3123 J. Watson, improvements in presses for compressing cotton

3135 A. Knowles, apparatus for cutting and getting coal

3145 J. H. Spencer, compound for lubricating the journals or necks and bearings of rolls, rotating shafts, and other rotating bodies

3180 N. W. Blanchard, substitute for curled hair for upholstering and other purposes

3199 S. Rusk, shoes for horses and other animals.—A communication

3249 I. Nasch, button-hole sewing machines

3287 P. Koch, fastening the knobs or handles of locks.—A communication

3306 C. Ashbury, improvements in steam boilers

3315 T. Weston and H. Weston, manufacture and coating or casing of metallic tubes and rods

3682 G. T. Livesey, apparatus used in the manufacture of gas

3717 J. B. Gough, improved collar stud

14 J. Smith, sickles and wires connected with mules for nning

298 D. Robertson, improvements in carding engines

358 J. Ward and J. Bowing, preparing and drying yeast

359 H. Bond and J. Riley, manufacture of quilts, counterpanes, and table or toilet covers

453 S. W. Clark and W. H. Sykes, signal and other lamps

505 S. Hulme, removing paint from wood

512 W. B. Adams, railways, tramways, common roads, and machines and vehicles to run thereon

578 A. Godillot, an improved military tent.

590 L. Sterne, construction of wheel tires

The English Mechanic
AND
MIRROR OF SCIENCE AND ART.
FRIDAY, MAY 6, 1870.

WHAT STRIPES THE SUNBEAM.

BY A FELLOW OF THE ROYAL ASTRONOMICAL SOCIETY.

THERE are, probably, very few modern discoveries which have excited such widely-spread interest as that of what has been called Spectrum Analysis; in fact, it is almost impossible to peruse, even in a desultory way, much of the current Scientific literature of the day without meeting with references, more or less explicit, to it. Inasmuch, however, as the subject has not hitherto been treated formally in our columns, and inasmuch, further, as it appears to us that a familiar exposition of it may enable many of our readers to appreciate and understand the references to which we have alluded, and which, presumably, have now little or no meaning for them; we have determined to endeavour to place the whole matter in as popular a form as it is susceptible of explanation in, and to tell the marvellous tale of the detection of the chemical constitution of our great centre of life heat and light, the Sun (and even of that of some of those infinitely distant bodies which spangle the midnight sky), by the aid of a mere triangular stalk of glass and a narrow slit in a metal plate.

We must, however, ask here, as we did on a former occasion, for the sustained attention of the reader. It is not a very easy subject which we have taken upon ourselves to discuss, and in our attempt to make it apprehensible we shall have to proceed, step by step, with, it may be, more or less iteration, in a predetermined sequence of explanation. We would, then, request the Student, *on no account to proceed with any paragraph, after the first, until he has thoroughly mastered the preceding one. If he will try his best to comprehend us*, we will promise to use all our endeavours to be comprehensible; and to use only such language, and employ only such illustrations, as shall be within the grasp of any moderately-educated artificer who may be sufficiently interested in the subject to follow us.

It was in the year 1675 that one of the greatest, if not the very greatest, of Englishmen who ever lived, Sir Isaac Newton, made the remarkable discovery that white light was not homogeneous; that is to say, that it could be split, or decomposed, into lights of various colours, and this he ascertained from the circumstance that when, under certain conditions, a ray of white light is *refracted* or bent, its components are bent in different proportions, or some more than others. He demonstrates this in Prop. 1., Theor. 1., of his "Opticks," published in the year just mentioned, under the heading, "Lights which differ in colour, differ also in degrees of refrangibility." Into his proof of this we need not enter, since we are now more immediately concerned with his second proposition, "The light of the Sun consists of rays differently refrangible." The annexed figure (Fig. 1) copied from the "Opticks," will serve to exhibit the manner in which he shows the truth of this experimentally. Through a round hole F, of ⅓rd of an inch in diameter, Newton allowed the Sun to shine upon one face B C, of a triangular stalk of glass (which we call a prism), "whereby," as he says, "the beam of the Sun's light which came in at that hole might be refracted upwards towards the opposite wall of the chamber, and there form a coloured image of the Sun. The axis of the prism (that is the line passing through the middle of the prism from one end of it to the other end, parallel to the edge of the refracting angle) was in this and the following experiments perpendicular to the incident rays." This means nothing more than that a sharp edge of the prism was downwards, and that such edge was parallel to the shutter in which the hole was made, and to the floor of the room in which the experiment was tried. Having found the position of minimum deviation of the prism (ENGLISH MECHANIC, Vol. X., p. 629), he proceeds as follows:—"The prism, therefore, being placed in this posture, I let the refracted light fall perpendicularly upon a sheet of white paper at the opposite wall of the chamber, and observed the figure and dimensions of the solar image formed on the paper by that light." He then goes on to describe the size and shape of this image of the Sun, and to prove that the different parts of it are differently refracted, and concludes his 2nd Theorem thus:—"This image or spectrum P T, was coloured, being red at its least refracted end T, and violet at its most refracted end P, and yellow, green, and blue in the intermediate spaces, which agrees with the first proposition, that lights which differ in colour do also differ in refrangibility. The length of the image in the foregoing experiments I measured from the faintest and outmost red at one end to the faintest and outmost blue at the other end, excepting only a little penumbra, whose breadth scarce exceeded a quarter of an inch, as was said above."

FIG. 1

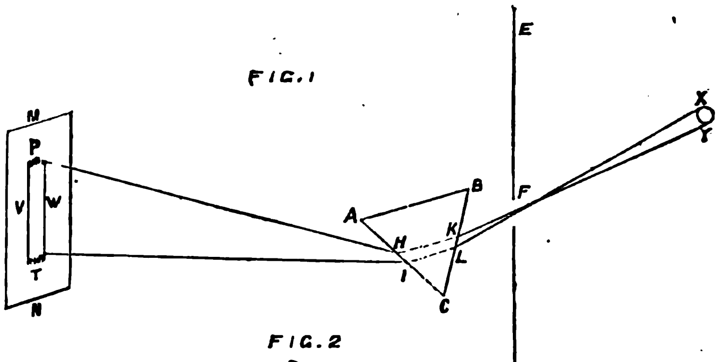


FIG. 2

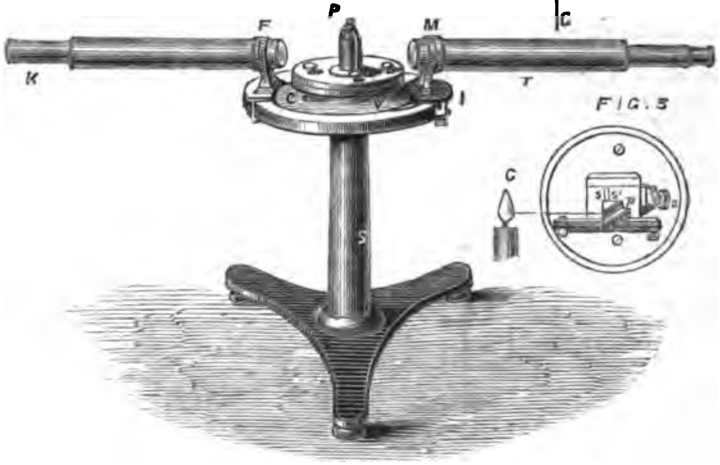


FIG. 3

The experiment whose nature we have thus indicated is at once so important and so striking when seen for the first time, that we would urge every one of our readers to repeat it for himself. The triangular prisms dependent from candle "lustres"—not those cut into many facets, but the plain triangular stalks of glass—will answer excellently to exhibit the phenomena of which we have been speaking; and as such a prism will be of great use in illustrating our future explanations, we would advise everyone who intends to follow us through this essay to provide himself with one or more of them. They may be had for a few pence each.

We may add to what we have said, that, by receiving the spectrum as described above, upon a screen, and then cutting a slit in that screen so as to let light all of one colour, say green, pass through in an isolated state, Newton found that such colour was no further decomposable, and that, on letting this ray fall upon a second prism, he only got green light upon another screen placed behind the first to receive it. He further showed that by examining the spectrum P T through a second prism placed below the level of the first, so as to reverse the order of refraction, he re-composed his coloured band into a spot of white light.

How or why this combination of colours affects the eye as white light, is too recondite a question to be discussed here, even were there any tenable theory to account for it. It is mainly connected with the anatomy and physiology of the eye itself, and it is therefore impossible, in this place, to do more than refer to it. We may just say, though, that the phenomenon itself may be exhibited in another form by means of a rapidly-rotating disc upon which the prismatic colours are painted in their due proportion, and by the motion of which they are blended, so that the disc affects the eye as an uniformly white, or slightly greyish-white one. Brewster ("Optics," pp. 71, *et. seq.*) propounded the hypothesis that there were three distinct coloured spectra—one red, the next yellow, and the third blue—which overlapped, the maxima of the red and blue spectra being at the ends, and that of the yellow in the middle of the visible spectrum, and the overlapping producing the intermediate shades of orange, green, &c., &c. The fallacy of this hypothesis has, however, been since conclusively shown by Helmholtz, who has proved that the green, for example, is *not* made up by the superposition of blue and yellow, and that it is undecomposable, and of one definite refrangibility. The importance of the discovery that light of each specific degree of refrangibility is monochromatic, and that each ray has its own special colour, will be seen as we go on.

So far as we have gone, then, we have arrived at this result, that what we call white light is in reality a mixture of violet, indigo, blue, green, yellow, orange, and red lights, and that, after falling upon one face of a prism, a beam of Sunlight emerges from the adjacent face, spread out into a sheaf or fan of these its component colours, the violet being the most bent, the indigo less, the blue less still, and so on to the red, which is bent the least of all. We have further learned that each of these is legitimately a primary colour; that is to say, it is of a fixed and unalterable refrangibility in the same medium, and it is monochromatic, or whole-coloured, and, consequently, undecomposable into any simpler elements. Should the reader, however, follow our advice, and repeat Newton's experiment for himself, he will observe that the colours are not sharply defined at their junction with the adjacent ones, but that they melt, as it were, into each other, and that the spectrum is, in fact, a continuous one, without break or interruption. It will readily be seen that this is referable, *inter alia*, to the shape of the orifice through which the beam of sunlight is admitted, as it is pretty evident that the rays which come through are inclined to each other at the angle (about half a degree) subtended by the Sun's disc to the eye. How the use of a round hole in his shutter caused Newton *just* to miss a discovery of the most vital importance we shall now very soon proceed to exhibit.

Before doing so, however, it will be as well, at this stage, to glance at the physical properties of the variously-coloured constituents of the spectrum, remembering that all light is due to the undulations of a medium pervading the whole of space, the difference in the rapidity of the vibrations of this medium affecting the eye as differences of colour. Numerical details on this subject may be found in a letter at p. 35 of the present volume. With regard to the words, "extreme-red" and "extreme violet," with which the table (*l. c.*) commences and concludes, we may just observe that, beyond the confines of the ordinarily visible spectrum, exist rays of light both more and less refrangible than any of those which we commonly see; but that by certain artifices or contrivances these may be rendered perceptible. Commencing at the red end, we find that the greater part of the heating effects of the Sun's light are referable to these red rays, and delicate experiments have shown that the maximum heating power resides at a point beyond that at which red light, or any light, ceases to be visible to the eye. Sir William Herschel was the first to draw attention to the fact that heating power mainly resided at the red end of the spectrum, announcing his discovery at the very beginning of the present century; while as early as 1777, Scheele published the results of some experiments, which showed that chloride of silver blackened much more rapidly in the violet rays than in any other part of the spectrum. The preponderance of illuminating power in the yellow rays must have struck every one who ever viewed dispersed light at all. Summing up, then, we may say that the greatest heat resides in that part of the spectrum just outside of the visible red; the most energetic chemical power just within the visible limits of the violet, and the brightest light about the middle of the yellow.

But it is time to return to what we were saying as to the shape of the aperture through which the Sunbeam is admitted to fall upon the prism; and we may now proceed to see how Wollaston made (without knowing it) a discovery of very high importance in connection with the subject which we are now considering. Instead of employing, like Newton, a round hole in his window-shutter, through which a number of overlapping spectra find their way, he let the Sun's light pass through a narrow *slit* parallel to the refracting edge of the prism, and upon now examining the spectrum he found it no longer continuous, but crossed in several places with *fixed dark lines*, which were permanent. Wollaston, however, like many other discoverers, seems to have quite failed to see the importance of what he had found out, and the matter slumbered until the year 1814, when the great German optician, Fraunhöfer, took the matter up, and, by viewing the spectrum of a very narrow slit through a telescope, succeeded in mapping, we believe, nearly 580 of these lines. They are hence called "Fraunhöfer's lines," even to this day. He further found out that these lines existed in both direct and reflected sunlight; that moonlight and the light of Venus also showed them, and that in the spectrum obtained from each of these sources, the position of the visible dark lines was fixed and invariable. Fraunhöfer made another discovery, too, of very great importance, which was that the fixed stars (which it is well known are themselves Suns) gave spectra containing dark lines, but they were *not the same dark lines* as he had previously detected in the Sun's light, whether directly or indirectly derived from him.

For the better explanation of our subject, we will now dismiss temporarily from our consideration the spectra of the celestial bodies, and confine ourselves for the present to the effect of heat on terrestrial ones, in so far as such heat leads to the evolution of light. Every blacksmith knows that when an iron rod is put into the fire it first arrives at a red heat, and as it becomes hotter it gradually emits light of greater and greater refrangibility, until ultimately it ends by giving off rays of all degrees of refrangibility, or becomes, as they say, white hot. If the reader will watch the gradual heating of a common poker by the aid of one of the prisms which we have recommended him to procure, he will find that it will begin by the emission of red rays; that as the heat increases, its spectrum will lengthen; and that orange, yellow, green, blue, indigo, and violet light will in succession become visible, the whole of the prismatic colours becoming apparent when the poker is intensely white hot. The same sequence of phenomena will be exhibited by any body, solid or liquid, which can be sufficiently heated; and it is most important to remark, that in each and every case (with the solitary and unimportant exception of an extremely rare substance called Erbia which we may quite neglect here) the spectra of all incandescent solids and liquids whatever, are *continuous*—that is to say; uninterrupted and uncrossed by dark lines of any sort or description. But suppose that, instead of a solid or liquid body, we are dealing with an incandescent gas, what sort of light will that emit? The answer to this is a curious one. Every element in a gaseous state, when heated until it becomes luminous, gives off its own special and peculiar spectrum; but this, instead of being continuous, as in the case of that emanating from a solid or a liquid, is broken, or discontinuous, and consists of *bright bands or lines*, with dark spaces between them. A simple and very striking way of showing this is by the aid of a common spirit lamp, into the flame of which certain salts are introduced to volatilise and burn in the form of vapour. Makers of fireworks are familiar with the use of strontium to produce a red colour, and of barytes to afford a green one; and we have, most of us, tried the experiment of burning a mixture of spirits of wine and common salt in a darkened room for the sake of observing the ghastly effect produced on the countenances of the spectators by its monochromatic yellow light. Now it is of the utmost importance to observe here, that all the salts of sodium (the base of common salt) tinge a flame yellow; all the salts of barium, green; all the salts of strontium, red, and so on: and further, that if we can, no matter how, heat the *vapour* of any chemical element sufficiently high to render it luminous, we shall find that its spectrum is special to itself, and dissimilar to that of any other body, and all this irrespective of the ordinary condition of such element, be that solid, liquid, or gaseous. But that we are, for obvious reasons, denied the use of chromatic printing, we should have certainly given figures of the spectra of some of the alkalies, as well as of those of carbon, hydrogen, and nitrogen; but under existing circumstances we must forego this valuable aid to explanation.

Prior to entering into any detail as to the kinds of spectra which we obtain when we regard the incandescent vapours of the various bodies to which we have been alluding, it seems essential here that we should make some reference to the method in which these spectra may be observed, and we therefore, to render this more intelligible, here (Figs. 2 and 3) give a figure of one of the simplest forms of spectroscope, the pattern being one of those of that very able and eminent optician, and well-known amateur observer, Mr. John Browning, F.R.A.S., to whom, probably, this instrument owes more than to any one artist living.

It consists, in effect, of a very dense flint glass prism P, standing in a truly perpendicular position in the centre of the circle C, which is itself supported by the stand S. The circle C is graduated, and upon it is an upright ring F, fixed firmly, another ring M, attached to an index I (reading by means of a vernier V), moves round the circle C on such index. Into this latter or moveable ring a telescope, M T, of the ordinary construction, is screwed. Into the fixed ring is fastened another telescope, with its object glass also directed towards the prism, but, in place of an eye-piece, carrying in its focus an arrangement of "knife-edges," shown in front view of Fig. 3. This consists of two thin plates of metal *s s'*, with their inner edges carefully ground and accurately parallel, and these are made to approach to or recede from one another by means of the screw with a milled head *a*, the effect of this being to make an exceedingly clean sharp slit of any width that may be required; a part of this slit is covered by the reflecting prism *p*, by means of which the light from any source placed in the position of the candle C, is reflected through it, together with that passing directly between its jaws; so that the spectra, side by side, can be seen in the field at the same time, and the comparison instituted between them. It is only needful to say at this stage that the slit formed by the knife-edges is turned towards the light whose spectrum is to be examined; that of course the rays pass out of the object glass F parallel, fall upon one face of the prism P, are refracted and dispersed by it, and that then they enter the object-glass M, and the spectrum is observed through the telescope T M, to which the object-glass belongs.

Let us conceive, then, that, this instrument being in adjustment, we turn the slit towards a burning spirit-lamp, into the flame of which we will commence by imagining that sodium, say in the form of common salt, has been introduced; and let us proceed to see what sort of a spectrum this yields. Certainly a most remarkable one; a brilliant yellow band, and that is all. The light emanating from this element in its vaporous form is wholly of one degree of refrangibility. Not a vestige of green or orange, and, *à fortiori*, not of blue, violet, nor red—a single bar limited in its width by that of the slit, and we have the entire spectrum of sodium. If now we examine the spectrum of potassium, what a wonderful contrast does it present! Two narrow lines at the red end of the spectrum, separated by a dark interval—then a huge dark gap, involving the orange, yellow, green, blue, indigo, and beginning of the violet, and then one solitary band in the violet—serve to indicate that the burning vapour of potassium emits lights of practically only two degrees of refrangibility, and those at opposite ends of the spectrum. If we regard the spectrum of strontium, we find, as we might expect, that the major part of its light is in the red and orange—where seven bands may be counted without much difficulty; then comes a wide black gap, and anon we find a solitary stripe of blue. We have given these three elements as examples, but had we extended them to thirty, our story would have been the same. Each and every one would be found to differ from all the rest, and to possess its own proper system of bright lines, some at one end of the spectrum, some at the other, some consisting of rays of several degrees of refrangibility, but all being composed, without exception, of bright bands with unmistakeable dark gaps between them. We may just mention, incidentally, that so astoundingly and inconceivably delicate is this method of analysis that the $\frac{1}{180000000}$ths of grain of soda has sufficed to show the sodium spectrum, and to flash up in the instrument as a brilliant yellow streak!!!; and further, although it is of little importance to our present object, that this line of sodium, when examined with adequate, optical aid (of which more by-and-bye), is seen really to consist of two lines, like hairs, close together. We may perhaps also add, that we may have as many substances in a vaporous form as we please at the same time in one flame, and that as they successively become volatilised, their spectra will appear one after another when that flame is examined by the aid of the spectroscope, ultimately remaining simultaneously visible until the dissipation of the respective substances which produce them.

(*To be continued.*)

ELECTRICITY—ITS THEORY, SOURCES AND APPLICATION.

By J. T. Sprague.*

(*Continued from page* 75.)

THE simplest form of galvanic generator, and the one first devised, is the combination o alternate plates of copper and zinc; most electrical works employ a good deal of space, and many figures, in describing the various forms devised by way of improvement, by Cruikshank, Wollaston, and others, consisting chiefly of the mode of arrangement in the containing vessels, the use of double copper-plates surrounding the zinc, and such-like matters, the value of which has been entirely destroyed by further progress. But as the simple copper-zinc arrangement is the most unsatisfactory form known, it is simply wasting time and space to describe such modifications of it, and therefore I shall only refer to *it* when required for elucidating principles, and as the starting point of all the forms.

109. Exciting Solutions.—A current may be generated by two metals in many solutions, but for the single liquid cell the only practical re-agent is sulphuric acid. This is the most powerful, and the cheapest, as it may be bought as commercial oil of vitriol, from about five farthings a pound, and still lower in large quantities. I may as well say here that for the convenience and information of readers I shall thus name the price of all the articles employed; those prices will be those I pay myself, knowing where to go, and are ordinary fair retail, not wholesale or trade prices; at the same time, ordinary purchasers in small quantities, and particularly buyers at chemists, as the retail dealers in drugs are called, will be asked much more.

Ordinary rectified oil of vitriol of full strength, specific gravity about 1840, will serve, but ordinary brown vitriol should be avoided for two reasons; if it contains nitrous acid it would be injurious to the silver in a Smee's cell, and cause local action on the zinc, in spite of amalgamation, in all; to test for this, mix a few drops with water in a test tube, and drop in a crystal of pure ferrous sulphate, or green vitriol, after the acid has cooled; if a brown colouration is produced, reject the acid. Another very common impurity is arsenic, which would be given off with the hydrogen and form a most deadly poison, if much is breathed, and be unwholesome in any case. Sulphuretted hydrogen passed into the diluted acid will cause a yellow precipitate if there is arsenic present. These are the only impurities of any consequence.

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* Sigma.

A good solution is made by mixing 1 part by bulk with 10 of water, which should be soft, as water containing lime is apt to form a deposit on the metal surfaces; if no other is accessible, it should be boiled with a little carbonate of soda and allowed to cool and settle before use; 100 grains by measure of such a solution will dissolve about 11¼ grains of commercial zinc, but it is bad economy to nearly saturate the acid, particularly if several cells are combined in series, as zinc is then pretty sure to be deposited on the lower part of the negative plate, which is thus destroyed for the time, and from which, as the zinc is pure, it is a troublesome process to dissolve it again. But allowing for impurity in zinc, local action, and a due proportion, or about one-fifth of free acid left, one pint of this solution would dissolve about 1¾oz. of zinc. We may thus calculate the work any cell is capable of doing as about equal for each pint of solution to 24 equivalents of chemical action, this being the true electrical unit of "quantity," as I shall hereafter explain. The cost of generation for each unit would thus be that of one pint of solution, 1¾oz. of zinc, and a fair per centage for wear of negative plate and vessels, divided by 24. This is the acid, and these the conditions applicable to all the following forms of simple cell.

110. COPPER AND ZINC.—When first a pair of plates are immersed in dilute sulphuric acid, and the wires connected to a galvanometer, a considerable deflection is produced, marking a powerful current, but even in a few minutes the effect rapidly decreases. The following experiment was made for purposes of comparison, with plates 2in. by 1in., half an inch apart, in the above-described solution, the plates perfectly fresh, the copper having been washed in nitric acid, and then in several waters; the deflections are those of a Tangent Galvanometer, and therefore capable of comparison, and, as will be hereafter explained, of actual valuation. First deflection, 40°, after successive intervals of five minutes, 34, 33, 32, 31, 31, 30, after one hour, 28, and after an hour and half, 26. The galvanometer and connections consist of about 15ft. of No 13 copper wire, a resistance by actual measurement of ·031, or 1·32nd of a British unit.

After a short while the copper is seen to be covered by a dark film, which it is commonly stated is oxide of copper, and the other metals contained in it. This is erroneous however, for it is evident that oxides could not possibly form in the presence of nascent hydrogen; it is really a combination of this hydrogen with the metal, and the diminishing power of the cell is due to the formation of this hydride or alloy, which prevents contact of the copper with the liquid, thereby increasing the internal resistance, while the affinity of the hydrogen in this condensed condition for the acid radical resists the polarising power of the zinc, and therefore diminishes the electromotive force of the couple or cell.

Pure copper, as deposited by the electrotype process, has a higher electro-motive power, probably because of its purity, but also on account of the nature of its surface, which is covered with innumerable fine points, from which the hydrogen is given off more readily than from a smooth surface. Hence if a copper negative plate is to be used, it should have a deposit of copper formed on it. Such a plate gave the following comparative results:—First deflection, 50°, and in successive five minutes, 35, 34, 34, in one hour, 33, and one and a half, 32.

It will be noticed that the greatest loss of power is in the first few minutes; indeed, the first deflection is of scarcely any value for the fall is so rapid that it is nearly impossible to say what the true deflection is, or when the needle has reached its position of rest after the first oscillations.

111. IRON AND ZINC.—Iron has often been recommended as a positive element because its surface keeps clean; its value will be evident from the following results, 25° falling to 18 and 16 in ten minutes. Still its cheapness may tempt some to use it, a very unwise economy. For this reason it should be stated that wrought or rolled iron is alone fit for use, as the presence of carbon in cast iron sets up local actions. One reason why iron is unsuitable is its low conducting power, which adds to the internal resistance.

Lead gave a momentary deflection of 39°, which fell in a few minutes to 5.

112. SILVER AND ZINC. The silver in this case was better than rolled metal, as it was deposited on electrotype copper, thus giving a favourable surface; this answers perfectly well. If a thick plate is laid on, it gives of course a higher conducting power, and is cheaper, for even the two coatings will contain less silver than a silver sheet of such thickness as to bear practical treatment. It gave 59° falling to 48, 47, 46, 45, at five minute intervals, and [illegible]° after one hour. Like copper, the surface is covered with a brown film, due to the condensation of hydrogen.

113. PLATINISED SILVER.—Smee having assured himself that the nature of the surface was of the greatest importance, and that the hydrogen is more readily given off from a rough surface than a smooth one, and also bearing in mind that platinum has the highest electro motive force of all the metals as opposed to zinc, deposited this metal as a fine black powder on the surface of silver, thus attaining both those objects, and yet avoiding the expense of platinum, and also the low conductivity of this metal, and the battery thus arranged, and which justly bears his name, is one of the most valuable gifts ever made to electrical science. It is of simple construction, the silver sheet is held in a wooden frame in a saw-cut down the middle of the inside surfaces; the top and bottom bars may be ¾in. thick. and the sides ⅜, the wood being well baked and soaked in melted paraffin before putting together by the usual mortises and tenons, and afterwards well covered with shellac varnish; a sheet of zinc is held on each face by means of a brass clamp with a screw, which presses them against the frame, and carries also the binding screw for the connection, that for the silver passing through a hole in the top bar, and being soldered to the silver; the zincs should be narrower than the silver, in order to give free escape for the gas.

Silver ready platinised may be bought, but it will require occasional renewal, and the process is very simple. The silver, being perfectly clean (it is best to wash it with nitric acid), is placed in a cell containing acid solution, and connected to it is a wire with a small piece of zinc attached, this may be merely wrapped in a piece of blotting paper, or a porous cell may be used to keep it out of reach of the platinum. The zinc is now dipped into the acid to a small extent, ¼in. square is enough, so as to produce a very slight action, and then a drop or two of platinic chloride is added to the acid, and immediately it begins to be reduced on the silver; after this is found to be wholly coloured, the action may be increased, and more platinic solution added, and at the last a brisk action should be produced, the object being, first to secure an adhesive deposit, and then a pulverulent one of platinum. The platinum solution is made by dissolving scraps of the metal in aqua regia, or a mixture of nitric and hydrochloric acid, by the aid of heat. Crystals may be obtained by evaporating to dryness and re-dissolving, but for the purpose required this is needless, as the excess of acid is not injurious.

Treating thus the plate used in the last experiment, and using with it one zinc, so as to have the same conditions as in all the other trials, it gave 71°; at 5 minute intervals, 66, 63, 61, 59, 57, in an hour, 50, and in an hour and half, 46. Like all the others its power suffers a rapid decrease, in this case due, chiefly, to the remarkable power possessed by spongy or pulverulent platinum, of condensing gases to many times its own volume, and retaining them in this condition. However, these comparative tests, though valuable and instructive, only treat one aspect of the question of value, that of constancy, and relative activity on short circuit; before coming to a conclusion, the action has also to be considered, when varying resistances, such as are met in practice, have to be overcome.

114. I have long been in the habit of using a peculiar plate in my Smee's, one composed of copper wire gauze, 40 meshes to the inch, which I first copper by electrotype, and then silver and platanise; the reason I used it at first was to enable the zinc to be placed in the middle, and to give a freer escape for the gas, and although the surface is at first view diminished by the openings, it is not so really, as the whole of the surface of the wires is active, the back as much as the front. Such a plate prepared for comparison gave 69°, falling to 50, 47, 45, 44, and in an hour and half, 42; this is less than the solid plate, but the reason is that it was not plated sufficiently thickly, and consequently its surface was smaller than it should have been.

115. CARBON AND ZINC.—Mr. Walker suggested the use of graphite plates, and has used them in batteries for telegraphic purposes; this combination gave 25°, falling in an hour to 23, and in an hour and a half to 21. It thus appears that the force is lower than with silver, or even copper, probably on account of the lower conducting power of carbon, but, on the other hand, it has the merit of comparative constancy.

It has also been platinised in the same manner as silver, which greatly increases its powers. As an illustration of the great resistance produced by the hydrogen, I arranged the plate, during platinisation, in connection with the galvanometer, showing a current of 6°; the moment the platinum salt was added, and the hydrogen employed in reducing it, the deflection rose to 34°, falling again to 12 as gas began to be again given off. When arranged as in the other cases, it gave 68°, falling to 63, 59, 55, 51, 49, to 37 in one hour, and 31 in an hour and half.

SALINE SOLUTIONS.—As it is well to know what attempts fail, as well as what is successful, I may say that many saline solutions will generate currents, but none are of any use in single fluid cells. Thus, carbon and zinc in common salt, chloride of ammonium, nitrate of soda, and various others gave a deflection of 6°, rapidly falling below the power of the Tangent Galvanometer; in fact, the zinc is not able to displace the alkaline or earthy metals which are chemically employed to precipitate it. These solutions have important uses in double fluid batteries, but then other affinities come into play, and these salts act chiefly as conductors, and act on the zinc only by being themselves acted on by the other agents, as well as the zinc.

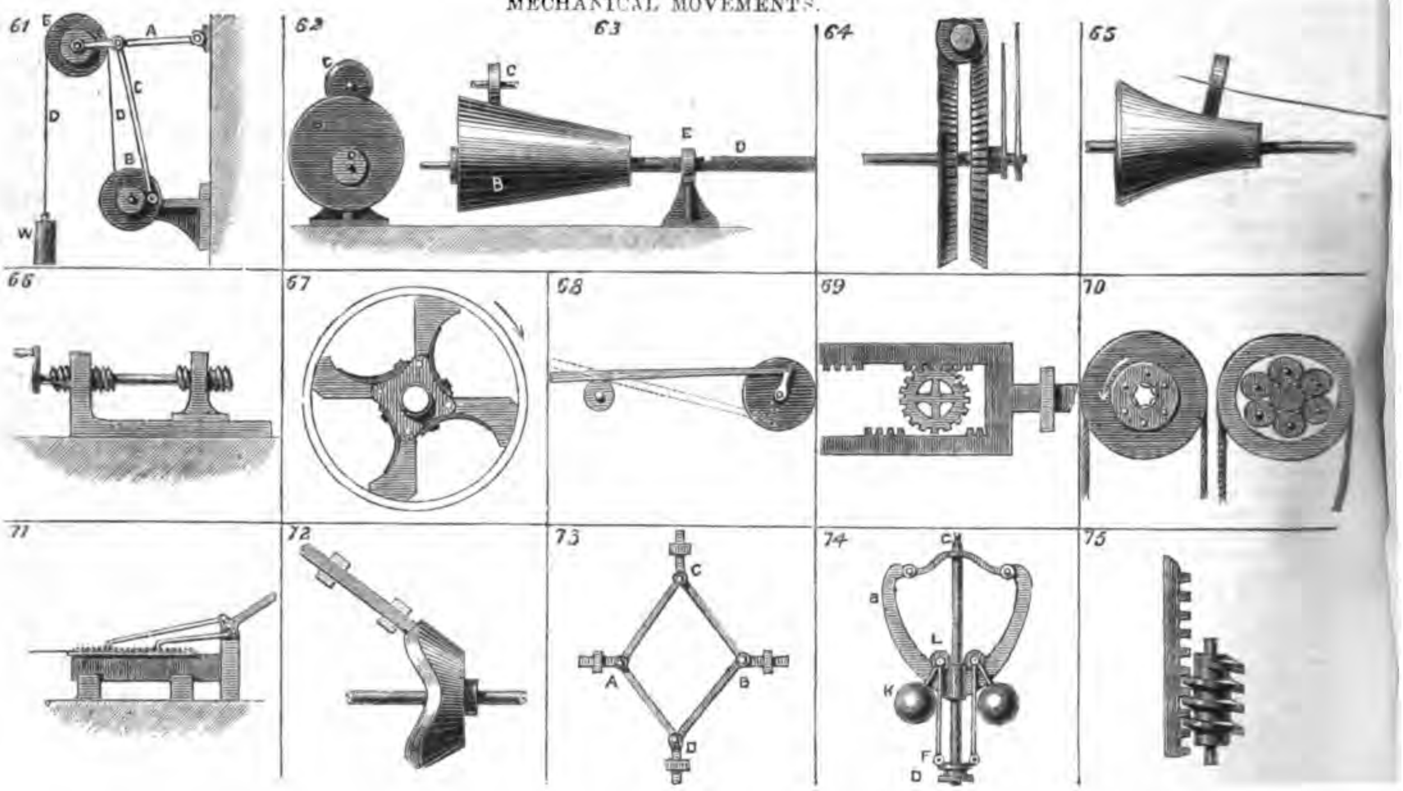
117. Having examined the principal elements employed in batteries which set the hydrogen free, their construction is a matter which need not occupy much attention, for the plan described for the Smee is applicable to all, but without requiring a complete frame; the old fashion of cementing plates into troughs is entirely abandoned, because it is impossible to clean them, a process constantly required, as the copper, when used, needs to be frequently heated to redness to renew its surface, and the zincs ought to be well brushed and freshly touched with mercury after 24 hours' full action, or they lose power, and become subject to excessive local action; but if this care be taken the local action is very small, and it is hardly necessary to remove the plates when not in use, unless a long interval is likely to elapse before they are to be used again, as they keep in much better order in the acid. Various experiments have resulted in a loss of from a quarter to half a grain per square inch of surface in 24 hours, in solutions of full strength.

118. Before passing, however, to the compound forms, I will make a present to the readers of the ENGLISH MECHANIC of a cell of my own arrangement, based on the long series of experiments I have made, and of which the foregoing are a selection. I should have deferred its description till after the examination of the general principles, but so many inquiries have been made lately on this subject that I expect the description will be welcome.

The containing vessel is an ordinary stone jar about 5in. wide by 9in. deep; a strip of gauze 15in. by 5in. is treated as before described, but a copper plate silvered, or sheet silver would do, though I believe not so well; this is made into a cylinder fitting inside the jar, and slung by three copper bands or wires (soldered to it and covered with cement or gutta percha after completion) so as to leave a space of 8in. in the jar below it; the suspending wires are turned over to the outside and soldered to a band going round the jar and fitted with a binding screw, a wooden cover is fitted with a hole in the middle, through which passes the connection to the zinc. The zinc is a strip 2in. wide by ¼in. thick, and at its foot is secured a little shoe or saucer of gutta percha containing mercury, which maintains the amalgamation. Of course the negative element is somewhat expensive at first start, but the object is to give it as large surface as possible; a series of carbon plates might be substituted, but they would cost as much as the silver and have no residuary value, and give less force; the platinising is done at the first charging, taking care to reduce all the platinum before inserting the proper zinc.

This battery is nearly constant, it deflected my

MECHANICAL MOVEMENTS.



galvanometer 81°, which means a very large current, and at 81° it kept it for hours. It remains ready for action at all times, and the heavy sulphate of zinc, as it is formed, sinks below the silver and leaves the solution active for a prolonged period, and may be drawn off by a syphon at intervals, and replaced with fresh acid solution without wasting the upper portion. This perfect cell has been too recently made to enable me to give all its results, but a much smaller one, and one not so fully developed, and contained in a quart jar, gave 78°, and after use for several days steadily in electrotyping, and three weeks irregular experimental work, gave 62°, having had had nothing done to it meanwhile. So powerful is this cell, that after the introduction of a porous jar to contain the zinc, it gave 76°, and with common salt substituted for acid in the porous jar it gave 63°; for many purposes it might be so worked, as cast zinc might then be used, the local action being lessened; in such case, as wide a porous jar as possible should be used, and its contents replenished at intervals when required.

(*To be continued.*)

MECHANICAL MOVEMENTS.*

(*Continued from page* 124.)

61. A COMBINATION movement, in which the weight moves vertically with a reciprocating movement; the down-stroke being shorter than the up-stroke. B is a revolving disc, carrying a drum which winds round itself the cord D. An arm C is jointed to the disc and to the upper arm A, so that when the disc revolves the arm A moves up and down, vibrating on the point G. This arm carries with it the pulley E. Suppose we detach the cord from the drum and tie it to a fixed point, and then move the arm A up and down, the weight W will move the same distance, and in addition the movement given to it by the cord, that is to say the movement will be doubled. Now let us attach the cord to the drum and revolve the disc B, and the weight will move vertically with the reciprocating motion, in which the down-stroke will be shorter than the up-stroke, because the drum is continually taking up the cord.

62 and 63. The first of these figures is an end view, and the second a side view, of an arrangement of mechanism for obtaining a series of changes of velocity and direction. D is a screw on which is placed eccentrically the cone B, and C is a friction roller which is pressed against the cone by a spring or weight. Continuous rotary motion, at a uniform velocity of the screw D, carrying the eccentric cone, gives a series of changes of velocity and direction to the roller C. It will be understood that during every revolution of the cone the roller would press against a different part of the cone, and that it would describe thereon a spiral of the same pitch as the screw D. The roller C would receive a reciprocating motion, the movement in one direction being shorter than that in the other.

64. Two worm-wheels of equal diameter, but one having one tooth more than the other, both in gear with the same worm. Suppose the first wheel has 100 teeth and the second 101, one wheel will gain one revolution over the other during the passage of 100 × 101 teeth of either wheel across the plane of centres, or during 10,100 revolutions of the worm.

65. Variable motion. If the conical drum has a regular circular motion, and the friction-roller is made to traverse lengthwise, a variable rotary motion of the friction-roller will be obtained.

66. The shaft has two screws of different pitches cut on it, one screwing into a fixed bearing, and the other into a bearing free to move too and fro. Rotary motion of the shaft gives rectilinear motion to the moveable bearing, a distance equal to the difference of pitches, at each revolution.

67. Friction pulley. When the rim turns in the opposite direction to the arrow, it gives motion to the shaft by means of the pivoted eccentric arms; but when it turns in the direction of the arrow, the arms turn on their pivots, and the shaft is at rest. The arms are held to the rim by springs.

68. Circular into reciprocating motion by means of a crank and oscillating rod.

69. Continued rectilinear movement of the frame with mutilated racks gives an alternate rotary motion to the spur-gear.

70. Anti-friction bearing for a pulley.

71. On vibrating the lever to which the two pawls are attached, a nearly continuous rectilinear motion is given to the ratchet-bar.

72. Rotary motion of the bevelled disc cam gives a reciprocating rectilinear motion to the rod bearing on its circumference.

73. Rectilinear into rectilinear motion. When the rods A and B are brought together, the rods C and D are thrust further apart, and *vice versa*.

74. An engine-governor. The rise and fall of the balls K, are guided by the parabolic curved arms B, on which the anti fraction wheels L run. The rods F connecting the wheel L with the sleeve move it up and down the spindle C D.

75. Rotary motion of the worm gives a rectilinear motion to the rack.

(*To be continued.*)

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* Extracted from a compilation by Mr. H. J. Brown, Editor of the *American Artisan.*

LIEUTENANT-GENERAL HUTCHINSON'S PROPOSED NEW RAILWAY SYSTEM.

REFLECTION will show that coning of the wheels of railway carriages is so far wrong in principle that it militates against progress in proportion to the extent of the coning.

The plan was originally designed in order that at curves centrifugal force should be met by wheels higher on the outer rail than on the inner, and that the wheels running over the greater distance (the outer curve) should virtually have a larger diameter than the inner wheels running over a less distance (the inner curve). The incorrectness of this reasoning is evinced by the fact that, owing to centrifugal force, the tendency of the carriage is to run in a tangential direction (calculated from the centre of the carriage), thereby forcing the outer leading wheel against the outer rail—the inner near wheel against the inner rail.

That coning wheels is mathematically opposed to progression, and occasions much waste of steam power, is manifest (for it is a drag on every carriage) when we consider that the wheels of all railway carriages could be coned to such an angle with the horizon that the lateral pressure *against* the rail would exceed the vertical pressure *on* it, thus producing a jamb, and that the less the angle the less would be the jamb—in other words, the less the coning the less the resistance to progress. It thus becomes evident that no wheel would so little resist progress as the cylindrical.

With wheels coned merely to an angle of 5° with the horizon, the increase of draught = $\cdot 0873\,\frac{W}{2}$, W representing the weight of the carriage.

When it curves, or from swaying to the right or left, the carriages shift to the part coned to 45° near the flange, the draught is doubled. The pressure (the horizontal pressure) varies as the tangent of the angle that the coned surface makes with the horizon.

Moreover, this constant resistance to progress from constant lateral pressure is yet furth[illegible] increased when the carriages, by swaying from side to side, cause one wheel to run up hill, the opp[illegible]site wheel down hill, thereby creating jerks an[illegible] oscillations, especially at high velocities, detr[illegible]mental to comfort, and as injurious to the permanent way as to the rolling stock—exacting moreover, unnecessary demands on the steam

LIEUT.-GEN. HUTCHINSON'S PROPOSED NEW RAILWAY SYSTEM.

FIG. 1

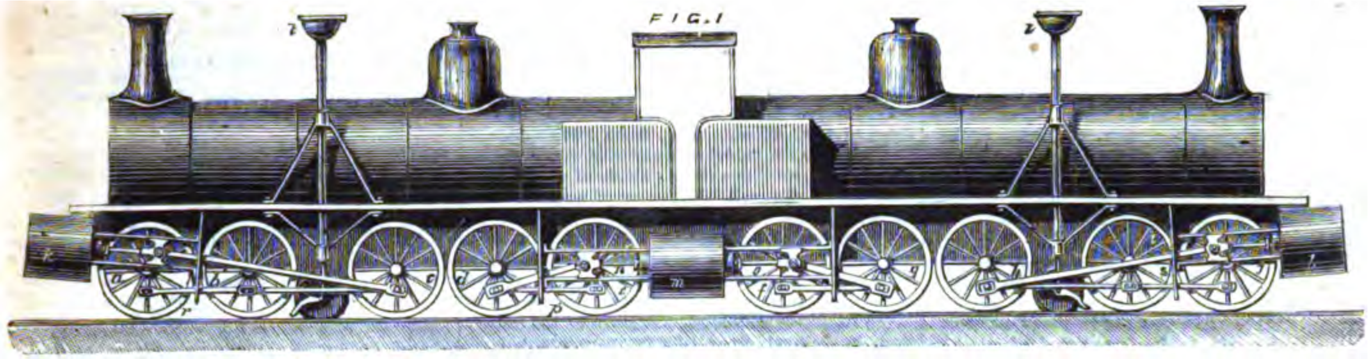


FIG. 4

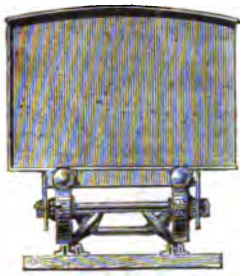


FIG. 3

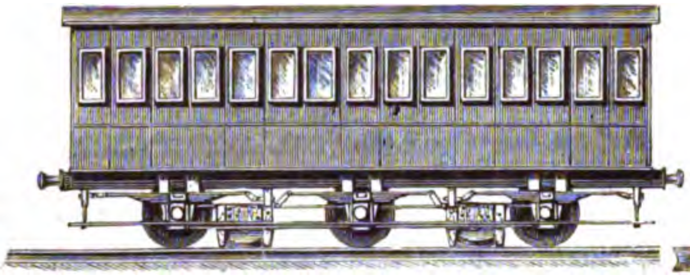


FIG. 9

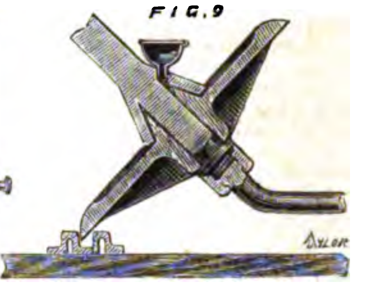


FIG. 5

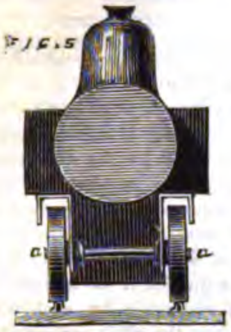


FIG. 6

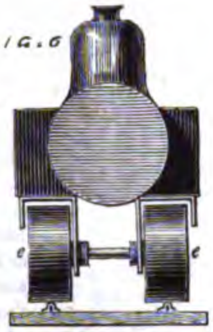


FIG. 7

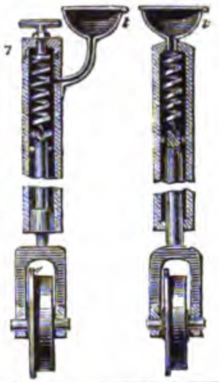


FIG. 8

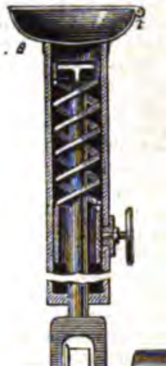
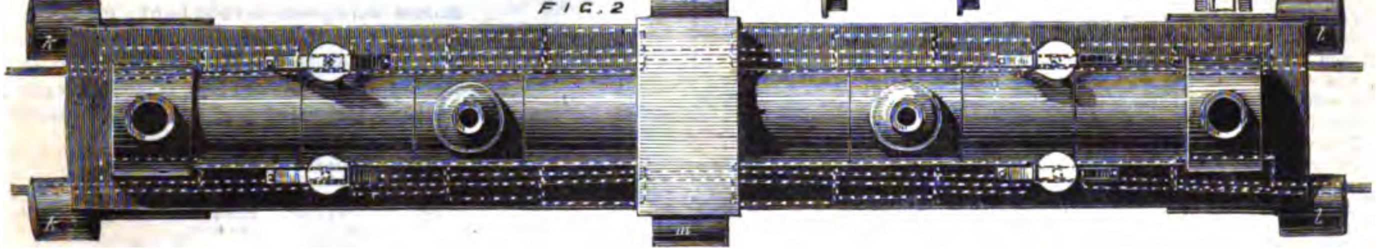


FIG. 2



power—"unnecessary" because they would not be exacted by unconed wheels.

These considerations predisposed us to wish success to any proposition for safely substituting cylindrical for coned wheels, and we feel bound to say that we think the inventor has designed a plan that will be found of great advantage to future lines. By his making the carriages run on many wheels, the rails may be made lighter than is usual, for it is nowhere strained by a great weight on any one spot, and by his giving (as shown on the curved line of rail, Fig. 2 in the woodcut) an increased breadth to the central wheels, proportionate to the severity of the curve, carriages can travel at the greatest speed round a circle whose radius (as is well exemplified in a model he has made) little exceeds their wheel base—for the outer edge of the broad wheels is at the severest curves supported by the rail, thus ensuring safety by virtually enlarging the base. In other words, the more centrifugal force acts upon the carriage, the wider is the part of the base which resists its displacement.

The chord (movable) of the curve may be regarded as the true rigid wheel base of the carriage. All the axles of the wheels are at right angles to the chord, and in every instance half the breadth of each wheel equals in length the part of the line, in the vertical plane of the axle, intercepted between the chord and the arc. To the *full* breadth must be added, as before stated, the breadth of the rail, and about 1in. for "play."

To ascertain the exact breadth of the wheels, let the breadth of half the axles of the several wheels (exclusive of the allowance for width of rail and "play") be respectively represented by D D_1 D_{11}, &c., placed respectively at distances C C_1 C_{11}, &c., from the centre of the chord (the centre of the wheel base).

Let G represent the width of the gauge,
R represent the radius of the curve of rail.
Then

$$D = \sqrt{C^2 - R^2}\,(R - G)$$
$$D_1 = \sqrt{C_1^2 - R^2} - (R - G)$$
$$D = \sqrt{C_{11}^2\,R^2} - (R - G)$$
&c., &c., &c.

Only the wheel base (the chord) lying within the curve has been spoken of. It is evident that the wheel base can be extended at both ends on the prolongation of the chord beyond the curve. Wheels placed on this prolongation prevent any overhang. The less abrupt the curves the greater might be the number of wheels.

It is mathematically correct that, regarding the part of the radius intercepted between the centre of the chord and the arc as unity of any measure, the diameter of the circle is equal to the square of half the chord expressed in the same measure plus 1.

The breadth given to the wheels would not lead to increased width at cuttings. At extremely severe curves the rail would be laid down close to the outer edge of the curve. With the curves of the ordinary radius of 20 chains, the breadth of the broadest wheels needs be no more than 6in beside the width of rail and the usual inch for "play." The projection of the broadest wheel outside the rails could never exceed 3½in.

The less acute the sharpest curve, the less need be the width given to the wheels, and the greater might be the length assigned to the wheel base within the curve, as well as without the curve.

The constructor of the locomotive would have to devise a somewhat different arrangement than is usual for some of its parts, but one quite feasible, to give room for the wide tires of the central wheels. It would be simpler than any double "bogie" carriage, from *all* the axles being parallel.

The parallelism of the axles would never have been found objectionable had it not been for the coning, and the grinding of the flanges against the rails. In many countries the whole of the common carts still continue a fixture to the axle, yet with heavy loads they easily turn corners where the outer wheel has to travel over a space many times exceeding the distance traversed by the inner. With the very unusual sharp curve of a 5 chain radius (110 yards) measured from the outer wall—in a curve of ¼ of a circle—the gauge being 4½ft. between the centre of the rails, the outer wheels only run over 2·3562 yards more than the inner. Manifestly, therefore, the evil arising from the difference in travel of the wheels of unflanged cylindrical wheels is more imaginary than real.

When a carriage is stationary, the perpendicular line in the vertical central longitudinal plane of the axle intercepted between the point of contact of the cylindrical wheel with the rail, may be regarded as the spoke of a wheel (the spoke on which the carriage rests). During one revolution of the wheel such imaginary spokes are endless in number—ever of the same length in cylindrical wheels, but of constantly varying length in coned wheels, as well as of varying inclination from the perpendicular, according to the degree of coning.

These points of contact (especially on the inventor's suggested light, deep, narrow rails) must be very small, therefore the change of the imaginary spokes from their one plane at right angles to the axle, to the unresisted spiral rotation necessary when the direction of the rail alters, cannot retard the rotation of the wheel (cannot retard progress), for each successive spoke still revolves in its own plane at right angles to the axle. On straight lines of rail, and at regular curves, all the imaginary vertical axles of each wheel rotate in one plane ever at right angles to the axle.

The 10 pair of wheels shown (Fig 1) in the representation of the locomotive (which is about double the ordinary length) are driving wheels—all have the same diameter, and all the pistons the same travel. The area of the piston of the central cylinder is of course about ⅓ larger than the pistons of the cylinders at the extremities, as it drives 4 pair of wheels—the others only 3 pair. Should there be a practical difficulty, which is not apprehended in making the one piston (with its double rod) both pull and thrust, and the 4 pair of wheels work harmoniously together, there might be two pistons in one cylinder, or two cylinders.

As regards progression, it seems undeniable that cylindrical wheels must demand less haulage than coned, whether or not they be arranged in "bogie" frames, and the inventor retains them on the line by means as little opposed to progress as can be imagined—viz., by guide wheels that have no other duty to perform than, on a straight line, to occasionally touch and rotate in a vertical plane against the vertical side of the rail, and at curves to act against the side in the direct manner that the cylindrical supporting wheels act on the upper surface.

These deeply-flanged guide wheels (Fig. 8) are placed at the extremities of the wheel base (within the curve), and sustain no more of the weight of the carriage than suffices, by means of a screw, so to press them down, that however sudden may be any sinking in the rail, the wheels follow it, and cannot get displaced. Through a horizontal movement (equal to the extent required by the severest curve) they, readily adjust themselves to the course of the rail, for the great length of the stem (playing in the tube strongly fixed to the carriage) saves them from any severe lateral pressure at top. In cases of difficulty this wheel seems much safer than the ordinary wheel, which, owing to the coning, has a bias to run upwards over the rail.

The wheels *b* and *i* are supposed to have flanges, which, however, are never called upon to act unless through some unlikely chance the guide wheels should get out of order, when as regards safety the carriage would be on a par with those now running.

It is evident that the diminution of haulage, consequent on the employment of cylindrical unflanged wheels solely to support, and of guide wheels solely to direct, must effect a valuable saving of steam for the substitution is made in every class of carriage.

The inventor says that the correctness of the principle would be inexpensively tested on any line by firmly joining three passenger carriages together supported on unconed wheels, and fixing vertical guide wheels (Fig. 8) at the points of junction. This triple carriage to be connected with the adjoining by the buffer bar described in the patent.

The inventor has designed other guide wheels (Fig. 9), which lie in a plane inclined to the horizon, and readily pass through the openings at guard rails and switches, but we are of opinion that the vertical will be the most liked.

The reservoirs containing a lubricant are marked *t*.

It is part of the proposed system that the rails on steep inclines shall be of great breadth, and that the friction (holding power) between them and the broad wheels shall be further increased by a constant escape of sand between their surfaces during ascents.

As the carriages run either end foremost, should it so happen in a line of railway that all the sharpest curves between the two termini bend the same way, it evidently would diminish the width necessary for the broad wheels, were the wheels so fixed to the carriages that, when running on a straight line, the centre of the wheels would not be on the rail, but lie a little outside of it towards that side of the rail where the principal curves bend outwards.

The curves on most of the railways in England are so wide that (without altering the rails), by giving the proposed additional breadth to the wheels, a greatly increased length could be easily given to all the carriages, therefore to the boiler, with a central fire, consequently augmented steam power to the locomotive; besides the increased holding power acquired by being enabled to place a greatly increased weight over the many driving wheels, and so making every locomotive a tank engine.

The working portion of the locomotive towards the centre and rear could be covered in to prevent injury from dust, not that it injures the machinery of the Fairlie, though its parts are more complicated.

As nearly £500,000,000 have been expended on railways in the United Kingdom, we cannot think, however great might be any suggested improvements, that a rapid change would be made in a system on which such vast sums have been spent. We are, however, mistaken if the present proposal be not gradually adopted in this country, and if those on whom will devolve the responsibility of constructing future lines abroad, in the most safe, economical, and durable manner do not follow a plan which we hold to be correct in principle, and may be improved on in the minor details. It is as applicable to the narrowest as to the widest gauge, and as it gives the means of ascending very steep gradients, and turning the sharpest curves, there are few countries where the rails could not be laid down as a surface line.

FIG. 1

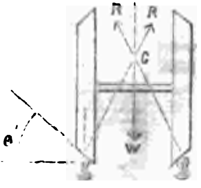
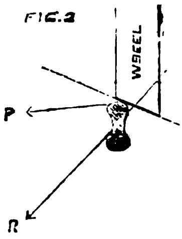


FIG. 2



If we take W the weight supported by any two wheels.

R R′ the equal resistances at the points of contact of the coned wheels with the rails, which will be perpendicular to the surface of the coned wheels. It is evident that these three forces (W R and R′) keep the system at rest. Therefore the direction of these three forces will meet in a point.

Produce them to meet in C

Then

$$\frac{R}{W} = \frac{\sin. R' C W}{\sin. R C R'}$$

Or, if we call the angle the coned wheel makes with the horizon θ'

$$\frac{R}{W} = \frac{\sin.(18) - \theta')}{\sin.(\theta + \theta)} \therefore R = \frac{\sin.\theta}{\sin.2\theta} W \qquad (1)$$

As the pressure on the rail is equal to the resistance of the rail, we have R as the pressure on the rail.

Now to find the horizontal pressure P (Fig. 2)

It is evident that the angle between

$$P \text{ and } R = 90^\circ - \theta'$$

$$\therefore P = R \cos. 90^\circ - \theta'$$

$$= R \sin. \theta \qquad (2)$$

Substituting R, value from (1) we have

$$P = \frac{\sin. 2\theta'}{\sin. 2\theta} W$$

$$= \frac{\sin. 2\theta}{\sin.\theta \cos.\theta} W$$

$$= \frac{\sin.\theta}{2\cos.\theta} W = \tan.\theta \frac{W}{2}$$

$$= \tan.\theta \frac{W}{2}$$

and as $\frac{W}{2}$ is a constant, the value of P varies with the value of tan. θ

If $\theta = 0$, that is, if the wheel be cylindrical

$$P = \tan. \frac{W}{2}$$

$$= 0 \frac{W}{2} = 0$$

that is, there is no horizontal pressure.

If $\theta = 90^\circ$, that is, if the wheel were simply vertical, and had no horizontal surface (an imaginary case)

$$P = \tan 90^\circ \frac{W}{2}$$

$$= \infty \frac{W}{2}$$

that is, the horizontal pressure is infinite.

If $\theta = 45^\circ$, that is to say, the wheel be coned to 45°

$$P = \tan 45^\circ \frac{W}{2}$$

$$= 1 \times \frac{W}{2} = \frac{W}{2}$$

that is, the horizontal would equal the vertical pressure.

If $\theta = 5^\circ$

$$P = \tan 5^\circ \frac{W}{2}$$

$$= \cdot 0873 \frac{W}{2}$$

Thus it is clear, that the horizontal pressure varies as the tangent of the angle that the coned surface makes with the horizon.

5 chain radius = 110 yards

Diam. yards.			yards.	
220	× 3·1416	=	691·152,	length of outer circle.
217	× 3·1416	=	681·7272,	length of inner circle.
	Difference		9·4248	

and $\frac{9 \cdot 4248}{4} = 2 \cdot 3562$ is the difference in length between a quarter of the two circles.

W. N. H.

COLOUR AND COLOUR BLINDNESS.

By "OMICRON."

(*Continued from page* 122.)

In the undulatory theory of light, difference of colour is accounted for by the frequency of the vibrations, or the number of impulses made on our nerves in a given time by the ethereal molecules next in contact with them, precisely as in the doctrine of sound the frequency of the aerial pulses, or the number of excursions to and from its point of rest made by each molecule of the air, determines the pitch or note.* The shortest wave produces violet light; the longest, red. Sir John Herschel has composed the following table, in which he gives the length, and the rapidity of the coloured rays of the spectrum, assuming the velocity of light to be 192,000 miles per second:—

Coloured ray.	Length of luminous rays in parts of an inch.	Number of undulations in an inch.	Number of undulations per second.
Red	0·0000256	39180	447 mils. of mils
Orange	0·0000240	41610	506 ,,
Yellow	0·0000227	44000	535 ,,
Green	0·0000211	47460	577 ,,
Blue	0·0000196	51110	622 ,,
Indigo	0·0000185	54070	658 ,,
Violet	0.0000174	57490	699 ,,

From this table we see that the sensibility of the eye is confined within much narrower limits than that of the ear, the ratio of the extreme vibrations being nearly 1·58 : 1, and therefore less than an octave, and about equal to a minor sixth. That man should be able to measure with certainty such minute portions of space and time is not a little wonderful, for it may be observed, whatever theory of light we adopt, these periods, and these spaces, have a *real existence*, being in fact deduced by Newton from direct measurements, and involving nothing hypothetical, but the names here given them. What marvellous mechanism must pervade Nature, to see in the flashing of an eye the innumerable and varying hues with which the earth is carpeted, the birds gorgeously plumed, and that distinguishes the races of animals and man!

But an acute discrimination of colours is not given to all alike, and we do not speak here of the effect that education in colour produces on the eye, but the natural inability that exists with some individuals to detect certain colours, and which no amount of education, or acquaintance with colour, will entirely obliterate. Among sufferers from colour blindness, a wide range of relative degrees of inappreciation to colour exists. The first, and the most severe case, is fortunately rare. It occurs when the sufferer can discriminate between no two colours; when the entire spectrum such as we have described arising from the decomposition of light by a prism presents merely gradations of light and shade, of black and white. In Taylor's "Scientific Memoirs," 1846, several cases of this strongest form of what is properly called colour blindness are placed on record, some of which we shall quote in the sequel. Another form in which colour blindness (and here the term is inappropriately applied) manifests itself is constituted by an inability to discriminate between the nicer shades of the more composite colours, such as browns, greys, and neutral tints, and there exists a last class, with whom it is difficult to distinguish between the primary colours, red, blue, and yellow, or between these and secondary colours.

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* Sir John Herschel art, "Of Light," in the "Ency. Metrop."

When we speak of the existence of an eye, perfectly formed, that was totally incapable of detecting any difference in colour, and with whom all colours resolved themselves into intermediate shades between black and white, we do not mean to be understood that perfect achromatism has ever been met with. The subject has never been treated with that care by medical men to enable us to assert that any eye, perfectly formed, is under all circumstances insensitive to colour. The apparatus for polarising light has enabled the philosopher to produce the most brilliant and purest tints, and till an eye has been subjected to every test that can be suggested shall we be warranted in asserting that a case of absolute achromatism has been produced? "And even if a human eye were altogether unimpressible to colour, it seems exceedingly doubtful whether we should be able to discover that it was so. We have it not in our power to subject an eye simply to the influence of colour. Every luminous ray is a bundle of colour-giving, heat-giving, and chemical or actinic rays, mingled in unequal proportion. Each colour ray, therefore, carries with it to the retina a different number of heat rays and chemical rays. Thus, if for simplicity's sake, we assume only three colours to exist, red, blue, and yellow, then the red ray of the spectrum is, in reality, when tried by the thermometer, much hotter than the blue or yellow. The blue, which is the coldest and darkest of the three primary colours, greatly excels the red and yellow in the number of chemical rays which accompany it, whilst the yellow, which is totally destitute of such rays, and contains very few heat rays, must necessarily consist almost entirely of colour rays, and further excels red and blue in luminosity. The retina, accordingly, in so far as it is affected by heat, will be most influenced by the red ray, in so far as it is susceptible of chemical change, by the blue ray; and in so far as it is influenced by luminosity by the yellow ray, apart from the special impressions made upon it by each ray in virtue of the colour." When, therefore, we ask any one to gaze at a rainbow, and tell us what he sees in it, we ask him to report on a series of complex sensations, to the production of which the brightness, heat, colour, and chemical force present in the light by which he sees it, all do, or at least may, contribute.* It is not probable, therefore, that if we were to paint a rainbow in streaks of black and white paint mixed in due proportion, that we should be able to reproduce before a colour-blind person the exact effect that a rainbow presents to him, because there might be a certain chemical quantity wanting, which in the original rainbow produces an impression on the eye of the colour-blind, though it is not such an impression as is produced on a normal eye by colour. For instance, Mr. Pole, whose eye is undoubtedly blind to red, and who distinctly asserts that "there is a hue of red which to me is colourless," could not form a red by merely mixing black and white in due proportions, but who to make red mixed one part of lampblack with five or six of *chrome yellow*, so as to darken it to the required tone. Carmine to his eye was produced by mixing nine parts of lampblack with one of *chrome yellow*. A peculiarity is often noticeable in the colour-blind, by the ease with which they can detect objects assisted by the least possible light. A case is mentioned in Wartmann's paper on the Colour-Blind, of a woman who could detect no difference of colour in the prismatic spectrum, and yet could read a book in a completely darkened room. This may be accounted for by supposing that the perception of different coloured tints to a normal eye induces a certain amount of fatigue to the retina, and renders it less sensitive to faint light, from which the colour-blind are free. Nor is it to be supposed that in cases where a normal eye perceives an object by the difference of colour from the objects surrounding it, that a colour blind eye sees the object of a smaller size. For instance, in the spectrum thrown upon a white screen, a normal eye is sensible to its appearance by the variation of colour, from the red extremity to the violet; to the colour-blind the spectrum is equally long and perfect in every particular except colour, and the eye is made sensible of its existence by the different degree of illumination that each colour presents, and if the colour-blind person had given to these different shades the terms red, blue, green, &c., it would be impossible to discover, from his description of what the spectrum presented, that he was a sufferer from colour blindness. This fact is particularly shown by the description of the spectrum by persons affected with colour-blindness in the second degree, that is, when two colours present precisely the same appearance, so that one colour cannot be detected from the other. Dalton was very particular on this point. The spectrum appeared as long to him as it did to Sir David Brewster, only Dalton saw one colour twice over. An instance of this severe deprivation of sensitiveness to colour is described in the "Philosophical Transactions" for 1777, in a letter from a Mr. Huddart to Dr. Priestley. The subject was a shoemaker, named Harris, living in Cumberland. The following is the account he gives of himself:—"That he had reason to believe other persons saw something in objects which he could not see; that their language appeared to mark qualities with precision and confidence, which he could only guess at with hesitation, and frequently with error. His first suspicion of this arose when he was about four years old. Having, by accident, found in the street a child's stocking, he carried it to a neighbouring house to inquire for the owner; he observed that the people called it a *red* stocking, though he did not understand why people gave it that denomination, as he himself thought it completely described by being called a stocking. This circumstance, however, remained on his memory, and, together with subsequent observations, led him to a knowledge of his defect. He also observed that when young, other children could discern cherries on a tree by some pretended difference of colour, though he could only distinguish them from the leaves by the difference of their size and shape. . . . . . I believe he never could do more than *guess* the name of any colour, yet he could distinguish white from black, or black from any white or bright colour. In general, colours of an equal degree of brightness, however they might otherwise differ, he confounded together." * There can be little doubt but that this is one of the few reliable cases of a complete insensibility to colour, and it is also related in the narrative of Mr. Huddart, that this man had two brothers similarly affected, and two other brothers and two sisters whose vision presented no peculiarities. The fact of this defect manifesting itself in more than one member of a family is not uncommon; and there is an instance of a gentleman who had *seventeen* relations that suffered more or less from this false vision, and often it appears that only the male members of a family exhibit this peculiarity. Indeed, the phenomena is much rarer among females than among males, and our ingenuity may be tortured to account for this fact. It is however certain, from the facts that Dr. Wilson collected, that when a female is marked by this peculiarity she exerts herself to the uttermost to hide it, which render statistics concerning female colour-blindness very difficult to accurately ascertain, and lead us to suppose that the number is less than is really the fact.

Mr. Inglis, of Edinburgh, reports a rather amusing case of total colour blindness in the person of a *house painter:* "The explanation of his prosecuting a calling for which apparently he was so unfit is found in the fact that he was an excellent draughtsman, with a good eye for form, and skilful in designing. He trusted to his wife to keep him right in mixing and selecting his colours. On one occasion when she was out of the way, and workmen were scarce, he took a part himself in painting a public building, which he had been employed to put in order. He mixed the colours himself, and believed that he had produced a *stone* tint, with which he proceeded to colour the walls. After he had gone over some square yards, he was informed that he was painting the building *blue.*" *

The second division that we have made among colour-blind people is marked by the inability to discriminate between the nicer shades of the more composite colours, and this class comprehends a far greater number of subjects than either the first or last. In this class the miscomprehension of colour is one of degree, and not of totality, and Dr. Wilson remarks that this defect seems to be rather the rule than the exception—at least among the male sex of this country. A defect of vision of this nature is probably to be overcome in some degree by education, and continual attention to colour. The inability to name a colour does not necessarily prove that the difference of the colour from any other is not marked on the retina. The scanty nomenclature employed by men generally in describing colour might lead one to suppose that they appreciated far fewer shades of colour than is actually the case. Even educated men are to be found who would call scarlet crimson, and magenta indiscriminately red, although they would be distinctly aware of difference between the colours arranged side by side. To judge, therefore, by the inability to name colours, we should conclude that colour-blindness was much more common than it fortunately is. In testing, therefore, for this slight degree of non-discernment of colour, it is necessary to dispense with names of tints. Give to a person a number of squares of cloth, or skeins of wool, and request him to arrange them so that all of the same colour and shade may be placed together, in gradual succession from dark to light. We ourselves have submitted this test to many of our acquaintance, and our experience is very similar to that of Dr. Wilson. Many will have no difficulty in arranging the full bright tints of the primary and secondary colours, but when the fainter tints come to be arranged, great hesitation will be often evidenced as to which bundle they ought to be placed in. The most frequent mistakes occur in blue and green (of course the test is made in full daylight), while pink and pale blue are a stumbling block to many who are able to arrange all the other shades, and the pink and pale yellow are often interchanged. "In truth we are all by birth, colour-blind to some extent, and painters know how long it is before the most susceptible eye acquires its maximum sensibility to colour."

For the general purposes of life, the slight error in the discernment of colour that this class exhibits is not likely to produce any very ill effect; not so, however, in the third and last division, in which the sufferers see no difference between the primary colours, red, blue, and yellow, or between these and secondary colours, or where the difference is so slightly marked that hesitation and confusion between these colours exist in the mind of the beholder. Dr. Wilson has devoted a large portion of his book to the consideration of circumstances in which colour is made to convey a certain amount of information to the mind, as in the case of railway signals and ships' lights. It is an unfortunate circumstance that, in the case of people who confound colours, red and green are the two colours that most often present a similar appearance to the eye, and the importance of these two colours in railway signalling is well known, and Dr. Wilson wisely doubts, considering the general prevalence of colour blindness, but that among the army of guards and signalmen of this country and the continent some cases may be found where the difference of red and green cannot be detected, and the danger of travelling is consequently increased. To those who are interested in the question we recommend his book, where they will find many amusing and instructive pages.

(*To be continued.*)

Dr. G. Wilson on "Colour Blindness."

* "Philosophical Transactions," 1777.

* Dr. Wilson, Op. Cit.

DRESSING MILLSTONES WITH THE DIAMOND OR "BORT."

(Continued from page 128.)

THE first who appears to have thought that the action by which the glazier produces a rectilinear crack along the surface of glass with his diamond might be availed of for producing a series of fine grooves or cracks on the surface of a millstone, so as to form a suitable dress thereon, was D. M. Childs, of Rochester, United States, and a patent was obtained for his invention in this country by A. B. Childs, on 23rd August, 1861, No. 2107. In his provisional specification Mr. Childs says :—

"The particulars of this invention relate to the application of the diamond or other mineral-cutting substance in the production of the small lines (or what is generally known as the cracking), in any required form upon the face of millstones. The diamond or other mineral cutting substance (of which one or more may be used) is to be drawn by the hand or by mechanical agency, so that the cutting edge or edges may cut into the face of the millstone, the fine line or cracks, instead of the ordinary metal mill-bill now used. Although I prefer the diamond to be drawn by the hand or by mechanical agency, I do not confine myself to that particular mode in the application of the diamond for the aforesaid purpose."

In his final specification, however, he makes no reference to "mechanical agency." Fig. 3 is a view of the instrument he uses, which is described in the following extracts from his specification, along with other interesting details :—

"The tool is composed of one or more diamonds inserted in a bit or handle, and when two or more diamonds are used, they are to be firmly set in a row at equal distances apart. The furrows or cracks are produced by running with adequate force the points or diamonds over the face of the stone where the lines are intended to be cut, and such operation may be conveniently performed by running the tool containing the diamond along the edge of a straight rule. Curved lines are made by operating the same diamond points by the side of a curved rulet. The width of the space separating the lines upon the grinding surface of the stone is regulated by holding the points more or less diagonally across the lines of motion.

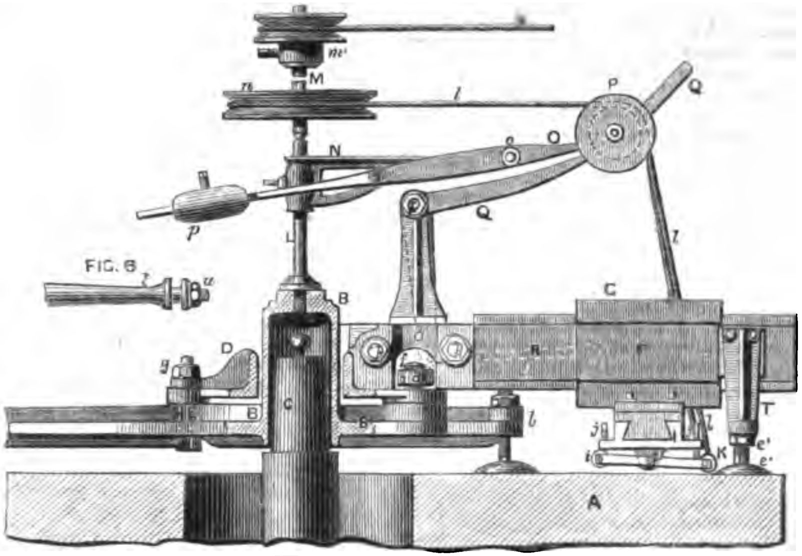
"In order to show the precise nature of my improvements I will explain the ordinary modes of dressing millstones. In the ordinary mode, the pick, being brought down upon the face of the stone, produces the stellated fracture, and thereby weakens or disintegrates the stone as far as the fracture extends, and the edges of the crack which have been thus weakened by the blow from the pick soon crumble away, and the particles thus detached are thrown out and wear the face of the stone. These disadvantages are prevented by my improvements in dressing millstones.

"The line cut by the diamond upon a glossy surface, which has never been detonated or disintegrated by a blow from a pick, is clear and distinct, having its edges sharp and fine. Millstones will be more perfect when dressed again according to my invention, as the diamond will cut below the bruises occasioned by the old mode of dressing with a pick.

"In the old mode of dressing with a pick the furrow is rough and nearly flat at the bottom, whereas furrows cut with the diamond are smooth, having the side upon which the grain rises a regular smooth inclined plane. There is no perceptible moisture generated in the operation of grinding with millstones dressed according to my process, and the sprouts are clean and dry, which I attribute to the fact that the grain is kept back or in towards the eye until well ground, and while the motion is less rapid, and consequently less liable to heat. When the flour has reached the extreme of the breast circle it is rapidly thrown from the stone with few, if any, inequalities to retard its egress, and it will be found that much less power is required for grinding, when my mode of dressing is employed, to produce the same amount of a superior article of flour."

There cannot be a doubt but that millstones can be dressed by Mr. Childs' process in a practically satisfactory manner, and with much better results than by the steel pick ; and it is to be regretted, as Mr. Childs was the first to use the diamond, that he received so little encouragement, and did not think it worth while to maintain his patent beyond its third year. Recent experience, however, makes it pretty pretty clear that his want of success was in a great measure owing to his using the common translucent glazier's diamond, instead of bort, which latter is not only less expensive, but in every way better suited for the purpose, as we shall shortly explain. It is true Mr. Childs included "other mineral substances" in his patent, but we understand his actual trials were confined to the common diamond.

FIG. 4.



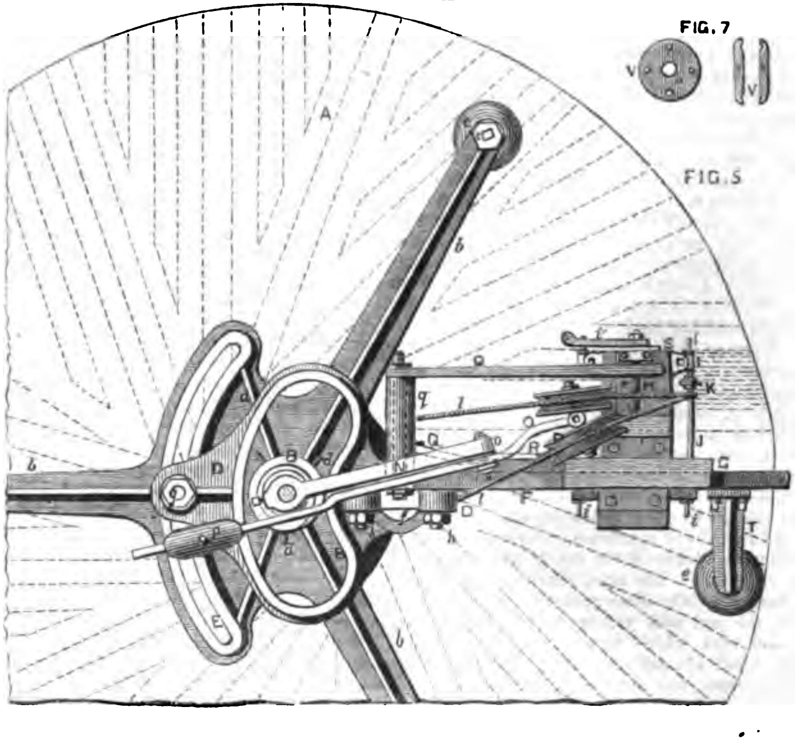


FIG. 7

FIG. 5

The second to use a diamond for millstone dressing was J. Dickinson, of New York, who invented a kind of parallel ruler for guiding the hand in drawing the diamond along the surface of the stone. His invention was patented in this country in the name of J. A. Knight, on 16th January, 1862, No. 118. The ruler was provided with a ratchet-feed motion, by which the distances apart of the lines were rendered regular ; but the ruler covered only a very small portion of the stone at a time, and in no way tended to preserve its truth or level.

In 1864, J. D. Jobin obtained a patent (No. 148) for a great variety of machine tools specially adapted for applying bort or carbon as cutters in working stone, marble, and other hard substances, and some of the combinations could have been used for producing the fine-groove dress upon millstones. It does not appear that they have as yet been used for that purpose, but there can be no doubt that this patent covers any use of bort as a substitute for steel covers. Indeed, the importance of this patent will necessitate our again referring to it.

To Samuel Golay, of Paris, undoubtedly belongs the credit of first introducing a practically successful method of dressing millstones otherwise than by the old handbill, and his merit is in no way diminished by the fact that since his plan was made known, others of at least equal efficiency, and possessing some advantages over his, have made their appearance. Golay's apparatus was shown in the Paris Exhibition, but attracted no attention. It was patented in this country in the name of G. Davies, on 30th April, 1867 (No. 1245). The British patent was purchased at the commencement of 1868 for, we believe, something less than £4000. The invention was practically tested, and it was decided to charge millers a royalty of £50 per pair of stones for the right to use it, several millers valuing it so much as to be quite willing to pay that sum. The original purchasers of the patent were fortunate in finding numerous parties willing to take off their hands the trouble of dealing individually with the multitude of millers scattered over the country, and by the middle of the same year they had sold licenses for various districts for prices amounting altogether to close on the amazing sum of £200,000.

Our readers will be curious to know the details of a machine occasioning such extensive transactions in so short a time, and we need no excuse in transferring from the specification to our columns the following full description :—

"It is well known that for several years the employment as a tool of hard stone, and especially of the diamond, has been adopted in various trades. Different applications have been made of these stones in working stones less hard, such as granite and others, and it is by a new application of this principle that the inventor has arrived at the solution of the difficult problem of cutting and dressing millstones.

"The invention comprises two essential points: firstly, the application of hard stones, and especially of the diamond, to cutting and dressing the millstones, this diamond acting so as to split off or chip the stone (exactly as the hand hammer does) by attacking it with blows succeeding each other with a great rapidity; the said blows may be produced by either a rotary or rectilinear motion, but the tool or diamond carrier which has been found to work best in practice acts by rotation, and in giving to this rotation a certain rapidity, a true chipping motion or succession of shocks is produced which attacks the stone, and by causing it to chip or fly off in minute fragments, produces the desired work.

"Secondly, an entirely new machine by the aid of which the diamond is caused to work, and which will be understood from the following description: Fig. 4 is an elevation (shown partly in section) of the improved apparatus, and Fig. 2 is a plan view of the same, as seen from above.

"The machine comprises a frame B consisting of a central socket, from which radiate the three arms *b* furnished with screws *c*, which serve for levelling the apparatus; this socket is placed on the end of the millstone axle C, so as to centre the machine by means of set screws *d* when the fixed or bed stone is to be dressed, but if the running stone is to be operated upon, then the centering is effected by means of a plug of wood which is fixed in the socket, and the end of which passes into the eye of the stone. The levelling screws *c* do not bear directly upon the surface of the millstone A, but upon small plates *e* of cast iron which rest upon the latter. On the framing is mounted a support D capable of turning on a fixed bolt *f*, and of being secured in any desired position by means of another bolt *g*, which is capable of being moved in the curved slot E in the framing; to the support D a dovetailed slide F is connected by two screws or bolts *h*, and it is upon this slide that the tool carriage G moves; the slide F, which generally maintains the horizontal position shown in Fig 4, may, however, be slightly inclined when it is required to dress the central hollow part of the stone where the corn enters; this is effected by slightly elongating one of the holes through which the bolts *h* pass. The carriage G can move on the slide F from the centre to the circumference, and *vice versa*, and, moreover, it carries a slide H capable of moving in a direction transverse to that of the principal carriage; this slide H carries below it the tool carrier I, which is mounted upon points or pivots *k*, and may be fixed in any required position by means of the pressure screws *j*; in this tool carrier the axle J of the tool K turns upon the points or ends of the screws *i*; the tool carrier is also provided with two other pointed screws i^1, upon which the tool is mounted when it is required to work near the centre. The tool K consists of a disc (hereinafter more particularly described) furnished on its circumference with a tooth of diamond or other hard stone either in the rough or cut, and caused to rotate rapidly by means of an endless cord or band *l*. In the top of the socket B of the framing a small column L is screwed, the upper part of which forms a kind of footstep in which the pointed end of a shaft M turns; the latter receives its movement from any convenient shafting or motive power by means of a cord or band passing round the pulley *m*; its other pulley *n* gives motion to the cord or band *l*, which causes the tool to rotate. The column L carries a bracket or gallows N, which may be fixed at the desired height and position by means of a set screw; this bracket is furnished with a fixed stud *o*, on which a lever O freely oscillates; the latter carries at one of its extremities the tension pulleys P, which guide the cord *l*, and at the other end a counterpoise *p*, which tends constantly to raise the pulleys P, consequently the latter preserve the tension of the cord *l* during all the movements of the carriage G. A to-and-fro motion is given by hand to the carriage G by means of the bell-crank lever Q which turns on a fixed centre at *q*, the lower arm of this lever being connected to the carriage by a link R. The lateral setting of the line H, and consequently of the tool K, is effected by means of a screw *r* and a ratchet motion S. To counteract the ill effects of deflection, which the weight of the carriage might produce upon the slide F, a supplementary foot T is fixed to that side of the latter opposite the carriage, this foot being curved so as to allow of the free passage of the carriage from end to end of the slide; the foot T is provided with a screw c^1 and a plate c^1.

"The operation of the machine is as follows:—The apparatus being placed upon the stone is levelled by means of the screws *c* and c^1, regulating the height in such a manner that the diamond tooth of the tool will be at about the height desired. The adjustment of the height of the latter is completed by the screws *j*. The machine is centered by means of the set screws which press against the millstone axle or the wooden plug which is placed in the socket B. The machine is so placed that the slide F is parallel with the groove to be dressed; the shaft M is then put in motion, giving movement to the cord *l*, and consequently to the tool; then by the aid of the lever Q, movement is given to the carriage G, which thus moves along the slide F; during this movement the diamond tooth of the tool K, which turns with great rapidity, attacks the surface of the millstone, and forms a radiating furrow therein; the carriage is then drawn back by the ratchet movement S, the slide H is moved laterally, carrying the tooth with it, and a second furrow commenced. This operation is repeated across the groove of the stone to the end of the traverse of the slide H, after which, following grooves of the same division or group, the machine is slightly turned, and the parallelism of the slide with the groove is effected by turning the support D round the bolt *f*, which is then fixed in position by means of the bolt *g*; the carriage is then set in motion again. The position of the machine must be changed for each division or group of the furrows. As there are some millstones furrowed to the right and some to the left, the machine is so arranged that the slide F may be fixed on either side of the lug of the support D to which the bolt *h* attaches it. The position of the carriage and its movement may thus be reversed for left-hand grooves. It will be observed that the pivoting of the support D round its bolt *f* is not theoretically indispensable, but if this facility were not afforded, a much longer movement of the slide H would be required to reach the three furrows of the division, and consequently there would be a greater danger of its getting out of truth.

"It may also be stated that the particular arrangement of the apparatus which is shown in the drawing is that which the inventor considers the most practical, but this arrangement may be varied without departing from the principles of the invention. The diamond also, instead of acting by rotation, might operate on the millstone by means of a rectilinear or vibrating motion. The diamond, or other hard stone, may be mounted in a great variety of ways. The arrangement represented at Figs. 6 and 7 is that which the inventor considers best to unite the conditions of simplicity and solidity; it consists of two discs or washers capable of being screwed together on an axle between the shoulder *t* on the latter and the screwed nut *u*. In the interior faces of these discs, and near to their circumference, are formed small recesses *v* of different sizes (see Fig. 7); these recesses are opposite to each other in the two discs, and when the latter are brought together form hollow cells having a small opening at the circumference of the disc; a piece of diamond or hard stone is fitted into one of these cells, so that a point or angle projects through the hole in the circumference, and the two discs are then screwed together by means of the nut *u*, so as to hold the diamond perfectly firm, and the tool is complete."

(To be continued.)

HAWKINS'S FIRE ESCAPE.

THE accompanying sketch illustrates an ingenious arrangement for a fire escape, which is intended to form a house fixture, so that it may always be ready for service in sudden emergency. The apparatus consists of a square net of sufficient length to reach from the upper story of a building to the ground, and so formed that the meshes can serve as a ladder, or as a means of lowering easily such persons as are too unnerved to descend by any other process than that of simple gravitation.

The whole apparatus, when out of use, is stowed away within a box placed within the room, and beneath the window, and, when required, the cover of the box is thrown open, and forms the platform from which the net is suspended, holding chains being attached to the net, and secured to the floor of the room, as shown in Fig. 2. In the same figure it will be seen that a small winding drum forms part of the apparatus, and is used for raising the escape by means of a light chain attached to it for this purpose (see perspective sketch). The network, which is formed of chains, is sufficiently large at its mouth to admit a moderate-sized person freely, but, as it contracts in its dimensions from its own weight as it nears the ground, the individual making use of it would be enveloped in its contracting folds, and force his way to the bottom without injury. In practice it will be found expedient to secure the lower end of the net at some distance from the building to which it was attached, in order, as far as possible, to obviate the unpleasant consequences inseparable from the contact of sliding humanity with hot chains. At the present time, when the question of compelling fire escapes to be attached to dwellings is being discussed, such an arrangement as the present ought to be well received, and, indeed, we believe that it is highly spoken of in influential quarters. New York has set us the example in insisting upon the providing of fire escapes to separate houses, and some 11,000 buildings have already been fitted with them. It is an example our municipal authorities would do well to imitate, and would certainly be the means of saving many lives which are now annually sacrificed.

FIG. 1

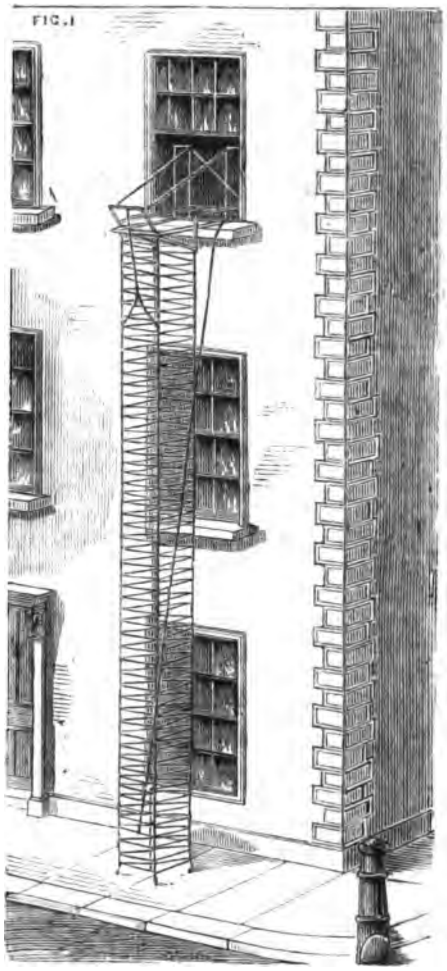
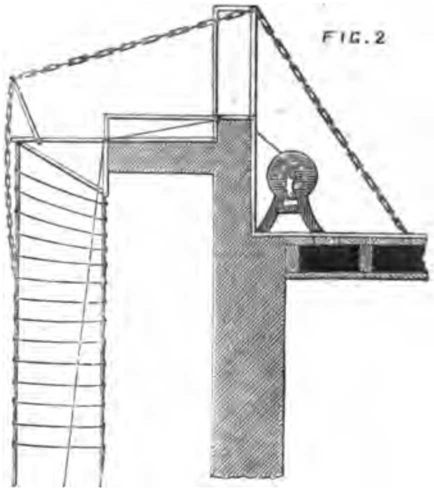


FIG. 2



SCIENCE FOR THE YOUNG.

By the Rev. E. Kernan, Clongowes College.

(*Continued from page* 106.)

§ III.—Inertia.—(*Continued.*)

APP. II. Card and Coin. The well-known experiment of poising on one finger a card with a small coin above, and filliping the card from under the coin, requires a certain dexterity for success. The principles of this experiment can be shown upon a table without danger of failure. A slip of wood *a* is laid upon a table, Fig. 14, and a small weight placed upon the end of the slip. Now, draw the slip *gently*, the weight moves with it, *a*; there is time for the motion to take effect upon the weight. 2. Draw the slip *quickly*, the weight is left behind; there was not time. So with the card and coin, a slow stroke throws both off the finger, a smart flip to the card leaves the coin on the finger. This experiment, as in Fig. 14, will succeed with even the lightest body, but according to the principles I. IV., the lighter the body the quicker must be the motion.

App. III. Rod broken. A rod of wood laid upon the edges of two glasses full of water may be broken by a smart blow without even spilling the water, Fig. 15 *a*. It may even be done when the rod rests upon two inverted bottles, *b*. The quick blow breaks the rod before there is time for the motion to take effect on the glasses or bottles. A bar of wood is quite heavy enough to strike with. It is well to note that it is quite possible to spill the water, and to break the glass. A very great point to mind is the steadiness of the foot, *f*. The glass should not rock about. Of course the shorter and wider the tumbler, the less danger of failure.

FIG. 14

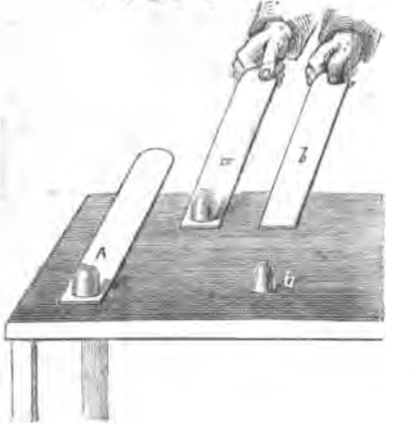
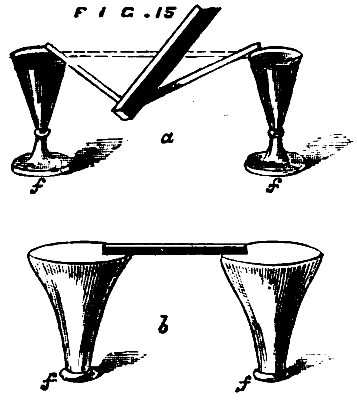
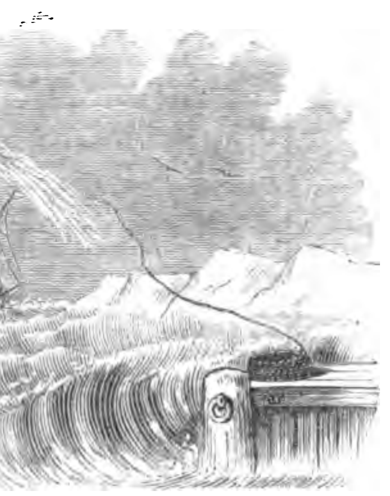


FIG. 15



App. IV. Rocket ropes. One of the great difficulties in throwing a rope from the shore to a ship in distress is to have the rocket move so slowly that there is time to overcome the inertia of the rope, or, in other words, to so coil the rope that it can receive the quick motion of the rocket. When it is not so coiled, the rope acts as the weight in Fig. 11, *b*; the first part of the rope is torn from the rest, which, from inertia, is immovable, Fig. 16. Much attention has been given to this important subject, both as to the projectile and the coiling or "faking" of the line, as it is termed. A good deal of interesting details may be seen in the English Mechanic, Vol. IV., p. 296, and Vol. V., p. 11. There is one point very much to the present subject, that the rocket is superior to shot, in consequence of its getting into motion gradually, whereas the shot starts at full velocity, and with a jerk.

FIG. 16



App. V. Deep-sea cables. While paying out a cable in deep water, there is considerable danger, in a rough sea, of a sudden snap from a lurch of the ship, which did happen in the laying of the first Atlantic cable. There was a mile or more of the cable hanging astern, and the brakes on deck were full on. The vessel gave a sudden pitch; there was not time to communicate the motion to the great weight of cable in the water; it parted.

App. VI. Projectiles. A bullet from a rifle will make a clean hole in a pane of glass; a cannon ball will go through a door open without closing it, &c. There is not time for the projectile to communicate the motion.

App. VII. Equestrian jump. The apparently difficult feat of jumping from a horse through a ring requires but one motion on the part of the performer. His body, by inertia, partakes of the forward motion of the horse; hence he need only rise up to arrive safe on the horse's back. Of the exact path of his flight in another place. In the same way, a person sitting in a railway carriage going at express speed may throw a heavy body—a ball, for instance—up into the air; it will fall into his hand, although he has advanced a yard or more while the ball was in the air, and it will seem to him to move in a straight line. A stone let fall from the window of the carriage seems to move straight down: not so to an observer standing on the road; the stone moves forward, &c. Wherever there is motion in a body, anything that separates from it continues, by inertia, the motion it had in common with the body.

App. VIII. Accidents from inertia. A horse stops suddenly; the rider may pass over its head unless prepared to resist the inertia of his own body. A person running, trips upon a straw, the upper part of the body moves on and causes a fall. In railway collisions, all are tossed about inside, or, strictly, toss themselves about, from the motion which they had acquired in the train; the waggons dash against one another with terrible force; and such is sometimes their inertia action, that they rise from the road and pile themselves one over the other, &c. In any body where there is motion, if this be suddenly stopped all that was connected with the body *has its* motion, if not rigidly joined, so as to resist the action of inertia. On the other hand, sudden quick motion of a vehicle may cause a person, standing especially, to be thrown about; some vehicles might drop a person on the road; a boat shot forward, those standing at the stern are thrown in the water; precious goods may be injured if carried off suddenly from a table, &c. Where there is rest, instant quick motion may cause an accident.

App. IX. Uses of inertia. Rope-walkers lean for an instant on the pole which they carry in their hands, and which, for an instant, is immovable; instrument handles are fastened or removed by a sharp stroke at either end; the instrument is for the instant inert; turning chisels and all others having no flange act thus: also plane-irons, spade-handles, and all of that sort, are tightened by the handle being struck against some immovable body; the head, by the motion acquired in striking the handle, moves on, through the action of inertia, along the point of the handle, when this is stopped by the stroke.

App. X. Liquids. Their inertia explains the difficulty that one has to carry a tray full of water. At each step the water moves on, and continues to move by inertia, when involuntarily the tray is stopped while taking the next step. Any effort in the opposite direction causes inertia to act towards the person. On a table a small flat tray with water exemplifies well the inertia of liquids; a quick movement, or a short stoppage, will nearly empty the tray. Waves in the ocean are an example on a grand scale of liquid inertia. Long after the storm has ceased, it is still disturbed, tossing and surging. On the other hand, the winds may blow for some time before the great waves are produced.

App. XI. Gases. The path of storms, another great natural phenomenon, is due to the inertia of the gaseous state. Sometimes these storms pass in a broad belt, outside which all is calm. Whatever may be their cause, they have gone by before there was time for the surrounding atmosphere to be set in motion.

Problems.

At the end of each *important* matter a few questions will be proposed, to be explained by the student according to the principles just established. These problems will sometimes be an exercise in the use of formulæ, at other times they will be facts, well known or extraordinary, to be accounted for, or else the conditions of certain results desired, or the results of certain conditions.

Prob. I. Were an engine to start at full speed, what would be the consequence to the train?

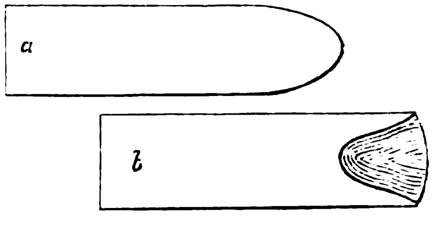
Prob. II. Why does a train slacken its speed so long before it comes to a station?

Prob. III. What would be the effect of letting an anchor fall from the last carriage of an express at full speed?

Prob. IV. How should one jump from a vehicle, against, across, or with the motion, and what would be the consequence in each condition?

Prob. V. In certain artillery experiments at Shoeburyness, some heavy pointed shot was found, after striking the target, to have its point reversed; its form was that of a roll of paper, of which the centre was pushed in. Fig. 17, *a*, shot before striking, *b*; section of shot after. Explain by inertia.

FIG. 17.



Prob. VI. Recent experiments have shown that sensations in the human body are transmitted at the rate of 29 metres per second. Why so very slowly compared with sound, light, electricity?

(*To be continued.*)

Corrigenda.—At page 79, line 6, col. 1, read *the laws* of equilibrium; Fig. 3 and 8 should be in chap. II.; 3 in the 2nd, 8 in the 3rd column; in line 41, 2nd col., for small read *closed;* line 89, *vernier v*, not vernier √; line 93 the vernier will be 19, 20 division divided into 20, 30. Col. 3, line 1 *space* not pace.

In Russia vaccination is not compulsory. According to official returns, 10,250,000 persons have died of small-pox in that country during the last seventy years. What say our friends of the Anti-vaccination League to this?

FIG. 1

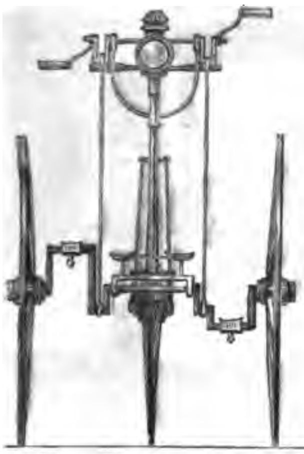
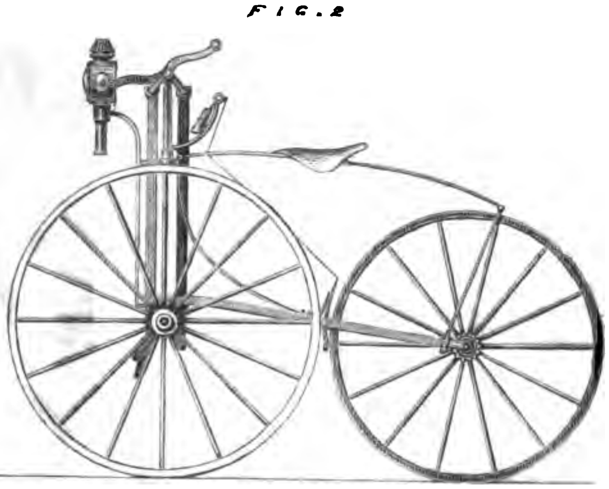


FIG. 2



DOIRIER'S IMPROVED VELOCIMANE.

MARTIAL DOIRIER, of Périgueux, Dordogne, France, a coachbuilder, has patented an invention for improvements in velocipedes. The idea of utilising manual power by combining it with well known mechanical principles to cover a given distance much more rapidly and with much less fatigue than by the means of locomotion natural to mankind is not new, as is proved by the various and numerous systems of velocipedes which have already appeared. Nevertheless, and despite their number, these various processes imperfectly accomplish the object with which they have been conceived, and none completely fulfil all the conditions requisite to the simple and regular action that should form the basis of their construction. The patentee believes that he has solved this problem by the production of the locomobile apparatus, to which in view of its special construction he has given the name of "velocimane." This novel aid to locomotion, or locomotive engine, has three wheels, two in front, the other behind. This number is not, however, invariable, and some may be constructed with four wheels, which would materially increase the original stability. The impulsion is given mainly by the action of the feet of the rider upon two pedals with cranks, these giving a rotary motion to an axle, which in its turn transmits it to the two front wheels. This axle is an entirely novel application; it has a double action; that is to say, its particular arrangement permits it in the first place to turn on itself, and further to diverge obliquely to the right or left, and thus to give the direction. Two other cranks of less size than those first mentioned tie these latter to the axle; their main purpose is to receive the heads of two connecting rods, which at the opposite end couple on to a horizontal shaft. The axle revolves between two bearings fitted on two forked pieces acting as supports; it is governed by the pole pin or working bolt, which being of one piece with the part in question, thereby permits the desired direction to be given to the axle. The entire arrangement rests as it were upon the two forked pieces. The fore carriage has a moveable plate composed of two superposed parts, through which passes the working bolt, and which receives at its upper part a lantern bearer, and the support of the beam which upholds the hind wheel. Resting or guide pedals are fitted and fixed to the forked pieces. The following pieces meet on the working bolt: 1°. The main support of the seat, which receives the saddle intended for the rider. 2°. The arched support of the beam intended to receive and uphold the beam of the hind wheel. 3°. The support of the directing or guiding arm, which serves to give to the axle the oblique movements required during the journey, and in the second place to work a brake placed in front of the wheel. 4°. The support of the horizontal shaft, which by the aid of two crank handles communicates to the above-described connecting rods an alternate come-and-go motion, thereby producing the rotary propulsion. 5°, and lastly. The upper curved part for carrying the lantern. The two first and the last of these pieces do not however completely adhere to the pole pin or working bolt, but are united to it by the aid of a wrought-iron perforated piece on which they abut, and which traversed by the said pin facilitates its rotary motion; the other pieces mentioned above find their actual fulcrum upon the working bolt. Independently of the preceeding pieces the inventor uses a shifting click arrangement fitted to the fore wheels with the object of making them drive together or separately, but leaving them play enough to prevent any hindrance to their evolution. The result of this novel arrangement is claimed to be a much greater active power when mounting an incline, paved or unpaved, a requirement which no vehicle of this nature has hitherto met. Figs. 1 and 2 are respectively a front and side elevation of the machine.

REVIEWS.

Arithmetic, Theoretical and Practical, by W. H. GIRDLESTONE, M.A., of Christ's College, Cambridge, &c. Second edition, revised and enlarged. Rivingtons: London, Oxford, and Cambridge.

THE science of arithmetic has probably been favoured in a greater degree than any other with attempts at elucidation by those who least understood its guiding principles. These would-be teachers deemed it quite sufficient, after a few pages of weights and measures, and examples of numeration and notation, to give the most abbreviated description of the *rules*, dimly illustrated by marginal examples. All attempts at explanation of the principles on which those rules are based, and of which, indeed, they are merely the mechanical exponents, were (perhaps wisely) left to the care of the teacher, who, too frequently, was as unprepared for the task as the book he consulted. Mr. Girdlestone's book is a pleasant antidote to the remembrance of such works. His system insists on the clear comprehension, by the student, of reasons, and his book is, as he says, "a protest against the still common process of teaching 'sums,' which may be called the 'magical process.'" "Follow the *rule* as laid down," says the master, "do not trouble yourself about the *reason;* but do this—do that—and, hey-presto, the answer." We recommend the purchase of Mr. Girdlestone's book to those of our readers who require a comprehensive and comprehensible book on arithmetic.

The Gas Manager's Handbook, &c., &c. By THOMAS NEWBIGGING, A.I.C.E. London: W. B. King, 11, Bolt-court, Fleet-street, E.C.

THIS volume is an exhaustive cyclopædia of the literature of gas lighting. The author has laid his hands on everything good that already existed in the way of tables and statistics, and has embodied the whole, with many additions, in the form of a volume, the want of which has been long felt by gas engineers and managers. An interesting chronology of gas lighting is appended to the book.

Gas Economy—Things worth knowing about Gas. By ROBERT FERRIER, Inspector of Meters for the City of Edinburgh. London. Houlston and Sons; Edinburgh, Menzies and Co.

THIS little book is issued in the interest of the gas consumer. There are many things connected with gas lighting which, if attended to on the part of the consumer, would promote economy and comfort, and prevent occasional disputes between the company and himself. These Mr. Ferrier has successfully endeavoured to point out. His position renders him perfectly independent in the matter, so that the rights and duties of consumer and manufacturer are fairly stated. The cheap price at which the work is published must insure it a good sale.

ASTRONOMICAL NOTES FOR MAY.

BY A FELLOW OF THE ROYAL ASTRONOMICAL SOCIETY.

THE Right Ascension of the Sun at Mean Noon on the First of May is 2h. 33m. 48s., and his North declination 15° 5′ 56″. He is consequently about halfway between the three bright Stars in Aries, and the Pleiades; and somewhat beneath a line joining these two asterisms (Map of "Eastern Sky," Vol. X, p. 64.) He now souths before Mean Noon, and the Equation of time must consequently be subtracted from the hour indicated by a sundial. On the first day of the Month this equation is 3m. 2·7s., and increases to 3m. 58·5s. on the 14th, after which it diminishes, and on the 31st amounts to 2m. 38·6s. The Sun rises in London on the 1st at 4h. 35m., and on the 31st at 3h. 52m., setting at 7h 21m. and 8h. 3m. on those days respectively. He is consequently 14h. 46m. above the horizon at the beginning of the Month, and 16h. 11m. above the horizon at the end of it. As we are now arriving at the period of greatest solar activity, the disc of the Sun will for some time never be free from spots, and consequently will form a remarkable and attractive telescopic object. Details will be found at p. 169 of our last volume, of the most effective methods of observing the phenomena exhibited by our great centre of light and heat.

The Moon will enter her first quarter at 38 minutes past 3 on the afternoon of the 8th. Will be full at 3 minutes past 6 a.m. on the 15th; enter her last quarter at 6h. 9m. a.m. on the 22nd, and be new in the forenoon of the 30th at 57 minutes past 9. She will be in Perigee at 9 o'clock in the morning of the 14th, and in Apogee at 9 at night on the 26th. She will be in conjunction with Jupiter at 5h. 31m. a.m. on the 2nd, and with Mercury 3 hours later. At 10 o'clock on the morning of the 6th with Uranus; and at 20 minutes before noon on the 17th with Saturn; with Venus at 32 minutes past 5 in the early morning of the 26th; with Mars at 6.49 on the evening of the 28th; once more with Jupiter at 2 minutes past 1 a.m. on the 30th; and finally again with Mercury at 38 minutes after midnight of the same day. There will be three Occultations of Stars by the Moon during May; the first on May 14th when o^2 Libræ will disappear at the moon's dark limb at 11h. 29m. and re-appear at her bright limb at 12h. 21m. On the 16th ξ Ophiuchi will be occulted at the bright limb of the Moon at 8h. 34m., and re-appear at her dark limb at 9h. 29m., at which time she will be rising. Later on the same night, at 10.13, the Star 5866 of the "British Association Catalogue," will disappear at the bright limb, and re-appear at the dark limb at 11.19. The age of the Moon at noon on the 1st is 0·7 day; at the same time on the 2nd, 1·7 days, and so on. At 11 o'clock at night on the 7th, Libration will have brought an additional part of her S.E. limb into view: and at 6 a.m. on the 28th, more of the S.W. part of her disc than usual will be visible from the same cause.

Mercury is an evening star during May, and will be most favourably situated for observation on the 11th, and for a few days afterwards. He may then be picked up, glittering to the West of North above the sunken Sun. Venus is a morning Star throughout the month. She will be dichotomized a little before the middle of it. The young Student who may have observed her during the time she was approaching inferior conjunction in February, will notice how markedly her apparent diameter has now decreased. Mars is also a morning Star, but continues in a most unfavourable position for observation. He is in Aries, passing just to the confines of Taurus at the very end of the month. Jupiter, also in Taurus, is practically invisible during May, from his proximity to the Sun, with which he is in conjunction at 2.34 a.m. on the 25th. He is on the Meridian at 2 minutes after noon on the 23rd. Of course, the phenomena of his satellites are absolutely invisible during this period. Saturn, in the Constellation Sagittarius, albeit at an inconveniently small altitude, now rises and comes into view at a more convenient hour of the night. He rises on the 1st at 11h. 11m. p.m., and on the 31st at 9h. 6m. p.m. The opening of his rings is now about at its maxi mum and but for his proximity to the horizon, he would be very favourably placed for examination. Uranus, in Gemini, is rapidly approaching the Sun, but may still be seen in the north-westerly part of the Heavens after dusk. He sets at 58 minutes after midnight on the 1st, and 59 after 10 on the 31st. Neptune is too close to the Sun to be seen.

Arago thought that there were some slight grounds for expecting a shower of Shooting Stars about the middle of May, and as no opportunity should be lost of adding to our knowledge of these strange Cosmical visitors, it may possibly be worth while to look out about the period referred to.

AGRICULTURAL IMPLEMENTS.

FIG. 1

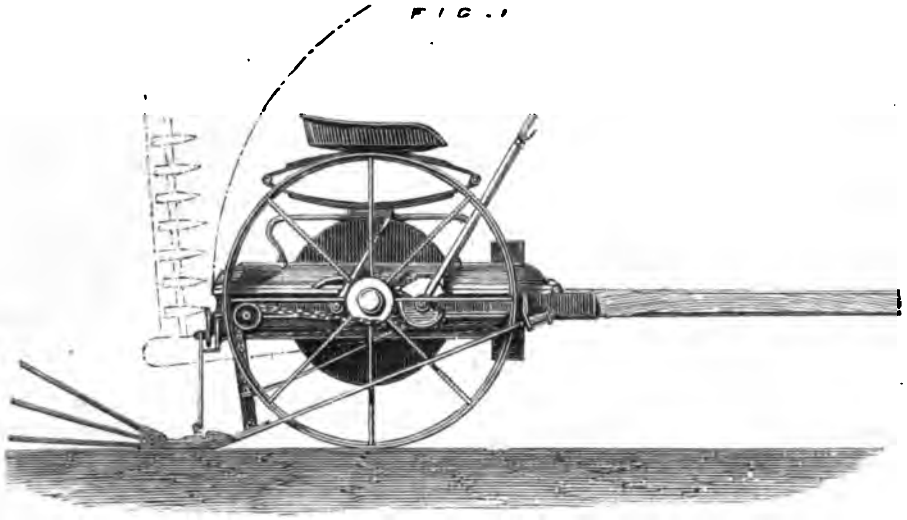


FIG. 3

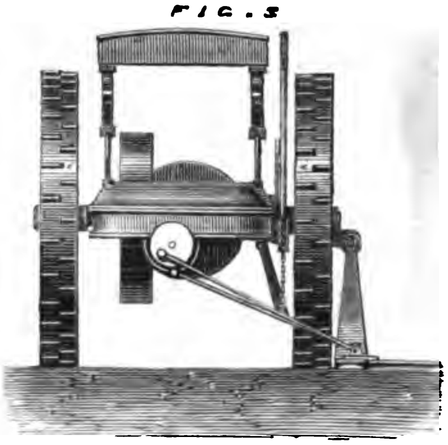
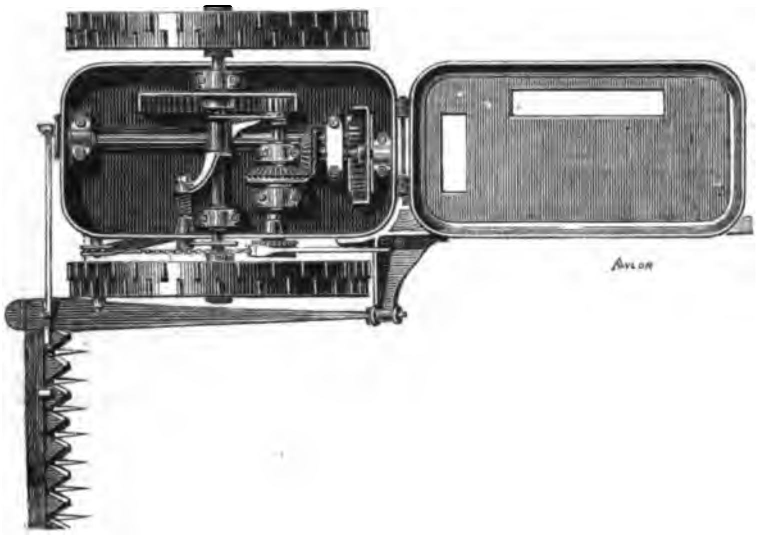
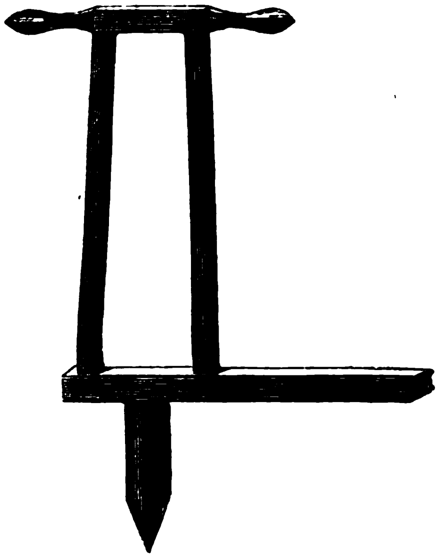


FIG. 2





POTATO DIBBLE.

DOMESTIC RECIPES.

THE "FOOD JOURNAL" SOUP.—This is a most excellent and economical soup for poor people. For one quart of soup, fry three onions in dripping, about the size of a walnut; then take half a carrot, and cut it up in small pieces, with one turnip, half a dozen potatoes, a little salt, pepper, and white ginger. Boil them together for four hours, very slowly. The cost is a little over a halfpenny a plateful of half a pint.

SPINACH FRITTERS.—Boil some spinach thoroughly, drain it well, mince and add some grated bread, nutmeg, ginger and cinnamon, all pounded; add as much cream, or yolks and whites of eggs, as will make it of the consistence of batter; scald a few currants, and mix them in. Drop the batter into a frying pan, on boiling lard, and as soon as the fritters rise take them out, drain, and serve.

POTATO PUDDING.—A few potatoes must be well boiled, and mashed fine, with a little milk, then sweetened to taste, and pressed into a pie-dish. Beat one egg, and lay it on the top, with a little grated nutmeg, and bake for half an hour.

POTATOES FOR NURSERY DINNERS.—Stir new milk into mashed potatoes till the mixture is as thin as double cream. Boil this with a little butter, pepper, and salt, for ten minutes.

BREAKFAST DISHES.—Omelette with or without herbs, and a layer of minced mutton or other meat is a favourite dish for breakfast. Also sandwiches made of hot toast and bacon between, with or without anchovy paste. A young rabbit cut up and fried is much liked. Minced mutton or beef, with bread-crumbs and clarified butter, salamandered, also make a change, in addition to kidneys and the remains of poultry and game, which all come in for breakfast dishes.

THE following amusing recipe for a dish of frogs is taken from a collection in Lady Llanover's excellent cookery book:—Take the thighs and fry them in clarified butter, then have slices of salt eel watered flayed, boned, boiled and cold: slice them in thin slices, and season both with pepper, nutmeg, and ginger; lay butter on your paste, and lay a rank of frog and a rank of eel, some currants, gooseberries, grapes, raisins, pineapple seeds, juice of orange, sugar and butter; this do three times: close up your dish, and when baked, ice it. Make your paste of almond milk, flour, yolks of eggs, and sugar. In the aforesaid dish you may add fried onions' yolks of hard eggs, cheese curds, almond paste, and grated

LETTERS TO THE EDITOR.

[We do not hold ourselves responsible for the opinions of our correspondents. The EDITOR respectfully requests that all communications should be drawn up as briefly as possible.]

*** All communications should be addressed to the EDITOR of the ENGLISH MECHANIC, 31, Tavistock-street, Covent Garden, W.C.

All cheques and Post Office Orders to be made payable to J. PASSMORE EDWARDS.

ALLEN'S REAPING AND MOWING MACHINES.

SIR,—The proposal lately made to devote a portion of your valuable space to the consideration of agricultural matters is a good one. It will, I imagine, embrace agricultural inplements; and as the farmers will soon be busy in the hay-fields—that is, if the traditional "April showers" only put in an appearance during the few days still left of the month—I send a description of an improved reaping and mowing machine invented by William Allen, of Auburn, New York, U.S.A. The object of this invention is to construct reaping and mowing machines in such a manner that they will be more durable and less liable to derangement, and may be worked with less power than the machines heretofore constructed. To this end all the teeth of the toothed gearing are cut instead of being roughly cast, so that they will work more smoothly than heretofore. All the toothed gearing and part of the mechanism, moreover, is enclosed within a cast or wrought iron box provided with a lid, so that access may be obtained thereto when required. The running or supporting wheels of the machine are mounted on an axle outside the bearings, and between which is mounted a driving wheel provided with internal teeth. The cutting mechanism is driven from this wheel, which drives a pinion on the end of the cross shaft of a bevel wheel, which drives a similar wheel on a short shaft, at the opposite end of which is another internal toothed wheel which drives a pinion on the crank shaft, whereby the cutter bar is actuated. Recesses are formed in the cast-iron case and its cover to receive the shafts and the projecting parts of some of the wheels, and the irons to support the driver's seat are inserted in sockets cast on or attached to the hinged cover of the box or case.

Fig. 1 is a side elevation of the machine; Fig. 2 a plan of the same with the cover thrown back to show the mechanism; and Fig. 3 an end view.

D. STUDELY.

POTATO DIBBLE.—ANTS.

SIR,—By way of adding my mite to the agricultural department of our journal, I have enclosed a sketch of an improved potato dibble, which I have had in use for the last four years, by the aid of which I can plant potatoes at more than double the rate I can by using an ordinary dibble. It may be useful to some of our gardening friends. The manner of using it is as follows:—The foot is placed between the uprights to force the dibble into the ground, at the same time laying hold of the two cross handles at the top to guide it. They also serve to pull it up again. The lateral extension gives the distance from one hole to the next.

I shall be much obliged if any of our friends can inform me of a way to destroy ants. Boiling water has no effect on them; I have emptied three kettles of boiling water into their holes, and in half an hour they were as lively as ever. I have also tried Glenny's plan of putting a marrow bone close to their holes to entrap them, but they will not go into it.

T. COOKE.

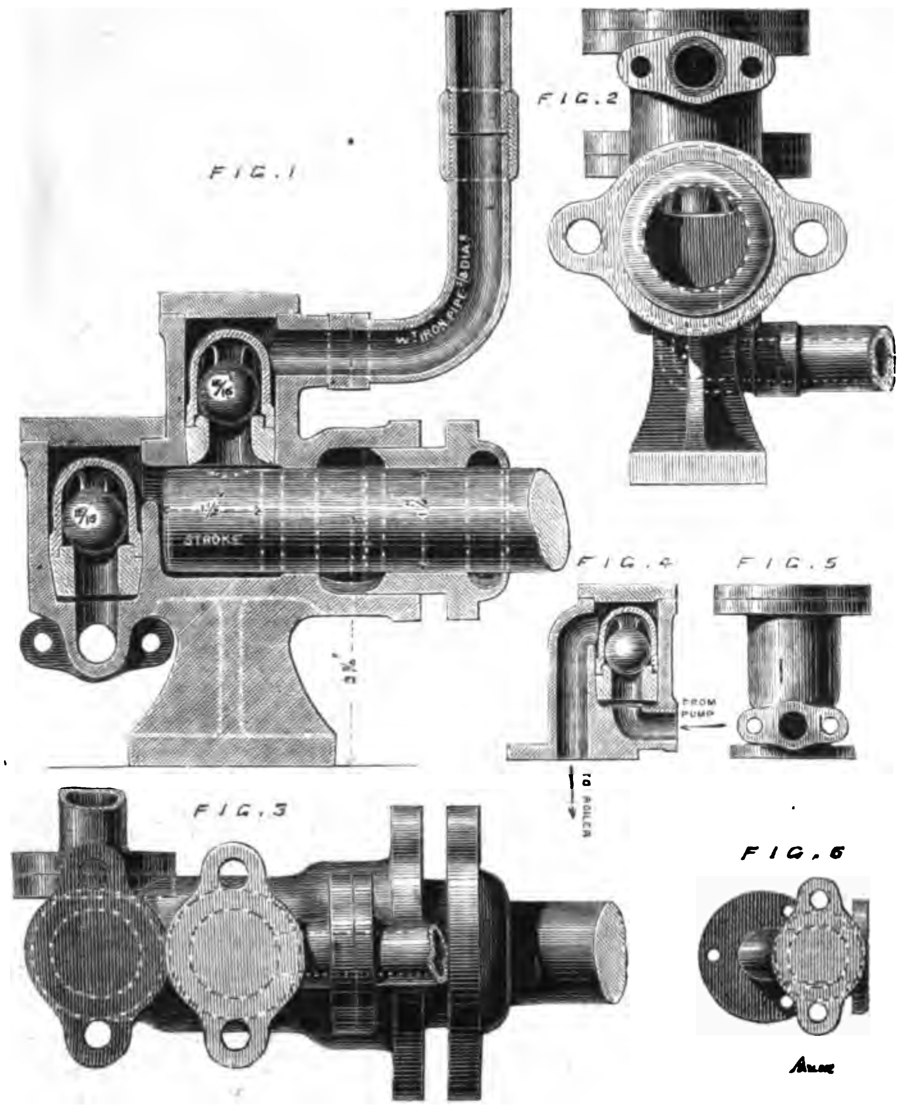
PATENT STEAM ENGINE LUBRICATOR.

(*For illustration, see next page.*)

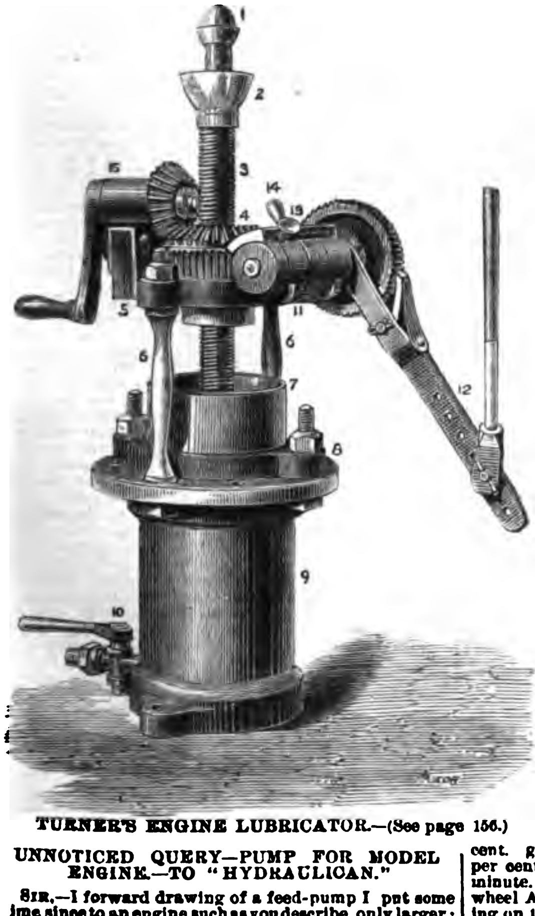
SIR,—We shall feel much obliged if you can make it convenient, and think it of sufficient utility to your readers, to insert the enclosed drawing of our patent steam engine lubricator. The advantages we claim for it over any other, whether impermeter, suet-cup, or revolving plug, are that it is not left to the vacuum, pressure of steam or condensation, which are all uncertain. Ours gives an uniform supply of lubrication, and above all is *safe*, inasmuch, as it is forced by the ram.

1. Rod which screws into tube to prevent lubricating substance escaping while working.
2. Cup to prevent overflow of tallow while filling.
3. Threaded tube fixed through the bottom of ram, and down which the cylinder is supplied.
4. Bevel wheel and spur cast together, and keyed on a wrought-iron bush.
5. Cap on top side works wheel and bush on bottom.
6. Uprights to which the cap is fixed.
7. Ram, which is cast hollow.
8. Glan, to prevent tallow or steam escaping.
9. Cylinder which holds tallow.
10. Tap connected with feed-pipe.
11. Eccentric shaft with worm and rack-wheel.
12. Lever and catch adjusted to the most convenient place for working.
13. Thumb-screw to handle in position while working.
14. Handle to throw out of gear when worked down.
15. Reversing motion to refill the cylinder.

JAMES AND E. TURNER, Buckley, near Rochdale.



PUMP FOR MODEL ENGINE.



TURNER'S ENGINE LUBRICATOR.—(See page 156.)

UNNOTICED QUERY—PUMP FOR MODEL ENGINE.—TO "HYDRAULICAN."

SIR,—I forward drawing of a feed-pump I put some time since to an engine such as you describe, only larger; also of the clack-box to go on the boiler, as you must have two valves between the pump and the boiler to ensure action; and the petcock may be screwed into the cover of the top clack of pump, or anywhere along the feed-pipe, by putting a ⊥ piece instead of one of the ordinary plain junction sockets. In making a small pump, the clack covers would be screwed in with a piece of greased card under, to make the joint, and the pipes screwed into tapped holes, instead of all having flanges with bolts and nuts. Otherwise the arrangement is, I think, as good as can be devised, as the valves are so easy to get at. Directions for making balls are given in No. 25, Vol. IX. J. K. P.

SHEWAN'S SPIRAL WATER WHEEL.

SIR,—In submitting to your notice one of my inventions, the spiral water wheel, I beg to acknowledge with pleasure and satisfaction that I daily receive through the medium of your widely-circulated paper information and wisdom.

As a favourable contrivance for low waterfalls, and for putting small volumes to advantage—for instance, to produce a ½ h.p., as desired by T. W. Boord, query 2473, for driving amateur machinery, with a volume of 68 cubic feet per minute playing into a wheel 5ft. 8in. diameter and 17in. broad, he can gain the power required. Or if "B. C." wishes to fix a much less costly engine than my turbine suggestion behind his dam, 7ft. high, he can, with a volume of 200 cubic feet per minute playing into a wheel 16ft. diameter and 4ft. broad, gain 12 h.p. In proof of this, before submitting it to you and my brother readers, I made one 4ft. 6in. diameter and 14in. broad, and gained over ¼ h.p. from a stream of 54 cubic feet per minute. To find the diameter and breadth of wheel, as a rule one-twelfth the lineal of the volume of water gives the diameter, and one-fourth the diameter the breadth. To find the power, multiply the weight of the volume of water per minute in pounds by half the diameter of wheel (the amount of fall), and that product by the breadth of the wheel (the leverage power), and divide by 33·000, and you have the number of h.p., which, less 15 per cent. gives the ordinary speed power, or rather 85 per cent. is the speed power, 3 to 4 revolutions per minute. Fig. 1 represents an edge view of my water-wheel A fitted on a shaft set at the angle of 45°, resting on two bearings C C. The funnel-shaped mouth is the same in diameter at N N as the breadth of the wheel, and S S shows two bevel wheels for conveying the power. Fig. 2 is a section of the spiral partitions, represented as loaded with water to excessive power, as may occur on the starting of the wheel, or on being checked by excess of work, such as driving circular saws, cutting through thick timber, &c.

FIG. 1

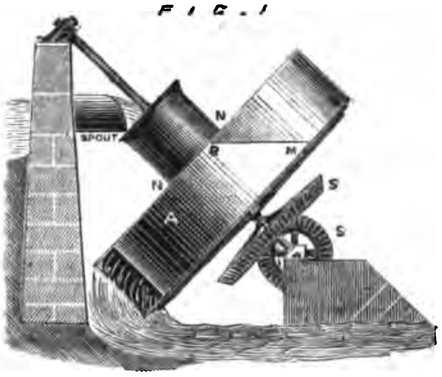
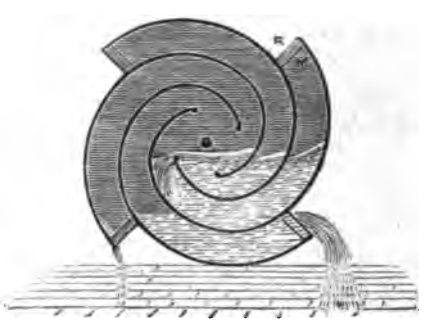


FIG. 2



Parties having a continual convenient stream of water sufficient to supply from ½in. to an inch pipe, may drive my centre-fluid hydraulic, as I call it, with a wheel 18in. diameter and 4in. broad, to keep up a continuous supply of compressed air for from one to six jets of my coal gas apparatus, whether for burning, brazing, heating, boiling, or cooking of any description. The four mouths of the wheel are at right angles with the wheel, as seen at *m r*, to retain a power level of water from *m* to *r*, Figs. 1 and 2.

I do not give an explanation of the centre-fluid hydraulic, as it is simply the reversed motion of an enlarged scale of the working drum of the wet gas meter, as generally known, for measuring gas consumed, which gives a steady compressed current of air. JOHN C. SHEWAN, Pitchcombe Works,
near Stroud, Gloucestershire.

SEWING MACHINES.

(*Continued from page* 114.)

LOCK-STITCH.—(*Continued.*)

SIR,—There are in different machines seven distinc varieties of shuttles, besides modifications between them. For command of tension, the Howe shuttle illustrated in the last number but one, at p. 113, is the best, although it is tedious to thread through so many holes. The reel R revolves in two holes in the ends of the shuttle; the hole in the thick end contains a bolt and spring, which the reel forces back so far as

FIG. 8

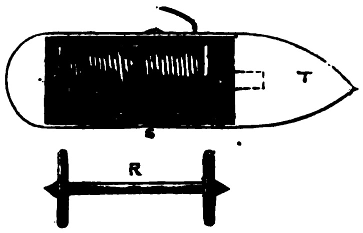


FIG. 9

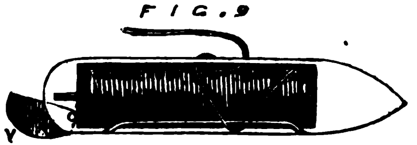
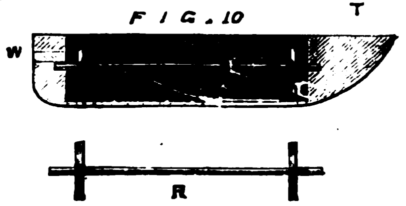


FIG. 10



to admit its being laid within the shuttle. On pushing the point of the reel to the hole in the front end of the shuttle, the spring forces it in and retains it.

The Singer shuttle reel is kept in place also by a similar bolt and spring, which is inserted in a hole in the front end of the shuttle, as represented at T, Fig. 8; the reel R rotates on centre points. The thread passes from the reel to a slot S in the under side of the shuttle, then back over the reel to the top side, through one or more holes, according to the tension required.

The threading is arranged on the same plan in the Thomas's shuttle, represented at Figs. 9 and 10, but the reel is square ended, and rotates in a hole in the point end T, and a slot U; in the thick end of the shuttle, a latch V is shown open, and is made to turn on its centre pin into its slot W, which it fits tightly. To hold the reel in place in the slot U a piece of watch spring X is soldered inside the shuttle to press the reel outward against the latch V. This spring is an important part in the regulation of the shuttle tension.

The top holes in the shuttle admit of threading either through 1, 3, or 5 holes, but not through 2, 4, or 6 holes; this is a defect in shuttles of this class, but is compensated for in the Thomas's shuttle by the spring X. Practice enables the operator to bend it to press on the reel and thread so as to give the required tension.

The Howe, Thomas's, and Singer class of shuttles differ in their length and thickness. For machines of corresponding power doing the same kinds of work, for bootmakers, tailors, &c., the Howe shuttle takes 1¼in. of the needle thread to pass around it; the Thomas's from 1½ to 1-16th, and the Singer 2in. The length of the Howe shuttle is 2¼in., Thomas's 1 7-8th inch, and Singer's 1½ 1-16th inch. The Howe shuttle will hold 17 yards of No. 24 cotton, Thomas's 15 yards, and Singer's 20 yards.

There is a defect in thick shuttles like the Singer requiring 2in. of thread to pass around it, because this 2in. must pass and repass through the eye of the needle for each stitch made, so that for 1000 stitches per minute, the passing and repassing of the thread through the needle eye will amount to 4000in. per minute, while the Howe or Thomas's requires only 3000in. per minute.

This one-third increased velocity over a thick shuttle, and through the needle eye, tends to fray or weaken the thread, so that the stitch cannot be drawn up so tightly, except by reducing the speed, or using a better and dearer quality of thread.

The thick shuttle is much used for slop clothing, but where strength and beauty of stitch is important, the Howe is preferred for best work, the Thomas's for flowering toe caps of boots and for the best description of tailors' work.

Thus the long thin shuttle has the preference; it holds its place for the best work, and has not been condemned, although much has been said about the cam movement for driving it, but why it should be condemned it is hard to make out, seeing it is exact in its movement, and allows for the working of the best shuttle.

The advocates of the thick shuttle drive it by a crank, or eccentric, which makes the shuttle travel a longer stroke than is required, and times or adjusts it badly for the needle thread. It not only has the long loop referred to passing around it, but it also places extra strain upon it. To sum up, it is the best contrivance for fraying, straining, and spoiling thread.

It must be allowed that driving the shuttle by a crank, or an eccentric, would be an improvement over the cam if it were equally efficient. The reduction of noise and wear would recommend it, although the difference, when the workmanship is good, is but a trifle, a well fitted cam and roller lasting for years.

Some of the more recent machines, put forward as wonderful improvements, multiply the evils referred to by straining a long loop around the shuttle, and at the same time cause the needle to rise before the shuttle has passed through the needle loop, so that the thread is being scraped by the shuttle and the eye of the needle, in two places at the same time. What would a lady think of an inventor coming in to improve her sewing if, while she was pulling her thread through, he used two instruments to scrape or fray it? Thus, at the same time spoiling its appearance and making it weak. No lady would allow herself to be deceived in this simple way, but let the thing be done out of sight, in a sewing machine made to please the eye, recommended by a skilful operator, with a cunning use of words, and then the inventor is so far successful as to sell a machine not constructed on sound mechanical principles, which the purchaser will find no to improve by use, but to cause much perplexity and trouble for years.

Against the use of a shuttle machine the following objections are urged by makers of the Spool lock-stitch machine:—"The shuttle stitch is used principally in large machines for heavy work. It requires both heavy and noisy machinery, as the shuttle used is about 2in. in length, and weighs more than a quarter of an ounce. In forming one stitch it advances its entire length through the loops, and recedes the same distance, consequently moves four inches at each stitch. The movement being reciprocating, the shuttle must be started, moved forward, and stopped, started, moved back, and stopped again at each stitch; that is, power must be applied to start the shuttle twice, stop it twice, and move it four inches at each stitch, besides the power required to drive the needle arm and other movable parts of the machine; hence the necessity of cumbersome mechanism, which renders the machines heavy, noisy, and entirely unfit for the use of women and for domestic purposes. In working thin material, as the tension of the two threads requires adjustment, it is difficult to bring the lock of them in the centre of the fabric; the working of the shuttle produces the zigzag stitch,; the lines of thread lie too high above the surface of the fabric; the management of the shuttle-thread is difficult, particularly for fine work, and fine thread cannot be used successfully with it."

The first objection as to weight and motion applies equally to the feed movement of the Spool machine, and would appear *more* complicated if described. The stroke or travel of the feed being ¼ of an inch, while the shuttle stroke is 4 inches, is not to be considered an objection, being useful work performed, which must take power on any plan, even if the thread be carried around the spool.

"The necessity of cumbersome mechanism, which renders the machines heavy, noisy, and entirely unfit for the use of women and for domestic purposes" is a mistake; instead of weighing more than a quarter of an ounce, one-sixth of an ounce is the weight of a shuttle in machines now working with great satisfaction and with *greater* power, at a less expenditure of force, being smaller and lighter, and with no more parts of cumbersome mechanism than a Spool machine.

"The tension of the two threads requires adjustment," and the shuttle thread can be adjusted to any degree, but the Spool thread is limited. The only objection to the shuttle is its noise—click, click at each stitch; it is a merry sound and they are wise who use it; in a good machine it does the finest and widest range of work, with the least trouble. In some machines the click, click, of the shuttle is reduced to a minimum by carrying it on its frame, instead of striking it forward and backward to slide on its bed.

A PRACTICAL MAN.

THE TELESCOPE.—ITS CONSTRUCTION AND MOUNTING.

SIR,—I believe that I can give "the Harmonious Blacksmith" (p. 110), in a very few lines, everything that is at present in print with regard to the performance of Mr. Newall's gigantic refractor; as also with respect to that of Mr. Buckingham's. My extracts are taken from the "Report of the Council of the Royal Astronomical Society," presented to the fiftieth annual meeting on the 11th of last February. The first has reference to the great Cooke Telescope; in speaking of which, after describing its construction and mounting the Report goes on to say: "Mr. Norman Lockyer, who had an opportunity of examining and trying this magnificent instrument shortly before its despatch to its owner, Mr. Newall, speaks in the highest terms of its mounting and mechanical arrangements generally; and so far as he was able to judge of its optical performance, with the low power to which the state of the weather restricted him, he considered it to be very promising." My second extract is briefer still, and is made from the notice of Mr. Buckingham's instrument; "regarding its optical performance, we have, as yet, no definite report."

That very unimaginative person, the Governor of Tilbury Fort, in Sheridan's play of "The Critic," says (in his attempt to check his daughter Tilburina's rhapsody), "the Spanish fleet thou canst not see—because—it is not yet in sight." For an analogous reason, I cannot proceed to quote any further from printed accounts of the two big telescopes, simply because there are no accounts printed to quote from. I regret that the information I am able to afford is so vague, but trust that our famous Musical Artificer will—like the Proctors in Doctors Commons—"take the will for the deed."

Touching the "H. B."s idea of platinising specula, I should not be hopeful that a mirror would emerge intact from the heating ordeal, at all. Mr. Purkiss, as a practical manipulator, would however be the man to test this.

I may inform Mr. Frank Fothergill p. 114, that the object glass to which he refers as having been commenced by me some time since, is still incomplete. I have worked at it in such an extremely desultory fashion, that I do not look forward at all hopefully to finishing it. I do not, however, plead guilty to sheer laziness, nor wish Mr. F. to imagine that I should derive any gratification from the application of the words of Tacitus to myself: "*Utque alios industria ita hunc ignavia ad famam protulerat.*"

Mr. Fothergill's question as to the linear difference in thickness between a spherical, speculum and one in the form of a paraboloid, pertains to Analytical Geometry. Should your correspondent be familiar with the theory of axes of co-ordinates as applied to surfaces of the second degree, he can work the matter out for himself, but if not, it is absolutely impossible to explain it in intelligible language.

Rigel being now practically out of sight, I cannot comply with the request of "Stella" p. 115, to see with how small an aperture the comes can be observed. I may just, however, say that the late Rev. W. R. Dawes saw it, and made a diagram of it and its primary, with a telescope of 24in. focal length and 1·6in. aperture; employing for the purpose a pancratic eyepiece and a power of 70.

I must congratulate "Neptune" on having secured the services of such an obviously competent computor as Mr. Vivian (p. 135). Only I hope that, for the benefit of the whole optical world, "Neptune" will favour us with a detailed account of the performance of his telescope, should he construct it from the curves which Mr. V. makes so little of calculating. By-the-bye, when, as a lad, I had some mixed mathematics drilled into me, I used, if I remember rightly, to be told that the rule for finding the principal focus of an unequally convex lens was to divide twice the product of its radii by their sum, As I write, I just try this on the edge of my paper with Mr. Vivian's first lens, and can *not* make

$$\frac{2 \times 137\cdot50 \times 62\cdot51}{200\cdot01}$$

come out 82in., or 6ft. 10in., for the life of me. I have not taken the trouble to pursue this very eccentric computation any farther. *Ex pede Herculem*, and I can fancy where I should land, were I to go through it all. But that I consider Herschel's formulæ to be open to the objection that a slight error in the radii of the tools involves serious consequences in the ultimate performance of the object glasses ground on them, I should advise "Neptune" to buy "Herschel on the Telescope," a three-and-sixpenny book published by A. and C. Black, and (if he be enough of an algebraist to be able to interpolate) to try whether he cannot do nearly as well as Mr. V. in working out the radii of his object glass himself.

With regard to what Mr. Preston states on p. 136, I would just observe that it is the size of the emergent pencil with which we are more immediately concerned in an opera glass. If the diameter of this pencil be greater than that of the pupil of the eye, there is so much light wasted, but as long as it is smaller than that of the pupil, the larger the object glass is, the more brilliant the image it transmits. I do not understand Mr. P's diagram, inasmuch as he places the eye in it, about halfway between the lens and its focal point. In reality he would see exceedingly little with his eye in such a position.

I suppose that the Equatoreal mounting of "H. A. C.'s" telescope (2618), p. 142, has been constructed by the maker for the latitude of his observatory, so as to require a very trivial adjustment of the polar axis to give it the proper elevation? The first thing, then, that he will have to do, will be to assure himself that the polar and declination axes are at right angles. This he must do by means of a spirit level on the pivots of the declination axis. Then he must get the optical axis of the telescope at right angles to the declination axis. He will effect this by inserting his transit eyepiece, setting the telescope in advance of a star, reading the vernier of his hour circle, and then noting the instant of the star's transit over his middle wire. Now turning the whole affair half round on the polar axis, let him again reclamp the telescope a little in front of the same star, again read the vernier, and once more note the time of its passage over the middle wire; then the difference between the times of transit, and that between the two readings of the hour circle should coincide accurately. If not, he must correct the error, if small, by shifting the wire frame through half the interval in the eyepiece; if glaringly large, by altering the position of the telescope itself in the cradle. After this he will have to see that the verniers of his declination circle read correctly. For this purpose let him thread a star on the declination wire, and read off its declination on the circle, then turning the whole instrument round on the polar axis, again thread the star on the wire; then half the difference of the circle readings will be its index error. Should this be large, the vernier must be adjusted; but if not sufficiently so to interfere with finding a star, it had better be left alone. Finally, once more carefully levelling the declination axis, he must make the vernier of his hour circle read XII. or XXIV., as the case may be. These instrumental adjustments being complete *inter se*, all he will have to do will be to set the declination circle to the declination of some known star (allowing for refraction, and, if needful, the index error of his circle), and then as the star crosses the field, to elevate or depress the polar axis bodily by means of the proper screws until the star runs along the declination wire. Knowing his local time he can now get the instrument into the Meridian in the way referred to on p. 85, by one operation; and should he succeed in this, and in the other adjustments to which I have referred, he ought to have no difficulty in finding such as star as Castor, in the middle of the day.

"Scorpio" ([illegible]), p. 143, may find the focus of any Huyghenian eyepiece, when he knows the foci of its constituent lenses, by the following very simple formula. Divide twice the product of the focal lengths of the lenses which compose the eyepiece by their sum, the result will be its focus. Thus, if we have a field lens of 3in focus, and an eye lens of 1,

$$\frac{2 \times 3 \times 1}{4} = 1\tfrac{1}{2}$$

so that a Huyghenian eyepiece so constructed would be equal to a single lens of 1½in. focus. The division of the focal length of the object glass by that of the eyepiece gives the power of the latter. Secondly, I may inform my querist that I should not only think a 3in telescope "good" which would show the 5th Star in the trapezium of θ Orionis, but *miraculous*. 3·75in. I should put as the very smallest aperture with which it could possibly be picked up under the most favourable conceivable circumstances. An eye like that of the late Rev. W. R. Dawes, a Dallmeyer object glass, and a superb night being conjoined, this speck of light might be seen with the aperture I have assigned. Thirdly, will Scorpio refer me to the volume and page in which I stated that a 2½in. telescope would not divorce stars less than 2″·5 apart? because I have no recollection whatever of ever having made any such assertion. I think it likely that a really first class instrument of this aperture would *just* split a 2″ pair of stars. The application of Dallmeyer's formula (which I have myself given long ago more than once in your columns), is almost too crucial a test for any instrument. Fourthly, the ordinary Huyghenian eyepiece is used indifferently with reflectors or refractors, as is the Ramsden, or positive, eyepiece for micrometric work. Finally, I should think that the Star in the larger telescope spoken of by your correspondent, would look rather smaller with 700 than it would with 250 in the smaller one; but focal length would enter as an element into this, the image being a spurious one. *Cæteris paribus*, the shorter the focus of our object glass the smaller the disc of a star.

A FELLOW OF THE ROYAL ASTRONOMICAL SOCIETY.

ASTRONOMICAL.

SIR,—Assuming that Mr. Fothergill, p. 114, is correct about "Dietrichsen's Almanac," the computer of the Ephemeris therein contained, must have made some odd mistake. A planet such as Mercury or Venus may change its declination perceptibly between its time of rising and setting, so that the interval between its rising and culmination may differ from that between its passage over the Meridian and its setting: but in the case of a fixed star—and Mr. F. speaks of "a Star"—its declination practically does not vary at all. So that its diurnal path is accurately bisected by the Meridian.

I cannot give "Scire Volo" (2524), p. 118, the longitude of Belfast with extreme accuracy, but he may take its time as being 6m. 38s. of Sidereal time, or 6m. 37s. of Mean Solar time slower than that of Glasgow, with a probable error of not more than a second.

The query of "A.H.Z." (2558) is almost meaningless without some indication of his locality. In *London* just now the Magnetic Needle points 19° 50′ to the West of North, but this declination varies markedly even in different parts of the United Kingdom. To take the place, for example, I have just mentioned in my previous reply, Glasgow, the declination this year is 22° 15′; while at Dover it is only 19° 10′. This will serve to show how very vague any answer must of necessity be to your correspondent's question in its existing form.

With regard to the letter of "Not a F.R.A.S.," on p. 135, I must candidly confess that I have actually been foolish enough to apply the correction *twice over*: ignoring, in a very careless way, that the difference in longitude already included it. His second example is right; and mine on p. 86, only correct for the purpose of obtaining his *local* mean time. Obviously, whatever the Sidereal time be at his supposed station, it is at that instant 8m. 7s. more at Greenwich; and as it is Greenwich Mean time we are seeking, we must take the Sidereal time at the preceding *Greenwich* mean noon from L.S.T. + 8m. 7s. (and reduce the result to mean time) to get what we require.

There would appear to be a recent fashion, with people who have nothing else to give, to offer prizes. May I commend this to the attention of "Veritas," p. 186, and counsel him to offer an organ, telescope, fish kettle, "History of England," set of flat irons (or something equally appropriate) to any one of the readers of the **English Mechanic**, who will explain the penultimate and concluding paragraphs in his letter on the page referred to?

Cœteris paribus, I may tell Mr. D. E. Williams, (2606), p. 142, that places on and near the Equator have the shortest dawn and twilight; and those near the Poles the longest. This arises from the fact that it is not absolutely dark until the Sun has descended 18° below the horizon; and that in latitudes where he is over head, he of course rises and sets perpendicularly; and very rapidly describes this arc of 18°. On the other hand, in high latitudes, his path becomes more and more oblique to the horizon as we approach the Poles, and he is a long time before he attains a depth of 18° below it: the ultimate result being that, even in England, at one season of the year, he never descends so deeply as this, and consequently there is no real night; and that as we come still nearer the poles, we arrive at a parallel of latitude on and beyond which, for half the year, the Sun does not set at all. If Mr. Williams has access to an ordinary terrestrial Globe, and will merely stick a white disc of paper on any part of the Ecliptic he pleases, and elevate the Pole of the Globe to various heights, he will be able to see the reason of all this at a glance. To imitate the condition of things on the Equator, all he will have to do, will be to place the axis of the Globe parallel with the wooden horizon, then turning the Globe on such axis, he will see his piece of paper rise and set perpendicularly. If now he will elevate the axis until it is perpendicular to the horizon, he will observe that his white paper sun will travel round and round parallel to it: of course at intermediate inclinations, describing paths of greater or less obliquity. We may find out, to select a familar example, the time during which twilight lasts in London all night long, by considering that the Latitude of that City is 51° 30′, or in other words that the Pole is elevated at that angle to the horizon: then, adding 18° to this we get 69° 30′. But from May 23rd until July 20th, the Sun's North Polar Distance is always *less than* this. So even at midnight, when he is due North, he is less than 18° below the horizon, and consequently there can be no real night. Any common work on Astronomy will give Mr. Williams further details on this subject.

A Fellow of the Royal Astronomical Society.

EARTH'S ROTATION.

Sir,—"C. R. O., Hants," adopts a mode of discussing centrifugal at tendencies which is a favourite one of my own in all such matters. It is so simple and clear as to be worth notin . In all such questions, one has only to consider what is the change of direction effected in a given time on a body moving with a known velocity to estimate what force has been called into action. By this simple principle I was able in my "Saturn" to weigh Saturn against the earth (by considering motion of his satellite Titan) without even having occasion for an illustrative diagram. The principle is very fertile.

I present my compliments to "C. R. O., Hants," on the lucidity of his reasoning.

Richd. A. Proctor.

FIGURE OF THE EARTH.

Sir,—Mr. Beardsley is an apt pupil of "Parallax," and will soon quote others to his purpose as cleverly as his teacher. He quotes me as saying the earth's rotation can be proved by the simple fact that a rotating semicircle may be made to keep pace with the sun. *I said nothing of the sort.* He quotes me as making a certain remark about Tycho Brahe's system. *I made no such remark.* Paradoxists may be divided into two great classes. I know *now* to which Mr. B. belongs.

What I really said of the experiment referred to was that it proved that if the sun move, his motion is of a certain character; what I said about Tycho Brahe referred, as B. knows, to the subject of the earth's revolution, *not* to her rotation.

"W. H. L." wants me to argue with Beardsley. With thanks, I decline.

Mr. Dyer must be a very young man not to know that Parallax and Co., are merely types of a class which will always exist. Suppose "Parallax" *does* "unsettle the minds of many people who have not studied the subject." What then? It serves them right for leaving the subject unstudied. They have been settled in ignorance, and "Parallax" is unconsciously doing capital work by unsettling them. More power to him! **Richd. A. Proctor.**

P.S.—In the hope of encouraging Beardsley to grow into another "Parallax," I invite him to screw up his courage, and invent a reason why the sun, supposing it to *set*, as shown in his Fig. 3, (borrowed from "Parallax)," does not seem to vary in size, with those awkwardly varying distances. He might extend his proof to the general solar motions as conceived by his teacher.

SIMULTANEOUS EQUATIONS.

Sir,—Various problems of simultaneous equations taken from Todhunter's large algebra have been submitted to your readers for solution. I beg, therefore, to send complete solutions to the last ten questions in his work as above-mentioned. The problems can be inserted at your convenience, and will probably be a great help to many students. Then

I. $4x - 3y + 2z = 9,\ 2x + 5y - 3z = 4,\ 5x + 6y - 2z = 18.$

$$\left.\begin{array}{ll}(1.) & 4x - 3y + 2z = 9\\ (2.) & 2x + 5y - 3z = 4\\ (3.) & 5x + 6y - 2z = 18\end{array}\right\}\text{Multiply (1.) and (2.) by 3 and 2 respectively.}$$

$$\left.\begin{array}{r}= 12x - 9y + 6z = 27\\ 4x + 10y - 6z = 8\end{array}\right\}\text{Add together.}$$

$$(4.)\ 16x + y = 35$$

Then add (1.) and (3.)

$$\begin{array}{r}4x - 3y + 2z = 9\\ 5x + 6y - 2z = 18\\ \hline (5.)\ 9x + 3y = 27\end{array}$$

Multiply (4.) by 3 and subtract (5.) from result.

$$\begin{array}{r}48x + 3y = 105\\ 9x + 3y = 27\\ \hline 39x = 78\end{array}$$

$$x = \frac{78}{39} = 2$$

$$9x + 3y = 27$$

$$18 + 3y = 27$$

$$3y = 27 - 18 = 9$$

$$y = \frac{9}{3} = 3$$

$$4x - 3y + 2z = 9$$

$$8 - 9 + 2z = 9$$

$$2z = 9 + 9 - 8 = 10$$

$$z = \frac{10}{2} = 5$$

Thus

$$x = 2,\ y = 3, \text{ and } z = 5$$

$$\text{II.}\ \left.\begin{array}{ll}(1.) & 5x - 6y + 4z = 15\\ (2.) & 7x + 4y - 3z = 19\end{array}\right\}\text{Multiply (1.) and (2.) by 3 and 4 respectively, adding the results we get (4.)}$$

$$(3.)\ 2x + y + 6z = 46\left\{\text{Then multiply (1.) and (3.) by 6 and 4 respectively, subtracting the results, we get (5.)}\right.$$

$$\begin{array}{r}15x - 18y + 12z = 45\\ 28x + 16y - 12z = 76\\ \hline (4.)\ 43x - 2y = 121\end{array}$$

$$\begin{array}{r}30x - 36y + 24z = 90\\ 8x + 4y + 24z = 184\\ \hline 2)\ 22x - 40y = -94\\ \hline (5.)\ 11x - 20y = -47.\end{array}$$

Multiply (4.) by 10, subtracting (5.) we have

$$\begin{array}{r}430x - 20y = 1210\\ 11x - 20y = -47\\ \hline 419x = 1257\end{array}$$

$$x = \frac{1257}{419} = 3$$

$$11x - 20y = -47$$

$$33 - 20y = -47$$

$$-20y = -47 - 33 = -80$$

$$20y = 80$$

$$y = \frac{80}{20} = 4$$

$$5x - 6y + 4z = 15$$

$$15 - 24 + 4z = 15$$

$$4z = 15 + 24 - 15 = 24$$

$$z = \frac{24}{4} = 6$$

Thus, $x = 3,\ y = 4$, and $z = 6$,

C. H. W. B.

EQUATIONS,

Sir,—I believe "C. H. W., B." p. 131, No. 206, has not given the complete solution of the 2nd equation, *an equation of the nth degree having n roots*, we have the two equations (*a*) $x^5 - 1 = o$, and (*b*) $x^5 + 32$, or $x_5 + 2^5 = o$.

(*a*) $x^5 - 1 = (x - 1)(x^4 + x^3 + x^2 + x + 1) = o$

Which gives

$x - 1 = o, x = 1$, and $x^4 + x^3 + x^2 + x + 1 = o$,

Reciprocal equation, dividing by

$$\times \ldots x^2 + x + 1 + \frac{1}{x} + \frac{1}{x^2} = o$$

Or

$$\ldots x^2 x^2 + \frac{1}{x^2} + x + \frac{1}{x} + 1 = o$$

Putting $\left(x + \frac{1}{x^2}\right) = z$, we have $x^2 + \frac{1}{x^2} = z^2 - 2$

$$\therefore \text{eq. } z^2 + z + 1 = o,\ z = \frac{-1 \pm \sqrt{5}}{2}$$

The eq. $x + \frac{1}{x} = z$, gives

$$x^2 - zx + 1 = o,\ x = \frac{z \pm \sqrt{z^2 - 4}}{2}$$

Replacing z by its value, we obtain four different values for x. For the eq. (*b*) $x^5 + 2^5 = o$. I suppose $x = y$, hence

$$-y^5 + 2^5 = o, \text{ or } y^5 - 2^5 = o.$$

This last equation can be put as follows:—

$$\left(\frac{y}{2}\right)^5 - 1^5 = o$$

Hence $\frac{y}{2}$ as in the 1st equation, and then y, and, changing signs, x, again 5 roots, total 10.—**Bernardin.**

BLUE MAHOE WOOD FOR FISHING RODS.

Sir,—Our friend "The Harmonious Blacksmith," p. 111, last number but one, wishes some information about blue mahoe wood, which he says is excellent for making fishing rods. He asks also where he could purchase it. I made some inquiries about the origin of that wood, and hope the following particulars may enable him to obtain it.

The name of mahoe or mahot is given to several plants, especially to different fibre-yielding *Hibiscus*, also to some *Lecythis* and *Dombeya*. Mountain Mahoe (*Hibiscus elatus*) is 50ft. high; a shingle of that wood coming from Jamaica, was exhibited in London, 1862, and said to last 6 years without any paint. Seaside Mahoe is *Hibiscus tiliaceus*, of which there is a white and also a blue variety; it is, I believe, 6ft. to 8ft. high; its name in Panama is Mayagua de la playa. Now, I find in a catalogue of MM. Fauntleroy and Co., (actual firm, Mundy, Horley and Co., 100, Bunhill-row, E.C.) the "Mayagua azul wood," and this will be, I believe, the "blue mahoe"; having no sample I cannot further examine it, but it will be easy for "the H. B." to apply to that firm, and I shall be happy if I have obliged him who has obliged so many brother readers. **Bernardin.**

AN *ENGLISH MECHANIC* MUTUAL IMPROVEMENT SOCIETY FOR BLACKBURN.

Sir,—As I feel certain there must be many subscribers to your excellent journal in Blackburn, I beg to suggest that a few of them who know each other should meet together, and arrange to have a meeting such as our Edinburgh and Manchester brethren have resolved upon. No doubt we could muster a goodly number, and help on this new intellectual project, for encouraging the arts and sciences.

J. Harrison Moran, 2, Brook-st., Eanam, Blackburn.

SALADS.

Sir,—Permit me to draw attention to the value of dandelion leaves as a salad. Although much used abroad, the plant is little appreciated here, as indeed many others that might enter into our dietaries. At this season of the year, salads constitute valuable articles of diet. They are recommended not only on account of their cooling and refreshing taste, but chiefly from their containing mineral matters, which are so essential to the maintenance of health. These mineral matters consist principally of salts of potassium and sodium. When vegetables are boiled, a certain portion of their mineral constituents is extracted by the water, and hence the practice of eating uncooked vegetables and fruit is a most wholesome one, as furnishing the system with saline matters, which are much needed. The following plants are used as salads in this country:—beer, celery, endive, garden cress, lettuce, radish, and water cress. To this list might be judiciously added the leaves of the dandelion, Lamb's lettuce, or corn-salad, sorrel, and many other wild plants, which through ignorance or prejudice are at present despised.

In making salads it will be found an improvement to use the leaves tolerably dry, to add a fair quantity of good oil, and not drench with vinegar, as is too often done. **Beta.**

CASE HARDENING.

Sir,—In reply to "St. George," I inform him that it is not a new plan of case hardening, although it was not generally known. I have used it for years, with only this difference, that I put about one-third of salt among the prussiate of potash, either in a retort or on the red-hot iron at the smith's fire, and by re-heating and giving it another dose it will be better. I case hardened some things about two years ago for experiment, and dipped them in a mixture of one-third of sulphuric acid among the water with good results. Everyone was surprised that saw them, and so was

Heathen Jack.

SCREW CHUCK.

Sir,—I have been looking for a reply from "Marine," in answer to "J. K. P.," who says he is in error in saying that "A. B." put a left-handed screw on his chuck. He says: "I know a machine with a screw on each end, the one right, the other left." If "J. K. P." saw a machine any other way it was wrong; for if the back centre is screwed in the spindle, it must be a left-hand thread. In the same number (262) "J. K. P." gives a drawing of Bennett's chuck. The thread is put on right-handed, and it is the reverse of that of "A. B." If "Marine" was in error, how are they not both the same?

Heathen Jack.

ANCIENT ARCHITECTURAL REMAINS IN INDIA.

SIR,—Probably there are very few places on the earth's surface where ancient civilisation and barbarism have co-existed side by side, as it were, to an extent equal to which has prevailed in what now constitutes the British dominion in India. At a remote period our Aryan ancestors conquered this country, but of course their conquest was not a perfect one (no conquests ever are, excepting those domestic conquests achieved by wives over husbands), and the Aryan conquerors became to a considerable extent amalgamated with the more ancient populations, which was probably the origin of the complex system of castes which grew up, the pure races, as the Brahmins and the warrior caste, remaining the governing classes, as, indeed, soldiers and priests, when united, almost invariably do, "even until this day."

In India the conquering race, to a considerable extent, adopted the superstitions of those they subdued. Modern Hinduism is anything but the pure theism of the ancient Aryans, as Baboo Keshub Chunder Sen would tell us; and some of those ancient populations seem not much, if any, further advanced in civilisation now than they were thousands of years ago, when the lighter-coloured Aryans conquered them. Nevertheless, they have in many instances re-occupied their lost ground, from which the higher race has retired, although they do not seem to have "improved the occasion," and copied the example of those who temporarily occupied, say, the site of the city of Mandoo, whose architectural works would do honour to Greek and Roman civilisation, if, indeed, their remains do not surpass any of the works of those peoples, except in statuary. The ground on which the remains of this ancient city stand is now occupied by the savage tribe of Bheels, who are not only incapable of mason's work, but are too barbarous to build even a comfortable hut to shelter them, or to cultivate the earth for their subsistence, and, like the Santhals, they are yet only armed with bows and arrows, a most convincing proof of a low state, for there can be no doubt whatever that gunpowder and the gallows are the most salient signs of civilisation. THE HARMONIOUS BLACKSMITH.

SHEATHING IRON SHIPS WITH WOOD AND COPPER.

SIR,—I did not intend to assert that the Admiralty had definitely adopted a modification of the plan for doing this which I designed about 1861, but only that they had adopted it experimentally—in the fast frigate Inconstant, if I am not mistaken. In my design there was no difficulty in obtaining a perfect adherence of the wood, for it was confined in dovetailed iron grooves formed by affixing angle iron to the ship's outer skin, and driving the wood into the grooves so formed. If I remember correctly, asphalted felt was introduced between the iron skin of the ship and the wooden sheathing, so as to form a water-tight joint, and prevent the injurious action of sea water on iron in contact with wood. I am almost certain I have the coloured drawings of this design by me, and if you think, Mr. Editor, the matter of sufficient importance for a small engraved illustration, I will look them up and send them to you. In regard to its importance I may remark that could mine or some similar plan be carried out without too great expense, iron ships might not only be employed as cruisers on stations where there is no dock accommodation for large war ships, but in such services as the Southern whale fishery, in which a ship often remains undocked for three successive years, and unless sheathed with copper would become the local habitation of the great Barnacle family to an extent undreamed of even by Charles Dickens himself.

THE HARMONIOUS BLACKSMITH.

A SOFT-VOICED PIPE FOR A CHAMBER ORGAN—FOG-HORNS.

SIR,—At the southern extremity of the Isle of Wight an experimental fog-horn has been erected, which is voiced exactly by the same means that are employed to voice the reed pipe of an organ; but those means are on rather a larger scale. The steel reed of this trumpet pipe is five inches long by two inches wide, and is put in motion by air at the pressure of about 10lb. to the superficial inch. How many inches of water this is equivalent to I leave "Adept" and Mr. Kemble to "kalkalate." This wee pipe, or chaunter, as a cannie Scot would term it, can hardly discourse *sweet* music, but its sound, A, second space in the treble, must, I think, be sufficiently "strident" to satisfy even Princess Alexandra of the ENGLISH MECHANIC herself; for I am told it can be heard many miles out at sea, when other sounds are so difficult to transmit through fogs.

A lifeboat is a very good thing, and I trust we English Mechanics will, ere long, add at least one more to the number of those which are stationed on our rockbound coast. But however desirable it is to save the lives of shipwrecked men, it is yet more desirable to prevent shipwreck; so I do hope this horn may long remain *exalted*, and, as Sam Slick would have said, its sound continue to be a *caution* to mariners, warning poor Jack of the dangers of too near an approach to land in foggy weather.

THE HARMONIOUS BLACKSMITH.

BLUE MAHOE WOOD.

SIR,—"The Harmonious Blacksmith" respectfully informs "Joe" that he, the said Vulcanite, is *not* in the market for fly rods, nor indeed anything else at pre-present, excepting it be ancient and rare musical instruments, and that he has no intention of entering the market, for fear he should himself be "sold." Banter apart, he cannot inform "Joe" the weight of his long three-joint North Carolina cane fly-rod, simply because it is not now in his possession, and can only say, in general terms, that it was extremely light, and did not fatigue the user much more than a rather powerful 12ft. hickory rod would do, and that he knows no solid wood which would not be very much heavier than bamboo.

May the "Blacksmith" take the liberty of cautioning "Joe" and others against being taken in by any of that old nonsense about rods weighing an ounce, or less, per foot of their length? He has seen a roach rod 22ft. long, weighing only 21oz., and its action was very good *without its butt*. This remarkably small weight was obtained by boring out its butt—made of shaved jungle bamboo cane—until it was less than ⅛in. thick. Need he add that it was soon split to pieces. When a suitable butt-joint—made of East India bamboo—was substituted for it, the rod became faultless; but then it weighed a few ounces more. No doubt it weighed heavier *in its bag*, but it did not *feel* heavier in the hand when in use, for the very simple reason that the additional weight was at that end *nearest* the angler. A very slight weight added to its top would have been much more felt, just as a small fish feels heavy to lift out of the water with a long rod.

THE FUEL OF THE SUN.

SIR,—Under this title a fellow blacksmith, who has rather more science than the ignoramus who writes this, has produced an interesting work based on the hypothesis that all interplanetary and stellar space is occupied with matter identical with that found on earth, and that the sun, in his journey through space, is continually attracting it to himself, at a rate probably exceeding 160 millions of millions of tons per second of time, and leaving behind him a proportionate quantity of what the author, borrowing an idea from his smithy experiences, terms exhausted fuel. This hypothesis appears to have the advantage of accounting for observed facts without requiring us to admit the existence of any unknown causes or new forces, excepting the assumption that the matter diffused through space is identical with that with which we are familiar, which seems at least very probable, although of course we must not assume that we are acquainted with all kinds of matter which may exist in the stars, the sun, in other planets, or even our own, seeing that we are not acquainted with its interior.

Mr. Williams thinks the temperature at the lower strata of the sun's atmosphere is rendered so high—probably far higher than the melting point of platinum—by that condensation which results from the great pressure due to the attraction of so large a mass; that the elements of water, and probably all terrestrial compounds, become dissociated, and that those elements from time to time rise into the higher regions of the sun's atmosphere, again to combine, with explosions compared with which our gunpowder and nitro-glycerine go off mildly. It is this re-combination of the constituents of water, accompanied by that evolution of light and heat which we term combustion, from which he thinks most of the sun's heat and light which we experience is derived, and I do hope "F.R.A.S.," Mr. Proctor, "Sigma," and other physicians, who, of course, know all about the sun's fuel, and everything else, will favour the unlearned blacksmith with their opinions on Mr. Williams's theory.

Mr. Williams is of opinion that the solid, or more probably *fluid*, nucleus of the sun is comparatively a small body, whose position, in relation to the common centre of gravity of the solar system, is to a great extent influenced by the planets, and that to its somewhat irregular fluctuations within its atmosphere may be due some of those more violent explosions which he thinks project matter far above its visible limit. To such projected matter he refers the cause of the zodiacal light, and probably also the asteroids. He sees no specific difference between large and small particles, and thinks that meteorolites and asteroids are simply larger and smaller specimens of the sun's projectiles, differing from each other only as small shot differs from cannon balls. If this hypothesis be reasonable, I can see no objection to its extension to the formation of all the smaller planets, say to Mars. For anything I can see to the contrary, the earth and all the rest, as far as Mars, differ from asteroids only in size, and may have been thrown off from our common parent, the sun, during one or more of his explosions—I hope not of ill-temper, although he is said to be rather *hot*. Chemically, meteorolites and our planet resemble Cæsar and Pompey in being "berry much alike," and perhaps the latter are only the *big brothers* of the former, for difference of size no more includes difference of genus that the huge magnitude of the elephant and the minuteness of a sucking pig prevent both from being pachyderms.

Perhaps Mr. Williams—in deference to the feelings of his weaker scientific brethren—feels the necessity of "drawing the line" somewhere, so, for the present, he draws it at Asteroids; why he should not include the smaller planets and our satellite, I can't guess. In a recent number of the ENGLISH MECHANIC, it is reported that Venus has lately had a baby (query, Was its cradle the observer's telescope?)—I mean a satellite—now if the sun has been for ages projecting meteorolites and asteroids, until the interplanetary spaces are thronged with them, it seems no more than reasonable that Venus may have picked up one, and, like a charitable female, *adopted* it. Considering the great distance her husband Mars has been from her during all historic times, this seems a more charitable hypothesis than that her satellite is her own production, and as charity is said to cover a multitude of sins, I hope my *charitable* suggestion may cover some of those manifold sins which, according to Mr. Herman Sloman, I have committed in the pages of our journal.

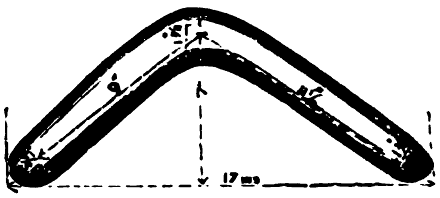
If the earth has picked up her moon in times past, and Venus lately adopted a little waif, which was sadly wanting maternal care, may not all the planets within the orbit of Jupiter have done the same, and really have attendant trains of satellites from the size of the smallest meteorolite to that of a small moon, of whose existence we are ignorant, only because they are too small to reflect enough of the sun's light to make them visible in our best telescopes? And may not some of them occasionally become luminous when they enter our atmosphere? I 've no very great difficulty in supposing the possibility of this, but that may be due to my crass ignorance.

As Mr. Williams thinks Jupiter is a sort of miniature sun, which our sun has picked up in his journey through space, "in the days when he went gipsying a long time ago," and never has, nor ever will, cool down to the temperature of a member of the "temperance association of planets," if such a body be, I have not included either him or his four moons among those bodies which I suggested may have been projected from our sun in the olden time. If, as he supposes, the surface of Jupiter is now as hot as melted platinum, and will never become cooler, I cannot help thinking that this great bomb, compared to which the asteroids are as sparrow shot, and the projectiles discharged from Mallet's mortar, mere grains of sand, must have been in a state of mere gas when projected, if it ever were projected, from the sun, and gas, perhaps rarer than hydrogen, could hardly have held together, and however much condensed during its trajectory, been shot so far as Jupiter is from the sun. Mr. Williams also thinks that Jupiter, Saturn, Uranus, and Neptune, and the planets, if any, yet more distant, have photospheres, and that none of the planets originally had atmospheres, but have "picked them up" by attracting aqueous vapour, &c., from interplanetary space, just as I have supposed they picked up their attendant satellites. That their aërial and liquid surroundings, whether in the form of atmospheres or oceans, have been derived from without or from within, is certainly a very interesting speculation, but one, I fear, of which there is what the Hibernian philosopher termed a very abundant lack of data from which to estimate the probabilities of either hypothesis.

THE HARMONIOUS BLACKSMITH.

THE BOOMERANG.

SIR,—I herewith beg to enclose a sketch of a small boomerang, which I made myself after an original model. I can throw it perfectly, and do so in the following manner—viz., I catch a firm grip of the long side near the point with the two forefingers and thumb of the right hand, holding the inside edge direct towards the ground. I aim at an imaginary object about 30 yards off, fetching the boomerang over the shoulder and flinging with a straight, smart throw, as if I wished to stick the point in the ground at the 30 yards' distance. It goes to the object straight, then gradually rising to a height of from 80 to 100ft., sweeps away to the left, and comes down in a circle and alights within a few yards of where I throw it from, generally behind my back. I find it does its work better when thrown against the wind, which should never be more than a breath. Mine is made of apple tree, but I fancy any tough hard wood would do, provided the grain runs parallel with the bend. This is necessary, for if the grain of the wood runs across, or through the bend, the boomerang snaps in that spot when it hits a stone or other hard object. I have made three or four now without any difficulty except that of getting the grain right. They have all broken at the bend owing to the straight grain. One I have used for two summers, came to grief last week. Anyone wanting further information will have it, and welcome, by applying through our unique journal. It is ¼in. thick, tapered on all sides to a fine but thick edge. VIVIS SPERANDUM.



HYPOCHLORIC ACID, &c.

SIR,—I see week after week that your paper is filled with valuable matter, therefore, absurd arguments are best omitted As to my communication respecting hypochloric acid, I shall not argue—the acid does not exist, although caustic alkalies absorb chlorine tetroxide. This latter was termed by Liebeg, in his "Elements," chlorous acid.

My tardiness in replying to "U," in your impression of the 8th, has been caused by my undertaking a series of experiments to determine how far I really could go in separating barium chlorate from the chloride, and the result was that when operating with quantities calculated to produce 30·4 grms. of the chlorate I was able to separate 26·7 grms. of this salt. I shall not give the full particulars unless specially required to do so, as it would be only taking up the space of your valuable journal.

If querists would only be more exact in stating what they require, and in many cases the purpose for which the article is required, they might often be answered in a very few words. For instance, in the barium chlorate question, if the pure article was wanted, why not have said so? However, I have, in spite of our old correspondent under a new face, quite satisfied myself that the pure article may be obtained by my method, and in spite of the bold assertion made by the correspondent alluded to, *the alkaline chlorates are easily separated from the chloride.*

If such separations as these were the only operations of a laboratory, practical chemistry must indeed be an easy science; but good instances of separations are not to be found in such single instances as the one just illustrated, the difficulty increases almost to perplexity when we have to separate bodies of complex structure formed by the obscure action of reagents upon bodies of organic origin.

GEORGE E. DAVIS.

Errata in article on "Symbols," col. 3, p. 98, for $\left.\begin{matrix}Ca'\\H_2'\end{matrix}\right\}$ read $\left.\begin{matrix}Ca''\\H_2\end{matrix}\right\}O_2$. Col. 1, p. 99 three errors occur in the formula; for tetrethyl ammonium hydrate, platosammonium chloride and ethyl aldehyde.

BREWING.

SIR,—Having seen from time to time many inquiries in your pages relative to brewing without eliciting a reply, I am induced to send you (another brick) for insertion, if you think desirable, the following:—

Much mystery is made about the art of brewing—it is an art easily understood—any one who can make tea can make ale or beer, the process being exactly similar. Put a handful of ground malt into a teapot, fill with water nearly boiling, mix, let stand for some time, pour off the liquor, add a few hops, and boil till the wort breaks—that is, comes up in large flakes—then draw off to cool; when it has cooled to about 60° to 70° add yeast to ferment it, and the beer is made. The above is the whole art of beer making, either on a large or small scale, and as many of your readers may like to try their hand at it, I will proceed to details. First, utensils: these in a small way should consist of a copper to hold, say 10 gals., a tub, an oar, a sieve, funnel and tap, a tub for cooling, and 2 9 gal. casks. Take 1 bushel of malt ground fine, place in the mash tub, then add 2 gals. of water at 182° of the thermometer (not having one, if it is sufficiently hot to bite the finger it will do), mix up well with the oar, so that it may be well wetted—if the water is too hot it will set the malt and prevent it breaking—after well mashing cover over with a sack, so as to hold the heat. When this, the wort, has stood one hour and a half, try your liquor; if it runs clear it is ready for boiling, if not clear put back again, and let it remain till clear, then draw off into your cooling tub preparatory to boiling. In the meanwhile have ready a second 10 gals. of water ready to pour into the mash tub upon the drained malt at a temperature of 190°, well mash and let stand one hour, then draw off if clear and proceed to the boiling. You take the first wort already drawn off, place it in the copper, adding 1lb. of hops and a small quantity of salt, make boil, and considerable attention should be paid that only a gentle ebullition be kept up; after boiling about an hour and a half, flakes will begin to come up, and when they come up somewhat large will be time to draw off to cool, and here it is that written instructions fail—*experientia doces*. If not boiled enough the beer is apt to taste raw and sickly, if too much it will thicken, and never be agreeable to the palate; when boiled enough, strain through the sieve into the cooler to cool to about 64°. Then take the second mashing and boil in a like manner, adding 1lb. fresh hops—the old ones will not do—for, say one hour, then draw off to cool, and you can add the two worts together, if so inclined, when at the same temperature—don't add the hot to the cold—to ferment together or separately, in either case you add one pint new yeast to each 9 gals. of liquor, stirred well in, set aside to work for two days, this is best done by—having placed the beer in barrels—filling up the barrels as they work over with beer retained for that purpose—in a week or so it will be ready for use.

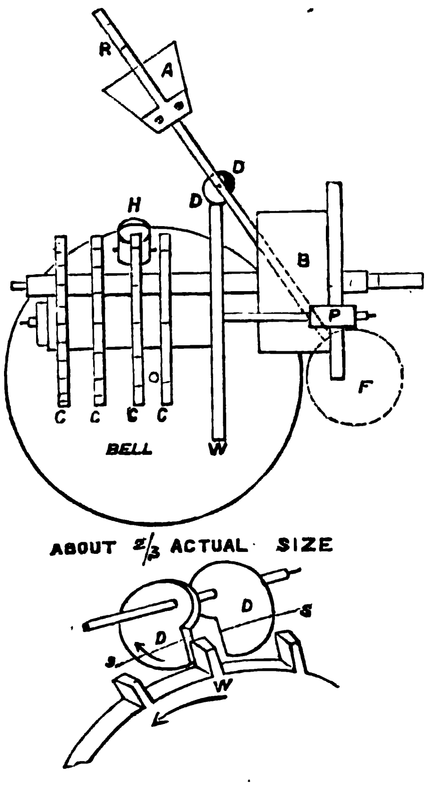
The above is brewing pure and simple, and I trust it will be found useful. Many an artisan could at all times ensure himself a glass of good wholesome beer at one-half the cost he pays for the vile trash now purchased at the public—the trouble is not much when once the mill is set a going if he will only have a little PATIENCE AND PERSEVERANCE.

METRONOME.

SIR,—I here furnish, in answer to query 2408, a sketch of this instrument unencumbered with the framework, in order to more clearly show its essential parts. B is the mainspring barrel, its wheel of 120 gearing into a pinion P of 10. Upon the axis of this latter, nearest the barrel, is a wheel W of 24, the teeth of which are of peculiar shape, so as, through an intervening contrivance, to give vibrating movement to the rod R. To explain this, I have made the separate sketch of this part enlarged. The object involved is that of converting the continuous motion of the wheel in one direction into that of an alternate vibrating one at right angle to it; and if the action has not already figured in the excellent plates of "Mechanical Movements," it is well worthy of description in the ENGLISH MECHANIC. The wheel teeth are very slightly undercut, and are square, but with their acting front so bevelled as to be wedge-shaped, their middle pins standing prominent. They are at intervals of about two teeth from each other. Upon an arbor placed transversely to the wheel are fixed two snail-shaped discs D D, at such distance apart as to just have shake between any two teeth of the wheel, which in turning may embrace them, and also to allow of similar shake when either of the teeth is between them. The discs are of equal size, but reversed in position, so that their acting slopes S, which are bevelled from behind, may stand in a line with each other.

Suppose now the mainspring is wound up, the front of a tooth of the impulse wheel will press against the sloping edge of the back disc and move it aside, to the right, until the tooth escapes from it and drops on to the slope of the front disc, which it also drives aside, but in the contrary direction, until the tooth finally escapes. A like action is caused by the succeeding teeth, the rate of their escape being governed by the position of a flattish weight or slider A, held friction tight on the rod by a spring clip, as shown in the figure; for the rod is fixed on the same axis as the discs, moves with them to either hand, and, in fact, is a pendulum, whose rate of vibration is controlled by shifting its centre of oscillation by means of the slider on the upward continuation of the rod. To dilate further upon this would require more space than the present communication warrants; suffice it to say that the frequency of the vibrations and their accompanying audible beats (the latter caused by the drop of teeth on the dead part of the discs, but intensified by the resonance of the wooden case) can thus be varied from 40 to 208 per minute. The much heavier lower weight F is to balance the slider, and by its momentum the discs are carried further than necessary for the mere escape of the wheel, so that the latter does not at once drop from the slope of one disc on to that of the other.

The part remaining to be described is that for striking the recurrence of stronger accents on a bell. This is effected by four cam wheels C, C, C, C, of equal size, but having respectively 8, 12, 16, and 24 teeth; which wheels are fixed on the same axis as the impulse wheel. To illustrate their action, I will take that of the cam of 12. Suppose the slider be set to 144 beats on the scale of the instrument, these will take place in one minute, and 72 teeth of the impulse wheel will be concerned in their production; or, in other words, the wheel, having only 24 teeth, will just make 3 revolutions. The cam of 12 being on the same axis will, of course, turn at the same rate; and if its teeth be allowed to lift the hammer tail shown at H, 36 blows will be struck on the bell for every 144 swings of the rod. This proportion of one chime to every 4 beats or swings will remain constant for any number the slider may be placed at; but the hammer is mounted on a slide, and can be brought into action with either of the other cams, when the proportion will be different, and every second, third, or sixth beat may be chimed; or the hammer may be slid out of action altogether, the slide on which it is fixed terminating in a push piece outside the wooden case.



The instrument is easily stopped, if desired, by restraining the rod R in the position shown in the figure, when the impulse wheel is opposed by the plain part of one of the discs. To prevent overwinding, there is a stop-work limiting the winding to 5 turns, and of course the barrel arbor has a ratchet and click.

The instrument which I make this description from is by Paquet, of Paris, and made according to Maelzel, who invented the metronome in 1815.

H. H. L., Manchester.

ROTATION OF THE EARTH, &c.

SIR,—I have lived long enough to feel convinced that under the head of "Original and Independent Thought" a great deal of original and independent nonsense is uttered; but I cannot help acknowledging that if the hearers of "Parallax" and charlatans choose to believe the rubbishing theories of those "gentlemen," they are perfectly at liberty to do so. If individuals supposed to be sane choose to accept the theories of these "gentlemen," by all means let them. If they cannot ask themselves the simple question "What advantage do Mr. Proctor and the other astronomers gain by telling these *lies*," ("fraud and falsehood" are the choice expletives Mr. J. Hampden uses), let them remain in their ignorance. Burning the candle to give them light is waste of time, life (for life is not too long), and money. But I agree with you that it is not advisable to smother Mr. Beardsley's letters; let them have the light of day by all means. By the way, I should like him to explain the following fact:—Last winter, while an unmistakable East wind was blowing on the surface of the earth, I saw dense clouds travelling from S.W. to N.E. cross the moon at the rate of 10 miles an hour. How does Mr. B account for this?

With regard to Mr. B's. little "difficulty" about a strong south wind infringing on the peaks of the earth, p. 90, he need not be alarmed. It would have about as much effect as Mr. B. could produce by blowing with all his might against the side of a cog wheel in rapid motion. Mr. B. does not say anything about the extent of surface on which this strong south wind is to blow. I imagine it would have to be a very broad "belt" indeed to induce the peaks of the Himalayas to deviate from the path they describe.

Does not Mr. B. think it would be advisable to give us his own theory instead of picking imaginary holes in the received explanations of mundane phenomena? Of course so learned and talented an inquirer into the mysteries of Nature has not adopted his theories without laborious and painstaking research, and has arrived at a solution of the various "difficulties" which is doubtless satisfactory to himself. It is of course not *impossible* that Mr. Proctor is wrong; but then again it is not even probable that Mr. Beardsley is right.

I have only recently discovered that Mr. Hampden founds his opposition to modern "astronomers" on Scripture testimony. What a marvellous misapplication of a wonderful book

Est proprium stultitiæ aliorum "vitia" cernere, oblivisci suorum. SAUL RYMEA.

COMMERCE AND TRADE.

SIR,—As "our" journal is the only one that circulates in every workshop and amongst all classes of workmen, I should like, with your permission, to elicit some opinions on the above subject. To make the matter plain, I will put the question in the form of a short extract from the "Statesman's Year-book for 1870":—

"The sum of the imports into the United Kingdom for the year 1868 was £294,693,608. . . . Meanwhile the exports for the year 1868 amounted in all to £179,677,812. . . . We are exporting less, and importing more. . . . The question arises, What sort of 'prosperity' does this indicate?"

I venture to think the answers to this question will be of very great interest to a majority of our readers; and certainly no journal has a better opportunity of eliciting useful information on this important subject than the ENGLISH MECHANIC. Of course politics are tabooed, as well as theology, or our "happy family" cage will become a den of "roaring lions." SAUL RYMEA.

A LIBEL ON BRITISH WORKMEN.

SIR,—I wish to call the attention of English mechanics to the following extract from a leader in the *Globe* of April 20. The writer says:—"Our notions of education are somewhat crude and superficial, and we are a trifle too proud of our barbarous alphabet and our imperfect multiplication table. Those men whose work is visible in Westminster Abbey spoke better English than ours, although they were unable to write it; and their education, being moral as well as intellectual, caused them to do good sound work, instead of 'scamping' everything in the modern fashion. They loved their work, whilst too many of our modern artisans hate theirs. Why they do so is a wide question. It is not wholly their own fault; it is the vice of an age in which *betting men and stockbrokers are the very cream of society* (!) The men who built our cathedrals had a share in the structure as complete as the architects. But the workmen of to-day are very much like other fungous growths of the time. They care for what their work will produce, not for the work itself. . . . The thing now deemed desirable to be learned is how to make the most money with the least expenditure of labour."

Now this is a deliberate and unjustifiable libel, for if the writer had really any knowledge of the matter on which he writes, and of the world in which he lives, he would have heard of a writer named John Ruskin, and if he had read his works he would have known that it is mainly through the system of paying by the piece that so much of the work of the present day is "scamped." To say that "everything" is "scamped" is to say that which is notoriously untrue; for although there are doubtless hundreds of houses "run up," that is no proof that "good sound work" is not put into hundreds of others; and I have not the slightest doubt but that Mr. G. G. Scott knows where to find masons and sculptors in every way worthy to build another "Westminster" or another "St. Paul's." To say that the men who built Westminster Abbey spoke better English than we do, and that they did better work because their education was "moral as well as intellectual" does not say much for the "advance of civilisation" or the "power of the penny press." If their language was so much "better" than ours, why does not the *Globe* adopt it?—possibly it might increase its very limited circulation. It is no palliation of the *Globe's* offence to say that it is not "wholly the fault" of the workmen; for anyone who looks down the list of tenders offered for any large building will see that in 9 cases out of 10 the "lowest tender" is accepted, although it is very likely *less than half* the amount of the highest. So long as "consumers of labour" adopt these tactics, so long will builders use inferior material and inferior workmanship. It is simply nonsense to say that the workmen of to-day care merely "for what their work will produce." I can go and buy an inferior watch at a low price; and I can also get a "good sound" article at a fair price. The labourer is always worthy of his hire; and it would be ridiculous to charge the watchmaker who asks a "good" price for the produce of his labour with liking his work only for what it will produce. The same argument applies to all the relations of life, and one number of the ENGLISH MECHANIC gives the "lie direct" to the assertions of the *Globe*; for there "he who runs may read" that men *do* love their work for their work's sake. The sentence about speaking "better English" shows the amount of knowledge of the whole subject possessed by the *Globe*, seeing that the men who built and rebuilt the extant West Minster lived at intervals between 1221 and 1809. (The foundation stone of the present building was laid by Henry III., in 1221, since which time it has been "added to" up to the reign of Henry VII. Portions have been re-built so late as 1809.) But possibly the best reply to such ridiculous "bunkum" is furnished by an earlier sentence in the very "leading article" from which I quote. "Such nonsense is not worth serious criticism, indeed, it is easily explicable from the fact that Easter is a holiday for journalists as well as politicians, and that newspapers must be filled, even though the *better brains* of the establishment are away in the country." It is a great pity the writer in the *Globe* could not see that a "pen" is a weapon that "stabs" both ways. Certainly the "better *brains*" were absent on this occasion. SAUL RYMEA.

CHICORY AND STARCH.*

SIR,—From unavoidable circumstances, partly connected with the business of this time of the year, I have been unable to pen down the article on starch; but such as it is I now send it to you. In the number before last of our MECHANIC, there is an article from the *Food Journal* in which it states that chicory is procured from the endive root. Is not this a mistake? The root of the *Cichorium intibus*, L. has been used for that purpose, and I should have thought the endive would not have been likely to be used in preference to chicory plant. There are several substances having the name of starch, and which chemists tell us are closely related to each other in chemical composition, —namely, Iceland moss starch, lichen starch, lichenin, found in Iceland moss and other lichens: animal starch, found in the liver and placenta; inulien, found in the root of the elecampane, dahlia, and Jerusalem artichoke; and the ordinary starch as we find it in rice, &c. This latter substance is that which forms the subject of the present article. Starch occurs in the form of grains of very various shapes and sizes, occurring in the cells of various parts of plants, most frequently in the seeds, roots, and stems, and also said to occur in the receptacles and pollen of flowers. These grains resemble each other in one particular, —namely, a point which, from its shape and position, is often characteristic of the kind of grain to which it belongs. In viewing starch under the microscope, as they lie in their containing cells, I think it is impossible to avoid the conclusion that this point is the point of attachment of the grain, and forms the nucleus around which the starch grain forms; for all the parts of the grain are related to it. Starch, under the microscope, usually presents the appearance of partial or complete curves surrounding or related to the above point, or hilum, as it is called; indeed, it would appear as if the grain consisted of a number of coatings, their common meeting point being the hilum. This structure is rendered more apparent in the following experiment:—Place a little arrowroot or potato starch on a glass slip with a little water, add a minute quantity of tincture of iodine, let it be a few seconds, then soak up the moisture with a small piece of blotting paper; place a thin cover of glass over the starch left on the slip, place on the microscope stage—a power of ¼in. focus will do very well; just drop a little strong sulphuric acid carefully by the edge of the glass cover so as to let it run between the two glasses, and cover the starch. The layers will swell out from the hilum like gelatinous bags, the light blue communicated by the iodine serving to render them visible. It would seem that the outer covering slightly differs in its properties from that contained in the interior of the grain; being coloured violet by iodine, as seen both in the whole grain, when the outer surface shows the violet; and when starch is heated for a short time in a large quantity of boiling water, and allowed to settle, the white sediment gradually deposited, separated from the liquid and examined by the microscope, shows the appearance of a gelatinous membrane, and, when tested with iodine, shows the same or similar violet colour to that which appears on the outer surface of the whole starch grain. The latter may be soaked for almost any length of time in cold water without apparent alteration; but if potato or arrowroot starch are pounded in a mortar, some of the grains will be seen crushed in various ways, the broken edges being covered with sharp angles. If rubbed up with a little cold water, and the liquid filtered, we obtain a white opalescent liquid, which deposits no sediment, and no filtering will clear, evidently an imperfect solution of starch; treated with a proper quantity of tincture of iodine, it shows the same royal blue as perfectly dissolved starch. This is obtained by boiling a small quantity of starch in a large quantity of water, when a perfectly clear liquid may be obtained by filtering, containing a small quantity of the starch in a perfectly dissolved state, which is shown by the royal blue above mentioned, being produced by the action of iodine. Rice starch treated in the same way gives similar results, only the smallness of the grains render it inconvenient for experiment. The iodide of starch produced is insoluble, or very slightly soluble in water; for if a small piece of solid iodine is dropped into the solution, the blue compound forms around the piece of iodine, while the liquid alone remains in appearance clear, though if the iodine be added in form of tincture, the blue compound never settles from the liquid in which it is diffused. Dry starch grains treated with iodine vapour (placed in a closed bottle with iodine) gives rather different results. The mixture commonly sold as arrowroot (arrowroot adulterated with potato) is coloured yellow sand; starch from the underground stem of *Calystegia sepium* (wild convolvulus) light brown, with all the rest, I tried—namely, Indian corn, wheat, horse radish, rice, and fennel. I obtained a violet after about a day's exposure to the action of the vapour; all showed a violet colour on being dropped into water. Starch is precipitated from its solution by solution of galls, and partially by acetic acid, some being precipitated and some remaining dissolved. The action of acids, &c., on starch is so well known that I may well leave out any further remarks on that subject. But in a future paper, if desirable, I may say a few words on the office performed by starch in nature, the nature of its production, and the means used to detect its presence. J. C.

SLOT CUTTING.

SIR,—I beg to tender my thanks to our obliging "J. K. P." for his reply on the above subject. I had, of course, no wish to put him to the trouble of searching the back volumes, and was not unreasonable enough to expect him to do so. I have now looked through the "Notes and Queries" of the whole series, but, I regret to say, without success. The question was, therefore, probably embodied in some longer communication. What the writer required was the means of cutting, in the lathe, the slots in the back part of pianoforte keys through which brass pins pass that hold them in their place. I looked out for an answer to this question, because it struck me that the solution would indicate a ready, expeditious, and accurate mode of cutting mortises in small articles of joinery. I almost fear the tool suggested by "J. K. P." is more adapted for metal than wood, as the cutting edge would be scarcely keen enough for the latter. Nevertheless, I shall try it. I was unaware of the shortness of the period during which "J. K. P." had been a contributor to the ENGLISH MECHANIC, and am really amazed at the large amount of valuable information he has afforded in that time. F.R.C.S.

THE WORKMEN'S INTERNATIONAL EXHIBITION.

SIR,—In answer to those of your readers who have not received any answer to their letters to me, I beg to say that although I am perfectly willing to afford them all the information and assistance in my power, I cannot afford them stationery and postage stamps as well, my services to the Workmen's International Exhibition being honorary.

They will therefore please to understand that the reason why they have not received answers through the post is, that they omitted to send stamped directed envelope for reply.

ROBERT BURGESS, 22, George-street, Oxford-st., W.,
Local Sec., W.I.E.

FISHING RODS AND FISHING.

SIR,—I have, as an amateur, made a good many salmon and trout fly rods, and have tried all woods except the one mentioned by "The Harmonious Blacksmith." What I always aimed at, was lightness and strength; if I had this, I was pretty certain to have both elasticity and firmness. After trying all woods, I succeeded in making a salmon and a trout rod which pleases every one who handles them; the first was 18′ 6″ long. Memel butt, hickory middle joint, lancewood and bamboo top, weighed 2lb. 3oz., and pulled out last season many a fine 15 and 20lb. salmon. The trout rod is 11′ 6″ long, ash butt, hickory middle, and lancewood and bamboo top, weighing 14oz. without the reel, and seems in the hand like a willow wand. I should like to see some matters relating to shooting and fishing, now and then in your journal; these are always interesting to both rich and poor, and when I am thus in the field, or more properly, the water, would like very much, if some of your sporting readers could give me a wrinkle how to catch mullet. I have tried them with every bait I can think of, from slob worms to boiled cabbage, and find myself circumvented. They are to be seen in large numbers during the summer and autumn months, lying motionless in the timber ponds, many of them 10 and 12lb weight, allowing one to go within a few feet of them, if quietness prevails, but the moment a line is thrown, away they go. VIVIS SPERANDUM.

A CORRECTION.

SIR,—I am afraid I must plead guilty to having committed a slight inaccuracy in the expression of the formula referred to by G. Firth, if it appears in the last volume, as stated by that gentleman in your last impression. Anyone versed in astronomical formulæ and expressions would see the error at once, and be able to rectify it, but to those who have not experience in those matters, I doubt not it is sufficiently puzzling. Of course by $\triangle$ is not intended the log. dist. but the dist. The formula will then offer no difficulty.

$$\begin{array}{lclclcl}
 & r & = & 0{\cdot}7215 & & & \\
 & \triangle & = & 0{\cdot}4210 & & & \\
 & R & = & 0{\cdot}9919 & & & \\
\hline
 & \text{Sun.} & & 2{\cdot}1335 & = \text{log.} & = & 0{\cdot}32909 \\
 & 2R & & 1{\cdot}9838 & & & \\
\hline
 & & & 0{\cdot}1497 & = \text{Log.} & = & 9{\cdot}17522 \\
\end{array}$$

$$\begin{array}{lcllcl}
r^3 & = & 9{\cdot}5749 & \text{Sun.} & = & 9{\cdot}50431 \\
\triangle^3 & = & 8{\cdot}8702 & \text{Sun.} & = & 8{\cdot}44510 \\
\hline
\text{Sun.} & = & 8{\cdot}4451 & \text{Log.} & = & 1{\cdot}05921 \\
\end{array}$$

OMICRON.

COTTON SPINNING.

SIR,—Many thanks for the quick replies to my inquiry respecting draught in carding engine. I quite agree with "B. W. Rochdale," that the rule I quoted (found in several small publications) does not give the draught sufficiently accurate, but that the draught should be the "difference between surface speeds of the first, or feed rollers, and last, or delivery rollers.

"Factory Lad" will perceive that the difference between traverse of doffers and callenders was intentional, showing the difference between the two speeds of delivery.

DRAWING FRAME ROLLERS.

I should set these as follows:—

Between 1st and 2nd........................3.21
" 2nd and 3rd........................1·80
" 3rd and 4th........................1·20

Total draught.................6·93

The best and cheapest publication, with plates, on Cotton Spinning, which I have met with, is one by "Kurt Neste." It costs 4s. or 5s., and may be had from John Heywood, Manchester, or Simpkin and Marshall, London, styled "The Mule Spinning Process." MUTUAL IMPROVEMENT.

THE SALTAIRE LATHE.

SIR,—Your illustration of Mr. Salt's lathe must have delighted many of your readers; but the poor description pinned to its tail must have equally disappointed them. Your amateur turning friends will be much puzzled to know how many of the self-acting motions are obtained, to say nothing of a host of other intricacies in such an elaborate and costly piece of work. Very complete it may be said, no doubt, but not the most complete lathe in existence by many a bit. A lathe designed and made by Mr. Smith for his own private use is a far more complete machine, and it may be said without fear of contradiction that the "Saltaire-Wardour-street Lathe" is an offspring of Mr. Smith's "Jersey Lathe," and I hope at some future time to send you a few blocks of rosette work, with photographs of other things done in the lathe that will set the wits of the fancy turning fraternity to work—a lesson not easily accomplished.

Your correspondent "J. K. P." does not seem satisfied with the description of the Saltaire-Wardour-street lathe, inasmuch as it does not mention Mr. Evans as the maker. He also states that Mr. E. *did not* make the overhead motion, only did a few alterations. If these alterations consisted in discarding certain parts and substituting his own improvements, it is very questionable whether it would not have been better let alone, and when "J. K. P." states that he knows a great part of the lathe made at Saltaire was put on one side and entirely re-made, he states, I think, more than he can prove. Will "J. K. P." be kind enough to name the parts that were laid on one side? I believe a double crank shaft made at Saltaire was discarded and substituted with one of Mr. Evans's improved single crank shaft—a very doubtful improvement indeed; I also believe that the standards, bed, heads, wheel, and other parts, such as leading screw-saddle, overhead motion, &c., was all or nearly finished before Mr. Evans had it, with the exception of polishing, and that the same had not been discarded. I am not aware that there are any of Mr. Evans's improvements in the lathe except the slide rest and single crank shaft, both of which were directly opposed to the designer's notion of lathe making.

A NATURAL FLAT.

ASTRONOMICAL.

SIR,—I am sorry that "Veritas" took exception to my using "qualified" in my note; I did so because I do not profess to be so myself, not being a mathematician, but only working from the formula given in the books, and as "Veritas" had used quantities (as coversine of arc) not mentioned by any authors, I wished to know if he was right in doing so, or whether he was misleading any of your readers taking interest in the subject: and he also deduced the mean horizontal parallax from the distance, and not the distance from the mean horizontal parallax, which is, I believe, the only data in conjunction with the *equatorial semi-diameter* of the earth for determining that distance.

Thanks to "R. H." for his information from the "Phil. Trans." He is not perhaps aware that all astronomers have agreed that that determination was too small, and that the equatorial horizontal parallax is now considered to be about $\left.\frac{8''{\cdot}91}{8{\cdot}95}\right\}$ from observations of Mars at opposition, and also from the velocity of light, and that this value is also supported from a re-discussion of the original observations of the transit of Venus by Cooke, recently communicated by Mr. Stone to R. A. S.

I submit that the *equatorial semi-diameter* of the earth is the proper quantity to use, the mean semi-diameter being the radius of the earth in latitude 45° ± and is only of value in determining the local parallax of any object from the geocentric position.

If Mr. Beardsley is the possessor of a telescope, will he allow me to suggest an analogical test as to the earth's rotation and sphericity? If he will observe the sun for some days in succession he will see spots traverse the surface from east to west; Jupiter or Mars, for some hours, markings traverse the discs in the same direction. Now if he will allow that these spots and markings are actual features of those bodies, he must also allow that there is motion on an axis, and as the object always maintains a round disc, this proves that they are spheres, as if merely circular discs, as they revolved they would alternately show as circles, then as ellipses, and finally as thin lines of light, according to their thickness. If the sun and the other planets are spheres, why the earth different? Also to consider that a sphere gives the largest surface with a given diameter, further, that it is the most convenient form for oceanic or terrestrial communication in any direction. I think he must allow this as strong collateral evidence.

Allow me to suggest that your space is too valuable to be taken up by mere verbiage whether "harmonious" or otherwise, and that useful information would be more acceptable to the bulk of your readers than personalities of any kind. S. B.

THE SUNFLOWER, &c.

SIR,—I have read the communication of "Tautau" on the many useful qualities of the sunflower with much interest, and have pleasure in transcribing the substance of a late address on "Plants as Sanitary Agents," by Mr. Ingram, at Leicester. The lecturer explained how plants and trees absorbed the moisture from the earth, which would otherwise appear in miasmatic vapours. Vegetable action produced oxygen and freed the air from taint, so that the multiplication of trees, shrubs, and plants increased the vital principle of the air and helped to get rid of its impurities. All trees are of course not alike in taste and constitution. Those which are deciduous, with large woolly or hairy leaves are not suited for towns; the particles of carbon which float in the air, resting on the leaves, often destroy them. Pines and firs require a pure air. The lime, plane, sycamore, elm, and chestnut, are amongst the trees that will thrive in towns. Low, marshy lands are greatly improved by heavy cropping. London sewage has made the poor sandy wastes of Barking Creek wonderfully fruitful. Vegetation seeks support, and seizes upon the pabulum within its reach; nothing, for instance, is too gross for a hungry and healthy vine. A singular fact was adduced in proof of the power possessed by plants to neutralise noxious exhalations. The observatory of Washington is situated in a dead marsh, the result of which was, that the assistant astronomers were killed off wholesale. Sunflowers were sown all round, and they reached their greatest luxuriance at the time when the fever was most rife; and the happy result was, that the fever disappeared, whilst the plants flourished on the poison that had committed such havoc. It was further suggested by Mr. Ingram that trees or their roots might be employed as filterers around wells suspected of impurity by the percolation of foul matters into the water within them.

I can inform our friend "Bernardin," that a few months ago I saw in a scientific and optician's shop nearly opposite Effingham Wilson's, Royal Exchange, London, some recent photos of Australian scenery, including an "Eucalyptus." "Over Sixty" had better invest in a "Macclesfield" tricycle, which is much cheaper and more easily worked by an elderly man than the "Edinburgh," which occupies a great space, and is actuated by the legs solely. The steering, which cannot be clearly seen from a photo or drawing, is managed by two broad crossed straps attached to the front axles and the short levers on either side of the graceful vehicle. I congratulate you on the varied improvements in our journal.

P. FRANCE, Harrington-street, Liverpool.

MR. BEARDSLEY'S DYNAMICS.

SIR,—It appears that Mr. Proctor and myself are at issue on a particular subject—namely, upon one branch of dynamics (or of the laws and properties of matter in motion), and he declares me to be "ignorant of the fundamental laws of dynamics." Cannot Mr. Proctor afford to be rather charitable than hostile? Cannot be find more pleasure in convincing me I am in error, than in fighting me in the dark at (according to his own showing) a disadvantage? Thousands of your readers can substantiate my assertion on page 90, but it must be borne in mind we must not tie ourselves hand and foot, as it were, to the so-called laws, brought into existence from necessity at the time other theories were advanced, and which I shall at a future time require to notice. I will not waste your valuable space further than to say I have done as Mr. Proctor beseeches *me not to do* hundreds of times, and find that the moment the feet touch the ground it is necessary to put the body in a slanting attitude to resist as far as possible the principle I named, arising from the forward motion of the train, and even after this precaution had been taken, found it necessary to put the feet into very nimble action. I must, therefore, "beseech" him in turn, rather than adopt an uncharitable course in condemning me as ignorant, to prove me to be *so*, and I will at once "lower my sword," and tender him my thanks. I shall also thank him to point out when, where, and by what arguments Galileo laughed away what he is pleased to call my "puerile" objections about the earth's atmosphere.

JOHN BEARDSLEY.

THE "PHANTOM" WHEEL.

SIR,—Having examined Mr. Tydeman's letter at p. 385 of Vol III, in which, according to his further letter which appeared in the MECHANIC, a fortnight since, he describes a wheel "of a precisely similar kind" to that made and advertised by this company. I now beg to offer that gentleman a simple denial of the identity; and, I think I may add, of the similarity of the two manufactures. The only point in respect to which the two wheels may be spoken of in the same connection is that both are "suspended" wheels. There is no novelty, however, as to the suspension, and we have never claimed any. That is a comparatively old affair; Theodore Jones's patent for it was issued in 1826.

Your correspondent is emphatic upon the point that the failures and defects of the "Spider" wheel are inseparable from, and are part of the suspension principle; and, whether intentionally or no, he leaves the impression on the minds of some, at least, of your readers—the two wheels being already rather dogmatically declared to be of a "precisely similar kind"—that the "Phantom" wheel must be certainly as useless as the Spider turned out to be.

The object sought to be attained in a suspended wheel is to make it sustain a weight in motion in such a way as to lessen the degree of traction required on ordinary roads. This is effected by hanging the axle in the centre of what I will call a continuous arch, or a circular spring, which, altering its arc, and the portions of its abutments to a degree nicely adjusted to the weight of the load, the velocity of the motion, and the nature of the road, keeps the axle or load as nearly as may be at a level with the line of the road. To effect this, the material of the arch or circular spring must be of an elastic, and yet very strong, nature; something capable of receiving, distributing, and absorbing rather than of resisting concussion. The arch must be made so as to bend in as a whole, and yet be unyielding in its parts. Its dimensions and substance should be well adapted to its work, and the principle of its construction should be such as to ensure the strain being distributed as evenly as possible over its whole area or circumference. A suspended wheel might be formed of a mere hoop of bamboo or cane, with four strings attached to it at equal distances, and joined to a stock in the centre. Such a wheel, however, would not do for serious work, because it would fail to comply with any one of the conditions I have just mentioned. The bamboo or cane would not stand continued concussion, and the weight of the load could not be fairly distributed over the whole of the circumference from so few points of suspension; the strain would be unequal, and would tend to pull the hoop into a square shape by bending it outwards at the points midway between the attachments of the strings to the rim. If, instead of only four there were eight suspending strings, the strain would be better distributed, as it would tend to make the circle into an octagon, and so on according to the number of points from which the rim would be held in towards the centre of the wheel. The hoop could of course be made superior to any strain whatever, even with only four suspending strings; and, on the other hand, it might be made so light and springy, as to require to be held in at every inch of its circumference by suspending rods. In either case the wheel would not be elastic, and nothing would be gained by the suspension principle so applied. The happy mean required is the adaptation of the material and the proportioning of the diameter and strength of the rim, and the number and strength of the suspending rods to the work required of the wheel, so that each part of the structure shall have its fair share of the load assigned to it, and no more. The wheel, as a whole, must be elastic enough to *give* to inequalities of the surface of the road, and yet strong enough to recover and retain a perfectly circular shape where the road is good and smooth.

It seems to me that Mr. Tydeman began badly by making his rim or arch in bad proportions, and that he then failed to properly retain or keep it in shape by a sufficient number of suspending rods. A 1in. steel *tube* formed a circle 6ft. in diameter, held in by wire rods 14in. apart from each other on the rim; thus what I will call the segments of his arch, the spaces between his suspending rods, were not far from flat at starting. The tubular shape of the rim did not improve its elasticity, and whatever it had of that quality, must have been soon destroyed by the "'ammer, 'ammer, 'ammer, on the 'ard 'igh road" which the cabman in *Punch* speaks of. The rim was too weak and slender as compared with its diameter, and it had far too little, or at any rate too widely separated, help from the very few suspending rods.

In a "Phantom" wheel, of half the diameter of Mr. Tydeman's, we use a continuous rim of American elm, 1in. square. Iron eyes with stems, $\frac{3}{16}$in. thick pass through this rim, and are fastened on the outside of it, and through these eyes, which are only about 6in. apart, sixteen pairs of suspending rods are passed to be held in the stock in the way your readers may see by referring to our woodcut. The rim is, under any circumstance, such as that of being over-weighed, prevented from altering its shape to an injurious extent.

Mr. Tydeman says that the suspending wires of the "Spider" broke too readily on being struck laterally. No wonder. They were only $\frac{1}{10}$in. black steel, in lengths of 34in. each. The suspending rods of the "Phantom" are in pairs, each $\frac{3}{16}$ thick, and only 16in. long; they are made, too, of a mild tempered steel, prepared purposely for the job.

Further, the passing of the steel rods through the steel rim of the "Spider," weakened it, and led to flattening at those points. This can hardly be the true cause of the flattening, I fancy. If the rim flattened in at the rods it must have bent outwards where there were no rods; it would therefore, apparently, have been stronger *at* the rods. The flattening, however, was in all probability due to the causes I have already referred to, and I can only emphatically deny that it is at all the case with our wheel.

J. A. MAYS, Secretary and Manager, the "Phantom" Veloce and Carriage Wheel Company, Limited, 10, King-street, Tower-hill, London, E.C., 21st April, 1870.

THE EARTH'S FORM.

SIR,—It is no tempting task to take up and reply to the wretched stuff which Mr. Beardsley is inflicting on your readers. In common with "Parallax," Mr. Hampden, and all the others of his tribe, he sets forth as facts things which have no existence as facts; he of course puts into the mouths of the orthodox, opinions which they do not hold, and, as a necessary consequence, his deductions from the one, and his ridicule of the other, are both erroneous and delusive. The "arguments" we have been favoured with, being within the compass of any half-trained schoolboy, will probably find plenty to answer them. My purpose is to give one or two on the other side—to set forth a real fact or two, which must first find an explanation before the globular form of the earth can even be doubted. First, if the earth be not round, how is it we manage to go *round the earth*; that is to say, if the earth be one continuous plane, by what conceivable process is it that by going steadily on in a straight line we come back to the point from which we started? Secondly, if the earth be a continuous plane, where does it end, and in what, and what is it built on and supported by, as we are invited to abandon the theory of central gravitation, linked up with that of the spherical form of the earth?

To show that I do not speak without authority, I may say that I hold a certificate from examiners that "I was a correct and able navigator" and that I have myself been "round the world," as well as up and down and round about in many ways. I once, after being two months out of sight of land, sent a man aloft to look in a particular direction for an island, and in half an hour he called out "Land Ho." Now will any one in his senses suppose that this would be possible if the doctrine on which we work were so fundamentally wrong that the world on which we travel is utterly different in form to what we suppose?

We do not chatter nonsense, we *know* that starting from England, we may sail west to America, cross that continent, go still west to Japan, China, India, and home, always westing, by the overland route. We *know* that we sail eastward to the Cape, to Australia, eastward still round the Horn, home again, coming north on our return as much as we went south on our outward voyage. We know also that if two people started at the same time on such journeys, and returned on the same day, on comparing time, one would have lived two days longer than the other in the same time; for one, prolonging each day by accompanying the sun, would in the complete journey have thus dissipated one day; while the other, going always to meet the rising sun, would have seen it rise and set once oftener than if he had remained in one spot.

It is true that in travelling over a wide plain, it is quite possible to keep going round and find oneself where one started. I have done it myself on a cloudy day, but it would be impossible if one kept a *straight line*, or went by compass; for even if we imagine that the sun, instead of following an apparent straight path, due actually to the world's own rotation, winds round the circumference of a great plane, a motion somewhat hard to reconcile with facts, and that we thus follow it and return to our starting poing, we have still to get over the magnet, and explain how it guides us in this extraordinary circular course, a thing perfectly easy to understand by those who know the earth to be a ball possessed of magnetic polarity, acted on, and being acted on by other magnetic bodies.

But it may be said that this only shows that the earth may be a long cylinder instead of a flat surface. Granted; but what sort of advantage would this idea be, having all the supposed evil consequences of the globular theory without one of its advantages. Nothing, however, is easier than to prove that the earth is not a cylinder. If sailing east or west we carry an accurate watch with us, it will continue to show us the time at the place we left; we soon find it does not show us the time at the place we have reached. If we are on the equator, we find that when we have thus sailed 900 geographical miles, there is a difference of one hour, and this being one twenty-fourth of a day, is also the same proportion of the earth's circumference; or treating it as an abstract circle, divided into 360 parts, it is 15 of these; that is, the difference of longitude is 15 degrees, the difference of time, 1 hour, the period during which this part of the circumference passes under the sun. But if we try this at another part, the case is quite different; the more distant we are from the equator, the less space we require to travel to make the difference of one hour; that is to say, the circles parallel to the equator diminish in actual length, and the cylinder on which they would be all equal passes into a globe.

Hence, strange as it may seem, the nearest way to a place due north or south, is to follow that line; but it is not so with a place due east or west, except at the equator. In the north we must follow a curve tending first north for half the distance, and then south; south of the equator, the reverse. This is what is called Great Circle sailing, and depends upon the fact that the shortest line between two points on a sphere is one which, if carried through, would cut the sphere into two equal parts. This is called a great circle. On the earth, all the north and south lines, or parallels of longitude, as they are called, though converging, are such; but of east and west lines, only the equator.

Time and space, the only realities or infinities, by-the-bye, require me to conclude for the present.

SIGMA.

STRENGTH OF CHAINS.

SIR,—I wish to call Mr. A. Tolhausen's attention to his rules on the tenacity of chains, which I will endeavour to prove wrong both in working and application. If a rule be correct the strain will be the same for same size of chain whether you work from a rule giving 8ths or 16ths.

In example *a* (by rule 1) the working out is incorrect. Here Mr. A. T. has it

$$d = \sqrt{8 \cdot 14} = \sqrt{112} = 10\tfrac{5}{8} = 1\tfrac{1}{4}\text{in.}$$

whereas

$$d = \sqrt{8 \times 14} = \sqrt{112} = 10{\cdot}5 = 1\frac{1}{16}\text{in.}$$

Having shown $d = 1\frac{5}{16}$in., I now proceed to Rule 2, wherein the multiple 30 should be 32. Then the example *b* (by rule 2) will be

$$d = \sqrt{32 \times 14} = \sqrt{448} = \frac{21}{16} = 1\frac{5}{16}$$

correct to the former rule, and not (as Mr. A. T. makes it appear correspond to his former erroneous working) 1¼in.

To the converse operation make the application, and it will appear much more clear: *a* (by rule 1)

$$\frac{6^2}{8} = \frac{36}{8} = 4\tfrac{1}{2}\text{ tons.}$$

This is as given by Mr. A. T., and is correct. Then for proof with corrected divisor 32. *b* (by rule 2)

$$\frac{12^2}{32} = \frac{144}{32} = 4\frac{16}{32} = 4\tfrac{1}{2}\text{ tons}$$

correct answer as by rule 1, and not $4\frac{4}{5}$ tons, as Mr. A. T. shows it; for according to rule applicable to areas of circles, a chain twice the size is four times the weight, hence a multiplier or divisor for 8ths being 8, must for 16ths be 8 × 4 = 32, proving the correctness of rule as applied in foregoing examples.

I am sorry to see Mr. A. T.'s remarks respecting ropes, which are also incorrect. I think he might with advantage have given us the modern experience of Huddart or Chapman in preference to Du Haunts 130 years ago. As, however, his remarks on this part of the subject seem unfinished, I forbear saying anything further at present, as my desire is only to put matters correctly for the benefit of your numerous patrons, and trust this will be received as given,

W. H. LAIDLER, Edward-street, Bow Common, E.

SILVERING SPECULA.

SIR,—About three months ago I commenced the grinding of a speculum for a telescope of the Newtonian form, and following the admirable directions given in your columns by your able correspondent Mr. Purkiss, I believe I have succeeded, only I have not been able to get it tried as yet. I have likewise made a diagonal plane of a piece of fine plate glass, as recommended by the same writer, This I have attempted to silver by the Rochelle salt method, described in the MECHANIC some time ago, but have not been successful as yet. I have attempted this method in preference to that one described by Browning, as I see some of your correspondents have succeeded well with it. Mr. Thomas Woodruffe, p. 17, Vol. IX., says it is "quite equal to Browning's at one-tenth of the cost." I got the crystallised nitrate of silver used for photographic purposes, and dissolved it in distilled water, adding ammonia as directed, and stirring with a glass rod until the precipitate formed, when the ammonia was first added was dissolved. The solution thus obtained was clear after settling, but there was a dark sediment in the bottom of the bottle. I could not get crystallised Rochelle salt, but I procured the powder, and made a saturated solution of it, and put it in a dish to evaporate, when, in a few days, I got beautiful crystals. These I dissolved in distilled water for the reducing fluid. I used for the plane 30 drops of the silvering solution, and 16 drops of the Rochelle salts, and cleaned it with rouge and wash-leather. I obtained a film, but so thin in the centre that the gentlest rubbing removed it from the glass, while all round the edges it adhered firmly and took a brilliant polish. As the film in the centre of the glass *only* appeared nearly transparent, and cloudy when held between the eye and the light, it occurred to me that the cause might be the glass not being sufficiently clean. I procured nitric acid, with which I rubbed it, and afterwards washed it to remove the acid, but with no better result. I tried both the silver and salt solutions double the strength—viz., 20 grains to the ounce of water, but still the same result. I have sometimes kept on the solution for some hours, adding more when nearly dry, by this means getting a thicker film in the centre; but then there was always whitish, rough patches, chiefly about the edges, which no amount of polishing would remove. I should feel very grateful if any of your numerous readers would help me out of my difficulty, and point out where I am in error, and advise me what to do.

Would Mr. Purkiss, "F.R.A.S.", or any reader, kindly inform me what should be the size of the diagonal plane for a speculum of 6½in. diameter, and 66in. focal length; or rather, I should like to know by what means it is known, so that I might be able to find for myself the size of plane for any size of specula.

I very much admire the telescope stand of Mr. Blacklock, late of Manchester, now of Aberdeen. I am making mine of the same form; would he kindly describe his method of mounting the speculum. I should feel obliged if he would ascertain if glass suitable for specula is to be got in Aberdeen, as the carriage from the south comes so high.

I may mention that in grinding and polishing my speculum, although I have followed the directions of Mr. Purkiss, I have not used a machine, but worked it entirely by the hand. I have, however, devised a means which I believe to be original, as I have seen no notice of it, by which a regularity of stroke with careful manipulation is insured. If my speculum turns out well when tried, I shall be happy, with your permission, to describe it for the benefit of such of your readers who, like myself, are unable to spare much money for such a purpose.

JAMES GRAY, Beauly, N.B.

EXTRACTS FROM CORRESPONDENCE.

THE BICYCLE.—"Veloce" says:—"Pending Mr. Newton's decision at Worship-street Police-court, as to a case of a bicycle circling, I think it only fair to say that to circle about is a very dangerous practice to pedestrians. If a rider wishes to practise feats, he should do it in a lane, or some other place where there is no traffic. But it is not to that part of the Inspector's evidence I wish to call attention; he says, 'he confined himself strictly to roadway, but circled about and rode round at a great pace (eight or nine miles an hour).' Now, Sir, I wonder whether it is the eight or nine miles an hour that is dangerous, or whether it is the circling about. I hope, Sir, that the magistrate's decision will not be unfavourable to the bicycle cause, for I think that as a means of locomotion, and a way to vigorous health and muscular power combined, no other machine can surpass it. If Mr. Newton's verdict will be a conviction, then I and others in the country will be open to conviction too, for it is only a nice comfortable pace this fine weather to ride nine miles an hour. Sir, I see that in France a new paper is begun, expressly devoted to the velocipede; why not in England? or devote a column every week in your worthy journal."

MR. BEARDSLEY'S LETTERS.—Mr. J. Dyer says:—"I have seen Mr. Beardsley's letters, but see but little in them calling for serious consideration. He appears to me to be objecting for the sake of it, and seizing upon any circumstance wherewith to attack the truths of astronomy. Some of his statements are retailed from "Parallax." I will, however, attend to the gentleman, and if he advances anything worthy a reply, and no more able person should answer him, I will make some observations when he has finished his letters; at present it is difficult to get at what he believes, or what he is aiming at. He is an ardent advocate of the views of "Parallax," and has written a book entitled 'Theoretical Astronomy Examined and Exposed,' of 128 pages. It is made up of dogmatic assertion and most disrespectful speaking (in some places almost amounting to abuse) of some of the best and most learned men of the day. He is or was a printer at Greenwich, and has sold the copyright of his book to Hampden. Mr. Hampden has also bought the copyright of a book published by "Parallax," entitled the 'Earth not a Globe.'"

THE PATENT LAWS.—"Beaten," states:—"For want of means to patent, I have for about two years nursed a loco-manumotive power. My ambition is to patent this power in England, France, and the States, and here comes the rub: the wealth of England has had the making of England's laws, of course they are made for the benefit of the wealthy class; the Patent Laws among the rest, the A B C of which is, that if a man can muster £40 within 6 months, he may have a patent, and this is exceedingly interesting to an inventor, who deems himself a lucky fellow if he can muster the price of 40lb. of potatoes when wanted, and with glowing admiration he contemplates the paternal, patriotic laws under which he lives, when he compares them to those of despotic France, or Republican and Democratic America, in either of which he may patent his invention for comparatively an 'old song,' be well protected in his rights, when obtained, and their defence and redress easy, if infringed. With respect to the English patent, my difficulty is, how to satisfy a capitalist without imparting the secret? Will any brother reader suggest a method, I confess that in this I am fairly beaten.

THE "VELOCIFERE."—Having read a letter from Mr. W. H. Reveley in your last issue, I am much surprised that the "velocifere" therein alluded to (a description of which was given in a former number of the ENGLISH MECHANIC) has not yet appeared before the public, as if it went only half as fast as described, namely, 15 miles an hour, with as little exertion as walking two or three, velocipede inventors need no longer rack their brains, as it ought to meet the requirements of the most exacting, and be invaluable to persons using such means of locomotion.—TRICYCLE.

REPLIES TO QUERIES.

[1669.]—SMALL FURNACE.—"C. R." can convert Napper No. 2 fire to answer his purpose if he has a fan, or by using Dorset liquid fuel. If "C. R." has not seen any of this fuel at work, I will send him a sketch of it.—GEO. STUART.

[2276.]—GRANITE POLISHING.—The granite must be first dressed as level as you possibly can, as that saves a deal of polishing, it being naturally a hard substance; then well rubbed with fine sand and water by an iron plane, until the tool marks are completely rubbed out, when it must be all clean washed off. Next apply No. 0 emery with water, the same as the sand, with this difference, the emery must be rubbed until it is reduced to a "sludge." It is better to have a frame about 6in. round the stone, and the joints closed with stucco, as that prevents it from losing; the quantity is ¼lb. to the square foot. Wash clean down again, and finish with putty powder (oxide of tin), applied on a felt attached to the bottom of the plane, taking care the felt do not glaze, else it won't bite. If the granite be very soft, flour emery will be better than No. 0.—W. R. M.

[2408.]—METRONOME.—For reply, see letter, page 161.

[2461.]—INHALATION OF IRON DUST.—Might not "Turner" contrive a kind of bellows with double tuyere to blow all dust away from his lathe, similar to the bellows used by the pointers in many needle mills?—JOHN D.

2502.—CIRCULAR DISC.—This can only be done approximately, and in doing so, suppose a line representing the radius of the orifice, the ends of which are the centres of the two circles representing the orifice and disc. Raise a perpendicular at the distance of ⅓ of the radius from the centre of the orifice, which will cut the circumference of the orifice in a point where the two radii meet. Let p be that perpendicular, which is also the half chord of two arcs, standing on the opposite sides of the same base. It also represents the sine of half the central angles. From which we can find the areas of the two segments, whose sum is equal to the half area of the orifice.

From the properties of the circle

$$p^2 = r^2 - \left(\frac{r}{3}\right)^2 = \frac{8}{9} r^2$$

$$\therefore p = \sqrt{\frac{8}{9}}\, r^2 = \frac{\sqrt{8}}{3} r = \frac{2}{3} r \sqrt{2} = 5{\cdot}657$$

r being equal to 6in. or half a foot.

Also,

$$R^2 = \left(\frac{2}{3} r\right)^2 + p^2 = \frac{4}{9} r^2 + \frac{8}{9} r^2 = \frac{4}{3} r^2$$

$$\therefore R = \sqrt{\frac{4}{3}}\, r^2 = \frac{2r}{\sqrt{3}} = 6{\cdot}928$$

R being equal to the radius of the disc again for half the central angles.

$$\frac{p}{r} = \frac{5{\cdot}657}{6} = {\cdot}9429 = \text{sin, } 70^\circ\ 33'$$

And

$$\frac{P}{R} = \frac{5{\cdot}657}{6{\cdot}928} = {\cdot}8166 = \text{sin. } 54^\circ\ 43\ 45''$$

central angles are equal to the double the last = 2 (70° − 33) = 141° 6′ and 2 (54° − 43¾′) = 109° 27½′

$$\text{Arc } 141^\circ\ 6' = 2{\cdot}4826, \text{ sin. } 141^\circ\ 6' = {\cdot}6273$$

$$\text{Arc } 109^\circ\ 27\tfrac{1}{2}' = 1{\cdot}902, \text{ sin. } 109\ 27\tfrac{1}{2} = {\cdot}9426$$

$$\frac{r^2}{2} = \frac{36}{2} = 18 \text{ and } \frac{R^2}{2} = \frac{48}{2} = 24$$

Segmentals areas of orifice and disc

$$= (\beta - \text{sin. } \beta\ \frac{r^2}{2} = (2{\cdot}4826 - {\cdot}6273)\ \frac{36}{2} = 3{\cdot}330$$

And

$$(\beta_, - \text{sin. } \beta_,)\ \frac{R_2}{2} = (1{\cdot}9102 - {\cdot}9426)\ \frac{48}{2} = 2{\cdot}22 \text{ sum}$$

of segmental areas = 56·61

$$\text{Half area of orifice} = \frac{r^2 \pi}{2} = \frac{113{\cdot}04}{2} = 56{\cdot}52 \text{ showing}$$

the approximation to be nearly right.

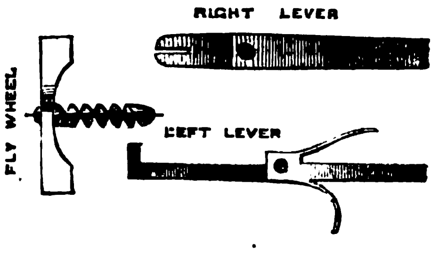
But in practice, the whole amount of labour is reduced to this simple fact of adding to the radius of the orifice, 1-6th of itself for the radius of the disc or more nearly as the √36 : √48.—R. D., 93, Broughton-street, Edinbro'.

[2505.]—WEIGHT OF WATER.—A cubic foot of rain water at 60° Fah. weighs 997·137oz. avoirdupois. The average weight of sea water at the same temperature is 1025ozs.; that of the Dead Sea 1240oz. The temperature of greatest density of rain water is 38° 8, and between that and 62° it varies but one part in one thousand. It is generally assumed (for convenience of calculation) that a cubic foot of rain water at 38°·8 Fah. weighs 1000oz.—BROTHER TED.

[2506.]—CAMPHORATED COLZA OIL is prepared by dissolving 1½oz. of camphor, broken up into small pieces, in one pint of colza oil, by aid of a gentle heat. I use an old jug and the oven of the kitchen fire after tea. This gives a powerful light, but would, I fear, be too expensive for general use.—C. WARD.

[2521.]—CURIOUS AFFECTION OF THE TEETH.—The deposit is called tartar, and consists of salts of lime and organic matter from the saliva. To prevent its formation the teeth should be cleaned twice a day at least with soft tooth powder (precipitated chalk is the best) and a little soap. When tartar has accumulated, it must be removed by the scaling instruments of the dentist.—J. M. K. E.

[2528.]—MUSICAL BOX.—The construction is very simple. A side-toothed wheel, on the axle of which is fastened one end of the winding-up spring (which is enclosed in a small circular box on the left), is put in gear with one end of the roller, on which are fastened the fingers or pins which lift the teeth of the comb, from whence the sound comes. The motion is regulated by means of a small fly-wheel playing before the spring-box (which, by-the-bye, goes out of sight during business). This fly, standing upright and having a thread round the stem, is acted on by fi.er wheels, which are in gear with the end of the roller. "Omar" will find on the top of the spring-box what is called a "Geneva stop," illustrated on page 53 (No. 12 being marked in the corner) of the present volume. The right end of the roller comes slightly over the edge of the same, and is caught in a slit in a small lever (worked by a pearl button outside), which moves the roller up and down its axle, thus altering the tune or position of the pins. The left button stops the revolution of the roller by the end of a lever turned like the letter L popping into a hole in the roller-wheel at the end of each tune. And now I must beg our Editor's pardon for taking up so much space in trying to explain the "guts" of a musical box.—HARRY BERTRAM.



[2534.]—ERRATUM.—The diagram given with the 3rd solution of this query belongs to the reply of "Gregory," page 139, Q. 1935.—X. X.

[2548.]—GILDING BATTERY.—"One in a Fog" has charged his battery wrong, to commence with. 1 part acid in 12 of water would be better than 1 in 2. The sulphate of copper should be suspended in the upper part of the solution instead of the bottom; but the main cause of failure is that he is using cyanide of potassium instead of aurocyanide. The cyanide must be charged with gold before he will get a deposit. If he persevered, this would be effected by the action of the battery; but his globe surface ought to be large.—SIGMA.

[2550.]—ETHERIAL GOLD SOLUTION.—This is applied simply by brushing over the steel surface, or by writing with a quill pen. The steel requires no preparation beyond its surface being clean and bright. The deposit is a mere film, which will bear little friction, and cannot be thickened by this solution.—SIGMA.

[2558.]—SUN-DIAL.—The following is a good method of setting a dial:—Set the dial by the sun at mid-day as correctly as possible. At nine o'clock on a bright morning set your watch by the dial. At three in the afternoon observe the difference between the dial and the watch, and correct the dial for half the difference. Proceed in this manner day by day till they agree perfectly. Observe, however, that the equation of time must be taken into account, and set your watch fast or slow, as may be necessary.—J. M. K. E.

[2558.]—SUN-DIAL.—The simplest method of obtaining a true meridian line for a sun-dial is from the Ordnance maps, on which the lines of longitude are accurately marked, and the Greenwich mean time, which is telegraphed daily to most towns and railway stations. If you set your watch by the Greenwich time, and then take your longitude from the map, adding or deducting 4 minutes in time for every degree, and 4 seconds in time for every second of longitude, as your place is east or west of Greenwich, if the sun and clock are together (which is only the case on a few days in the year), you will readily obtain your meridian. Thus, the place I reside at is 0′ 48″ west of Greenwich. This is equal to 3 minutes and 8 seconds in time; therefore, on a day when the sun and clock agree, when my watch shows 12h. 3m. 8sec., the sun will be on the meridian. Of course the equation table is necessary at all other times.—ANON.

[2559.]—ANTIQUE.—If "Vivus Sperandum" will send W. Nelson Last, Bury St. Edmunds, an impression of his cornelian ring per post, he will (through the ENGLISH MECHANIC) give him the information he requires. The art of polishing the engraving is not lost; but it is only the best engravers that attempt it.

[2565.]—HERBAL OF THE BIBLE.—"Ixion" may obtain "Plants and Trees of Scripture" of the Religious Tract Society, Paternoster-row.—W. G. RAYBOULD.

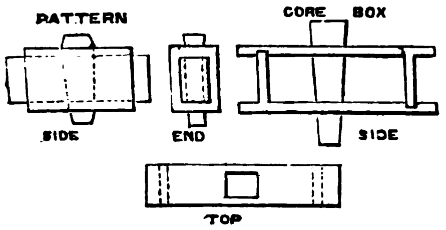
[2565.]—HERBAL OF THE BIBLE.—"Bible Natural History, containing a Description of Quadrupeds, Birds, Trees, Plants, &c., mentioned in the Holy Scriptures." By the Rev. F. O. Morris. Published by Groombridge & Sons.—WORKING WOMAN.

[2566.]—TOOTH POWDER.—Armenian bole is the best and cheapest tooth-powder to be had for keeping the teeth fresh and white. Twopennyworth will last for six months. It is of a reddish colour, and sold at any respectable doctor's shop. Use the least quantity on tooth-brush every morning with fresh cold water, and in a few days it will make the teeth beautiful.—*Forrest Millar*, Glasgow.

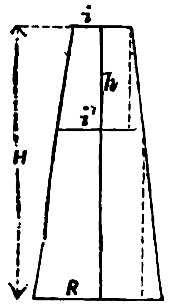
[2567.]—CHIMING CLOCK.—If "Toodles" will take out the old cords of his clock, and put in stronger ones, or catgut, he will find this much better than putting a haybag in the bottom of his clock-case.—D. H. S.

[2573.]—ÆOLIAN HARP.—In answer to "R. B.," I have much pleasure in giving him all the information I can. It is constructed of very thin yellow pine. The length equals the breadth of the window, the depth about 4in., and the breadth about 6in. There is a bridge at each end of the box like the bridge of a violin, with screw pins in it, for relaxing or tightening the strings. The strings are of the finest catgut, seven, ten, or more, all tuned in unison to the same note. There is a circle 1½in. in diameter drawn on the top of the box, exactly in the middle, underneath the strings, which is pierced with small holes, to act as a sound hole. Place the instrument in a window and draw down the sash, which will force the wind over the strings and cause it to sound.—VALVE. P.S.—Many thanks for the insertion of my query, 2562, No. 265, but there are one or two typographical errors in it which will make it rather hard to be understood. Perhaps you will be so kind as to insert the following correction:—"Reed hibs" should be "reed holes," and "accident" should be "accidentals"—that is, sharps or flats that occur in the course of a piece of music.

[2579.]—MALLET.—If "Anon" wants to make a pattern for his mallet, the following will give him all the information he requires:—Let him make a block of wood the size of the shell (outside size), and nail a piece of wood on each end the inside size of shell, about 1¼in. thick, and nail two pieces, one on top and the other on under side, the size of hole required for shank, and about 1in. thick, the top one being larger than the other, to form a taper. Those are called prints; they leave an impression in the sand to bear the cores. He will have to make a core-box the size of inside size of shell, composed of two sides and two ends, it being a frame the size of the core (inside size), with a hole cut through each side the size of small prints, one larger than the other, with a piece of tapered wood fit through them, to project about 1¼in. through each side; must be left loose to pull out. Make the core-box the same length as the block and the two large prints. A diagram will greatly assist him. If "Anon" requires any more information about them, I will give it with pleasure.—J. H. H.



[2582].—WEIGHT OF FRUSTUM.—$H = 12$ft., $R = 2$, $r = 1$, cub. ft. of iron = 440lb. What will be the weight of the frustum? 1st. Supposing 4 tons cut off, at the lesser end, diameter of the plane of section, &c.



1st. The well-known formula $V = \pi\frac{H}{3}(R^2 + r^2 +$ $r)$ gives for the weight 17t. 28.

2nd. Observing that $R^2 + r^2 + R\,r + \frac{R^3 - r^3}{R - r}$, we have the proportion:

$$\left(\frac{h}{3}\cdot\frac{r'^3 - r^3}{r' - r'}\right) : \left(\frac{H - h}{8}\cdot\frac{R'^3 - r'^3}{R' - r'}\right) :: 4 : 13{,}28$$

Similar triangles give

$$\frac{h}{r' - r} = \frac{H - h}{R' - r'} \therefore r'^3 - r^3 : R'^3 - r'^3 :: 4 : 13{,}28$$

$$\text{and } r' = 1{,}37$$

$$h : H - h :: 0{,}37 : 0{,}63, \text{ gives } h = 4{,}44$$

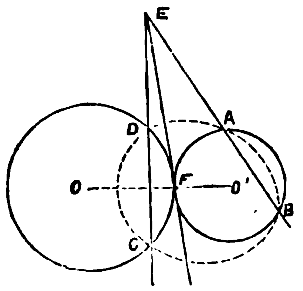
The proof gives a slight difference proceeding from the neglected decimals, &c.—BERNARDIN.

[2593.]—DEFECTIVE BATTERY.—If the silver plate has been in contact with the zinc, it has probably absorbed some mercury, which would spoil it. It would require to be heated to redness to drive off mercury, cleaning, and replatinising, for which see paper on Batteries sent with this reply. The contact screw is most likely too loose, and the vibrations shake it away from the spring. If so, a piece of thread inserted in the screw-hole will tighten it up.—SIGMA.

[2594.]—BORING WOODEN HANDLES.—I suppose, from "A. B's" question, that he has many handles to bore, and in that case a half-round bit, or a short piece broken off a carpenter's nose-bit, and soldered into a small brass chuck to fit into the centre hole of the poppet head, would be a good way of starting the holes. The handles should be held either in a clam-chuck, or be supported by a collar plate. I always use a common gimlet, taking care, however, not to work it as you work a cork-screw—viz., holding the bottle still and turning the screw round, but holding the gimlet firmly in the right hand, and letting the tool handle shift at each half turn in the left hand, as by this means you can feel whether it is running straight down the middle or not, and with a *common* gimlet you can apply force sideways to scoop the hole when you find any tendency to running out. The usual way is to burn the tools into their handles, and I see no objection to the practice, provided, first, the hole has been bored deeper than the point of the tang of the tool will go; and, secondly, that all the charred portion of the wood is filed or scraped out of the hole before driving the tool finally in. If the tool is thin, with a broad tang, like a Lancashire file, it will burn its own hole too wide in the narrow direction, so a thinner tool should be used to do the burning. A much better plan is to have two or three floats, or small taper files, cut on one side, and one edge only, with a few coarse teeth, and one or all made to cut backwards, for getting out the holes to suit different dimensions of tangs. Almost any old tool that is small enough will do to make them of, and the notches may be, and are better for being, as uneven as you please; and the tool need not be hardened, or if hardened, should be lowered to saw-temper, so that you can easily sharpen it with a file. The best wood for handles is ash, as it does not blister the hands. It must be well seasoned, or the ferrules will drop off, and a dressing of linseed oil and yellow ochre, with alkanet-root to give a red tinge, should be smeared on, and allowed to dry on for a day or two, before giving the finishing rub-off.—J. K. P.

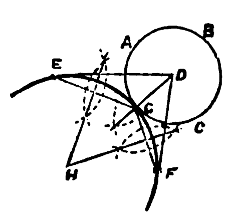
[2598.]—LEYDEN JAR.—A charge might be given by means of a glass rod, but it would be a tedious business, and not much satisfaction to be got out of it when accomplished, by means of frequent rubbing and application.—SIGMA.

[2604.]—PROBLEM.—To draw a circle passing through two given points and tangent to a given circle. Let O be the given circle, and A B the points. Through A B draw a circle cutting the first, hence C, D, and E. From E draw a tangent to circle O, and the circle passing by A, B, and F will answer the problem:



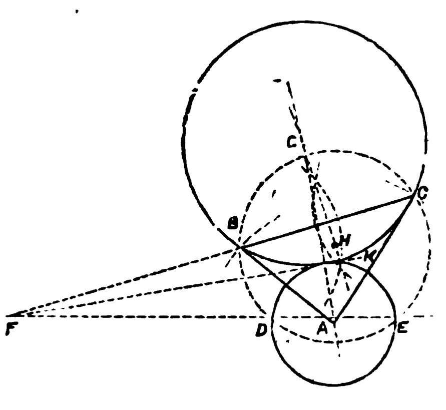
E A . E B = E C . E D (Euc. III., 36 cor.) = E F^2 (37.) and the reciprocal of prop. 37 proves that the circle O' is tangent to E F, hence to circle O. I could say also: having the point F, I draw a circle passing through A and B, and tangent at F to the line E F.—BERNARDIN.

[2604.]—PROBLEM.—Let A B C = given circle with centre D, and E and F respectively the two points. Join E D, D F; bisect E D F, which will cut the circumference in G, the point of contact for the required circle. Join E G and G F, each of which bisected and produced will cut in H. H G will then be the radius of the circle required.—HARRY G. NEWTON.



[2606.]—DAWN, &c.—The periods of day and night are caused by the earth's rotation on its axis. The change from day to night and from night to day takes place in the following manner:—The sun enlightens only that half of the earth's surface which is turned towards him; and as the earth successively presents different parts of its surface to and from the sun, these parts must have alternately light and darkness. At the Equator the day and night are of equal length during the year—*i. e.*, 12 hours each. At the Poles the day and night are of equal length during the whole of the year; but there is only one day and one night, each being six months in duration. The dreary winter of the Polar regions is relieved by reflected light or twilight by auroras, and by the full moon. Other reasons for these changes are, the earth's annual motion round the sun, and the earth's axis being inclined to the plane of its orbit. Hence, Hudson's Bay Territory, Greenland, Lapland, Siberia, will have the longest starlight.—R. WILSON.

[2604.]—PROBLEM.—(By the kindness of a Professor of King's College, London). A is the centre of the given circle; B and C the two given points; bisect B C and draw H G perpendicular to B C; then the centre of the required circle lies somewhere on the line H G (produced if necessary). From an arbitrary centre H, draw a circle through B and C, cutting the given circle in D and E; produce C B to F, and draw E D produced to F; draw F K tangent to given circle, and from A draw A G perpendicular to F K; then G, the point of intersection of H G and A G, is the centre of the required circle. P.S.—Supplementary.—If the tangent F K is drawn to the lower side of the given circle, and the diameter drawn at the point of contact, and produced till it cuts G H produced, then the required circle falls outside and embraces the given one.—J. K. P.



[2609.]—OLD COIN.—Roman. Read VESPASIANUS and JUDÆA CAPTA.—COLLECTOR.

[2609.]—OLD COIN.—The piece found by "X. I. D." is a coin of Vespasian, Emperor of Rome from A.D. 69 to A.D. 79. On the obverse there is the bust of the emperor, with his name and titles. Reverse, a female figure, seated, weeping, under a palm tree; a Roman soldier, standing, behind. Inscription: IVDAEA CAPTA (Judæa taken). The letters S. C. appear upon nearly all the Roman brass coins. They stand for *Senatus Consulto* (by decree of the Senate), because all the brass coinage was under the control of the Senate. This coin was struck in commemoration of the subjugation of Judæa by Vespasian and Titus, and of the total destruction of Jerusalem, A.D. 70. It is rare, and the market value would be between 10s. and 15s. It is a very famous and interesting piece.—HENRY W. HENFREY, M.N.S., &c., &c.

[2621.]—CUTTER BAR.—In reply to "Foreigner," I made one of these to the design of "D. H. G.," and had to make the same complaint of it that he has. "D. H. G." very kindly told me that the cutter is shown in the drawing projecting far more than it would be in use, for that it was meant for a lathe whose centre line is 9-16th inch above top of slide-rest. I think the crank might be a little longer without doing harm.—J. K. P.

[2624.]—PROPORTIONS OF SPACE.—The volume of a sphere = volume of the cube constructed on its diameter × 0·5236. The weight of lead shot that can be packed in a given case must necessarily vary according to the diameter of that shot.—B.

[2624.]—PROPORTIONS OF SPACE.—TO "MECHANICUS."—One single sphere is ·5236 of the surrounding cube; but if you have a number of spheres, and put three of them together in a triangle, or four in a rhombus (not a square), and go on packing others round them, each ball will stand in the middle of twelve others equidistant from it and from each other. It may be proved that each ball occupies on an average ·707 of the cube of its own diameter, while the ball itself is only the ·5236 of that cube, or what is the same thing, the ball would occupy only ·5236 of the whole space if we started packing with a square in the middle instead of a rhombus.—See Denison's "Astronomy without Mathematics," 4th edition, p. 266.—J. K. P.

[2629.]—THE QUEKETT CLUB.—Allow me to inform Ed. H. Jones that the "Journal of the Quekett Microscopical Club" is published quarterly, price one shilling, by Mr. Robert Hardwicke, 192, Piccadilly, London, W., from whom your correspondent can obtain information as to the means of obtaining the journal in Bristol.—W. H. G.

[2631.]—SPHERICAL FORM OF THE EARTH.—The reply to "Ajax's" question depends upon the form of the bottom of his cistern. If it was a true flat, such as an instrument would make, or a level would show, it would apparently be hollow in the middle, and water would remain there long after it had run off the ends. In that case the water would be deepest in the middle; but if the bottom was a level like a billiard table, on all parts of which water would alike rest, it would be a curve, and the depth of water alike in all parts. The extreme idiocy of the arguments, as their utterers call them, set forth on this subject is really too much for people who know anything of the matter. No intelligent human being who really has examined the subject could entertain a doubt about the spherical form of the earth. It can be measured even in a long building. If the two ends are truly vertical, a measure taken along the top is longer than one along the ground line.—SIGMA.

NOTES AND QUERIES.

◆

[2637.]—**ELECTRIC LOCOMOTIVE.**—Will some kind brother inform me how to construct an electric locomotive engine, to run on rails by electricity?—R. F. D.

[2638.]—**MAKING BUTTER.**—I have heard there is an easier way of making butter than churning; can any reader tell me how it is done?—Cambridgeshire.

[2639.]—**OPINIONS WANTED.**—Perhaps some of your numerous readers will be so kind as to give me their opinions about the cause of the following:—A short distance from here are four horizontal engines, which are used for drawing coal; one steam valve is common to them all four, likewise one lever for reversing them. In lowering down the pit they have full steam, about one-third of the distance, then it is shut off, and the lever brought into the centre notch, which ought to close the ports, but the pair of engines to the right hand still continue to exhaust, and those to the left do not. If some of our intelligent men will give their opinions as to the cause and its remedy, it will perhaps benefit others as well as myself, for I know that when the engines were made, it was intended that they should not exhaust at all in lowering after one-third of the distance, as it is a shaft where they have only one rope going.—John W. Bedford.

[2640.]—**GIRDER PATTERNS, &c.**—In making patterns for girders, gutters, &c., that are stronger at the bottom than the sides, the pattern has to be made round, so that when the casting cools, the contraction draws it straight. Will some practical man be so good as to give a rule for calculating how round to make any girder, gutter, backstay, or anything else of a similar character?—John W. Bedford.

[2641.]—**MEDICAL COIL.**—(Page 513.)—Will "Sigma" kindly explain what he means by saying, "solder 2 to N. battery pole," and further on he says, "lead 2 and 3, and any other ends, to screws at the other end of board." Is this correct, and if so, please say how it is to be done, that is 2 at both ends of the board and different screws, and also the best kind of battery to use.—Unlearned Man.

[2642.]—**FISHING RODS.**—"The Harmonious Blacksmith" says he has had considerable experience in making fishing rods; I shall be very pleased if he (or any other practical gentleman) will give me a few hints how to make a useful rod, about 14 or 15ft. long, the best kind of wood for each piece, how to put the ferrules on, and any other information that he thinks would be useful.—A Young Tyke.

[2643.]—**IRON PRISM.**—A square prism of malleable iron, whose length is equal to four times that of one of its sides, is to be rolled (or flattened) into a square plate of uniform thickness, such that its whole superfices shall just be equal to its solidity. Required, the size and thickness of the plate, the solidity of the said prism being 2916 cubic inches, allowing no waste in the metal.—A Middletonian.

[2644.]—**ADULTERATION OF TURPENTINE.**—Would some one inform me how I can best, or at all events easily, ascertain whether turpentine is adulterated?—Basis.

[2645.]—**IMPERFECT TWO MANUAL ORGANS.**—I should be obliged if any of your readers would enlighten me upon the following:—I have a two manual organ, and am sorely troubled with the reed stops being so often out of tune in the swell organ. The reed stops are cornopean, clarion, and oboe, but the clarion is the one that gives me most trouble. The oboe keeps pretty well in tune, but is very slow in speaking. The reason of the reeds not keeping in tune is, I am informed, that the pipes and tongues are not made in proportion to each other, and that to remedy this would be almost as expensive as having new pipes. I wish to know if I am correctly informed as to the cost, also what would be the cost of a set of flute pipes to replace the clarion, and the cost of applying them?—Anti-Discord.

[2646.]—**GILDING PLATE GLASS.**—How do glass sign writers gild the back of plate-glass, after the letters are written, and *vice versa*?—Blackburn.

[2647.]—**COLOURED PRINTS FOR DECORATION.**—Where can I buy those coloured prints which, when steeped in water, may be laid on to any smooth work, and the paper on which they are printed slid away, leaving the print firmly attached to the article operated upon?—Blackburn.

[2648.]—**CARDING ENGINE.**—Would "B. W. R.," or some other brother reader, please inform me, through the medium of our highly-esteemed journal, which, in his opinion, is the best carding engine at present in operation, and that has the most modern improvements? If accompanied with a drawing, perhaps the matter would be rendered still plainer. I believe the carding engine in general use in the Manchester and Bolton district, is that to which the American patent automatic movement is applied. Would he also say what, in his opinion, is the best appliance for grinding the main cylinder and doffer, and what is the difference effected between using the ordinary grinding strickle and the patent grinding pulley, which is worked from end to end of the engine by means of a spiral groove in the shaft?—Excelsior.

[2649.]—**PIANOFORTE.**—Will the "Harmonious Blacksmith" inform me of the following questions, viz.:—1st. How are the holes that the lever wire works through, which lift the damper, bushed? 2. How are the same holes bushed in the hammer butts?—M. L. Moffatt.

[2650.]—**TO "F.R.G.S."—MAP PROJECTIONS.**—I shall feel much obliged if you will tell me the method of projecting a map on the gnomonic projection, having any given place, say London, in the centre, or if the description would be too lengthy, I should be glad to know the name of any book where I could find an account of the method?—J. M. K. E.

[2651.]—**LECLANCHE BATTERY.**—Will any brother subscriber tell me how to re-charge the porous cell of a Leclanché battery. Those in my possession are patent cells, made at Silvertown, by the Gutta Percha and Telegraph Works, Co., Limited.—Telos.

[2652.]—**SULPHATE OF ZINC.**—Will any correspondent inform me how the sulphate of zinc of commerce is manufactured?—Telos.

[2653.]—**CHEMICAL SOLUTION.**—I have a solution composed of sulphuric acid, sea salt and water, in which a quantity of zinc has been dissolved. Will any correspondent tell me what the precipitate, which has been formed, is?—Telos.

[2654.]—**METRICAL ACT.**—Of what date is it? Does it not give the exact reduction of English weights and measures into metrical? I propose to querists to employ only the letters A. K. W. for "A kind answer will oblige," or rather to add nothing and always (which is the case) suppose this phrase understood?—John D.

[2655.]—**ARCHERY.**—I am about to purchase a self-yew bow. Would some brother archer kindly give me his advice as to how to choose a suitable one, as to strength, &c.? I have shot for two seasons with a hickory backed lancewood bow, of 46lb. tension, which has an unpleasantly sharp pull, but is not too strong for me. Ought a self-yew bow to be stronger, if so, how much? Is there a good modern book on archery?—Young Toxophilite.

[2656.]—**BOOKS.**—Can "Sigma," or any other of our numerous readers, recommend a good book on practical electric telegraphy? I have made inquiries at several booksellers without success?—Much in Want.

[2657.]—**FORBES KNITTING MACHINE.**—Might I ask, through the medium of your journal, Forbes, Bros., and Co., of Glasgow, to give a more detailed account of their knitting machine, illustrated in No. 251 of your last Vol., feeling sure that many of your readers would like to see the same?—Vigie.

[2658.]—**OBJECT GLASS.**—Would any of my brother readers kindly give me a little information whether I could get a stronger object glass for my telescope, which glass is 1in., and if I could see distinctly without altering the other glasses in the inside?—Ignoramus 2.

[2659.]—**ASTRONOMICAL BOOKS.**—Would some reader kindly inform me where I could obtain the best and most authentic elements of the planets' orbits, including the asteroids, with price?—D. Jenkins.

[2660.]—**LEO'S VELOCIPEDE.**—Will "Leo," whose velocipede appeared in the Mechanic, No. 218, Vol. IX., gives a description of the indiarubber springs which bring the pulleys back to their first position; how are they fixed, what size should they be, and will he give a description of his ratchet work? Can any other readers, who have had experience in ratchet velocipedes, give me information as regards the ratchet, pawl, pulley, spring, &c.?—An Old Subscriber in a Fix.

[2661.]—**GALVANISING CAST IRON.**—What is the bath composed of for cleansing cast iron for galvanising, and of what is the galvanising bath itself composed? The kind I refer to, would be a bath similar to that used for galvanising iron buckets?—B. Webb.

[2662.]—**WATER METER.**—Will any brother reader be kind enough to give me a full description of a high pressure water meter, its construction, and the action of the water in passing through it, how it is measured, &c.? The one the water company furnishes me with, registers four and five times more one quarter than another, and I can affirm that the quantity used is as regular as possible?—Fidus Achates.

[2663.]—**QUICKSILVER.**—Will a brother reader furnish me with a solvent for quicksilver? I accidentally spilt some over some watch wheels, and want to clean them; and if what will do for the above will it do for plated jewellery?—Fidus Achates.

[2664.]—**ARM CHAIR.**—I have an arm chair, the leather covering very much faded, but in good condition; can any one tell me how to stain it a maroon colour?—Excelsior.

[2665.]—**INDICATOR.**—I should feel exceedingly thankful if any one would kindly give instructions for constructing the indicator used with induction coils?—L. Lewis.

[2666.]—**COPPER DEPOSIT ON CAST IRON.**—I want to get a deposit of copper on cast iron; will some reader kindly inform me what chemicals to use?—Di Ves.

[2667.]—**PAINT TO COVER TARRED WOOD.**—Can any of your readers recommend a paint or coating to cover tarred posts? It would have to adhere to the tarred surface, and to resist the tar oozing through it in summer. Colour must be light, as it is to make tarred posts pretty visible on a dark night, and save people from driving against them?—Associate.

[2668.]—**SKETCHING FROM NATURE.**—Will "Sunshine," or some other kind reader, inform me where to obtain (wholesale), and the price, acetate and muriate of cobalt?—Typograph.

[2669.]—**MAGNETISM.**—I should be glad of any information that will lead me to a correct solution of the following questions in magnetism:—1. How would you figure the magnetic curves of the earth, and show their relation to the line of dip? 2. What is meant by horizontal intensity, vertical intensity, and total force? 3. What is meant by secular variation?—F. P.

[2670.]—**ARTIFICIAL TEETH.**—I want to repair the gold plate to a set of teeth; can any of my brother readers inform me how I can get the teeth off the pins, and the method of securing them again?—Montique.

[2671.]—**CANOE BUILDING.**—Many thanks to "Boat Builder" for the kind manner in which he has noticed my query on the above subject. Will he oblige by explaining the following. He says, "the strakes or planks are worked first, and the timbers put in afterwards." How are the planks kept to the proper curve and shape of canoe while building? How are the edges of the strakes fastened to each other? I purpose making it of yellow deal, 3-16ths. of an inch thick. What would be the price of 40ft., a foot wide? If he would give me a few plain practical directions as to how to go about it, I should feel greatly obliged, as I am totally ignorant of the art?—C. D. R.

[2672.]—**DRAFT WANTED.**—We are short of a draft at our works to keep our steam up, and there is a large chimney, distant from boiler 80 yards. Will some one of your numerous readers inform me of the best means of carrying the flue underneath the ground that distance, and if it would be an effectual means of attaining the desired end?—H. Gregorieff.

[2673.]—**CASTING SILVER BALLS.**—Could any of my brother readers inform me of a better method for casting silver into small ornamental balls; casting them in sand (as I do) they come out so rough, which I want to avoid. I have tried plaster of Paris, but only part ones come; is it for want of ventilation, or what, and how is it to be done?—Castor.

[2674.]—**CLEANING WHITE CORAL.**—Can any reader inform me how to clean white coral, and restore it to its original beauty, after being exposed to the dust, which has made it almost black?—Inquirer.

[2675.]—**POLISHING WATCH PIVOTS.**—In polishing a pivot with a square shoulder, what is it that produces those cuts or ridges in the shoulder? I have heard it attributed to several causes, but never could learn the exact cause or motion which produces them; perhaps some practical watch pivoter will give the best plan for preventing ridgy shoulders, and so help a young beginner?—C. R.

[2676.]—**MODEL STEAM ENGINE.**—Some time since I saw advertised a small model vertical engine, with a spirit lamp underneath to raise steam; according to the drawing there seemed to be a cylinder and piston, that turned a small fly wheel on the top; the price, I believe, was 4s. 6d.; can any brother subscriber give a drawing of the model in question, showing how motion is produced by steam in so small an engine?—C. R.

[2677.]—**HYDROGEN GAS FOR BALLOON.**—Would any reader acquaint me how many cubic feet of carburetted hydrogen gas is required to float a human being of eleven stone weight, in our atmosphere; also, what size balloon should it be to carry this volume of gas?—Henry Nutt.

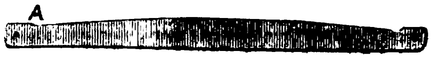
[2678.]—**THE "HIGH PEAK" VELOCIPEDE.**—Can any brother reader give me dimensions, &c., to enable me to make a three-wheel velocipede, known as the "High Peak" velocipede (an illustration of it appeared in the Mechanic some time ago). Perhaps some brother reader would also kindly give his experience as to the capabilities, &c., of the above machine.—G. M.

[2679.]—**UNANSWERED QUERY.—CURLING HORSEHAIR.**—Can any reader inform me how horsehair is cured and curled; also, how feathers are steamed and purified?—One in a Fix.

[2680.]—**LANDSCAPE PAINTING.**—Can some artistic correspondent favour me with a recipe for making a good medium or "megilp" for water colour painting?—O-ce-o-la.

[2681.]—**COPPING MULE.**—Is there any reader who knows of a work treating on the self-acting mule, the part more particularly termed copping the mule; or can any subscriber give a good practical rule for copping a mule? A drawing of the rail would be of good service in pointing out parts of the rail likely to effect the shape of the cop; for instance, if I had a rail this

A



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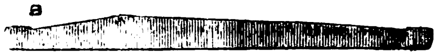


shape, A, and I altered it to this shape, B, what would be the result in the shape of the cop?—Oldham.

[2682.]—**TO THE REV. T. W. WEBB.**—In the English Mechanic of April 15, Mr. T. W. Webb mentions, that he was successful in separating ζ Cancri, so recently as the 31st of March last. Will you permit me to ask him to give, in an early impression of your paper, the observed position, angle, and distance between this close double? I should also feel much obliged to him, if he could give me the result of any observations he may have made on ζ Herculis during the last six months?—Omicron.

[2683.]—**IRON PALLISADINGS.**—Will any reader kindly inform me how long iron pallisadings, painted, varnished, and bronzed, stand the weather?—W. A. J.

[2684.]—**ENGINE CHIMNEY.**—Perhaps some of your kind readers will give us the proper size of an engine chimney for a boiler, 25ft. in length, 5ft. in diameter, as the one we have is far too small; also, if we should consume any more fuel with a larger one, and is there any rule for calculating the size of such chimneys? The furnace is 5ft. by 4ft. 6in., with a flush flue?—A Subscriber.

[2685.]—**AMATEUR TURNERS' CLUB.**—I and my brother have just heard with pleasure that there is an amateur turners' club come into existence; will some subscriber give us all the information respecting it they can?—M. H. Hume.

[2686.]—**ARNOLD'S CHIMNEY VENTILATOR.**—Can any of your numerous readers inform me how to balance Arnold's chimney ventilator? A sketch will much oblige?—Ironfounder.

[2687.]—**DUSTING BRASS MOULDS.**—What is the best thing to dust brass moulds with, and why should not charcoal do?—Ironfounder.

[2688.]—**RENDERING WOOD INCOMBUSTIBLE.**—Is there anything that will prevent wood from taking fire, and if so what, liquid or otherwise?—Ironfounder.

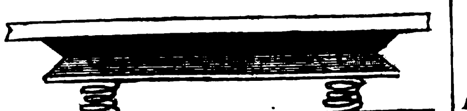
[2689.]—**TURBINE.**—Can some reader give a sketch and explanation of the best form of turbine to work horizontal shaft, which takes about ¼ h.p. to drive, size of inlet and outlet, or makers of same?—Simpleton.

[2690.]—**ALGEBRA.**—Many thanks to kind and able Mr. Henfrey, for his response to my query about the planet Neptune. Whatever you do, don't weed your

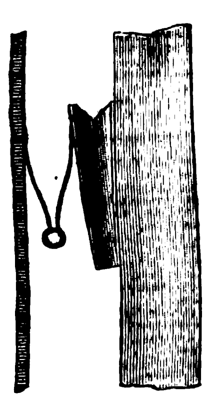
Notes and Queries" too much; some, like mine, may be unimportant, but none will be downright silly, and all will be serious and earnest. Remember the educationalism of the thing, and, like as the *Times* is the recognised vehicle for advertisements, so let the English Mechanic be the oracle for scientific inquirers, young and old, little and big. My present incubation is in the algebra nest. I see several of your correspondents frown on algebra; so do I. Of course we admit the convenience of algebraic notation, for formulas, &c.; but still, take the "science" itself, and is there not a great deal of "humbug" in it? Is not this why Mr. Biggs and "Pneuma" cannot agree? What good can there be in bringing you up always to some such result as plus *or* minus the square root of minus two, $\pm\sqrt{-2}$? It may sound grand, but how can the like be ever serviceable? The farther you push the *science itself* (and I have gone deep into it), the more do you find it only a wilderness of paradoxes. Is not the whole equation system a mistake, such as "Colenso's" quadr. equ. ex. 62, 19; or Todhunter, p. 196, where the horse costs "£60 or £40," and we are to be quite content with the *or*. Even take it, that all this is the present bad handling of algebra; well, is there any book that shows you how to escape the endless ors and paradoxes? I should be glad to hear that the addled egg is not Algebra's, but mine own.—Gimel.

[2691.]—TO "ADEPT"—Will "Adept" kindly tell me the use of the following:—No. 1. On the wind trunks of an organ of two manuals, 38 stops, by Messrs. Hill and Son. No. 2. On an instrument of smaller size, by Bryceson, Bros., under sound-board. When the bellows are blown in a jerking manner, or when the instrument is played, these move backwards and forwards very quickly.—W. J. Raybould.

Nº 2



Nº 1



[2692.]—BOTANY.—Wanted a plain description of the hedge mustard and cuckoo flower?—Non Alumni.

[2693.]—KEEPING COPPER PLATES FLAT.—Will you, or any of your readers, inform me how to keep thin copper plates perfectly flat, in continually passing through callender rolls; they pass through about 15 together, and the average size is 24in. square.—C. H.

[2694.]—GREATER PTHAH.—Can any of your readers tell me what is meant by the "Greater Pthah?—Minnehaha.

[2695.]—GEOGRAPHICAL.—Will some one be so good as to tell me what is the meaning of key in the words, netherset-key, key-house, key-spink, in the neighbourhood of Madeley, Staffordshire?—Minnehaha.

[2696.]—CLEANING FLAGS.—Can any of your readers suggest a way for removing tar off flags, placed there by street advertisers?—Minnehaha.

[2697.]—CANARY.—What is the best treatment for a canary suffering from "wheeziness"?—Minnehaha.

[2698.]—MILL AND FORGE WORK.—ROLLING.—Would some of my brother readers inform me of a book treating on mill and forge work; also, if some kind friend, who understands rolling, would tell me what speed per minute the following rolls should run—viz.: guide rolls, merchant ditto, and forge ditto?—A Subscriber from the First.

[2699.]—CROQUET RULES.—NAPKIN RINGS.—Where can I obtain the latest rules for croquet; also, how can I mark boxwood rings so as easily to distinguish one from another?—W. F.

[3700.]—DEVELOPERS.—What are the best developers to use for photographing designs and paintings, also for portraiture?—W. Crawley.

3701.]—KOLA NUT.—Will "Bernardin," kindly inform me where the kola nut is to be procured in London, and the price? I am reading up for a stiff examination, and shall be glad to try its restorative powers, after his plan, described in the Mechanic of March 12.—Gaddha.

[3702.]—INLAYING FANCY WOOD.—Will some brother reader describe fully the *modus operandi* of inlaying fancy wood, such as is done on desks, &c.—A Suscriber.

[3703.]—PASTEBOARD.—I shall feel greatly obliged of some contributor could give me some information in pasteboard making. I have tried several methods of drying, but I can't find out how to dry them straight. I have hung them in hot rooms, but they buckle, and are dried very irregular; and I have also tried them in a baker's oven, betwixt plates of galvanized iron, but that would not do, as it only dried the edges. Or if you could inform me if there are any books published on the manufacture of pasteboard? I know it can be done, for I have seen pasteboard perfectly straight and hard, but I cannot discover in what manner it is done. Any information on the above subject will be thankfully received?—Thomas Grist.

[3704.]—TO "BUSY BEE."—In your reply to my inquiry for waterproofing paper, it states, 1oz. of gum nitric. I have inquired at several houses for it, and the answer is, that the article is not known, and they think it must be a misprint. Can you inform me as to the above?—A. Speight.

[3705.]—COLOURS FOR GLASS PAINTING.—I shall be very grateful to any of your readers who will tell me of a rich *transparent permanent* pigment, in crimson, brown, *i.e.*, port wine hue; also, a pure bright yellow. Crimson lake, with the admixture of burnt sienna and umber, yields the colour in all depth and brilliancy, but the crimson lake is such a vanishing colour, that I doubt if the browns would render it permanent in continual exposure to daylight. The colours are to be used with oil and varnish for glass painting Amongst all the varied and valuable information contained in your journal, I have never noticed any on the old art of window painting, I do not mean the modern staining and mosaic patchwork. I have been a painter of dissolving views for years, but I should be thankful if you could assist me in the former matter?—Sable.

USEFUL AND SCIENTIFIC NOTES.

WHAT IS WANTED IN MODERN ART.—If the Arts are to flourish among us, says John Ruskin in one of his Oxford lectures, we must recover for the mass of the nation three requisites which they at present want: 1. Wholesomeness of food. We must no longer allow them to eat and drink poison instead of food; everything provided for their daily sustenance must be good and pure, as well as plentiful. 2. Wholesomeness and decency in dress. It must be such as becomes their rank—serviceable and good, and, at the same time, becoming and in good taste. 3. We must improve the lodgings. All ecclesiastical architecture is developed for civil and domestic building and its highest achievement may be said to be a "glorified roof." Now, in this our modern architects are strangely at fault; they seem hardly to know what to do with the roof. Roofs ought never to be built of iron, but always of wood or stone. And we must remember that the little roofs must be built before the large ones. We must see that the poor have houses suited to them, built as strongly as possible, and daintily decorated.

A NEW PLANISPHERE.—Mr. John Love, Royal Bank, Greenock, read a paper on the 25th inst. before the Royal Scottish Society of Arts on "A new planisphere for showing the altitude and azimuth of the sun or star." The object of the contrivance, it appeared, was to facilitate the study of nautical astronomy by illustrating mechanically the observer's relations to the path of a celestial body, and more especially to the sun's path; and the means employed for this purpose consisted of two stereographic projections of the sphere, one of which was to lie symmetrically upon the surface of the other, and to revolve upon over it on their common centre. Both projections were drawn on the plane of the meridian—the one on an opaque disc, being a representation of the sphere with reference to the lines of its motion and the divisions of its time; and the other on a transparent disc, being a representation of the sphere with reference to its lines of altitude and bearing. The arrangement showed the systems of circles which respectively belonged to those two aspects of the celestial sphere; and it was the intersections of the two systems, read through the transparency, which were to give the intended information.

A PROCESS FOR RE-SHARPENING FILES.—M. Werdermann has exhibited a very interesting and economical process for this purpose, before the Societé d'Encouragement of Paris. Well-worn files are first carefully cleaned with hot water and soda: they are then placed in connection with the positive pole of a battery, in a bath composed of 40 parts of sulphuric acid, 80 parts of nitric acid, and 1000 parts of water. The negative pole is formed of a copper spiral surrounding the files, but not touching them; the coil terminates in a wire which rises towards the surface. This arrangement is the result of practical experience, When the files have been in the bath ten minutes, they are taken out, washed, and dried, when the whole of the hollows will be found to have been attacked in a very sensible manner, but should the effect not be sufficient' they are replaced in the bath for the same period as before. Sometimes two operations are necessary, but seldom more. The files, thus treated, are to all appearance like new ones, and are said to be good for 60 hours' work. M. Werdermann employes twelve medium Bunsen elements for his batteries.

SILVER.—The tenacity of silver has been studied by Matthiessen, and can be stated for comparison as follows:—Alloy of tin and copper, 1; gold, 3·6 to 4·3; copper, 4·3; silver, 7·2; platinum, 7·2; iron, 13; steel, 30. It is so ductile that a grain of it can be drawn out 400ft., and it can be hammered into leaves so thin that it would require 100,000 of them to make a pile an inch in height. Its conductivity for heat is to copper in the ratio of 100 to 73·6; and for electricity, as 1000 to 964. Cast silver expands, according to Calvert, between 0° and 100° per cent., 0·001991; and its specific heat is 0·05701. Although silver conducts heat remarkably well, its power of radiation is very small, so that a silver vessel retains the heat of a liquid contained in it longer than any other metal. Pure silver, if highly heated in oxygen, will absorb 6·15 to 7·47 volumes of that gas; and under the same circumstances, will take up 0·907 to 0·938 volumes of hydrogen, 0·486 to 0.545 carbonic acid, and 0·12 carbonic oxide—in property differing considerably from palladium.

MULBERRY LEAVES.—The Science and Art Department of the South Kensington Museum has placed at the disposal of the Silk Supply Association a room for the purpose of rearing silkworms during the ensuing months of May and June. The Association being possessed of some very rare and valuable eggs, or "grain," imported by the Hon. Secretary from Siberia, Mantchouria, Szechuen, Shang-tung, and other places where there exists no disease, will be enabled to demonstrate, for the information of sericiculturists in this country and in the colonies, the simple practicability of silk production. The subject is one of national interest, and, it is hoped, will stimulate our Colonies to turn their attention to silk cultivation. Persons interested in silk culture at home or in the Colonies, may have the opportunity of studying the entire process by application to the Hon. Secretary, 65, Morgate-street, E. C.

THE GUINEA AND THE POUND.—It is among the things generally known that the guinea obtained its name from the gold from which it was made having been brought from the Guinea coast by the African company of traders. The first notice of this gold was in 1649, during the Commonwealth of England, when on the 14th of April of that year the Parliament referred to the Council of State a paper presented to the House concerning the coinage of gold brought in a ship lately come from *Guiny* for the better advancing of trade. But it was in the reign of Charles II. that the name was first given to this coin. It is among things not generally know that when the guinea was orriginally coined the intention was to make it current as a twenty-shilling piece; but from an error, or rather from a series of errors, in calculating the exact proportions of the value of gold and silver, it never circulated for that value. Sir Isaac Newton, in his time, fixed the true value of the guinea, in relation to silver, at 20s. 8d., and by his advice the Crown proclaimed that for the future it should be current at 21s. A curious question arises out of the fact alluded to; how many millions of money has the English public lost by the payment of a guinea when a twenty-shilling piece would have sufficed had the costly error never have been fallen into?

THE PRUSSIAN NEEDLE-GUN.—A contributor to the *Allgemeine Militar-Zeitung* writes:—"As you know, two improved models of the needle-gun are on trial, which both aim at increasing the rapidity of firing, with as little waste as possible. From fifteen to twenty shots may be fired by them in a minute, so that the apprehensions of those may be quieted who are alarmed as soon as they hear another army can load more quickly than ours. I and many others are inclined to shrug our shoulders when we hear the nonsense so current on this subject. All who have any experience know that two, or perhaps three, well-aimed shots are the most we can obtain from infantry in the field."

EXPANDING DRILLS.—The *Mining Journal* reports that Mr. E. P. Gleason has invented a drill applicable to rock-boring purposes. He proposes a drill whose cutting parts are attached to a bar by a joint, and formed with a round back taking against an incline, so that as the drill is dropped or projected the cutter acts laterally, and finally forms, by continual working, a chamber with an inclined top and bottom surface surrounding the drill-hole. This chamber can be enlarged by successive cuts above or below the first chamber. The cutting ports are easily sharpened or replaced when worn; and by using two cutters, acting on opposite sides, one forms a means of re-action for the other, so that the drill-bar remains central, or nearly so, in the drill-hole.

MUDDY WATER CLEARED BY ALUM.—A comparatively small quantity of alum will clear muddy water. A piece as small as a hickory nut, or even less, according to the impurity of the water, will precipitate the dirty colouring matter in a pailful of water. It has simply to be dissolved, stirred, and left to settle. This method is frequently adopted along the Missouri and Mississippi rivers. In the manufacture of lakes used in painting, the dissolved colouring matter is precipitated by alum. All this rests upon the peculiar property of alum to combine, when in solution, with the most foreign particles in suspension or even solution.

PORTABLE MOTIVE POWER.—A correspondent of *Nature* draws attention to an important discovery made by an American, which bids fair to supply the want of a portable motive for machinery. At the last expedition of the American Institute, it seems, there was shown an elliptic lockstitch sewing machine driven by an electric engine small enough to fit into a common hatbox. A series of eight magnets are set on the periphery of a circle, and around these revolves an armature of steel which is continuously propelled by the magnetic action, and thus operates the machinery that moves the needle. Connection with this motor is had by means of a small slide within reach of the operator, at whose will the current may be cut off entirely or the speed of the needle graduated, as may be desired.

DR. ANGUS SMITH ON THE CHEMICAL EXAMINATION OF AIR.—Dr. Angus Smith read a very important paper at a meeting of the Association of Medical Officers of Health held last week. The subject, says the *Medical Times and Gazette*, was the "Examination of Air," and the most striking feature was the announcement that he had detected and measured the nitrogenous organic matter in different kinds of air, and that between country air and the air of towns or of close rooms there was a most marked difference in this respect. The process adopted by Dr. Smith was very novel and ingenious. It consists in shaking up a small quantity of perfectly pure water with a measured volume of the air to be examined, by which operation the organic impurity of the air is transferred to the water, which is afterwards analysed by the ammonia process invented by Wanklyn, Chapman, and Smith. The author of the paper expressed great confidence in the results he had obtained, and said he would not scruple to ask for the demolition of all crowded courts in towns, the atmosphere of which presented the characteristic signs of contaminated air.

ANSWERS TO CORRESPONDENTS.

*** All communications should be addressed to the EDITOR of the ENGLISH MECHANIC, 31, Tavistock-street, Covent Garden, W.C.

MORE TESTIMONIES.

"The ENGLISH MECHANIC is one of the finest scientific journals of the day, and as an advertising medium it is unequalled."—R. B. SCOTT, Rochdale, April 23, 1870.

"I think the ENGLISH MECHANIC is the best paper I ever knew to advertise anything of any kind in."—R. ROGERS, Rudge Pottery, Chilmark, Salisbury, April 28, 1870.

The following are the initials, &c., of letters to hand up to first post, Friday, April 29:—

W. T., P. P. W., J. W. P., J. Sharpe, An Amateur, Sergius, A. B., St. George, Britannia, A. Fitchener, Electro, Le Diable, H. M. Gossypium, Rev. E. Kernan, Mordant, W. Walker, A Good Boy, Progress, Tangent, A. Telhausen, Emigrant, Kensington Amateur, D. T. Batty, Thos. Perks, Llah, R. Passmore, Strongbow, A. Farquhar, R. A. Anderson, A Great Sufferer, Dr. Galle, S. Smith, A. P. Rhys, J. Hastings, E. H., H. C. B., J. Francis, J. M. and Son, T. Mason, Sidney Biddell, Geo. Luff, S. M. Y., J. Jennings, W. H., W. J. H., J. R. Leifchild, H. N., Veritas, J. A. M., W. Taylor, F.R.A.S., W. R., J. H., C. F. Jensen, Excelsior, Maori, Eleve, Falcon, Observer, Young Mechanic, Snatchblock, Student in the Fog, A. Boughey, Cyl, J. Francis Bender, W. Baguley Maschil, Amateur Artist, Carbon, B. W. R., Constant, One in a Fix, F. A. Edwards, Quick, W. Chadwick, A. B., D. Forbes, Sans Aide, Z. E. X. B., H. Saunders, Young Joiner, Schemer. T. R., J. B. and Co., T. K., F. G., Whilley Partners, F. K., Capt. O. H. Stokes, W. Pearson and Co., J. T., A. Kerr, A. G. de V., Wm. Kelsey, R. Burgess, G. E. D., J. H. M., S. and B. S., R. A. P., J. Gedge, W. Conisbee, J. Bourne and Co., J. Radcliffe, Philip Egerton, W. S. McKay, J. C. and Co., Geo. Price, N. S. Heinken, W. Munro, S. P. H., J. W. B., Josiah Waterhouse, J. Billings, Live and Learn, Col. J. B., J. R. T., F. R. S., Rev. E. T., J. B. W., J. D. Lamb, A Learner, Capt. S. C.

T. S. H., who forwarded letter on "Readings from the Globes," is requested to send his address.

R. R. SCOTT (Rochdale).—For the sixpenny-piece you enclosed in your letter we had to pay 8d. The letter was not registered, and the Post Office authorities very correctly say they cannot undertake the transmission of coins: and in unregistered letters, as so sent, they are exposed to serious risk; but when registered they are practically safe. As a step towards the more general registration of all such letters, the fee has been reduced from 6d. to 4d., and it has been decided to register all letters unquestionably containing coin, even though they be posted, as in this case, without registration, and to charge them on delivery with a double fee of 8d., in addition to the ordinary postage.

J. R. T.—The error arose from your indistinct writing. Be more particular in writing proper names.

G. SMITH.—We don't know "J. C. H.'s" address. If you have anything to say, and particularly if you can speak from experience, on the abuse of lunatic asylums, our columns are open to you.

URBAN next week.

To MILLERS.—In Mr. Sharpe's letter, p. 134, for "saving of flour" read "saving of power;" and for "20ft.," "12½ft.," &c., read "20st.," &c.

HY. SWALLOW.—No stamps enclosed.

M.R.C.V.S.—Yes. No doubt many of our readers would like some information on "domestic pets."

HENRY W. HENFREY, next week.

. E. Y.—The library of the British Museum is free. You must, however, get two householders to recommend you.

THE Sixpenny Sale Column is the only place in which can appear queries forwarded by O. C. C., S. H. (Pontefract), R. S. George (Sunderland).

T. JONES.—No, we cannot. There is no real remedy but the razor, and we suppose you will hardly care about trying that. Why waste our time and your own in writing about such nonsense?

A CONSTANT READER.—You may do so without infringing anybody's "rights."

J. MOSEDALE.—June 4, 1869. In future consult index, and save us trouble of searching.

T. J. O'CONNOR.—Hardwicke, 192, Piccadilly, and Groombridge, Paternoster-row. The first is monthly, price 1s. 6d., and the second quarterly, price 2s. 6d.

C. G.—Cannot say. We do not estimate for publishing books.

R S.—Yes.

W. B. B.—Apply to a medical man. The disease results from different causes, and it would be dangerous to advise.

JOHN BRYCE.—Write them for a description.

J. J. (Rotherham).—See back numbers.

W. BIRD.—See page 114, present vol.

FRATER.—Similar information has been given recently—more than once.

A YOUNG TYKE.—Yours is only a different manifestation of the same disease. Let your friend apply to any chemist. Third query inserted.

CAMBRIDGESHIRE.—Your first two queries have been answered many times.

M. L. MOFFATT.—The numbers in the indices refer to the pages.

ENTOMOLOGIST.—Your queries were answered at some length in the early numbers of Vol. X.

JAMES BELL.—Your mention of the can of water experiment shows strongly how people wilfully misinterpret facts. The rest of your letter is simple assertion unsupported by argument.

FILIUS NULLUS.—Can you not try it? The use of the sugar of lead was at the time strongly deprecated by one of the medical journals.

A. A. TOMS.—All your queries have received answers in our pages many times.

FAN.—First ascertain whether electricity can be applied in working the bells. It strikes us you are altogether in the dark.

CHARLES T. W.—37, Boulevard Bonnenouvelle, Paris.

H. BEVELING.—Thanks. The lines are good, but not appropriate for "ours."

C. J. F.—If an illustration or description of your patent appears in the ENGLISH MECHANIC or any other paper you cannot patent it afterwards. Publishing it makes it public property.

UNEQUAL STEAM PRESSURE.—We have received a long letter on this subject in answer to Mr. Ben Wood. Had the letter been shorter and contained fewer personal reflections we should have inserted it. Why cannot correspondents, in discussing scientific questions, give each other credit for good intentions, and be more tolerant of each other's supposed shortcomings?

S. F. SHAKESPEARE, of Thrapstone, writes us to say that he invented "the pedespeed" two years ago, and found it to answer very well. Is he sure it answered well? In what condition were his feet and ancles after using the invention a couple of hours?

W. R. T.—Answer through the ENGLISH MECHANIC. If such information is good for one it is good for a thousand.

J. B. R.—Cannot answer by post.

J. T. MURPHY.—For information on Phantom Veloce see advertisement on second page.

THE *ENGLISH MECHANIC* LIFE-BOAT FUND

Subscriptions to be forwarded to the EDITOR, at 31, Tavistock-street, Covent-garden, W.C.

	£	s.	d.
Amount previously acknowledged	£170	9	10
Collected by Mr. George Luff, of Staunton Harold, Ashby-de-la-Zouch (second collection):—Proceeds of concert given in Staunton Harold schoolroom, £4 1s. 10d.; James Cheatle and wife, 3s. 6d.; Mrs. Morgan, 1s.; S. J. White, 1s.; Bertie Luff, 6d., Willy Luff, 6d.; Widow Fairbrother, 2d.—all of Staunton Harold. Miss Leadbitter, 2s. 6d; S. Watson, 2s. 6d.; Mr. Deekin, 2s.; Mrs. Deekin, 1s.—all of Chartley. R. T. Tasker, Esq., 5s.; Henry King, Esq., 2s. 6d.; William Armson, 2s.; Joseph Bullock, 1s. 6d.; John Brown, 2s.; W. Hall, 2s.; E. Thompson, 2s.—all of Melbourne. Mrs. Taylor, Rochdale, 1s.; Geo. Holloway, Belton, 1s.; Geo. Orchard, 2s. 6d.; G. H. Gibson, 6d.; Thos. King, 1s.; Mrs. Hodder, 6d.; S. E. Johnston, 2s.; Thos. Wright, 1s. 6d.—all of Ashby-de-la-Zouch	6	3	6
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Tinplate Worker, Gargrave	0	1	0
Jem and Bob	0	1	0
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New Subscriber...	0	2	6
R. S.	0	1	0
Non Alumni	0	1	0
	£179	6	10

THE INVENTOR.

IN obedience to the suggestions of a number of readers, we have decided on appropriating a portion of our space to a condensed list of patents as nearly as possible up to the date of our issue.

APPLICATIONS FOR LETTERS PATENT DURING THE WEEK ENDING APRIL 26, 1870.

1130 H. B. Barlow, Manchester, doors, locks and latches.—A communication

1131 J. F. Spencer, Westminster, and W. Inglis, Bolton, steam engines

1132 S. Barton, Manchester, distributing apparatus to be applied to garden hose.

1133 F. Tallis, 83, Fleet-street, London, cocks for gas, or for liquids or fluids.

1134 R. Cherry, Halifax, looms for weaving.

1135 B. J. B. Mills, 35, Southampton-buildings, studs, for buttons.—A communication

1136 S. C. Lister, Bradford, weaving silk and cotton velvet

1137 D. Forbes, York-place, Portman-square, and A. P. Price, 47, Lincoln's-inn-fields, improvements in the treatment of sewage

1138 E. Hoyle, Bradford, manipulating gold leaf for ornamenting

1139 M. Nolden, Francfort-on-the-Maine, curing or drying mealy and grainy stuffs, heating, cooling, and mixing fluid substances, and condensing gaseous ones

1140 D. Sowden and R. C. Stephenson, Bradford, boring, drilling, and turning wood or metal

1141 W. Brown, Portsmouth, improvements in the construction of thrust blocks, plummer blocks, and such like mechanism used in steam ships

1142 H. W. Hammond, Manchester, manufacture of superphosphate of lime.—A communication

1143 W. R. Lake, Southampton-buildings, cartridges for breech-loading fire-arms.—A communication

1144 G. Symes, Goding-street, Vauxhall, and J. W. Young, Portland terrace, Regent's-park, portable apparatus for manufacturing gas

1145 A. V. Newton, 66, Chancery-lane, improved device for operating the throttle valve or regulator in locomotive engines, and for other like purposes.—A communication

1146 C. Cooke, Kensington, improved combination of articles used for culinary purposes.—A communication

1147 J. G. Jones, Blaina, near Newport, Monmouth, and G. W. Elliott, Chesterfield, improvements in slide valves

1148 E. B. Sampson, Hope Mills, near Stroud, apparatus for feeding machinery employed in carding or preparing wool and other fibrous substances

1149 J. Green, Wrexham, manufacture of coke, and the apparatus connected therewith

1150 W. Smith, Heywood, looms for weaving

1151 W. Catt and C. S. Catt, Ipswich, wheels for carriages

1152 W. R. Lake, Southampton-buildings, condensers for marine steam engines.—A communication

1153 R. Sinclair, Glasgow, apparatus to promote circulation in locomotive steam boilers.—A communication

1154 W. R. Lake, Southampton-buildings, London, improvements in reversible butt hinges.—A communication.

1155 J. H. Johnson, 47, Lincoln's-inn-fields, hardening composition, and its employment with india-rubber, gums and oil.—A communication

1156 W. Batchelor, Winchester, improvements in fire-bars

1157 R. P. Beattie, South Castle-street, Edinburgh, improved construction of valve cock.

1158 A. M. Clark, 53, Chancery-lane, improvements in shirt fronts and cuffs.—A communication

1159 G. W. Ley, St. John's-road, Croydon, improvements in the production of raised and sunken designs in imitation of carving in wood, ivory, bone, and other materials

1160 R. F. Bigot, Paris, apparatus combining the functions of a bung and of a self-acting vent-peg

1161 W. A. Oatey, Wadebridge, reaping and mowing machines

1162 J. Milton, Glasgow, yarn holders

1163 M. C. Hull, New York, heating stoves or furnaces

1164 A. V. Newton, 66, Chancery-lane, improved adjustable bedstead.—A communication

1165 J. H. Johnson, 47, Lincoln's-inn-fields, reaping and mowing machines and an apparatus for sharpening the cutters of such machines.—A communication

1166 J. T. Sheppard, Northampton, cutting heel and sole pieces or other forms of leather

1167 T. Bell, Walker Iron Works, Northumberland, treating calcined pyrites for the better utilisation thereof

1168 E. Farrington, 63, Grande Rue Passy, Paris, breech-loading fire-arms

1169 J. Gray, Uddingston, Lanark, improvements in ploughs

1170 G. T. Bousfield, Loughborough-park, Brixton, mowing and reaping machines.—A communication

1171 J. R. Clark, Maine, U. S. A., machinery for knitting

1172 C. Bardy and L. Dusart, Boulevart de Strasbourg, No. 23, Paris, preparing certain organic bases for producing colouring matters.

1173 J. A. Wade, Kingston-upon-Hull, and J. Cherry, Hornsea, improvements in roofing tiles

1174 G. W. Cooke, and H. Kennedy, Bangor, securing ridges of slate or other material to the roofs of buildings

1175 H. Shaw, Newport, Kentucky, U. S. A., machinery for hulling cotton seeds and separating their kernels from the hulls and fibres

1176 W. Gossage, Widnes, decomposition of certain metallic sulphides, and in the production of alkaline compounds

1177 G. Little, Oldham, combing cotton wool, and other fibrous materials

1178 V. Milward, Ipsley, Warwick, wrappers for preparing needles, and apparatus for counting needles

1179 M. M. Silber, Boulevard de Strasbourg, No. , Paris lamp for burning petroleum and other mineral oils

1180 C. Lungley, Greenwich, manufacture and in the securing of tubes, taps, and plugs in boilers and other vessels

1181 T. Feather, Cleckheaton, machinery employed in slubbing, drawing, and finishing worsted and other fibres

1182 G. Bernhardt, Radcliffe, machines for spinning and doubling fibrous materials

1183 C. H. Savory and W. R. Barker, New Bond-street, apparatus for effecting fumigation, vaporisation, and inhalation

1184 J. P. Ferris and E. Craddock, Gresham-street, London, portable apparatus for generating illuminating gas

1185 L. C. Schermerhorn and C. Schermerhorn, Derby, apparatus for manufacturing cheese

1186 P. Spence, production of prussiate of potash, prussiate of soda, and prussian blue

1187 M. Brown-Westhead, Manchester, and R. Smith, machinery for plaiting or folding tapes and other narrow fabrics.

1188 M. Bayliss, Cannon-street, London, manufacture of spikes

1189 W. Thompson and T. Stather, mills for grinding cattle food and other materials

1190 A. Morand, Leeds, kilns or ovens

1191 S. D. Tillman, Jersey city, Hudson, New Jersey, U. S. A., improvements in boilers, air heaters, steam condensers, and analogous constructions

1192 G. Fenwick, Gateshead-on-Tyne, ropes or cables to be used for telegraphic or other purposes

1193 F. D. Sutherland, King William-street, London, travelling bags and portmanteaus

1194 E. L. Parker, Birmingham, improvements in buckles or fastenings for braces

1195 J. Lord, Crawshaw Booth, J. Gresty, Manchester, and C. Cross, Pendleton, apparatus for separating and sorting cotton

1196 S. Randall, Linsdale, and J. Randall, Stevenage, construction of harrows

1197 G. J. Firmin, 19 Lorn-road, North Brixton, self-registering water or liquid gauges

1198 L. Wray, Ramsgate, apparatus for crushing ores

PATENTS SEALED.

3081 C. A. Ofverberg, filters and filtering apparatus.—A communication

3088 J. Lockwood, couplings for railway engines, carriages, and waggons

3099 W. Blackett Haigh, circular saw benches

3100 J. S. Grierson and R. Philips, bronzing, colouring, and illuminating cards and paper

3103 J. P. Rennoldson, steam lubricators

3104 J. Dodge, apparatus for forging or shaping metals

3107 T. Briggs, materials used for packing

3110 W. A. Martin and E. Wylam, fuel-feeding and smoke-consuming apparatus for furnaces

3134 J. James, bending and jointing metallic or other sheets so as to form boxes

3178 A. H. Brandon, motive-power engines, and in the means and mechanism for generating such power.—A communication

3198 M. Wilson, improvements in sink traps

3225 G. D. Davis, machinery for working rudders

3291 F. Clark, manufacture of pipes, bricks, tiles, and other articles from clay

3339 W. N. MacCartney, improved railway carriage for passengers.—A communication

3463 F. W. Webb, improvements in locomotive and other steam engines and boilers

165 J. Dewar, treatment of certain substances for manure

200 J. Dewar, treatment of certain substances for food and for manure

415 W. R. Lake, apparatus for drying sugar.—A communication

419 R. Looker, construction of horticultural structures, cases or enclosed spaces

604 R. Hayward, manufacture of yarns and fabrics containing horse-hair

619 J. Allmann, machinery for dressing or sifting ground wheat or other grain.—A communication

3109 C. Simpson, manufacture of miniature or toy bricks for the use of children

3111 A. Bowater, rolling or shaping metals

3116 T. Clark, improved implements adapted for constructing tube wells and driving hollow piles

3136 W. W. Girdwood, self-lubricating metallic elastic packing

3138 T. Taylor and J. W. Davies, apparatus for singeing horses

3147 E. H. Monckton, improvements in electricity and means of telegraphing

3152 J. C. Mewburn, improvements in apparatus for feeding boilers, and for raising and forcing fluids generally.—A communication

3171 P. Jensen, guns for bayonet drill.—A communication

3174 R. Spice, artificial stone.—A communication

3194 E. Finch, dock gates and caissons

3412 L. Mount, apparatus for "filling" match splints or other splints

3491 J. H. Johnson, spring mattresses.—A communication

3522 D. Prideaux, purifying and calcining gas and soap limes

58 R. Morris and M. D. Penney, treating shoddy and other animal waste to obtain ammonia and salts of ammonia therefrom

234 W. Hay, making paper

254 R. Hayworth, R. Woodcock, and J. M'Cabe, looms for weaving

498 G. Twigg, shearing and clipping apparatus

487 C. Bartholomew, apparatus to be used in getting coal

600 S. G. George, producing pictorial, ornamental, and other designs and devices

653 J. Polson, treating grain and in the mechanism employed therefor

The English Mechanic
AND
MIRROR OF SCIENCE AND ART.
FRIDAY, MAY 13, 1870.

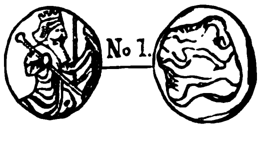
ANCIENT COINS.—I.

BY HENRY W. HENFREY.

IT is impossible to estimate too highly the great value of ancient coins as illustrators of history. Their influence extends to the remotest ages, and the remotest countries, and they are undoubtedly the most veracious and imperishable of historical records. "I soon perceived," says Admiral Smyth, "the mischievous error of the too general opinion, that an acquaintance with ancient coins is more the province of the antiquary than of the scholar, that it was of little permanent advantage to the general reader, and that it was useless to him whose avocations in life admit of but brief intervals for literary researches. My conviction, on the contrary, showed that without these infallible vouchers, independent of their intimate connexion with the fine arts, there cannot be a clear understanding of many customs, offices, and historical events; that an experimental acquaintance with medals is a higher advantage than the ignorant will admit it to be; and that no one can be disparaged by a pursuit which engaged the attention of and enrolled among its votaries such men as Alfred, Cromwell, Napoleon, Selden, Wren, Canova, Camden, Evelyn, and Chantrey. Looking backwards to antiquity is not at all going back to it; but the process inculcates various and invaluable cautionary lessons."

We now purpose to give a few particulars of the most interesting coins in the several series, commencing with the Greek, as being the most ancient. The earliest of these were struck in the island of Ægina in the seventh century B.C. They have a tortoise or turtle on one side, and square indented marks on the other. In shape they are thick and globulous, being struck out of a bullet-shaped piece of silver, in order to assist the high relief. The different denominations of the Grecian silver coins were the *drachma* or *drachm*, the eighth part of an ounce, worth about 9d.; the *didrachm*, or double drachm, worth 1s. 6d.; the *tridrachm* (very rare), or piece of three drachms, worth 2s. 3d.; and the *tetradrachm*, or piece of four drachms, worth about 3s. of our money. There are many divisions of the drachma which it is not necessary to notice here in detail, but they consisted of the *obolus* and its multiples and divisions. The coins of the Lydians are next to those of Ægina in antiquity, and to these succeed the gold and silver *Darics* of the Persians.

These Darics, struck under Cyrus or his nearer successors, are the pieces mentioned under the name of *drams* in the Bible, 1 Chronicles, xxix. 7; Ezra, ii. 69, viii. 27; Nehemiah, vii. 70, 71, 72. They were current in Palestine in the period after the return from Babylon. The Darics which now exist are thick pieces of pure gold, weighing about 128 grains troy; and bear *obverse*, the figure of a King of Persia kneeling with a bow and javelin, or a bow and a dagger; *reverse*, an irregular sunken square. See the engraving No. 1.


No 1.

The coins of the ancient Greeks are divided into two grand divisions. 1st, those struck by cities and states, sometimes called *autonomous*, and 2nd, those of sovereign princes.

Copper money was not coined by the Greeks until nearly two hundred years after the first coinage of silver, that is, in the fifth century B.C. The commonest denomination was the *chalkos*, worth about half-a-farthing. There were also pieces called *lepta*, which were divisions of the chalkos. Gold was first coined in Greece about the middle of the fifth century B.C.

The workmanship of Greek coins was at first very rude and barbarous, but it gradually improved until, about 500 B.C., it had attained some degree of excellence. But the most beautiful specimens of numismatic art belong to the century extending from 450 to 350 B.C. The coins of Athens are perhaps some of the most famous, and the most remarkable symbol on them is an owl. Pieces of Rhodes have the flowers of the pomegranate, Corinth, a pegasus or winged horse; Argos, a wolf's head; Bœotia, a bull's head; Crete, the minotaur's head, and the labyrinth; Pharsalia, a horse's head; Marseilles, a lion; Peloponnesus, a tortoise; Scio, a sphinx; Sicily, three legs joined; Thessaly, a horse, &c. A bull on Greek coins is supposed to be the symbol of a river.

The most ancient Greek coins are those coined by cities, many of them having been struck before those of the Macedonian kings—the earliest princes who coined money. These civic coins generally have on the *obverse* the head of the genius of the city, or some favourite deity, while the *reverse* usually bears some symbol used by the city. The inscription contains the initials, monogram, or the complete name of the city. Pinkerton remarks, "Some conoisseurs prefer the regal coins of Greece, others the civic. The former interest by their portraits, the latter by their variety. The former are more important perhaps to ancient history, the latter to ancient geography. To him who is fond of ancient geography, the civic coins are singularly interesting. It is also pleasing to see ancient accounts of cities, of their customs, religion, and the like, confirmed by the coins."

The monarchic coins of Greece are usually very like the civic, except that they generally have the head of the King on the obverse; and a figure of some god or goddess on the reverse, with the name of the prince. Amongst the Macedonian series the coins of Alexander the Great are very fine, and his tetradrachms and drachms are of common occurrence.

The engraving No. 2, represents a tetradrachm of Lysimachus, King of Thrace, bearing on the obverse the head of Alexander the Great as a young Jupiter Ammon. The coins of Alexander himself seldom, if ever, have his portrait.

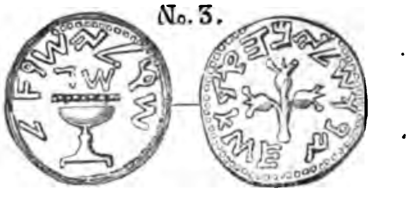
No. 2.

The later Greek coins struck under the Roman dominion, and having a Roman emperor's bust on the obverse, are called *Imperial Greek* coins.

Ancient coins also exist of kings of Sicily, Cyprus, Caria, Pæonia, Heraclia Pontica, Epirus, Egypt (some of this country bear the busts of Antony and Cleopatra), Syria, Asia Minor, Sparta, Pergamus, Cassandria, Parthia or the Arsacidæ, Persia, Cappadocia, Paphlagonia, Thrace, Pontus and the Bosphorus, the Bosphorus only, Bactria, Ariana, Bithynia, Illyricum, Armenia, Arabia, Mauritania, Galatia, Cilicia, Judæa, Getæ, Commagene, Edessa, Palmyra, Gaul, Britain, &c.

It may be interesting to give here some account of the Jewish coins mentioned in the Bible. The earliest are shekels and half-shekels in silver, weighing on the average 220 grains troy for the former, and 110 for the latter. They are generally believed to have been coined by Simon the Maccabee, on receiving the permission of Antiochus VII., king of Syria about 140 B.C., to coin money with his own stamp. See the Apocrypha, 1st book of Maccabees, xv. 6.

The shekels have *obverse*, a vase, usually believed to be the pot of mamma; above it is the date in Samaritan characters, "Year 1," "Year 2," or "Year 3." These signify the years of Simon's pontificate, the first one being equivalent to B.C. 143. Circumscription in Samaritan letters:—"Shekel of Israel." *Revers*, a branch bearing three flowers, or Aaron's rod that budded. Circumscription, in the same language, "Jerusalem the holy." See the engraving No. 3.

No. 3.


The half-shekels in silver are exactly similar except that they are rather smaller in size, and have the words "Half Shekel" instead of "Shekel of Israel," on the obverse.

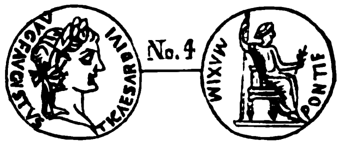
There are coins dated "Year 4," and of very similar design, undoubtedly belonging to the same series as the silver shekels and half-shekels.

Copper coins are also assigned to John Hyrcanus, high priest, B.C. 135—106; Aristobulus and Antigonus, B.C. 106—105; Alexander Janneus, high priest and king, B.C. 105—78; Queen Alexandra, B.C. 78—69; Antigonus, high priest, B.C. 40—37. The common type of the *obverse* is the name of the prince within a wreath; and of the *reverse*, two cornucopiæ united, &c.

The farthings spoken of in the New Testament were the *quadrans* and the *assarion*, small copper coins worth about a farthing. The mite was half one of these.

Coins exist in brass (or copper) of Herod the Great, and his successors Herod Agrippa I. and Herod Agrippa II. There are also some small copper pieces struck at the time of the revolt of the Jews which ended in the destruction of Jerusalem by Titus, A.D. 70. They have a vine leaf and stalk on one side, and a vase on the other.

The last Jewish coins are silver shekels and quarter shekels struck by the famous Barkobab who headed the insurrection in the time of Hadrian, A.D. 135. He also coined copper money.


No. 4

In our next article, we purpose to give some account of the ancient Roman coinage.

(*To be continued.*)

COLOUR AND COLOUR BLINDNESS

BY OMICRON."

(*Continued from page* 151.)

THE ease with which the three primary colour appear to be distinguished by the colour-blind, is greatest for yellow and least for red. Yellow, blue, and red is the order in which they are most easily distinguished, and we believe no case is reported in which yellow was the colour concerning which the greatest number of mistakes was made. Blue, when well illuminated, well seen, and some of the colour-blind assert that that is the colour which they can see best, and yet when blue and yellow are mixed, and form green, the number of mistakes is greatly increased, some mistaking it for blue, and the majority for red, and occasionally for yellow. When Dalton first wore the scarlet robes, on his accession to the dignity of D.C.L., he compared it in colour to the leaves of the trees; for him there was no distinction, and in almost every famous case of colour-blindness the same two colours have been confounded. Troughton, the optician, saw no difference between the petals and leaves of plants. Red is the greatest puzzle to those who confound colours. To some, like Dalton, it has positively no existence, others occasionally see it, but as often confound it with green. It is a very curious sight to submit different shades of red and green wool to colour-blind persons, and ask them to arrange the wools according to their different colours and shades. Some will lay them out in one single row, attending with great nicety, apparently, [illegible] irrespective brightness of colour; we say apparently, for it is not easy for a normal eye to decide whether a shade of full green is darker or lighter than a shade of full red. Some will make two distinct bundles, in which the reds and greens will be about equally divided, but possibly the most amusing sight is to see a person debating whether a brilliant red shall be placed along with a bright green, and possibly when he has *guessed* right, for he has no certainty, he will be unsatisfied with the assortment, and transfer the red to the green bundle. In many cases an artificial light will enable one who confounds colours to see them as they appear to a normal eye, and if the assorted bundles of red and green wool be laid before them by candle light, their mistakes are in some cases evident to themselves, when their disappointment is sufficiently aggravating. Green and red being such stumbling blocks, it is not surprising that the more composite colours in which green and red enter in combination, should prove equally ambiguous to a colour-blind eye. Purple is taken for blue, the red not being detected; orange for yellow, olive for brown, and so on. A gentleman communicated to Dr. Wilson the following account of his own peculiarities of vision:—"As far as I can tell, the following expresses my experience as to colours. Yellow is the far brightest colour, blue nearly as bright; these are the only two I see distinctly in the rainbow. Red I can distinguish when bright, but other shades I confound with stone colour or grey. Green I have no distinct conception of, according to its different shades it appears black, brown, red, yellow, blue, and grey. I cannot distinguish at any distance the ripe cherries on a tree, or strawberries from their leaves. The flowers on the scarlet geranium I cannot see distinctly at a distance by daylight, but by candle light there is a marked difference between them and the leaves. I have no conception of what is meant by complementary colours, or of the agreement of different colours when blended together, as, for instance, what kind of a carpet accords with red curtains in a room. With regard to my want of perception of green, it appears to me that the blue and the yellow hues neutralise each other, and would, in equal proportions, constitute what is really no colour, varying from a drab or grey to a dingy black. When the blue rays predominate it appears blue drab, and when the yellow rays are in excess, it appears a yellow drab. When the blue and yellow are proportionately blended, as in a lady's green silk dress, it appears to be very similar, and no more colour than a drab silk. The dry dirt of the street I should equally suppose to be green. I also confound red and brown frequently. I cannot distinguish between treacle and blood spilt in the street, by daylight, though I believe I could by candle-light." This peculiarity of vision is best shown by giving the experience of those who have been the sufferers from it, and as these narratives may be the most interesting portion of our paper to the majority of your readers, we shall make no scruple nor apology for extracting such remarks from other cases as shall best serve our purpose. Dr. K. gives an interesting account of his confusion of colours, but it is too long for complete insertion "Blue and yellow," says he, "are the brightest colours. Red, that is scarlet, is a pleasing *sober* colour, which refreshes my eye as much as green; indeed, I cannot tell any difference between certain shades of these. Red sealing wax and grass, for instance, are absolutely the same exact colour. Prussian blue and red have the same hue. The rose, the lips, a ruddy complexion, and the face of a man discoloured by nitrate of silver, are to my eyes absolutely the same. Red-hot coals and gamboge yellow are to me identical in colour. Infusion of red cabbage, deepened by alkalies, or reddened by acids, to me exhibits no change of colour, only a greater intensity or deeper colour; the actual colour remains absolutely the same. I cannot detect cherries or strawberries from the leaves, but by their form. In purchases I have made many mistakes; for instance, I purchased a red dress thinking it a green one. I have on more than one occasion bought red and green trousers, thinking they were brown, and had to get them dyed afterwards to get them worn. In Paris I bought a red cap thinking it a green one; in fact I could give many instances of similar mistakes." When Dr. K. refers to the infusion of red cabbage being darkened by alkalies, he unwillingly furnishes proof as well as statement of his colour blindness, for the infusion which is originally purple is not deepened in tone, but absolutely changed in tint to a bright green. Dr. Y. says red cabbages growing, pickled, or in infusion, are the most beautiful blues I can imagine, and it was by not observing any change by acids in the infusion of red cabbage, when attending the chemical class, where I used to stare for the whole hour, expecting to see the change, that I first became aware of my great defect. The author of these papers had his attention first called to the incapacity, in certain individuals, of detecting colour by noticing that a gentleman to whom he was showing, in a large refracting telescope, the beautiful pair of stars that compose β Cygni, saw no difference in colour between the two, and compared them both to the colour of the top part of a gas flame. Any person with a normal eye that has seen these two strongly coloured stars, will own that this gentleman presented a strongly developed case of colour-blindness, and there can be little doubt but that a personal equation exists in chromatics as certainly as it does in time, though numerous circumstances render it difficult to arrive at the exact amount of correction that ought to be applied to observers' opinions of colour to reduce them to a uniform standard. The study of sidereal chromatics requires a very correct eye for colour, and the correct determination of colour of stars affords a most convincing proof of the entire absence of anything approaching to the phenomenon that we have attempted to describe in this paper; to those who are interested in this particular study, we recommend Admiral Smyth's work on "Sidereal Chromatics."

As in all the cases we have mentioned the symptoms of colour-blindness displayed themselves at a very early age in each subject, it is not absurd to suppose that the defect was congenital, but there is one notice on record where colour-blindness was the result of injuries received from an accident, and this circumstance is of the highest importance, as it points out the probability of pathological inquiry revealing the true cause of colour-blindness, and eventually teaching to scientific men its successful remedy. This gentleman, a surgeon himself, had been thrown from his horse, and sustained a concussion of the brain, and there can be little doubt but that to this circumstance is to be traced the insensibility to colour that the eye of this gentleman ever after retained.

It will not have escaped the attention of the careful reader that in every case mentioned but one, the subject of colour-blindness has been a male. He will naturally be led to inquire whether the defect does not make its appearance in females. That there are cases of colour-blindness to be met with in the "softer sex" is undoubtedly the fact, but the instances are much rarer, and when they do occur, the ingenuity of the unhappy subject is exerted to its fullest extent to keep the defect from being noticed. Dr. Wilson, in carefully prosecuted inquiries for a term of nine months, discovered only six cases, and had the opportunity of examining but one. The unwillingness that ladies have to confess their inability to detect shades of colours makes the rarity appear greater than is really the case, as we before hinted, and Dr. Wilson notices that women of the better class, who had to make purchases where the defect might be noticed, usually brought a friend with them to avoid detection. In arriving at any accurate statistics with reference to women, a great difficulty is felt in meeting with large bodies of women together, who can be submitted to a trial. This defect is supplied with men by examining a section of the army or police force, or any other body of men, but except in the case of factory girls (whose want of education renders them peculiarly unfitted for a trial of this description), or lunatics, who are also not desirable for evident reasons, it will not be easy to meet with a large collection of ladies on whom to experiment. Dr. Wilson's inquiries were made in the shops of haberdashers and silk mercers, and the result of his inquiries can hardly be regarded as satisfactorily settling the question of the proportion of the male to the female colour-blind.

Dalton was the first to attempt to inquire what proportion of the population were colour-blind, but his inquiries were not sufficiently extended to lead to any accurate results. He remarks—"That out of 25 pupils that I once had, to whom I explained this subject, two were found to agree with me, and on another similar occasion one." Professor Subeck found five out of 40 youths, who composed the two upper classes in a gymnasium at Berlin, to be colour-blind. Professor Pierre Prevost declared that the colour-blind amount to 1 in 20, and Professor Wartmann did not think that the last estimate was a great exaggeration, for he says, "I have readily found a number of persons affected with this singular anomaly."* The carefully-conducted, and much more widely-extended examination of Dr. Wilson is the most reliable with which we are acquainted. The total number examined was 1154†, principally soldiers and members of the police force. Of these 1154, 21 confounded red with green; 19, brown with green; 25, blue with green. The total number to some extent colour-blind was therefore 65, or 5·6 per cent., which gives 1 in every 17·7 persons as marked with this extraordinary anomalous vision. "For my own part I think it probable that the number of persons in this country as markedly colour-blind as Dalton was—*i.e.*, given to mistake red for green, brown for green, purple for blue, and occasionally even red for black, is not less than 1 in 50; and including all kinds and various degrees of colour-blindness, 1 in 20."‡ We are not able to offer any statistics having reference to observations as to colour-blindness made in any other part of the world, but it seems not unreasonable to suppose that in a country where numbers are obliged to follow occupations which do not give full exercise to the external senses, the keenness of perception may not be so great as in countries where the senses are more eagerly trained. The susceptibility of the inhabitants of the higher latitudes to colours is far inferior to that of the race who produce the magic dyes of India, or the still nobler one that built the glowing walls of the Alhambra. Even our neighbours the French excel us in this matter, and it is not perhaps saying too much to assert that most of the civilised, and even the barbarian people, excel us in a taste for colours.

Before we conclude these few remarks on Daltonism, or colour-blindness, or whatever name the reader may give this peculiarity, it is desirable that we mention a few of the causes that have been assigned by medical and scientific men to account for the defect, and, perhaps, first of all, will arise the question whether the peculiarity is to be traced to the physical formation of the eye, and whether the simple inspection of the organ could decide whether a person was a sufferer from colour-blindness or not. And here possibly opinions will differ according to the sentiments of the readers, and if he be a phrenologist he may decide that a knowledge of that science (some perhaps will object to the term *science*) is sufficient to recognise an abnormal eye. One of the accounts that we have partly quoted, and whose length did not permit of the entire recital, adds the following testimony in favour of phrenology: "The only fact which somewhat staggered me relative to phrenology was that a phrenologist, then unknown to me, now a valued friend, asked me one day to answer him candidly whether I knew colour, as in me the bump of colour was absent. Several phrenologists who have seen my head since have agreed as to the absence of the so-called bump." The only case in which a colour-blind eye has been submitted to a post-mortem examination (so far as we are aware, with the exception of some general observations by Mr. White Cooper), was that of Dalton, at which Mr. Bally, formerly assistant to Dr. Spurzheim, was present, and took casts of several parts of the brain and skull. "He (Mr. Bally) pointed out a remarkable prominence on the frontal portion of the orbitar plates (which represents the phrenological site of the organ of colour, and the imperfect or deficient development of the convolution of the anterior lobes, which rested upon them. Of course Mr. Bally adopted this as the true explanation of the peculiarity of Dalton's vision; and we as witnesses not only without faith in phrenology, but even opponents, are bound to record the fact." But although we have arranged these two cases side by side, as being prominently marked out by phrenologists, as establishing their theory, there is in reality no connection between them, for those who have seen Dalton's bust, by Chantrey, will see that the superciliary ridge is projected very markedly, so as to overhang the eyes, and would have been selected by phrenologists as a sign of the possession of an exquisite sense of colour.

(To be concluded next week.)

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[*] "Taylor's Scientific Memoirs," 1846.

[†] This number includes 150 of Professor Kelland's pupils, examined by that gentleman.

[‡] Dr. G. Wilson, Op. Cit.

SCIENCE FOR THE YOUNG.

BY THE REV. E. KERNAN, CLONGOWES COLLEGE.

(*Continued from page* 154.)

§ IV.—ATTRACTION.

THERE exist various sorts of attraction, which are divided into two classes—I. Attraction insensible at a distance; II. Attraction sensible at a distance. The first class contains attraction of composition, or chemical attraction; attraction of cohesion, the force by which the particles of a body hold together, or, as it is commonly called, "molecular attraction;" attraction of adhesion, the force which unites separate bodies of the same or different natures. The second class comprises electrical and magnetic attraction, and *the* attraction: attraction of gravitation. Chemical, electrical, and magnetic attraction are studied in their own treatises; "mechanics" deals with attraction of cohesion, adhesion, and gravitation.

No. I.—Laws.—The three sorts of attraction are included in one set of Laws.

Law I. Cohesion exists in all bodies. Solids, liquids, and even gases, have a force by which their particles are held together. That which is clearly seen in the solid state exists in the other state, though very much diminished.

Law II. Cohesion varies in different bodies, and in the different states of the same bodies. It is more in some solids than in others, and diminishes as the solid passes to the liquid and gaseous state.

Law III. Adhesion may be observed between bodies in all states. Solids adhere to solids, to liquids, to gases; liquids to liquids and gases; even perhaps gases to gases.

Law IV. All bodies attract one another. It may not be perceived by an effect of motion, but the *effort* at motion exists, between the greatest and smallest.

Law V. Attraction of gravitation is inversely as the square of the distance. In formula, (G gravitation, D distance); $\frac{G}{G'} = \frac{D'_2}{D_2}$ N B. 1°. This fractional form of proportion will always be used, and will be found, after a little custom, to be very convenient. 2. The letters with a dash (G′ D′) will always signify the subject matter in other conditions. Thus here G′ D′ signify either the gravitation of a second body at *its* own distance, or that of the same body, at a new distance. The full expression contained in the formula is, the gravity of one body is to the gravity of another as the square of the distance of the second is to the square of the distance of the first; or, the gravitation of a body in one position, is to the gravitation in a second position, as the square of the distance of the second position is to the square of the distance of the first. And this, be it said once for all, is the method of formulising "inverse proportion."

Law VI. Gravitation is directly proportional to the mass of matter. In formula $\frac{G}{G'} = \frac{M}{M'}$ the gravity of one body is to the gravity of another as the mass of matter of the first is to the mass of matter of the second.

No. II.—Proofs.—Almost all these laws admit of experimental proof. Some proofs, however, are not what are called class experiments.

Law I. That solids have their particles cohering requires no proof. Liquids: A rod of glass dipped into melted glue, water, or spirit, lifts from each a drop, smaller as the perfect liquid state is approached. These drops consist of particles held together by cohesion. In gases there is such a predominance of an opposite force, that it is not easy to prove the existence of cohesion; yet analogy to the other states seems to require it, of course in a very diminished condition; and the ease with which the heavy visible gases can be drawn about, so to speak, almost proves what analogy suggests.

Law II. The great difference of force required to separate the particles of different bodies. The strongest man cannot pull asunder a small cylinder of iron; the weakest boy can pull asunder a cylinder of elder pith. Lead in the solid state is strong in cohesion; in the liquid it is not much more than water. Water in the solid state as ice holds together well; as steam it has but the questionable cohesion of a gas.

FIG. 19

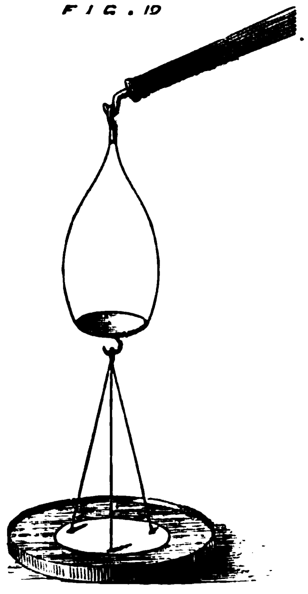


FIG. 20

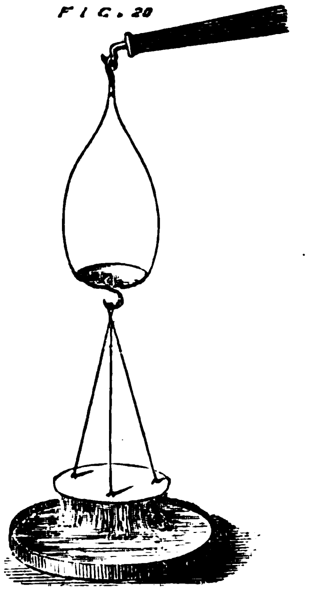


FIG. 21

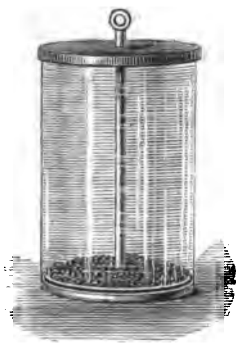
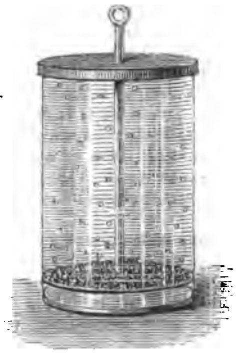


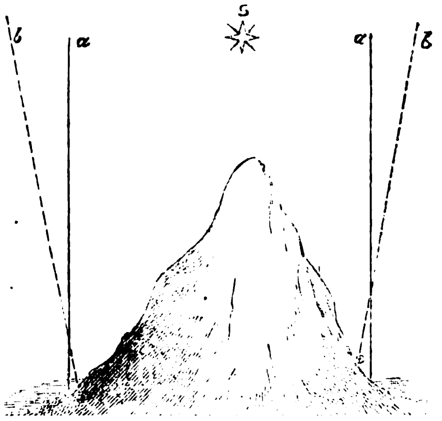
FIG. 22



Law III. Between *solid and solids.* Two plates of metal, glass, &c., ground very smooth and level, will adhere without any intermediate body. It is commonly stated that two bits of a bullet made smooth will cohere; or, two bullets, a part of each being removed, when well pressed together, will bear a considerable weight, even as much as 20lb. weight. This experiment was first shown by Triewald. Wax may be used, but it is not so convincing. Between *solids* and *liquids.* The glass rod lifts the liquid (Law I.) by means of their mutual adhesion. But there is an experiment, said to be Taylor's, and celebrated for the controversy to which it gave rise, which affords a very convincing proof. To one of the pans of a balance is hung a flat disc. By weight in the opposite pan, equilibrium is restored. Press the disc down gently to a tray of water underneath; remove the hand, the disc, and with it the balance arm is held down by the adhesion of the water and the disc, Fig. 19. A considerable increase of weight in the opposite pan is required to raise the disc. The increase of weight varies with the liquid; it is less as the fluidity is more perfect. When the disc is forced gently up, the cohesion of the liquid state is well seen. The water is drawn up in a hollowed form, Fig. 20, growing thinner as the disc rises. Between *solid and gases.* Into a deep receiver of glass, Fig. 21, is passed down by means of a wire a leaden capsule filled with large shells of granulated zinc. Set the receiver aside in a quiet room for a day or so. The zinc decomposes the water slowly (a little acid might be added to quicken the action). After some time the shells of zinc will be seen covered with shining bubbles of gas, which, though under considerable water pressure, forcing them up, still adhere to the solid. A slight shock to the capsule — raise it a little and strike it against the bottom—produces a beautiful "shower" up of silver-like bubbles, Fig. 22. Left quiet again for an hour or two, bubbles of gas will be again found on the zinc. Between *liquids and liquids.* A tube of glass wet with water, dipped into oil, will withdraw some of the oil, although these liquids are usually held to be repulsive one of the other. Between *liquids and gases.* The air which is in water, and gases in general "in solution," as it is called, may be said to be in *part* retained by the adhesion of gases and liquids; for it is well known that in aërated liquids the gas can to a great extent be liberated without any change of pressure. For instance—by stirring soda water, champagne, &c., with a bit of bread, the gas will be freed. As to *gases, and gases* perhaps, the law of "perfect mixture" may be caused by adhesion. However, the nature of the gaseous state does not seem to require that help to the action of Berthollet's law.

Law IV, being Newton's great discovery, and serving in his hands to explain all the difficulties, and remove all the absurd and contradictory notions regarding the system of the universe, ought to be more than sufficient to establish its truth. However, this is not all. It has been proved in two ways. The first was an accidental result—the second by means of an apparatus constructed in part specially for the purpose. The accidental discovery was made in Peru, where some French philosophers were carrying out a series of astronomical observations at either side of Chimborazo.

FIG. 23



They found, on comparing results, that their instruments pointed differently at their respective sides of the mountain. The "pointing" of the instruments was controlled by a line with a small weight hung to it. Since, then, the instruments pointed differently, the position of the line must be different. The cause assigned was that the mountain attracted the weight, and consequently gave a different pointing. The astronomical observation required was the "zenith distance" of a star—*i.e.*, the distance of a star from a point vertical to the observer; Fig. 23 (S) *a true* zenith distance. The instruments guided by the line and weight made it S *b* at one side, and S *c* at the other. This remarkable fact having caused much excitement in the scientific world, the English Astronomer Royal, Dr. Maskelyne, was sent to Scotland in 1772 by the King to make experiments on the north and south side of Shehallien (Perthshire). The deflection of the line was found to be very considerable, something over seven seconds, at either side of the mountain. The apparatus for this law will be found amongst the applications.

(To be continued.)

WHAT STRIPES THE SUNBEAM.

BY A FELLOW OF THE ROYAL ASTRONOMICAL SOCIETY.

(Continued from page 146.)

FIG. 5

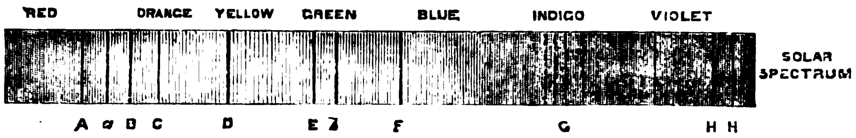
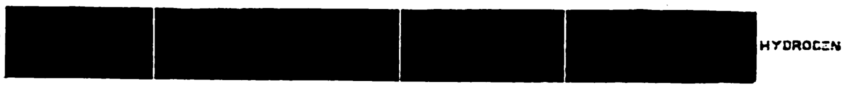


FIG. 6

FIG. 7



NOW, remarkable as all this is, it is in its leading features by no means new. Nearly 120 years ago Melville observed the yellow tint communicated to flame by soda, and Sir David Brewster revived this idea in 1822 in his invention of the monochromatic lamp. Nay, Sir John Herschel, in the same year, instituted experiments on the spectra of various substances, and notably of strontium and of the chlorides of copper; and in his "Treatise on Light," in the "Encyclopædia Metropolitana," Vol. 4, published in 1827, says:—"The colours thus communicated by the different bases to flame, afford in many cases a ready and neat way of detecting extremely minute quantities of them." Among the names of those who pursued this curious train of investigation, we find, too, the honoured one of Fox Talbot—perhaps better known as the practical originator of photography in England, and the inventor of the Talbotype; and he, albeit erring in his determination of the elements to which certain lines were referable (and notably with regard to the yellow line of sodium, of which we have previously spoken, and which he attributed to water!), yet points out clearly how the spectra of particular elements supply unerring means of deciding what those elements are. Next, as we approach our own time, we find Professor W. A. Miller, F.R.S. (whom we shall by-and-bye have to speak of as the associate of that eminent astronomical sprectroscopist, Mr. William Huggins, F.R.S., in his researches on the chemical constitution of the heavenly bodies) pursuing investigations into the spectra of the metals of the alkaline earths. Then, in 1857, Swan showed conclusively how the single yellow line which we have mentioned above was produced by sodium; and how, moreover, this element was everywhere present in earth, air, and sea; so that, light our lamp where we may, it is almost with a moral certainty that the combustion of sodium will at once commence.

It is, however, to two German philosophers, Bünsen and Kirchhoff, that we may be said to owe spectrum analysis in the form in which we now possess that most potent addition to chemical science. Commencing their experiments on the spectra of the metals, some year or two after the period at which Professor Swan was at work on the subject, they, in their laboratory at Heidelberg, gradually built up, on a solid foundation, that marvellous theory by the aid of which we are able to look out into the dim confines of space, and assert that certain elements are present in, or absent from, the infinitely distant bodies which tenant it. Let us try and follow their reasoning, and see how they arrived at so very wonderful a conclusion; albeit to do this will involve some slight repetition of what we have previously said. As our aim is, however, above all things, to secure clearness and perspicuity in our explanation, a little reiteration is unavoidable.

They began, then, by volatilising or vapourising the substances whose spectra they wished to examine by means of what is known as a "Bünsen's gas-lamp," or "Bünsen's burner," the invention of one of the experimenters himself. One form of this is represented in Fig. 4. The gas passes through the supply pipe *s*, into a perforated chamber *c*, where air mixes with it; they both rush up the tube *c t*, in combination, and the mixture is ignited at *t*; *r* represents a ring burner to make a larger circle of flame. This fits in at *t*. The effect of this arrangement is to consume the solid carbon particles in the coal gas with great rapidity, and, consequently, to give a flame which, while tremendously hot, emits scarcely any light at all. The great advantage of this arrangement will be evident when we reflect that in dissolving various substances in alcohol (or spirits of wine) and burning that, when we examine the resulting flame with our prism, we not only get the spectrum of the dissolved substance, but that of the burning alcohol as well, thus complicating the observed appearance in a very perplexing way. On the other hand, with the fiercely hot, but scarcely luminous flame of the Bünsen burner, we get practically nothing but the incandescent vapour of the particular substance which we may have under examination. Employing, then, this simple and ingenious apparatus, in conjunction with their spectroscope, Kirchhoff and Bünsen soon convinced themselves that "the most different salts of the same metal, if they are volatile, produce the same bright lines in the spectrum, but with different degrees of brilliancy: and that a mixture of salts of different metals gives a spectrum similar to that which would be produced by a superposition of the several spectra of the individual metals." In his original memoir, Kirchhoff, after speaking of the recognition of the lines of the several metals under varying circumstances of their production, goes on to say—and this is of the very greatest possible importance—"The dark lines of the solar spectrum afford invaluable assistance in determining the position of the bright lines of the elementary bodies." He then proceeds to describe an arrangement entirely similar in principle to that illustrated in Figs. 2 and 3, and observes—"In this way, whilst in the upper half of the field of the (astronomical) telescope, the solar spectrum is seen, in the lower half, but in immediate contact with the other, the spectrum of the artificial source of light becomes apparent, and the positions of the bright lines in the latter spectrum can be accurately compared with those of the dark lines in the solar spectrum. In order to obtain the spectra of the metals, I have almost invariably employed the electric spark, chiefly owing to its great luminous intensity." To this we may add that the spectrum of any body gaseous under ordinary condition, such as carbonic acid, hydrogen or nitrogen, is obtained by the passage of the electric spark through the gas under examination, which is itself sealed up in a glass tube; and that even to the naked eye, the difference of colour presented by the spark is most noticeable, it appearing blue in carbonic acid, red in hydrogen, and yellow in nitrogen. And here, although we are slightly anticipating, we cannot forbear to notice that when we examine the spectrum of this red hydrogen spark we find it to consist of merely three bright lines—one red one so brilliant as almost to overpower the others; one bright greenish-blue one, and one dark blue, or almost indigo line, which is naturally not so bright; and that the fact of the most vital importance in connection with this is that these three lines are found to be *absolutely coincident with three of the well-known dark lines in the Sun's light*, of which we spoke on p. 146, as "Fraunhöfer's lines," when compared with them in the way indicated above.

And now, in order that we may comprehend and realise the import of the great discovery of Bünsen and Kirchhoff, let us, as it were, take stock of the knowledge which we are so far in possession of. And, firstly, we have learned that every incandescent solid or liquid, when its light is examined by means of a prism, gives off a continuous spectrum—that is to say (assuming its temperature to be sufficiently high) one, which, starting from the least refrangible end, consists of red, orange, yellow, green, blue, indigo, and violet rays, successively melting into each other without break or interruption of any sort or description. Then we have seen that if we examine the light of an incandescent gas or vapour, we no longer find it yielding a continuous spectrum, but one of rays of relatively few degrees of refrangibility; so that in regarding a narrow slit illuminated by such light, through a prism, we obtain a spectrum consisting of bright lines in various parts of the solar spectrum, but separated by intervals of total darkness. Lastly, we have the discovery of Wollaston, or perhaps rather of Fraunhöfer, that the Solar Spectrum is crossed by a series of stripes, lines, or shadows, whose places in it are fixed and invariable; that these lines are seen in all light derived directly or indirectly from the Sun, such as that of the day sky, the moon, *the planets*, &c., and that although some *of the dark lines* pertaining to sunlight are found *in certain of the* fixed stars, yet that others are absent. We stated on p. 146 that Fraunhöfer had mapped between 5 and 600 of these lines. We may here add that more recently Kirchhoff and Angström have increased the number to very many hundreds, some of them being of the very last degree of faintness.

In figures 5 6 and 7 we have endeavoured to give some faint pictorial idea of what we have been describing; but it is obviously impossible to reproduce in black and white upon a wood block the chromatic phenomena exhibited. Fig. 5 is intended for the Solar Spectrum: Fig 6 for that of Sodium; and Fig. 7 for that of Hydrogen.

Well, then, in 1814, Fraunhöfer discovered that when he got the spectrum of the Sun (Fig. 5), and the spectrum of Sodium (Fig. 6), into the field of his telescope together, the dark line which he lettered D, and the yellow line of sodium, were coincident, each appearing as the mere prolongation of the other; and in 1849, the great French physicist Foucault, noticed, on passing direct solar light through the vapour of sodium that the dark line D came out in the spectrum of the Sun with startling distinctness.

These facts, however, remained barren until 1859, when Kirchhoff and Bünsen began their investigations, which eventually led to such surprising results, and the exceeding importance of Kirchhoff's crucial experiment is such that we will give his account of it in his own words: "In order," he says, "to test in the most direct manner possible the truth of the frequently asserted fact of the coincidence of the sodium lines with the lines D, I obtained a tolerably bright solar spectrum, and brought a flame coloured by sodium vapour in front of the slit. I then saw the dark lines D change into bright ones. The flame of a Bünsen's lamp threw the bright sodium lines upon the solar spectrum with unexpected brilliancy. In order to find out the extent to which the intensity of the solar spectrum could be increased, without impairing the distinctness of the sodium lines, I allowed the full sunlight to shine through the sodium flame upon the slit, and, to my astonishment, I saw that the dark lines D appeared with an extraordinary degree of clearness. I then exchanged the sunlight for the Drummond's or oxyhydrogen lime-light, which, like that of all incandescent solid or liquid bodies, gives a spectrum containing no dark lines. When this light was allowed to fall through a suitable flame coloured by common salt, dark lines were seen in the spectrum in the position of the sodium lines. The same phenomenon was observed if instead of the incandescent line a platinum wire was used, which, when heated in a flame, was brought to a temperature near to its melting point by passing an electric current through it. The phenomenon in question is easily explained upon the supposition that the sodium flame absorbs rays of the same degree of refrangibility as those it emits, whilst it is perfectly transparent for all other rays."

We may just notice here that throughout the quotation we have made, the *lines* D are spoken of, whereas in our diagram (Figs. 5 and 6) we show a single line only. The fact is, that it requires several prisms and considerable magnifying power to show this line double, and inasmuch as it is extremely unlikely that any of those for whom we are writing will be in possession of the exceedingly powerful and very costly instruments needful to show D as two lines, we have spoken, and shall continue to speak of it merely as one.

To return, however, to Kirchhoff's capital experiment. He had, in effect, produced artificial sunlight, for upon the continuous spectrum given by his incandescent lime, or platinum wire, he had obtained the dark line of sodium. Now what does this mean?

(*To be continued.*)

A PRACTICAL TREATISE ON THE HARMONIUM.*

BY HERMANN SMITH.

THIRD DIVISION.—CHAPTER III.

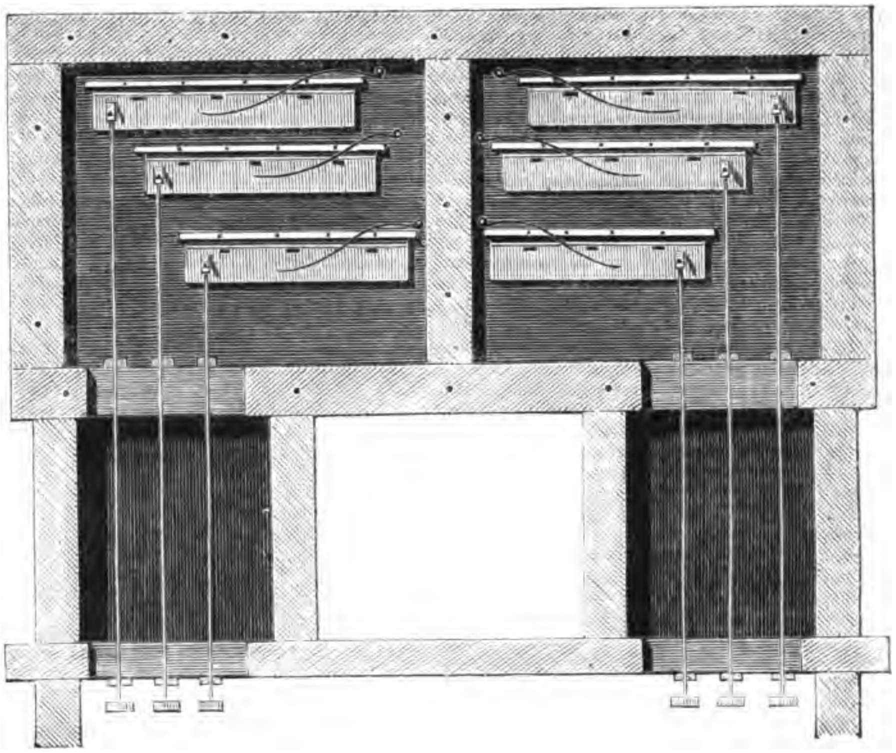
OF THE UPPER SOUND-BOARD, OR SWELL.

(*Continued.*)

> "IT produces such an agreeable sensation to employ one's self about something of which one has only a half knowledge, that no one should reprove the amateur for meddling with an art which he can never thoroughly learn, neither should we blame the artist if, passing the limits of his peculiar art he chooses to recreate himself in an adjoining field."—
> GOETHE.

THE plan illustrated in the former chapter was suitable for an instrument in which length could be allowed, whilst restricting depth from front to back as much as possible. The plan now presented is designed for harmoniums which we suppose permit us freely to consider the most advantageous arrangements in the general construction favourable to musical effect, and to this end several new features are introduced which on a little reflection you will perceive aid the resonant powers of the instrument, and give breadth and volume to the tone: in the front the space over the pallets is entirely enclosed, and at the back, covering the whole area of the sound-board, a large body of air is held vibrating in sympathy. The circulation of a large amount of air in the harmonium has an important value which no amateur should overlook. As springs to a carriage secure an easy sway to its motion, so this air cushion sustains and distributes with elastic swell the thousand shocks of vibration initiated by the reeds each time that they freshly start into eager speech. Hence it is that in large harmoniums we can always play more softly with continuous sound than upon small sized instruments. The leading principle in construction should be plenty of air and plenty of wood. The tendency of manufacturers is to the contrary. Competition says, Restrict both, give as little wind as you can scheme along with, for it costs money to enclose it, sell as little wood as you can for your bargained price, reduce proportions everywhere, and whenever possible, make three harmoniums out of the wood that your rivals, less gifted in contrivance, are consuming for two. These traders are not altogether to blame; it is a necessity forced upon them by the nature of the competition, which demands lowness of price, until it bespeaks indifference to quality or value. The real fault is with the purchasers, in inability to discriminate real worth, or in deficiency of musical taste, a state of things which tells sadly against the cause of true music, and is particularly hard against harmoniums, which have to bear more than their share of deterioration. Whilst we deplore such results, it is but fair we should remember that trade and art are distinct in aspect. Competition in trade, emulation in art. It is a piece of the world's good fortune when the two are found harmoniously united.

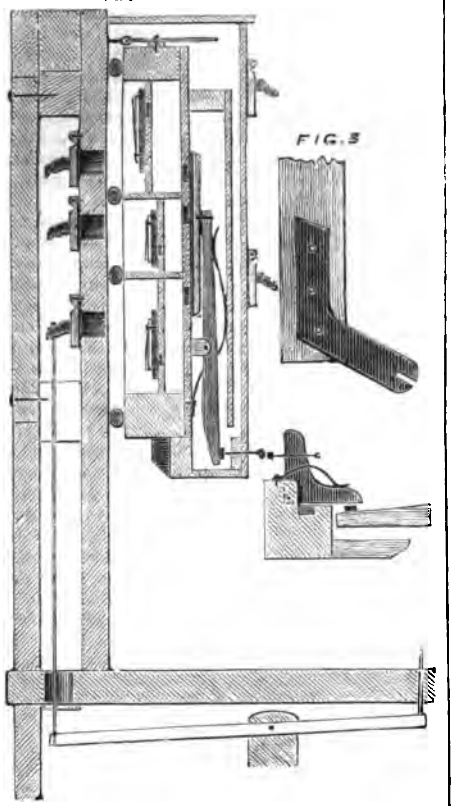
FIG. I



In justice to the amateur we will suppose him to be anxious for the best, and generous in the time and material he devotes to his labour. In this work of the valve-board the wood should be very clean, of picked quality, free from knots; an inch thickness will not be too much, the frame round it also as thick, and firmly fitted to the back-board. The central portion of the back-board is removable, for the purpose of adjusting the valves or springs, as occasion may require. When in position it is screwed to the frame of the valve-board, which has previously been faced with thick soft leather, to prevent any escape of wind. The wind does not now enter by the ends of the sound-board, but through a valve-board, in the same manner as it does in the horizontal disposition of the sound-board, and the trunks rise from the back of well, the upper valve-board being a fixture upon them. In order to open the valves we have stop rods, and flaps, and levers working in the usual manner, and then obtain a reverse action by means of stems arranged on the bottom of well. A stem, as shown in illustration Fig. 2, is, by an ordinary sticker or poker, depressed at the near end, and as the other end rises the rod connected with the valve rises and opens it. The place where this stem or lever should be pivoted you will calculate according to the amount of opening desired for the valve. Probably it will be sufficient to open a valve only an eighth of an inch, or less, to lightly-voiced reeds. Or the amount of throw may be determined in another way. At right angles with each valve a small projecting arm is placed, which is hollowed or grooved underneath. Into this hollow the rounded end of the rods fits easily, and is held by a tapped wire screwed through the top of the arm into it. By this method adequate play is left for the movement of the rod, whilst the amount of throw exercised on the valve may be regulated by the position or distance at which it is pinned by the wire. The rod is still further steadied by little cross bars across the top and bottom of the trunks, drilled with holes, through which the rods are passed and allowed to work freely. These bars are very slight—mere guides—as it is not desirable by any obstruction to impede the free current of wind up the trunks. It may in some instances be of advantage to place springs on the stems that are fitted at the bottom of the well, but otherwise the springs upon the upper valves will return the rods, and retain them in contact with the stems.

FIG. 2

FIG. 3



The ends of the trunks are to be bound round with leather, and every care taken to prevent the least escape of wind. It is not merely the loss of wind that we are on guard against; the loss in itself may be very trivial, but it is the weakness thereby spread over the whole body of air enclosed in the well, a weakness materially affecting the articulation of the reeds, and the quality of tone likewise in the most subtle manner.

Over the pallets we are now able to obtain a more perfect mode of enclosure by extending the toning-board beyond the "touch" ends of the pallet stems. A rail is fixed along the lower edge of the sound-board, covered by a ledge projecting over the ends of stems, and perforated with small holes above each stem for the passage of tapped wires, which have buttons of leather or wood at each end, or perhaps only at one end, the other being screwed into the stem itself. When that mode is adopted the ledge should be slight, that it may not bind the movement of the wire, but when the wire is free, having its buttons at both ends, then the ledge may be half an inch or more in thickness, and each hole be bushed with cloth; it is a little more trouble, yet is much the better method of the two. It is desirable you should be very careful to adjust all these buttons to fully meet the buttons tapped into the squares, for the reason that unless everything is in contact from finger to pallet, the touch and speech cannot be equal throughout in rapid playing, which demands that the speech of the reeds should be as prompt to the lightest as to the fullest depth of touch. All the particulars and instructions necessary for the amateur on the making and adjusting of stems, and pallets, and springs, and valves, having been fully detailed in former divisions of the treatise, it is not needful to repeat them here.

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* The copyright of this treatise is reserved by the Author. It was commenced in 94, and continued in Nos. 96, 98, 100, 105, 109, 116, 118, 124, 126, 132, 133, 136, 141, 151, 153, 166, 172, 180, 190, all of which are to be had except No. 98.

In the last chapter the plan described admits of one variation which the present one does not. In that, the sound-board may be fixed in its position whilst the back may be made to be opened for the purpose of tuning. In some respects this mode is advantageous, as avoiding the risk of interfering with the adjustments of the front actions in the repeated turnings backward and forward during the process of tuning; the objections are that even to remedy a defect in a single reed, the instrument would require to be moved from its place, and that many tuners would find it inconvenient to tune to another person's fingering, or to go from front to back, time after time, through the whole of the tedious operation. Besides these there is another consideration, that when the lower manual is to be tuned it is an advantage to have the upper sound-board out of the way; on the other hand, if it is to remain a fixture, then space for opening the lower sound-board must be calculated and allowed for in laying out the original design.

In Fig. 3 we illustrate the preferable shape for side-irons to be used to the upper sound-board. You would require to have them made purposely, as all the side-irons in general use are of the straight pattern. There will be no difficulty in getting these made at any village forge. The advantages of the shape are that the sound-board, when it is turned forward to you, clears all the adjacent action with perfect freedom, and may be brought to a lower level, adding much to the facility and convenience in manipulating the reeds, and also a better set of the sound-board upon the valve-board is obtained, a closer pressure on the wad, and consequently a more air-tight fit. But to secure this latter advantage it is essential to regard the accuracy of the form and the fitting of these side-irons by taking care that the pivots on which they work are placed a little distance lower than the horizontal line of the lower edge of sound-board; if they were above that line it is obvious that extra pressure at the upper hooks would only tend to part the lower edge of the sound-board from the wad, because if you strike a circle from the pivot, causing it to touch the wad, and draw a horizontal line to the centre of that circle, the line being above the line of lower edge of sound-board, you will see that the descent of the circle is a retreat from the vertical line of the valve-board, and the sound-board, the more it is tightened by the upper hooks, will incline away from the lower rim of wad, instead of working up to it. However nicely you may adjust the sound-board at the onset, yet you will find that the repeated opening and closing during tuning will so flatten the wad that the hooks will work loosely, and you must tighten up the eyes, screwing them in a turn or two more. The lower edge cannot thus be tightened up, and therefore, with forethought, you will provide against this by setting the sound-board originally so that it will have to bear a greater strain during closing, and then by the time everything is complete and in working order, it settles down, properly equalised in bearing upon the wad.

We have shown two pairs of forte shutters; these you can work in any convenient way, link them together, or arrange in Venetian swell fashion, always careful that the edges bed upon leather. A really effective "forte" can only be obtained in using shutters when means are taken to secure a perfect box-like enclosure of the pallets—a crevice that will admit the passage of a sheet of writing paper will neutralise the best part of the shutters' effect; just as the music from a whole band will pass through a keyhole, so will the sound spread itself through the crevice. In the swell of the organ the sound cannot wholly be shut in; close it perfectly as ingenuity can contrive, line it with thickness after thickness of brown paper, build it of 3in. thickness of wood throughout, yet sound will penetrate through all. Remember this, and you will understand why we so insist on plenty of wood in the harmonium to mellow and ripen the quality of its tone. The common practice has been to provide box and shutter work in the most expensive class of instruments, and the makers have relied on such means for softening the character of the harmonium. The result has been the grave mistake of producing a "forte" that is unbearably harsh and disagreeable. It is an error you should sedulously avoid in your own work. The harmonium with open shutters should be considered the normal condition, and you will ensure for that a pleasant quality even at the fullest strength of its sounds, just as in the organ the swell with free open shutters is in its rightful relation to the full organ. All modifications soften down from the original standard, and every gradation of strength, then, has its own charm. Unless you can attain such light and shade, your harmonium may be a pride to you as a memento of labour, but it will hardly be what you would equally desire, a never-failing pleasure to listening ears. Opportunity favours the amateur; he is free from the restriction of competition, and study of the nature of the elements he has to deal with may greatly stand to him in the stead of experience.

(To be continued.)

ON ORIGINAL EXPERIMENTAL RESEARCH IN RELATION TO EMPLOYMENT FOR WORKMEN.*

IT is an important national question, "By what means can employment for workmen in this country be increased?" My reply is, "By encouragement of experimental scientific research."

I have observed that increased employment of workmen constantly results from original experimental research in science in the following order: Experimental researches in science lead to scientific discoveries; scientific discoveries lead to practical inventions; and practical inventions lead to increase of employment. Usually, a scientific investigator first discovers some new fact or principle in science; next, an inventor applies this discovery, in the form of an invention, to some useful purpose; and then a manufacturer or man of business brings it into general use, and employs workmen or servants to assist him. In some cases, however, the discovery of a new truth in science, its application by invention, and its practical carrying out, are all effected by the same individual.

The following examples will illustrate the foregoing observation:—The discoveries of voltaic electricity, electro-magnetism, and magneto-electricity, by Volta, Oersted, and Faraday, led to the invention of electric telegraphy by Wheatstone and others, and to the great manufactures of telegraph cables and telegraph wire, and of the materials required for them. The value of the cargo of the Great Eastern alone in the present Bombay telegraph expedition is calculated at three millions of pounds sterling. It also led to the employment of thousands of operators to transmit the telegraphic messages, and to a great increase of our commerce in nearly all its branches by the more rapid means of communication. The discovery of voltaic electricity further led to the invention of electro-plating, and to the employment of a large number of persons in that business. The numerous experimental researches on specific heat, latent heat, the tension of vapours, the properties of water, the mechanical effect of heat, &c., resulted in the development of steam-engines and railways, and the almost endless employment depending upon their construction and use. About a quarter of a million of persons are employed on rail ways alone in Great Britain. The various original investigations on the chemical effects of light led to the invention of photography, and have given employment to thousands of persons who practise that process, or manufacture, and prepare the various materials and articles required in it. The discovery of chlorine by Scheele led to the invention of the modern processes of bleaching, and to various improvements in the dyeing of textile fabrics, and has given employment to a very large number of our Lancashire operatives. The discovery of chlorine has also contributed to the employment of thousands of printers, by enabling Esparto grass to be bleached and formed into paper for the use of our daily press. The numerous experimental investigations in relation to coal-gas have largely been the means of extending the use of that substance, and of increasing the employment of workmen and others connected with its manufacture. The discovery of the alkali metals by Davy, of cyanide of potassium, of nickel, phosphorus, the common acids, and a multitude of other substances, has led to the employment of a whole army of workmen in the conversion of those substances into articles of utility.

The foregoing examples might be greatly enlarged upon, and a great many others might be selected from the sciences of physics and chemistry, but those mentioned will suffice. There is not a force of nature, nor scarcely a material substance that we employ, which has not been the subject of several, and in some cases of numerous original experimental researches, many of which have resulted, in a greater or less degree, in increasing the employment for workmen and others.

The variety and extent of the employments which have resulted from scientific research are so great that they ramify in some form or other through nearly all our manufacturing, artistic and commercial occupations, our social relations, and our every-day life; and those employments have become of such common occurrence that we are apt scarcely to think how much experimental research has had to do with their production and we are thus led to undervalue original experimental investigation as a means of producing employment. Persons in general can easily understand that an acorn planted in the ground will, in the course of time, become an oak, because it is a palpable and visible effect; but they cannot so readily perceive that the abstract scientific fact discovered by experiment to-day, will probably soon become an invention of practical daily use, not because *it is less real*, but simply because it is a phenomenon *less evident* to the senses, and requires a *greater* exercise of intellect to perceive it.

In many instances, the application of original experimental science in new inventions has superseded, and, in a limited sense, diminished, manual labour, but it has in such cases either substituted more intellectual occupation for it, or has opened up new sources of employment to a far greater extent by increasing trade and manufacture. For example, the number of waggoners and horses now employed to collect and deliver all the goods for railways is much greater than the whole of those employed for conveying the goods of the country before railways were constructed.

The capability of developing increased employment by the means proposed is immense, and practically unlimited, because scientific discovery is quite in its infancy, and we are at present only on the very threshold of a knowledge of the forces of nature and of the constitution of material substances; in this sense, therefore, experimental scientific research may be viewed as *the* great fountain-head of employment for workmen.

The reason why original experimental science is the great fountain-head of industry in manufactures and trades is, that it is only by means of such research that we can become accurately acquainted with the forces and substances involved in manufactures, and be enabled to use them to the greatest advantage. The intimate connection between science and industry is shown by the fact that when new scientific discoveries are published there are numerous inventors who immediately endeavour to apply them to useful purposes, and men of business ready to carry out the inventions practically.

The great and important results already obtained by the cultivation of original experimental research show that it is a national necessity, and naturally suggests the idea, can we not by a greater degree of encouragement of such research still further increase employment for working men, and still further elevate their intellectual condition?

At the present time there is in this country no recognised payment for the labours of scientific discovery, and no provision for the support of men who investigate science; any person is at liberty to take the published results of scientific men from the transactions of the Royal Society, the Chemical Society, and other learned bodies, and employ them as the basis of inventions and patents, without the slightest payment, notwithstanding these results have been obtained at an immense cost of study, time, and labour, and a large amount of money. I do not mean by these remarks to conclude that scientific discoveries should not, on publication, become at once public property, but that some means of support should be provided for the men who make them, and thus the development of employment for workmen be increased.

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* From *Nature*.

Experimental scientific research, in the stricter sense of the words, is a comparatively modern thing, and though it has existed in a more limited degree during many centuries, it can only freely exist and thrive in civilised countries. Even at the present time, in consequence of the peculiar nature of the occupation, its hopelessness as a source of emolument to the investigator, the great skill and extreme self-denial required, and frequently danger incurred in its pursuit, and the consequent great difficulty of achieving *success* in it, scarcely one person in one million of the population of England is exclusively devoted to it, although a much greater proportion occupy a small amount of their time in its advancement.

The extension of physical and chemical knowledge by means of experiments and observations is national work: it benefits the nation, but does not pay the investigator. The various scientific men who discovered the chief facts and principles of science upon which steam-engines, electric telegraphs, and all the modern applications of science are based, received no remuneration for their researches. The results of purely scientific investigations are generally unsaleable, because, instead of benefiting a single manufacturer only, they benefit the whole nation; the nation, therefore, being the gainer, should pay and provide for those who make such researches. And when we consider that in this country upwards of 576 millions of pounds have been expended in the construction of railways alone, and immense sums upon electric telegraphs, which would never have been expended but for such labours, and nearly all of which have given employment to numberless workmen, it is evident that the magnitude and national character of the results would fully justify national encouragement of original experimental research.

The more abstract an experimental investigation is, the more important and widely diffused are its practical results. Who would have thought, when Oersted in his original abstract research in electro-magnetism first made a magnetised needle move by the influence of an electric current, that his labours would lead to the expenditure of many millions of pounds in the laying of telegraphs all over the earth, and the employment of many thousands of persons in their construction, maintenance, and use? And who can tell how many similar important discoveries have been lost to the nation, and how much of the present deficiency of employment for workmen has arisen in consequence of experimental scientific investigators not having been paid for their labours?

At present, original experimental researches are generally made by teachers of science who expend a portion of their incomes in making experiments and observations; but the very limited means of such men is a serious loss to the nation by greatly retarding the progress of discovery, and consequently also of improvements in manufactures. Many of the experiments, also, necessary for the development of new discoveries are beyond the means of such persons at present, and cannot be made without the command of greater wealth.

If England is to keep pace with the progress of foreign intellect and of foreign manufacture, and keep her workmen fully employed, there must not only be a general diffusion of scientific knowledge throughout this country, but there must also be national encouragement of original scientific investigation.

Has it been wise in our Governments thus to overlook a great source of the nation's wealth, to disregard a most important means of national economy, to neglect the great fountain-head of industry? Shall we allow foreigners to supplant us in manufactures, and shall our fellow-men continue to be driven to emigration by want of employment? or shall we develop for them new sources of labour by means of original experimental research? It needs only to bring the subject fairly and effectually before the attention of our present enlightened and progressive Government, to ensure its careful and early consideration.

The neglect of original experimental science in this country by our Governments has long been noticed by scientific men and others, and a suggestion has been made to the British Association by Lieut.-Colonel Strange, to found "National Colleges of Original Research," in which science should be investigated, but not taught. This would be one way of supplying the want; the funds for supporting such colleges might with propriety be obtained from the fees paid for patents, because patents are in many cases based upon the published results of original experimental researches; other ways of supplying the want might also be indicated. GEORGE GORE.

POPULAR FOOD ANALYSIS.—COCOA.*

THERE is probably no article of diet with regard to the origin of which there is so much confusion in the popular mind as that forming the subject of our present article. Cocoa nuts and cocoa nibs, cocoa nut milk and cocoa oil, are all believed to be derived from one common source. This confusion arises principally from the circumstance, that the name of the substance which we use as a beverage should really be spelt *cacao*, and is as totally distinct a term, when so written, from cocoa, as the two plants thus confused are from each other. The cocoa nuts, so greedily devoured in our childhood, *au naturel* or in the form of cocoa nut rock, and which, in adolescence, we knock off sticks on the Derby day, when the champagne has developed our destructive propensities, are the produce of the cocoa palm, or *Cocos nucifera*; while, on the other hand, the cocoa which we boil for breakfast is the seed of the *Cacao theobroma*, a dwarfish, although pretty tree, and very different from the gigantic palm already mentioned. The *Cacao theobrama* is found chiefly in South America and in the West Indies, but is also cultivated to some extent in the Isle of France, its principle commertial varieties being those of Trinadad, Guayaquil and Bahia. It bears a fruit not unlike a melon, in the soft rose-coloured substance of which the cocoa seeds are embedded. The seeds themselves are about the size of a large almond, but somewhat thicker, and not so regular in shape. Those from the two first-mentioned districts are covered with a brown and bitter husk, enclosing a somewhat pasty and deep-coloured mass, which constitutes the useful portion; while the seeds from Bahia, on the other hand, are smaller, lighter in colour, and have in the interior a tinge of greenish brown. The number of seeds in the cacao fruit varies according to the districts in which the tree is cultivated. When ripe, the fruit changes from green to yellow, and it is then gathered and opened; and the seeds having been taken out, are dried in the sun, or are subjected to a slight fermentation, by burying them in the earth, before being dried.

Cocoa is manufactured for domestic use in various ways:—1. The seeds are very gently roasted till the flavour is well brought out, and, after being winnowed from the husks, are broken into little pieces. In this form they are known as cocoa nibs. 2. The seeds, having been roasted, are ground between hot rollers into a paste, and, after due admixture with starch and sugar, the paste is either desiccated and reduced to powder,—in which case it is called "soluble," "homœpathic," "digestive," or any other attractive name—or it is dried in masses, forming flake and rock cocoas. 3. The roasted and winnowed seeds are ground to paste, sugar and seasonings added, and cast into moulds, in which form they are called chocolate. Dr. Johnston states that the separated husks are largely imported into this country under the name of "miserable," and used for adulterating common cocoas, to form a cheap and agreeable beverage for the poorer classes! The composition of cocoa is shown by the following analysis by Mitscherlich:—

Theobromine... ...	1·20
Cacao Red	3·50
Cacao Butter... ...	49·00
Gluten	15·00
Starch	16·00
Sugar	0·60
Cellulose	5·60
Ash	3·50
Moisture	5·60
	100·00

It will be noticed that cocoa possesses, like tea and coffee, an active nitrogenous principle called *theobromine*. This principle resembles theine or caffeine, inasmuch as it is also white, crystalline, and bitter; but it contains more nitrogen even than these substances, and is consequently more active. All that has been said about the sustaining and other properties of caffeine, in our coffee article, may be considered as applying also to *theobromine*. Cocoa likewise contains a volatile oil, similar to that of coffee: but it differs from the latter substance in possessing in a high degree fat and gluten, both of which tend to increase its nourishing properties. The fat, commonly called cocoa butter, may be extracted from the seeds by reducing them to a pulp, and squeezing them between two heated metallic plates, when the fat melts and is pressed out. It is of the consistence of suet, white and semi-transparent, and melts at 30° centigrade. It is principally stearin with a little olein, and has a peculiarly agreeable taste and odour.

From all this it is evident that cocoa is an exceedingly nourishing, but, at the same time, a very rich article of food. Dr. Johnston, with good reason, compares it to milk, as follows:—

	Cocoa.	Milk (dried)
Fat or butter ...	51 ...	24
Casein or gluten...	21 ...	35
Sugar or starch...	22 ...	37
Ash ...	4 ...	4
Theobromine ...	2 ...	0
	100	100

But cocoa being richer in fat than milk, and, consequently, more indigestible, some sanitary authorities are prepared to approve of its dilution, by means of starch and other such substances. This is, however, sometimes pushed to an extreme extent, and Dr. Normandy says: "Unfortunately, however, many of the preparations of the cocoa nut sold under the names of chocolate, of cocoa flakes, and of chocolate powder, consist of a most disgusting mixture of bad or musty cocoa nuts, with their shells, coarse sugar of the very lowest quality, ground with potato starch, old sea biscuits, coarse branny flour, animal fat (generally tallow, or even greaves). I have known cocoa powder made of potato starch, moistened with a decoction of cocoa nut shells, and sweetened with treacle; and chocolate made of the same materials, with the additions of tallow and ochre. I have also met with chocolate in which brick-dust or red ochre had been introduced to the extent of 12 per cent.; another sample contained 22 per cent. of peroxide of iron, the rest being starch, cocoa nuts with their shells, and tallow. Messrs. Jules Garnier and Harel assert that cinnabar and red lead have been in certain samples of chocolate, and that serious accidents have been caused by that diabolical adulteration. Genuine chocolate is of a dark brown colour; that which has been adulterated is generally redder, though this brighter hue is sometimes given to excellent chocolate, especially in Spain, by means of a little annato. This addition is unobjectionable provided the annato is pure, which, however, is not always the case." Out of sixty-eight samples examined by the *Lancet* commission, thirty-nine were found to contain ferruginous earths.

(*To be continued.*)

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* By J. MUTER, Ph.D., in the *Food Journal.*

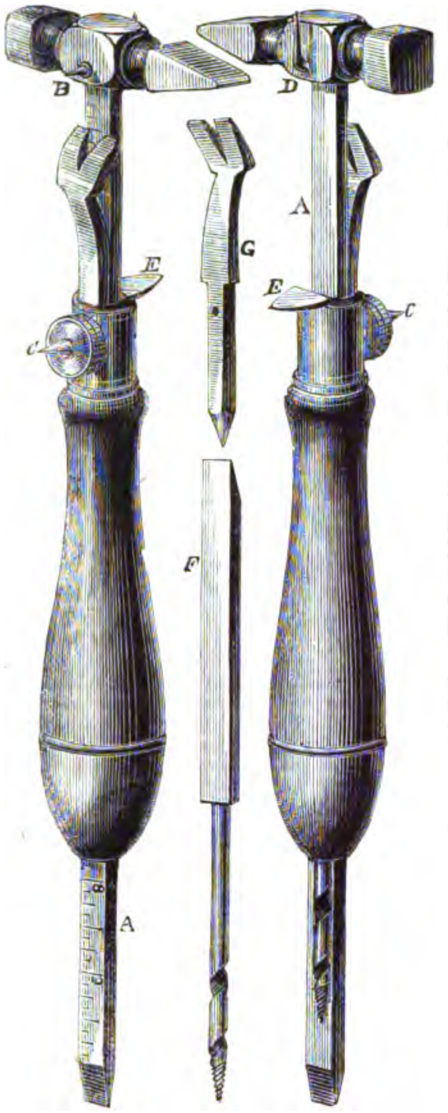
STOCKWELL'S IMPROVED COMBINATION TOOL.

THIS is one of the numerous family of tools designed to economise space and material, by making the parts applicable to various uses. It is a combination of a tack hammer, square, rule, screw driver, claw, marking awl, chisel, gimlet, can opener, compasses, and washer cutter.

The nose of the hammer is made flat on the bottom, and set at right angles with the shank A. The shank is made of steel, and divided into inches and eighths of an inch. This construction gives the square and the rule. On one side of the hammer head is a point B, and a similar point is made on the head of the milled set screw C. By loosening this screw, the shank A may be drawn out or thrust in to adjust these points to different distances, so that circles of various sizes can be marked out with them, as with compasses.

On the opposite side of the head is a pointed hook D, which, in connection with the blade E forms the can opener. The pointed hook is thrust through the tin plate, as near as may be to the centre of the top of the can, and the blade E being pressed down through the tin, a sweep of the handle cuts out a circular disc, through which the contents may be taken out.

The end of the shank A opposite the hammer head, is formed into a screw driver. Loosening



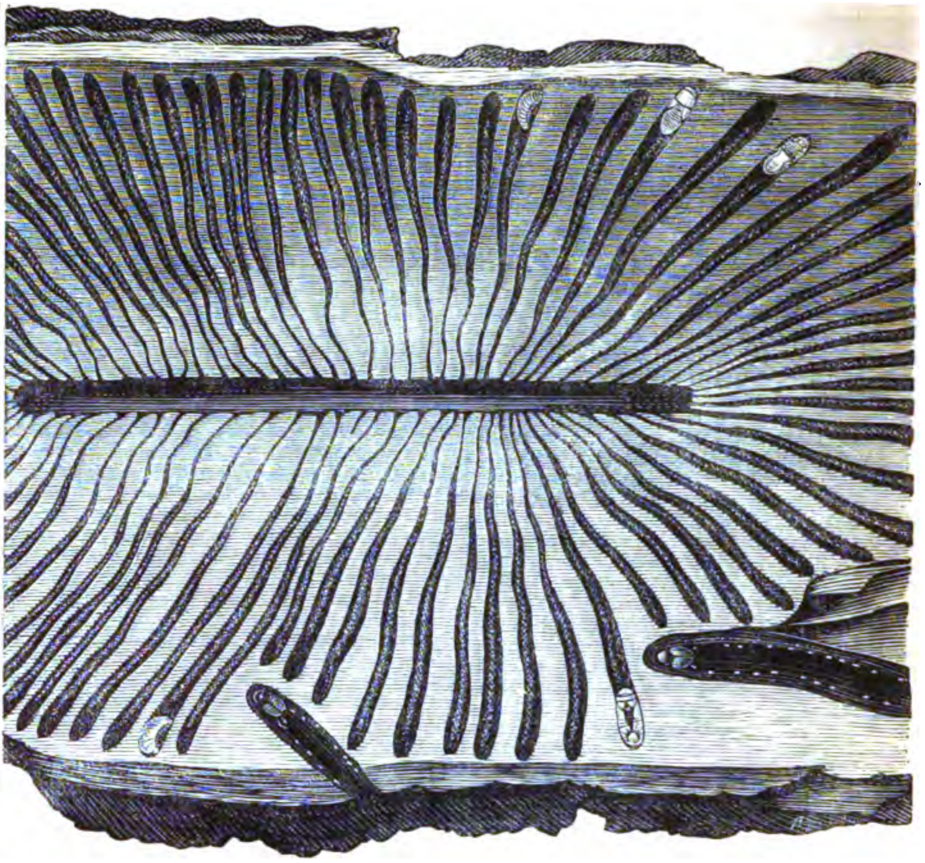
the set screw C allows the shank to be taken out of the handle, when the chisel and gimlet E may be taken out. When either the chisel or gimlet are required to be used, they may be placed in the handle and held by the set screw C; as the shank A is held when the hammer is used. G represents the claw, which has at the opposite end a marking awl. This can also be used by fixing it in the handle with the set screw. By turning the handle so the knife will be on the same side as the point, or hammer; it can be used as a washer cutter for pump valves, waggons, etc.

Patent allowed, through the *Scientific American* Patent Agency, April, to G. W. Sockwell, inventor, Natchez, Miss., U.S.

BORING INSECTS.

MANY of the lower forms of animal life possess powers of boring which, considering the soft materials of which they are made, seem very surprising. "It is hard for us to understand," says the *Scientific American*, "how such animals are naturally provided with tools adequate in some cases for penetrating into the densest timber, or in others even into the solid rock."

The illustration represents the operations of the wood boring beetle. The insect when about to deposit her eggs, selects a tree of suitable size, and commences her operations on the bark. At the bottom of the illustration will be observed a small inclined hole, and at the end of this a beetle is to be seen; this is the little architect who, by the joint exertions of herself and her progeny, has so wonderfully penetrated the tree in every direction. Another hole, running horizontally across, will likewise be seen at the right of the figure, and in the end of this another beetle may be seen similarly engaged. When the exertions of the insect have prepared a sufficiently large hole, she then commences to lay her eggs.



OPERATIONS OF THE WOOD-BORING BEETLE.

But before proceeding to this subject, let us just dwell for a moment upon the magnitude of the work she has accomplished.

The hole bored into the heart of solid wood is about fourteen or fifteen times longer than the body of the beetle, and the animal must, by the help of its jaws, tear away and remove a bulk of timber more than twenty times its own bulk. We shall gain some idea of the amount of labour necessary for this, by considering what would be the corresponding work that should be executed by a man, were he to be equally adapted with the beetle for this kind of work. He would have in a few days to bore into a mass of solid timber a cylindrical hole, about eighty or ninety feet long, and about three feet in diameter.

The central part of the illustration shows another stage in the history of these tunnelling operations. We will suppose that a beetle has finished the hole of which the two already described are the commencement. All along each of these will be seen little white spots; these represent the eggs which she lays as she proceeds. The long line in the centre of the figure represents a part of the completed hole, along the sides of which the eggs are laid.

When the eggs of the beetle are hatched, the little animal that comes from them is at that stage of its existence utterly unlike its parents. It is at first a little grub without legs, and quite as unlike a beetle as an earth-worm is unlike a house-fly; this is called the larva condition of the beetle; and it is equally true of every other insect, that in the early stages of its existence it is utterly unlike in appearance, in food, and habits, to the parents from which it has sprung. Thus the dragon-fly, with which we are all so familiar, and which is such an ornament to our streams, was, when young, an unattractive and somewhat ferocious-looking grub, wholly resident in the water, over which, when mature, it skims, but which it never touches. The food, too, of the larva of the dragon-fly is quite different from that of the mature insect.

This being understood, we shall not be surprised to find that when the eggs of the beetle we are describing are hatched, the young that come from them are quite unlike their parents. They are small white grubs, rather uninteresting in appearance, but endowed with a most tremendous appetite and vast powers of digestion. The food which supports the little grub is the solid wood of the tree itself. It will be remembered that each egg was deposited on the side of the hole, and there it remains attached until it is hatched; thus the little creature finds, the moment it becomes conscious of its existence, the food which nature intended for it surrounding it in boundless profusion. At once it commences to eat the wood that is under it, and thus it speedily excavates for itself a little hole, the bottom of which gradually deepens as the insect proceeds. Its brothers and sisters, likewise hatched about the same time, commence each to eat their small hole, and thus from the main tunnel a number of small holes gradually extend through the trunk, all commencing, of course, from the hole originally made by the parent insect.

Now, as the little grubs progress onwards, they at the same time grow in size, and their appetite consequently increasing, the hole gets gradually larger, and this is, of course, also necessary to allow for their increased dimensions. Gradually they proceed farther and farther from the centre, and approach nearer and nearer to the outside of the tree; but just before they finally emerge, when they are just beneath the bark, a curious change comes over them. They have now grown to be as large as their parent, but still they are grubs; they have not donned the legs and wings which are necessary for the perfect beetle, but the tree which has housed and fed them in their infancy still affords them shelter till their final development. As they get near the bark they cease to eat, and fall into an inert condition; but all this time a wonderful change is taking place within their bodies—they cast off their skin and are transformed into perfect beetles. Speedily they emerge from the tree to find themselves in a new and wondrous world, and to use and enjoy those powers of flight which they have so recently and so curiously acquired. Truly this is a very astonishing history; we have seen one beetle boring into a tree, we see a hundred emerge from it; the solid substance of the trunk has afforded nourishment to the numerous offspring. There is no more interesting department of natural history than that which treats of the habitations of insects; and there is, perhaps, hardly any insect more interesting in this respect than this wood-boring beetle.

MECHANICAL MOVEMENTS.*

(*Continued from page* 148.)

76. Continuous rotary motion of the cam gives a reciprocating rectilinear motion to the bar. The cam is of equal diameter in every direction measured across its centre.

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* Extracted from a compilation by Mr. H. J. Brown, Editor of the *American Artisan.*

MECHANICAL MOVEMENTS.

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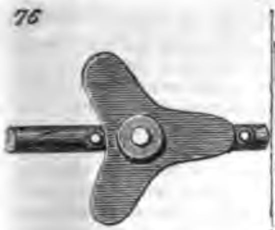

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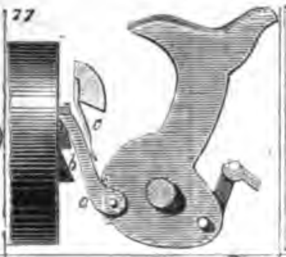

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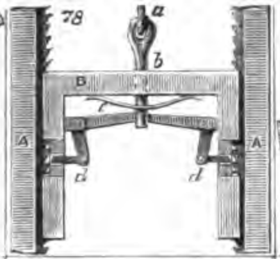

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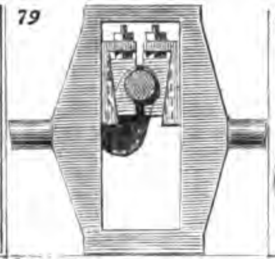

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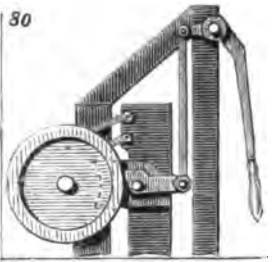

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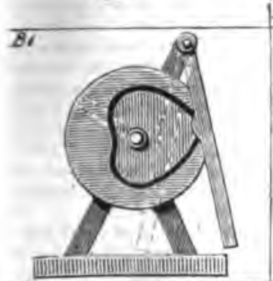

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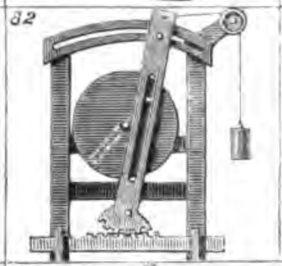

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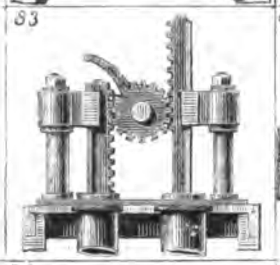

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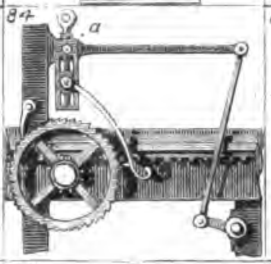

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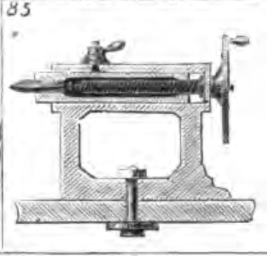

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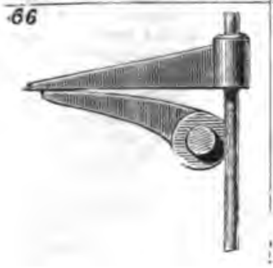

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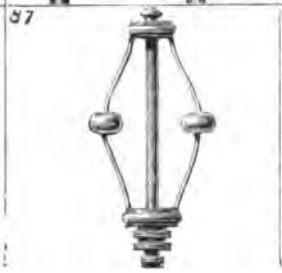

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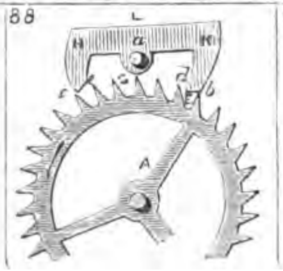

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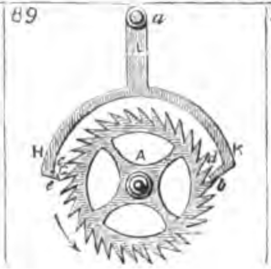

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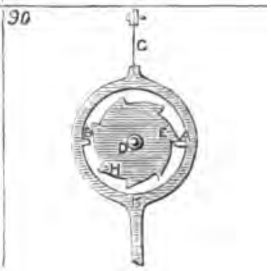

77. Col. Colt's invention for obtaining the movement of the cylinder of a revolving fire-arm by the act of cocking the hammer. As the hammer is drawn back to cock it, the dog *c* attached to the tumbler, acts on the ratchet *b* on the back of the cylinder. The dog is held up to the ratchet by a spring *c*.

78. C. R. Otis's safety-stop for the platform of a hoisting apparatus. A are the stationary uprights, and B is the upper part of the platform working between them. The rope *a* by which the platform is hoisted, is attached by a pin *b*, and spring *c*, and the pin is connected by two elbow levers with two pawls *d*, which work in ratchets secured to the uprights A. The weight of the platform and the tension of the rope keep the pawls out of gear from the ratchets in hoisting or lowering the platform, but in case of the breakage of rope, the spring *c* presses down the pin *b*, and the attached ends of the levers, and so presses the pawls into the ratchets and stops the descent of the platform.

79. Crank and slotted cross-head, with Clayton's sliding journal-box applied to the crank-wrist. The box consists of two taper lining pieces and two taper gibs adjustable by screws, which serve at the same time to tighten the box on the wrist and to set it out to the slot in the cross-head as the box and wrist wear.

80. A mode of working a windlass. By the alternating motion of the long hand-lever to the right, motion is communicated to the short lever, the end of which is in immediate contact with the rim of the wheel. The short lever has a very limited motion upon a pin, which is fixed in a block of cast iron, which is made with two jaws, each having a flange projecting inward in contact with the inner suface of the rim of the wheel. By the upward motion of the outward end of the short lever, the rim of the wheel is jammed between the end of the lever and the flanges of the block, so as to cause friction sufficient to turn the wheel by the further upward movement of the lever. The backward movement of the wheel is prevented by a common ratchet-wheel and pawls; as the short lever is pushed down it frees the wheel and slides freely over it.

81. The revolution of the disc causes the lever at the right to vibrate by the pin moving in the groove in the face of the disc.

82. By the revolution of the disc in which is fixed a pin working in a slot in the upright bar which turns on a centre near the bottom, both ends of the bar are made to traverse. the toothed sector producing alternate rectilinear motion in the horizontal bar at the bottom, and also alternate perpendicular motion of the weight.

83. By a vibratory motion of the handle, motion is communicated by the pinion to the racks. This is used in working small air pumps for scientific experiments.

84. Represents a feeding apparatus for the bed of a sawing machine. By the revolution of the crank at the lower part of the figure, alternative motion is communicated to the horizontal arm of the bell-crank lever whose fulcrum is at *a*, near the top left-hand corner of the figure. By this means motion is communicated to the catch attached to the vertical arm of the lever, and the said catch communicates motion to the ratchet-wheel, upon the shaft of which is a toothed pinion working in the rack attached to the side of the carriage. The feed is varied by a screw in the bell-crank lever.

85. Is the movable head of a turning lathe. By turning the wheel to the right, motion is communicated to the screw, producing rectilinear motion of the spindle in the end of which the centre is fixed.

86. Toe and lifter for working puppet valves in steam engines. The curved toe on the rock-shaft operates on the lifter attached to the lifting rod to raise the valve.

87. Pickering's governor. The balls are attached to springs tne upper end of each of which is attached to a collar on the sliding sleeve. The springs yield in a proper degree to the centrifugal force of the balls, and raise the sleeve; and as the centrifugal force diminishes, they draw the balls towards the spindle and depress the sleeve.

88 and 89. The former is what is termed a *recoil*, and the latter a *repose* or *dead beat* escapement for clocks. The same letters of reference indicate like parts in both. The *anchor* H L K is caused by the oscillation of the pendulum, to vibrate upon the axis *a*. Between the two extremities, or pallets H K, is placed the escape-wheel A, the teeth of which come alternately against the outer surface of the pallet K, and inner surface of pallet H. In 289 these surfaces are cut to a curve concentric to the axis *a*; consequently, during the time one of the teeth is against the pallet, the wheel remains perfectly at rest. Hence the name *repose* or *dead-beat*. In 288 the surfaces are of a different form, not necessary to explain, as it can be understood that any form not concentric with the axis *a*, must produce a slight recoil of the wheel during the escape of the teeth, and hence the term *recoil* escapement. On the pallets leaving teeth, at each oscillation of the pendulum, the extremities of teeth slide along the surfaces *c*, *e*, and *d*, *b*, and give sufficient impulse to pendulum.

90. Another kind of pendulum escapement.

(To be continued.)

ON THE RELATIONS BETWEEN BODY AND MIND.*

Lecture I.

GENTLEMEN,—The relations of mind and body in health and in disease I have chosen as the subject of these lectures, not with the hope of doing full justice to so complex and difficult an inquiry, but because it has for some time been my special work, and there was no other subject on which I should have felt myself equally justified in addressing you. No one can be more deeply sensible than I am how little we do know accurately of the bodily conditions of our mental functions, and how much of that which we think we know is vague, uncertain, and fluctuating. But the time has come when the immediate business which lies before anyone who would advance our knowledge of mind unquestionably is a close and searching scrutiny of the bodily conditions of its manifestations in health and disease. It is most necessary now to make use of the results of the study of mind in health to light and guide our researches into its morbid phenomena, and in like manner to bring the instructive instances presented by unsound mind to bear upon the interpretation of its healthy functions. The physiology and the pathology of mind are two branches of one science; and he who studies the one must, if he would work wisely and well, study the other also. My aim will be to promote the reconciliation between them, and in doing so I shall embrace the occasion whenever it offers itself, to indicate the principles which should guide our efforts for what must always be the highest object of medical science and art,—the production and preservation of a sound mind in a sound body. Actually to accomplish much of this purpose will not lie in my power, but I may bring together fragmentary observations, point out the bearing of them on one another and on received opinions, thus unfold their meaning, and mark broadly the lines which future research must take.

Within the memory of men now living insanity was such a special study, and its treatment such a special art, that it stood quite apart from general medicine in a mysterious and mischievous isolation; owing little or nothing to the results of progress in other branches of medicine, and contributing nothing to their progress. The reason of this it is not hard to discover. The habit of viewing mind as an intangible entity, the notion of it as an incorporeal essence, which science inherited from theology, prevented men from subjecting its phenomena to the same method of investigation as other natural phenomena; its disorders were thought to be an incomprehensible affliction, due to the presence of an evil spirit in the sufferer, or to the enslavement of the soul by sin, or to anything but their true cause—bodily disease. Consequently, the treatment of the insane was not in the hands of intelligent physicians, but was given up to coarse and ignorant gaolers, whose savage cruelties will for all time to come be a great and ugly blot upon the enlightenment of the age which tolerated them.

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* Two lectures delivered at the Royal College of Physicians in 1870. By Henry Maudsley, M.D., F.R.C.P., Professor of Medical Jurisprudence in University College, London.

Matters are happily changed now. On all hands it is admitted that the manifestations of mind take place through the nervous system; and that its derangements are the result of nervous disease, amenable to the same method of investigation as other nervous diseases. Insanity has accordingly become a strictly medical study, and its treatment a branch of medical practice. Still it is all too true that, notwithstanding we know much, and are day by day learning more, of the physiology of the nervous system, we are only on the threshold of the study of it as an instrument subserving mental function. We know little more positively than that it has such function; we know nothing whatever of the physics and of the chemistry of thought. The conception of mind as a mysterious entity, different essentially from, and vastly superior to, the body which it inhabits and uses as its earthly tenement, but from which its noblest aspirations are to get free, still works openly or in a latent way to obstruct the study of its functions by the methods of physical research. Without speculating at all concerning the nature of mind—which, let me distinctly declare at the outset, is a question which science cannot touch, and I do not dream of attempting to touch,—I do not shrink from saying that we shall make no progress towards a mental science if we begin by depreciating the body, not by disdaining it, as metaphysicians, religious ascetics, and maniacs have done, but by labouring in an earnest and inquiring spirit to understand it, shall we make any step forward; and when we have fully comprehended its functions, when we know how to estimate fitly this highest, most complex, and wonderful achievement of organised skill, it will be quite time, if there be then any inclination to look down upon it with contempt.

The truth is that in inquiries concerning mind, as was once the case in speculations concerning other natural phenemena or forces, it has been the practice, to begin where the inquiry should have ended. Just as the laws of physical actions were evoked out of the depths of human consciousness, and the relations of bodies to one another attributed to sympathies and antipathies, attractions and abhorrences, instead of being acquired by patient observation and careful generalisation, so has a fabric of mental philosophy been reared in the doubtful revelations of self-consciousness, in entire disregard of the more tedious and less attractive duty of observation of facts, and induction from them. Surely it is time we put seriously to ourselves the question whether the inductive method, which has proved its worth by its abundant fruitfulness wherever it has been faithfully applied, should not be as rigidly used in the investigation of mind as in the investigation of other natural phenomena. If so, we ought certainly to begin our inquiry with the observation of the simplest instances—with its physiological manifestations in animals, in children, in idiots, in savages, mounting by degrees to the highest and most recondite facts of consciousness, the interpretation or the misinterpretation of which constitutes what has hitherto claimed to be mental philosophy. The inductions which we get by observing the simple may be used with success to disentangle the phenomena of the complex; but the endeavour to apply the complex and obscure to the interpretation of the simple is sure to end in confusion and error. The higher mental faculties are formed by evolution from the more simple and elementary, just as the more special and complex structure proceeds from the more simple and general; and in the one case as in the other we must, if we would truly learn, follow the order of development. Not that it is within my present purpose to trace the plan of development of our mental faculties, but the facts and arguments which I shall bring forward will prove how vain and futile it is to strive to rear a sound fabric of mental science on any other foundation.

To begin the study of mind, then, with the observation of its humblest bodily manifestations, is a strictly scientific method. When we come to inquire what these are, it is far from easy to fix the point at which mental functions begin. Without doubt, most of the actions of man, and many of those of the higher animals, do evince the operation of mind, but whereabouts in the animal kingdom it first appears, and what part it has in the lower nerve functions of man, are questions not easily answered. The more closely the matter is looked into, the more clearly it appears that we habitually embrace in our conception of mind different nervous functions, some of which proceed from different nerve-centres, and the more necessary it becomes to analyse these functions, to separate the more simple and elementary, and to discover in the concrete as much as possible of the meaning of the abstraction. Is the brain the exclusive organ of mind? If it be so, to what category of functions shall we refer the reflex acts of the spinal cord, which take place independently of the brain, and which often achieve as definite an end, and seem to display as intelligent an aim, as any conscious act of volition? It needs not to illustrate in detail the nature and extent of reflex action, which is familiar enough, but I may select a striking example in order to serve as a text for the reflections which I wish to bring forward. One simple fact, rightly understood and truly interpreted, will teach as much as a thousand facts of the same kind, but the thousand must have been previously observed in order to understand truly the one; for it is certainly true that to apprehend the full meaning of common things, it is necessary to study a great many uncommon things. This, however, has been done in this instance by the distinguished physiologists whose labours have fixed on a tolerably firm basis the doctrine of reflex action; we may, therefore, take as our starting point the accepted results of their labours.

It is well known that if the hind foot of a frog that has had its head cut off be pinched, it is withdrawn from the irritation. The stimulus to the afferent nerve reaches the grey matter of the spinal cord, and sets free a force which excites to action the corresponding motor nerves of the same side. When the foot is pinched more strongly, the force liberated by the stimulus passes across the cord to the motor nerves of the opposite side, and there is a simultaneous withdrawal of both limbs; and if the excitation be stronger still, there is a wider irradiation of the effects of the stimulus in the grey matter, and a movement of all four limbs following, the frog jumping away. These movements of the decapitated frog, which it is plain effect the definite purpose of getting it out of the way of harm, we believe to be analogous to the violent coughing by which food that has gone the wrong way is expelled from the human larynx, or to the vomiting by which offending matter is ejected from the stomach. Independently of consciousness and of will, an organism plainly has the power—call it intelligence or call it what we will—of feeling and eschewing what is hurtful to it, as well as of feeling and choosing what is beneficial to it.

But the experiment on the frog may be made more striking and instructive. Touch with acetic acid the thigh of a decapitated frog over the internal condyle, and the animal rubs it off with the dorsal surface of the foot of the same side; cut off the foot and apply the acid to the same spot, and the animal tries to get at it again with its foot, but of course, having lost it, cannot. After some fruitless efforts, therefore, it gives up trying in that way, seems restless, as though, says Pflüger, it was seeking some other way; and at last it makes use of the foot of the other leg, and succeeds in rubbing off the acid. Notably we have here not merely contractions of muscles, but combined and harmonised contractions in due sequence for a special purpose. There are actions that have all the appearance of being guided by intelligence and instigated by will in an animal the recognised organ of whose intelligence and will has been removed.

(To be continued.)

VANADIUM.

PROFESSOR ROSCOE, F.R.S., delivered on the 21st of April last a lecture on Vanadium, before the Chemical Society. This metal, he said, was discovered in 1830, by Sefström, in the celebrated Swedish bar-iron made from the Taberg ore. Sefström ascertained some of the most peculiar characters of this substance, proved it to be a new element, and prepared some of its compounds in the pure state. The reactions by which vanadium can be separated and distinguished from all the other elements are:—1st. The formation of a soluble sodium vanadate when the vanadium compounds are fused with sodium carbonate. 2nd. The formation of an insoluble ammonium vanadate when sal ammoniac is added to the solution of a soluble vanadate. 3rd. The production of a splendid blue solution when this ammonium salt, dissolved in hydrochloric acid, is warmed with reducing agents, such as oxalic acid.

Sefström, not having leisure to prosecute the full examination of the properties of the new metal, handed over his preparations to Berzelius; and it is to the investigations of the great Swede that we owe almost all our acquaintance with the chemistry of vanadium.

Since Berzelius's time, vanadium has been discovered in many minerals, of which a lead ore containing lead vanadate, and called by the mineralogists, vanadinite, is the most important.

In 1865 Professor Roscoe came into possession of a plentiful source of vanadium, in a by-product obtained in the preparation of cobalt from the copper-bearing beds of the lower Keuper Sandstone of the Trias, at Alderley Edge, in Cheshire. Following, in the main, the process of preparation adopted by Sefström, Professor Roscoe obtained, from the above-mentioned source, several pounds of pure ammonium vanadate, from which all the other compounds of vanadium can be prepared.

What, now, were the conclusions to which Berzelius arrived, from his experiments concerning the constitution of the vanadium compounds? He assigned to its three oxides the formulæ VO, VO_2, and VO_3, whilst the chloride was represented by VCl^3. The atomic weight of the metal he found to be $V = 68{\cdot}5$.

Some years afterwards, Rammelsberg observed that vanadinite, a double salt of lead-vanadate and lead chloride, is isomorphous with apatite and with mimitesite, the former containing phosphoric, the latter arsenic acid. This crystallographic analogy would lead us to conclude that the oxide of vanadium in the vanadinite has the formula V_2O_5, agreeing with the corresponding oxides of phosphoros and arsenic, P_2O_5 and As_2O^5; but the unyielding chemical fact of Berzelius compel us to view the oxide in question as VO^3. It was, then, evident that here was either an exception to the law of isomorphism, or else Berzelius's views were erroneous.

Professor Roscoe, in order to endeavour to clear up this question, had carefully repeated Berzelius's experiments, and he found them confirmed in every particular; but, having pursued the subject further than Berzelius, he had succeeded in obtaining the key to the enigma presented by the above anomalous crystallographic relations.

The lecturer has proved that the substance supposed by Berzelius to be vanadium is not the metal, but an oxide, and that the true atomic weight of the metal is 51·3. The vanadic acid, VO^3, of Berzelius, hence, becomes V_2O^5, corresponding to P_2O^5, and As_2O_5; and the above-mentioned isomorphism is fully explained. The sub-oxide of Berzelius is a tri-oxide, V_2O_3; whilst the terchloride (VCl_3) of Berzelius is an oxychloride, $VOCl_3$, corresponding to oxychloride of phosphorus, $POCl_3$.

Professor Roscoe has succeeded in obtaining bromine and iodine compounds of vanadium, and also various metallic vanadates. He went on with his lecture by pointing out that the characters of the vanadates bear out the analogy of the vanadic acid with the highest oxides of phosphorus and arsenic; and stated, in conclusion, that vanadium, hitherto standing in no definite relation to other elements, must now be regarded as a member of the well-known triad class of elementary substances, comprising nitrogen, phosphorus, boron, arsenic, antimony, and bismuth.

DRESSING MILLSTONES WITH THE DIAMOND OR "BORT."

(*Continued from page* 153.)

GOLAY'S machine was generally admitted to be a great advance on anything previously proposed, and many millers adopted it under the impression that nothing better could be obtained; others, however, waited, seeing that there still remained defects connected with the dressing operation which that machine did not remove, and also hearing of other plans that very soon made their appearance on the commercial success of Golay's becoming generally known.

Golay's machine supplied one desideratum, in making a dress superior to what could be obtained by hand, in putting in the dress or cracking on the millstone in clean, straight, unbroken, uniform manner, and in less time than by hand, and it had the great advantage of making the mill masters less dependent on the individual skill of the men. Notwithstanding these great advantages, however, many millers consider that the machine is defective in many of its details, more specially in not tending to keep the millstones in better track or level than formerly. The machine rests on three small feet, and is, consequently, dependent for its level on the small local spots whereon those feet happen to be placed, and can in no way check or correct the inequalities which escape the proving staff. As the machine is worked by power it is impossible to use it while the mill is standing, that is at the very time when a miller most wishes to put his stones in order and give them extra work and care. It also necessitates the stones being dressed on one spot, as well as the erection of driving gear for the purpose; and whilst not being quite so dependent on individual skill as with the hand-bill, a certain amount of skill is indispensable to obtain a uniform depth of the cracking, and to prevent the diamond from being broken or injured, as it is very liable to be at the high speed at which it rotates. These defects form a serious drawback from the advantages of this machine, and a hindrance to its more general use.

There cannot at the present time be the least doubt that the practical success of the mere cutting action in Golay's machine was in reality due to a very great extent to his using, not the diamond, but bort or carbon, of which the special and distinctive properties and peculiar suitability for cutting hard stone had been previously discovered by Jobin. It was very fortunate for Golay that he met with specimens of bort for his trials, for he would certainly have met with no better or more permanent success than Childs or Dickinson had he had only common glaziers' diamonds to work with.

Popularly the term "diamond," or "black diamond," is applied to the stones used for dressing millstones; but the term is inaccurate, and bort—which is the substance really used—is not diamond. The diamond properly so called is a crystalline substance with an easy cleavage; and even when reduced to fine dust, the particles retain their crystalline structure; hence the grittiness, in which lies the great abrading power of the dust. Bort, on the contrary, is amorphous, or destitute of crystalline structure or cleavage, and its dust, having no grittiness or abrading power, is quite useless to lapidaries. Bort, probably like the diamond, consists mainly of carbon, but in an allotropic or different state. It is very remarkable that the amorphous bort should be harder than the crystalline diamond, but so it is, and a good specimen of bort will with a single steady rectilinear stroke cut in stone a groove one-eighth of an inch in depth—work which would be simple destruction to any translucent or crystaline diamond.

We may now compare Golay's vague description of the substances he proposed to use, "hard stones, and especially the diamond," with Jobin's clear and definite statement published three years before Golay's. In the specification of his patent, to which we have already referred, Jobin says:—

"The invention consists principally in the use of the materials or substances called bort and carbon, these being employed instead of steel for the cutters or cutting surfaces or points of the tools or machines. These substances are well known to lapidaries, and may be procured from Brazil and other places were diamonds are found, being, in fact, rough or impure portions of stone found in connection with the diamond; and not being sufficiently pure to be suitable for jewellery these substances can be used with economy and advantage. Bort or carbon are extremely hard, and not capable of being drilled on the edge or worn away by friction with any material but themselves."

The success of Golay's machine was not at first attributed to the kind of stone, but to his peculiar and very ingenious rotatory chipping action, and it was at one time thought that that action was absolutely essential to success. It is clear, from Golay's specification, that this was his own opinion; and it was owing to this belief that so large a sum as £200,000 was so soon invested in the patent.

The first to put forward any plan in competition with Golay's was Robert Young, an engineer and experienced maker of machinery specially for millers. It was not, however, Golay's success which first drew his attention to the matter, for in 1862, when Knight's patent was obtained, he had received one of Knight's machines from America, and had endeavoured to obtain its adoption by several millers in Scotland, but found that the expense of the diamond was objected to; and he was then unaware of the existence of the not only less expensive, but also more suitable bort. Though discouraged, Young himself still remained convinced of the desirabily of a millstone dressing machine, and never abandoned the idea of producing a successful one. He did not see why a plain rectilinear cut with the diamond, such as had been proposed long before by Childs, should not answer as well as the rotatory chipping, if suitable arrangements were made for its application. He designed various modifications of apparatus for carrying out his views, and took out a patent on February 12th, 1868, No. 475, the mere title of which showed that he aimed at things beyond what Glay had contemplated, it being "Improvements in apparatus for training, levelling, and dressing millstones." Careful observation and experiment soon led Mr. Young to see that the quality of the diamond or cutting material had an important bearing on the matter, and that, in fact, when bort was used the excessively rapid power-using rotatory clipping action introduced by M. Golay was an altogether unnecessary addition. Mr. Young's study of the subject resulted in the principles that in order to make bort act satisfactorily with the simple rectilinear cut like that of the tool of an ordinary planing machine, it must be held in a slide guided firmly and steadily, so as to move accurately in a straight line, and be unable to deviate therefrom either upwards or laterally, and that to meet the inequalities and varying hardness of the burr stone composing the millstone face, the bort should not be held with absolute rigidity, but so as to have an extremely slight elasticity. Whilst designing his apparatus in accordance with these principles, he further arranged it so as not only to maintain the truth and level of the stone, but also so as to gradually correct any departure therefrom. The patent already referred to and a more recent one, comprise various modifications of Mr. Young's apparatus, but the following is a description of the one which he finds best adapted to the various practical requirements.

(*To be continued.*)

A GOOD PAINT.

WE would direct the attention of those desirous of trying good paint to the sorts manufactured by "Jay's Metallic Paint Company," of the Woodham Works, near Vauxhall Station. It is very cheap, not only in its first cost, but in the economy of its use, one coating being equal to two of any other paint, according to the inventor. The chief merit of the invention is in the utilisation of the common resin of commerce in combination with oxide of zinc. The resin is first broken up into dust or small pieces, and then dissolved in benzoline or turpentine until the solution acquires the consistency of syrup or treacle, or equal parts of each of the above spirits or hydrocarbons, and any other hydrocarbon that will dry and combine with drying oils can be used instead of turpentine or benzoline. When the solution is complete it is gradually added to the oxide of zinc, which has previously been made into a paste with boiled linseed oil, until the whole mixture acquires the consistency of paint suitable for use. A white paint is thus produced of a most durable and glossy character, capable of resisting heat, moisture, cold, and friction better than any other known paint. Other pigments, such as sulphate of barytes, oxide of iron, Brunswick green, red lead, or any other known ingredient, can be added to make any desired colour of paint. One great advantage of its use is its effectual resistance to heat and moisture. It never blisters or cracks, even under the hottest sun or the most inclement weather.

ON AN APLANATIC SEARCHER, AND ITS EFFECTS IN IMPROVING HIGH-POWER DEFINITION IN THE MICROSCOPE.[*]

THE Aplanatic Searcher described by Dr. Pigott is intended to improve the penetration, amplify magnifying power, intensify definition, and raise the objective somewhat further from its dangerous proximity the delicate covering-glass indispensable to the observation of objects under very high powers.

The inquiry into the practicability of improving the performance of microscopic object-glasses of the very finest known quality was suggested by an accidental resolution in 1862 of the Podura markings into black beads. This led to a search for the cause of defective definition, if any existed. A variety of first-class objectives, from the $\frac{1}{16}$ to the ¼, failed to show the beading, although most carefully constructed by Messrs. Powell and Lealand.

Experiments having been instituted on the nature of the errors, it was found that the instrument required a better distribution of power; instead of depending upon the deepest eyepieces and most powerful objectives hitherto constructed, that better effects could be produced by regulating a more gradual bending or contraction of the eccentrical rays emanating from a brilliant microscopic origin of light.

It then appeared that delusive images, which the writer has ventured to name *eidola*,[*] exist in close proximity to the best focal point, (where the least circle of confusion finds its locus).

(I.) That these images, possessing extraordinary characters, exist principally above or below the best focal point, according as the objective spherical aberration is positive or negative.

(II.) That test-images may be formed of a high order of delicacy and accurate portraiture, in miniature, by employing an objective of twice the focal depth, or, rather, half the focal length of the observing objective.

(III.) That such test-images (which may be obtained conveniently two thousand times less than a known original) are formed (under precautions) with a remarkable freedom from aberration, which appears to be reduced in the miniature to a minimum.

(IV.) The beauty or indistinctness with which they are displayed (especially on the immersion system) is a marvellous test of the correction of the observing objective but an indifferent one of the image-forming objective used to produce the testing miniature.

These results enable the observer to compare the known with unknown. By observing a variety of brilliant images of known objects, as gauze, lace, an ivory thermometer, and sparkles of mercury, all formed in the focus of the objective, to be tested with the microscope properly adjusted, so that the axes of the two objectives may be coincident, and their corrections suitably manipulated, it is practicable to compare known delusions with suspected phenomena.

It was then observed (by means of such appliances) that the aberration developed by high-power eyepieces and a lengthened tube, followed a peculiar law.

A. A lengthened tube increased aberration faster than it gained power (roughly the aberration varied as r^2, while the power varied as r).

B. As the image was formed by the objective at points nearer to it than the standard distance of 9in., for which the best English glasses are corrected, the writer found the aberration diminished faster than the power was lost, by shortening the body of the instrument.

C. The aberration became negatively affected, and required a positive compensation.

D. Frequent consideration of the equations for aplanatism suggested the idea of searching the axis of the instrument for aplanatic foci, and that many such foci would probably be found to exist in proportion to the number of terms in the equations (involving curvatures and positions).

E. The law was then ascertained that power could be raised, and definition intensified, by positively correcting the searching lenses in proportion as they approached the objective, at the same time applying a similar correction to the observing objective.

The chief results hitherto obtained may be thus summarised:—

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[*] By C. W. Pigott, M.A., and read before the Royal Society.

[*] From εἴδωλον, a false spectral image.

The writer measured the distance gained by the aplanatic searcher, whilst observing with a ¼-in. objective with a power of seven hundred diameters, and found it $\frac{2}{10}$ of an inch increase; so that optical penetration was attainable with this high power through plate-glass nearly ¼in. thick, whilst visual focal depth was proportionably increased.

The aplanatic searcher increases the power of the microscope from two and a half to five times the usual power obtained with a third or C eyepiece of 1in. focal length. The ¼ thus acquires the power of a $\frac{1}{25}$, the penetration of a ¼. And at the same time the lowest possible eyepiece (3in. focus) is substituted for the deep eyepiece formed of minute lenses, and guarded with a minutely perforated cap. The writer lately exhibited to Messrs. Powell and Lealand a brilliant definition, under a power of 4000 diameters, with their new "⅛ immersion" lens, by means of the searcher and low eyepiece.

The traverse of the aplanatic searcher introduces remarkable chromatic corrections, displayed in the unexpected colouring developed in microscopic test objects.*

The singular properties, or rather phenomena, shown by eidola, enable the practised observer in many cases to distinguish between true and delusive appearances, especially when aided by the aberrameter applied to the objective to display eccentrical aberration by cutting off eccentrical says.

Eidola are symmetrically placed on each side of the best focal point, as ascertained by the aberrameter when the compensations have attained a delicate balance of opposite corrections.

If the beading, for instance, of a test-object exists in two contiguous parallel planes, the eidola of one set is commingled with the true image of the other. But the upper or lower set may be separately displayed, either by depressing the false eidola of the lower stratum, or elevating the eidola of the upper. For when the eidola of two contiguous strata are intermingled, correct definition is impossible so long as the aperture of the objective remains considerable.

One other result accrues: when an objective, otherwise excellent, cannot be further corrected, the component glasses being already closely screwed up together, a further correction can be applied by means of the adjustments of the aplanatic searcher itself, all of which are essentially conjugate with the actions of the objective and the variable positions of its component lenses; so that if δx be the traversing movements of the objective lenses, δv that of the searcher, F the focal distance of the image from the objective when δx vanishes, f the focal distance of the virtual image formed by the facet lenses of the objective,

$$\frac{\delta v}{\delta x} = -\left(\frac{F}{f_1}\right)^2$$

The appendix refers to plates illustrating the mechanical arrangements for the discrimination of the eidola and true images, and for traversing the lenses of the aplanatic searcher.

The plates which the author supplied with the paper also showed the course of the optical pencils, spurious discs of residuary aberration and imperfect definition, as well as some examples of "high-power resolution" of the Podura and Lepisma beading, as well as the amount of amplification obtained by camera-lucida outline drawings of a given scale.

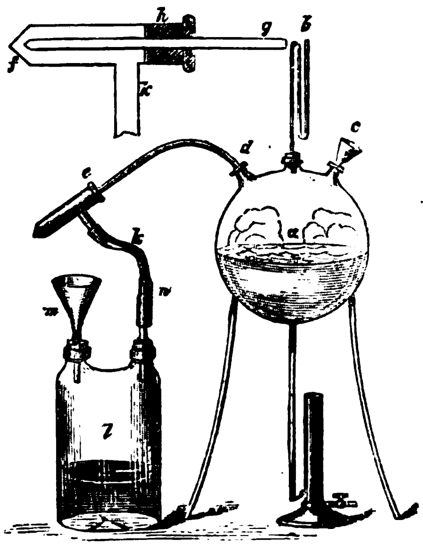
AN IMPROVEMENT IN FILTRATION.

By Prof. John C. Gilbert, M.D., New York College.†

To those who have been unable to employ Bunsen's improvement in filtration because of an insufficient supply of water to produce the necessary exhaustion, it may be of interest to know that all the practical advantages may be obtained by means of a simple and inexpensive apparatus, which it is the object of this communication to describe.

The apparatus consists of a stout boiler a, with three openings accommodating respectively a pressure-gauge b, a supply-funnel c for the introduction of water, and a tube d connecting with the exhausting arrangement or steam vacuum-tube e, represented in section at f, in which f is a brass or glass tube ½ an inch in diameter, terminating in a small conical opening or nozzle $\frac{1}{32}$ of an inch in diameter. In the interior of f and passing air-tight through the stuffing box h, there is a similar tube g about ¼in. in diameter and terminating in a nozzle or opening like f, and about $\frac{1}{64}$ of an inch in diameter. At k a tube ¼in. in diameter opens into f.

The nozzle-tubes f, g being placed in position as shown in the figure, steam is raised to the boiler a; this passing through the tube d e to g, issues with violence from the nozzle; and in passing through the nozzle of f produces an exhaustion in the interior of the tube f which may be applied as desired by a flexible tube attached to k. The vacuum produced depends partly on the shape of the nozzles, and partly on their relative position. The latter adjustment is obtained by slipping the tube g through the stuffing-box h until the proper position is found. In the arrangement employed by me, I have without difficulty obtained with a pressure of one atmosphere of steam in the boiler an exhaustion capable of raising mercury 8in. perpendicularly in a tube attached to k, the exhaustion increasing steadily as the pressure of the steam increased.



At l m the filtering-apparatus is represented as attached to the steam vacuum-tube f by the flexible india-rubber connector n.

THE *ENGLISH MECHANIC* SOCIETY OF ARTS.

(Edinburgh Branch.)

In accordance with the advertisements in the English Mechanic of April 22nd and 29th, a number of its subscribers met in the Waverley Hotel on the evening of the 29th. Being unanimously of opinion that the formation of a society, having in view the aims and objects spoken of by several correspondents in our pages, they appointed a chairman, and at once proceeded to give themselves a name.

After a pretty sharp discussion (in the course of which Mr. Kemp—the originator of the idea—took occasion to point out specifically the advantages to be derived by the members meeting together), the name given above was agreed upon. It was then decided that the meetings should be held on the first Thursday of every month, commencing on Thursday, May 5th, at 8.15 p.m. A committee of seven was appointed to draught out rules and bye-laws for the guidance of the members; as a mark of esteem it was decided to elect Mr. J. Passmore Edwards, Honorary President.

A very general and decided expression of opinion was given concerning the very great improvement recently effected in the English Mechanic, and a cordial vote of thanks was passed to the Editor for his efforts in that direction.

The thanks of the members having been awarded to Mr. Kemp as the founder of the fabric, the customary vote to the chairman closed the proceedings.

The committee met on Monday, May 2, at 8.30 p.m., when the following among other rules were agreed to:—

1. No party, political, nor sectarian religious subject shall be discussed at the meetings.

2. The meeting shall be opened by one of the members reading an essay (original, we presume, but not so specified), not more than 15 minutes in length. The discussion arising thereon to be finished not later than 9·20 p.m., the remainder of the evening to be devoted to asking and answering questions on any subject in which any of the members may be interested.

C. E. Gordon, Interim. Sec.

THE MANCHESTRIAN *ENGLISH MECHANIC'S* MUTUAL IMPROVEMENT SOCIETY.

In accordance with the advertisement in last week's issue of the English Mechanic some of its subscribers living in Manchester assembled on Friday, the 29th of April, at the Dog and Partridge Hotel, Corporation-street. Mr. A. Tolhausen gave an address on the propriety of forming such a society, and the advantages likely to be derived from it. After speeches from Mr. Rees, Mr. Tweedale, and Mr. Baguley on the formation of the society, it was determined to meet again at 8 o'clock p.m., on Monday, the 16th of May, to enrol members, to appoint officers, and to elect Mr. Tolhausen as the hon. secretary.

MATHEMATICS.

By C. H. W. Biggs.

CHAPTER III.—(*Continued.*)

Decimals.

(*Continued from page* 83.)

§ 37. If the denominator of any fraction be 10, or some power of 10, it can be immediately written as a decimal, but if the denominator be 4, 5, 6, &c., it may or may not be capable of being exactly expressed as a decimal. For all practical purposes, however, the difference between the fraction expressed by either method is too little to be considered.

Thus α ⅓ = ·3333333, *ad infinitum.*
β ¼ = ·25.

In α* we have a decimal answering *nearly* to the vulgar fraction.
β " " *exactly* " fraction.

Decimals of the former kind, when the figures are repeated over and over again, are termed *circulating, repeating,* or *recurring* decimals, and the part repeated is called the *period* or *repetend.* The method of transposing a vulgar into a decimal fraction is to divide the numerator by the denominator, adding noughts to the former as required. Thus $\frac{31}{3} = 10\frac{1}{3}$; 10 remaining in both cases as a whole number, and $\frac{3)\,1\cdot00000}{\cdot33333,\ \&c.,} = 10\cdot3333$, &c. To facilitate calculations, a *dot* is generally placed over the figure or figures repeated, instead of writing down the figures over and over again.

Thus: $\cdot\dot{3} = \cdot3333$, &c., and $\cdot\dot{5}\dot{7} = \cdot575757$, &c., and $\cdot\dot{3}14\dot{7} = \cdot31478147$, &c. When the figures recur immediately after the decimal point we get a *pure* circulator; all other periods are called mixed.

§ 38. From what has already been said, it appears that the methods of calculation wherein decimals are introduced, cannot in the slightest degree differ from those of common arithmetic; and that the only matter involving any difficulty is the determination of the limit where a product or quotient is made up of an integral or decimal series, or of both combined. The rules for this determination are simple, and can be easily understood, as will be seen in the following paragraphs.

§ 39. Addition.—In adding vulgar fractions we reduced the fractions to a *common* denomination, and then the sum of the numerators gave the required result. But in decimals we have the numerators alone expressed, and the unexpressed denominators are easily made *common* by the mere arrangement of the figures in a certain order. Thus in a series of decimal fractions whose sum is to be obtained, since the first place of decimals in each of the numbers is the place of the *tenths*, the sum of *all* the digits occupying that place is the sum of the numerators of a series of fractions having the common denominator ten; the sum of the digits in the second place will be the sum of the numerators of a series of fractions with the common denominator 100; and so on. If, therefore, the given series of numbers is so written one below another that the decimal points are in one *vertical* column, then the digits in every column will be the numerators of fractions with the same denominator; further, if the *sum* of the *second* column be *ten—i.e., ten one-hundredths* $\frac{10}{100}$ we may substitute *one-tenth, i.e., one* unit of the first column in its stead, and generally we may carry from column to column in the decimal parts the same as in the whole numbers.

Ex. Add together 2·3; 4·5; 16·7; 141·1 and 363·2. Writing these numbers so that the decimal points are in one vertical column, we have

$$\begin{array}{lr} & 2\cdot3 \\ & 4\cdot5 \\ & 16\cdot7 \\ & 141\cdot1 \\ \text{by adding as} & 363\cdot2 \\ \text{in whole Nos.} & \overline{} \\ \text{we get} & 527\cdot8 \\ \hline \end{array}$$

or by neglecting for a moment the integers we may write:—

$$\frac{3}{10}+\frac{5}{10}+\frac{7}{10}+\frac{1}{10}+\frac{2}{10}=\frac{18}{10} \text{ or } 1\frac{8}{10}$$

Now adding the integers we get 526, to which add $1\frac{8}{10}$ making as before $527\frac{8}{10}$, for $\cdot8 = \frac{8}{10}$

Ex. Add together 3149·7864, ·0002, 79·3856 and 8940·0126. As before set down thus:—

$$\begin{array}{rl} & \delta\ \gamma\ \beta\ \alpha \\ 3149 & 7\ 8\ 6\ 4 \text{ or } \alpha = \dfrac{4+2+6+6}{10000} = \dfrac{18}{10000} \\ & \cdot\,0\ 0\ 0\ 2 = \dfrac{10+8}{10000} = \dfrac{1}{1000} + \dfrac{8}{10000} \\ 79\cdot & 3\ 8\ 5\ 6 \quad \text{in practice we carry } \dfrac{1}{1000} \text{ to} \\ 8940\cdot & 0\ 1\ 2\ 6 \quad \beta\text{, setting down 8 under } \alpha\text{, and so} \\ \hline \text{Adding we get } 12169\cdot & 1\ 8\ 4\ 8 \quad \text{on, for we have: } \dfrac{6+5+2}{1000}\text{, add to this} \\ \hline \end{array}$$

$$\text{in } \beta\ \frac{6+5+2}{1000} + \frac{1}{1000} \text{ carried as above } = \frac{14}{1000}$$

$$= \frac{10+4}{1000} = \frac{1}{100} + \frac{4}{1000}$$

&c., &c.

Ex. Find the sum of 23·4; 610·721; ·2004; 1647·36, and ·00176.

$$\begin{array}{r} 23\cdot4 \\ 610\cdot721 \\ \cdot2004 \\ 1647\cdot36 \\ \cdot00176 \\ \hline 2281\cdot68316 \end{array}$$

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* Alluded to by Mr. Reade, F.R.S., in "Popular Science Review" for April, 1870.

† Communicated by the author to the "Philosophical Magazine."

* In α the decimal differs by $\frac{1}{10000000}$, and by carrying on the decimal places we can make this difference as much smaller as we please, for we diminish the difference *ten times* by the addition of every decimal place.

Questions on §§ 33, 38 inclusive.

Ex. 10. Express as decimals:—

(1). $\frac{3}{10}, \frac{3}{100}, \frac{3}{1000}, \frac{3}{10000}$

(2). $1\frac{1}{2}\ \frac{3}{4}, \frac{4}{5}\ 16\frac{5}{6}$

(3). $\frac{12}{144}, \frac{28}{56}, \frac{1}{640}, 7\frac{13}{24}$

(4). $\frac{15\frac{1}{2}}{16}$ of $\frac{11}{62\frac{1}{2}}, \frac{15}{17}, \frac{15}{33}$

Ex. 11. Find the sum of

(1.) 279·805, 340·72, ·008, 569 and 1·307.

(2.) 15·625, 25, 143·015625, ·41087 and 3·161

(3.) 108·62, ·001, ·1076, ·7, 1736·17365 and ·01.

(4.) 927·614, 104·416, 3·01796, ·45 and 197.

(5.) 61427, 1427·6, 427·61, 27·614, 7.6142 and ·61427.

(6.) Add together 367-tenths; 47-millionths; and 15-hundredths.

(7.) Find the sum of 1000-millionths, 100-thousandths, 10-hundredths, and 1-tenth.

§ 40. Subtraction.—This, like addition, is a simple process when every fraction has a similar denominator, and therefore if we arrange the decimals as in addition, we get figures of like values under one another. Thus 546·4306 — 46·436 is written:—

$$\begin{array}{r}546{\cdot}4306\\ 46{\cdot}436\\ \hline\end{array}$$

and proceeding as in simple subtraction we get 499·9946

Ex. 38·001234 from 5694

$$\begin{array}{r}5694\\ 38{\cdot}001234\\ \hline 5655{\cdot}998766\\ \hline\end{array}$$

Obs. That every series of figures in which no decimal point is expressed is conceived to have one affixed to the last figure on the right, and that cyphers may be added beyond this limit, from which the decimals are to be deducted.

Ex. 12. Subtract.

(1.) 724·316 from 815·472.

(2.) 32·72 from 187·64159.

(3.) From 287·15 take ·209176.

(4.) 34927 — ·691425 and 63 — 1·4700.

(5.) Find the difference between 20 and ·02.

(6.) Between 1756·4 and 175·64; also between 17·564 and 1·7564.

§ 41. Multiplication.—To multiply any decimal by ten, one hundred, one thousand, &c., we have simply to move the decimal point one, two, or three places respectively to the right, from

$$2.345 \times 10 = \frac{2345}{1000} \times 10$$
$$= \frac{2345}{100} = 23{\cdot}45$$
$$2{\cdot}345 \times 100 = \frac{2345}{1000} \times 100$$
$$= \frac{2345}{10} = 2{\cdot}345, \text{ and so on.}$$

§ 42. To multiply by any number. Place the multiplier under the multiplicand as in common arithmetic, and proceed as usual, observing to cut off as many figures in the product for decimals as there are figures of this denomination in both the multiplier and multiplicand together.

Ex. Multiply 314·16 by 3·2406.

314·16	Here we have *two* decimals
3·2406	„ *four* „
188496	Total *six*
125664	Therefore in product mark off *six* figures as decimals from the right.
62832	
94248	
1018·066896	

§ 43. The proof of the rule by which we are directed to cut off as many decimal places in the product as there are together in the multiplier and multiplicand may thus be shown:—

$$1 \times 1 = 1$$
$$10 \times 10 = 100$$
$$100 \times 100 = 10000$$

By the examination of which results, as it appears that a multiplier and multiplicand, containing each three figures, are necessary to yield a product which is the smallest integral expression that can be given with five places of figures, so that it is conclusively apparent that no more than *four* places of figures can result from the multiplication of the two largest integral expressions that can be afforded with two places of figures. We know, moreover, that unity multiplied by unity only produces unity, and therefore that the multiplication of the two largest decimal expressions that can be formed, will never yield a product as large, which must consequently be a purely decimal series. Again, the expression ·1 is the smallest decimal that can be written where one place of figures only is employed, and this decimal multiplied by unity still gives a product no greater; therefore, if it be multiplied by another decimal, the largest that can be expressed in one place of figures, it must yield a product less than that which was shown to be the smallest decimal expressible by one place of figures, which product must necessarily, on this account, have two places of decimals. Hence the rule is rendered conclusive. Accordingly, when the product yields fewer places of figures than there are in the multiplier and multiplicand together, cyphers must be prefixed to the *left hand* of the result, till the required conditions are fulfilled.

Ex. $\cdot 1 \times \cdot 9 = \frac{\begin{array}{r}\cdot 1\\ \cdot 9\end{array}}{\cdot 9}$, but the total number of decimals in the answer must be two, therefore we prefix 0, and write ·09.

Ex. 13. Multiply by ten:—

(1.) 1·078, 56·310, ·087, 113·2676, 14·364.

(2.) By a hundred, 345·921, 67·36, 427·614.

(3.) By ten thousand, 31·0097, 610·41263, ·310096.

Find the product of:—

(4.) 120·5 × 41·76, 375·4 × ·057.

(5.) ·0001 × ·001, 32·1 × 2·31.

(6.) 713·72 × 81·076 × 2·03, 16 × 27·1 × ·617.

(7.) 3·04 × ·201 × ·0152, 101·5 × 1·015 × 01015.

(8.) (27 × 31·85) × (3·16 — ·316), (4·198 — 1·7096) × 31·276.

(9.) 1·1 × ·011 × 1·01 × ·0101, ·013 × 1·6 × ·007 × 3·05.

(10.) 2178·6 × 31·74 × 21·72 (61·87 × 2·19 — 3·07) × 4·86.

(*To be continued.*)

THE USES AND VALUE OF SALT.

A correspondent of the *Illustrated Photographer*, having noticed some recent communications on the subject of salt as an article of diet, sends the following remarks thereon:—A really heavy tax on salt is the cruellest impost that can afflict a nation. The first settlers of a colony have described the want of salt as a most severe privation, and stated that the arrival of red-herring, salt cod, or stockfish, has been hailed with public rejoicing. Salt is good for man and beast. For our useful allies, the ruminants, salt is the first condition of health and vigour, and succulence. The experience of most farmers will show the benefit derived from mixing salt with the food of cattle. It appears to be the natural and universal stimulus to the digestive organs, and frequently recalls the appetite more speedily than any other stomachic. It is, besides, a vermifuge which, with cattle, very seldom fails. It promotes the condition of sheep when occasionally sprinkled over their food or placed within their reach. It is the basis of nearly every medicine which has real power over their disease, the rot; and it has often completely arrested its fatal progress. Coarse salt herbage growing near the sea is preferred by cattle to the fattest pasture of the interior, and in many markets the highest price is given for mutton fed in salt marshes or meadows. It was said by One who spake as never man spake, "Ye are the salt of the earth." Salt is a pledge of hospitality. The Arab feels bound to protect and shelter the stranger who has tasted salt beneath his tent. Salt is eminently the element of salubrity and preservation. The household article most highly valued by people living at great distances from the sea is salt. In besieged cities, the commodity whose price rises quickest is salt. Salt is the principle of growth and vigour. Man's stature and strength are said to be in proportion to the salt he consumes. The Patagonians and Otaheitans, the tallest of men, use, or used to use, sea water for cooking their food. The Britons, who live in a saline atmosphere, are the most hairy race of mankind in Europe. Repairers and beautifiers of ladies and gentlemen are advised to note this remarkable fact. Without salt, men could not preserve the provisions, fish and meat, which they have obtained by their toil and industry. Deprive men of salt, condemn them to eat unsalted food, and they soon become infested with all sorts of parasitic vermin. The Abyssinians, who eat much meat, and have no salt, are generally afflicted with tape worms. It is recorded in some book that amongst certain Northern nations the interdiction of salt was the capital punishment reserved for the aristocracy. After weeks or months of a saltless regimen, the culprit sank under the attacks of innumerable parasites. North American stags traverse immense distances for the sake of drinking at saline springs; instinct or family tradition has taught them that it is the only means of getting rid of the ticks with which they become infested while browsing in the woods. Pigeons are passionately fond of salt. There are sundry recipes, some not too cleanly, not only to keep them from deserting their dove-cote, but to entice and retain vagabond and wandering pigeons. There is the bit of salt cod, the roast joint of pickled fox, the lump of clay kneaded with brine and aromatic seeds; but, in all, it is the salt which is the real attraction. Pigeons peck at walls, as goats and sheep lick them, to obtain the saltpetre which sometimes effloresces on their surface. Bees are fond of drinking water decidedly charged with saline elements.

LETTERS TO THE EDITOR.

[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]

*** All communications should be addressed to the Editor of the English Mechanic, 31, Tavistock-street, Covent Garden, W.C.

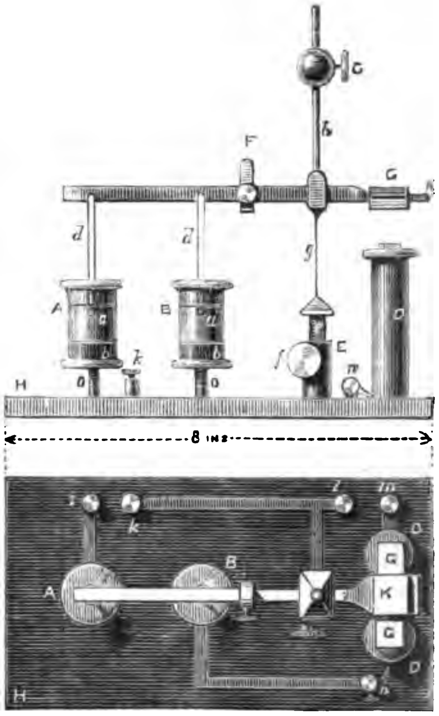
All cheques and Post Office Orders to be made payable to J. Passmore Edwards.

I would have every one write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that, as to other things, knows no more than what everybody does, and yet to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks: a vice from whence great inconveniences derive their original.—*Montaigne's Essays.*

CONTACT BREAKER.

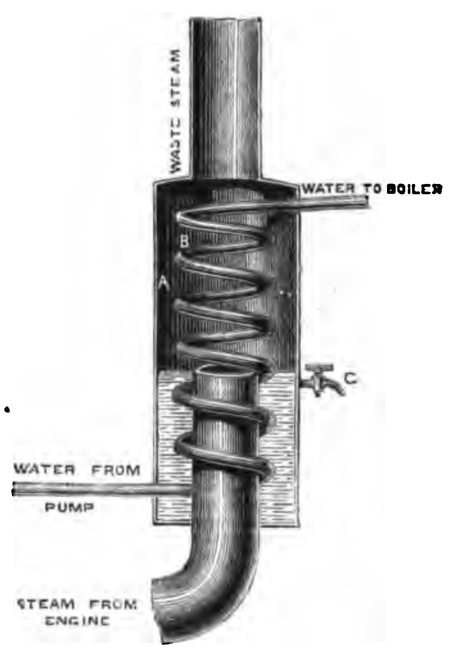
Sir,—I cannot say where you can get Rhumkorff's breaker in England. Any optician that has foreign connections can procure it for you. Stœhrer, in Dresden, I believe is where the one I had was procured. The price was £2; but with patience you may make one yourself. The simplest form I here annex, but it will hardly do if you want to go in for experimenting. I will send Rhumkorff's to the Editor next week. A brass block *e* contains a rack *e* and pinion worked by the milled head *f*. The head of the rack carries a well hammered brass spring *g*, about 2 or 2½ centimetres broad, upon which a copper rod K rests, carrying at one end the armature G, and at the other two platinum pendant wires *d d* (it is sufficient if about ¼in. of the bottom end only be of platinum). The head of the spring *g* carries also a stout brass wire *h*, on which a ball C can be raised or lowered; also the saddle F. The ball serves to regulate the speed of the instrument. The saddle also can be moved about to regulate the balancing of the beam. A and B are the two mercury cups—glass with hard varnished wood bottoms—which are adjustable on the brass screws *o o*, which go through into the mercury *b b*; on the mercury is some good alcohol *a a*. The rack is for adjusting the distance of the anchor from the electro-magnet D; *i* and *k* are the two binding screws for the inducing current, and *l* and *m* for the battery that works the instrument (a single Grove with 6″ by 4″ platinum answers very well). A is therefore the breaking cup for the induction current, and B for the breaker working current. If the instrument goes quick the alcohol is very easily thrown out; which is prevented by the wooden covers, which have a slot running from the centre hole to the circumference to allow of their being taken on or off. When standing, the platinum points should not touch the quicksilver, and all the connections should be made, and the instrument then started by a slight inclination of the wire *h* with a glass rod. In the same manner it is stopped by holding the wire still. The greatest power is obtained when the instrument is worked, so that the time the current is closed is longer than the time during which it is open. This is the same principle as Rhumkorff's, but much simpler. Any other information that lies in my power I will gladly give.

Tangent.



STEAM AND WATER.

Sir,—If "Mancestrian" will introduce a check valve between his economiser and the boiler, it will, I think, effectually remedy the evil he complains of. For general information to "Mancestrian" and others, I enclose a rough sketch of a feed water heater (in other words an economiser),



which I fitted to a 14 horse engine. By allowing the exhaust pipe to project through the bottom of the casing A, all condensed water may be run off or utilised at the outlet C. I made the casing 9ft. long by 18in. diameter, of ½ plates. The internal water coil B was 1¼in. inside diameter, and about 18ft. long before it was coiled. It was a very effective appliance, heating the feed water to within 10° of the steam in the boiler. This arrangement, moreover, permits the pump to be worked with cold water, which any practical man will see is an advantage. I shall be happy to furnish details on application for my address through the advertisement column. **Llah.**

TO MILLERS.

Sir,—I bow in submission to your judgment in respect to some remarks which I have made in relation to some statements in Mr. Sharpe's letter. I could not help smiling when I saw that my letter had made its appearance in public, with both its head and tail severed from the body. Rather keen treatment this.

It does one's heart good to be told of one's faults or weak points. Man generally is blind to these in himself; and he is a friend indeed who has the courage to come forward and point them out; though this may be at times rather trying to proud humanity, nevertheless it may have a very salutary effect upon the patient; and I hope that I am to-day a better and wiser subject on account of this correspondence with my dusty brethren. And I hope also that others have profited something from the hints thrown out by various correspondents upon this most important branch of industry.

"A Stoneman" still adheres to his text about millstone balancing, and I am glad to find that what he says is the result of practical experience; so also is mine, and facts are stubborn things. But while looking at both in the face I must acknowledge that he has arrived at a greater degree of perfection than I have, and am afraid ever shall; but am open to conviction. He says that he has had considerable experience as a millstone builder, and is slightly acquainted with what composes a millstone, &c. He will probably allow others also to know a little about this, though not to the same practical extent, yet sufficient to give an opinion, which is also the result of much thought and experience. He asks why should a stone's standing balance become disturbed when running? An answer to this has been attempted before; but further, the reason in my opinion is simply because the balance weight does not coincide with its counteracting object in its radial distance from the centre. And to illustrate what I say, may I kindly ask him to say whether by the aid of Clarke and Dunham's patent balance he cannot disturb the standing balance when running by lowering or raising the weight? Let me also remind my friend that I did not say that a true and level bedstone was not essential to a standing balance, because I consider a standing balance virtually of no use and practically non-effective. Let me also remind him that I did not mean to convey the idea, "the faster the stone runs the greater tendency it should have to *un*equalise its gravitation." What I meant to convey was, that it would drag even at its greatest velocity. If he will be kind enough to refer to my letter, I think he will find this to be correct. I desire here to say that I am far from considering "A Stoneman" ignorant or unpractical, but far otherwise, and thank him personally for his opinion.

Thos. Evans.

Sir,—I read in your journal with pleasure the remarks of your correspondents on millstone balances. There is evidently a great difference of opinion as to the merits of the running balances. I confess I cannot see what use they are. I maintain that if you keep your stone properly balanced when standing, and with a good face and nicely dressed (so that it may carry a good feed), and last, but not least, keep your driver right, you have no need to bother yourself about expensive patent balances. Of course these remarks may be much criticised, but it is the result of many years' experience and study.

Millstones, like other things, differ in their nature, and it would be idle to define a certain mode of dressing them; this is entirely left to the judgment and common sense of the stoneman, who alone can make them work as they should. I may mention here that I have a stone that will run empty as well as grinding, and it works no better than any one in the mill. I perfectly understand what running balances are designed to do, and would fully appreciate their good services (if any), yet up to the present time I am at a loss to understand why practical millers should value them so highly.

I should be glad to hear more under the above heading from your readers, and especially about silk dressing machines. **J. S.**

Sir,—Your correspondent "A 'Stoneman" says he has asked many millers for their opinion on millstone balancing, but till now could get no direct reply.

I am not surprised at that being the result of his inquiry, but I think if he studies the information that is to be obtained in the pages of the English Mechanic, he will soon be able to give a direct answer to any one who asks his opinion, and will also see the value of "science combined with practice," but he must have patience if all at once he cannot understand how the unequal density of the materials of which a millstone is composed is acted upon when rapid motion converts gravity into centrifugal force, but the same laws govern the motion of the millstone as hold the world in its orbit round the sun since its first being launched forth into space. In these pages we have the scientific freely imparting their learning, and in turn asking questions of the practical workman. Such a bond of brotherhood the world of literature has never before seen. Other papers, seeing the success of the English Mechanic, are playing "second fiddle," but to the English Mechanic must be awarded the leadership, and the results must have far exceeded the most sanguine anticipations of the proprietor—but I have no business to wander from my subject in hand, as I generally try to write only what I know to be of practical value, but just this once I trust our Editor will allow me to scribble upon what I know but little about. I see a "Clerical Correspondent" rather out of his depth when he recommends working steam engines by clockwork, instead of coals, and I think that by admitting such letters as John Bearsley's, page 134, the English Mechanic, does good, as harm would be done if they were excluded, for many of those who have valuable practical knowledge, are so completely ignorant of all scientific method, that they do not even know of its existence, but I feel sure the correspondent "A Stoneman," for whose benefit I now write, will not remain one of this class, but will endeavour to combine the pleasure and advantage of scientific and practical knowledge which is necessary to understand the balancing of a millstone in motion. **R. R. Smith.**

THE EARTH'S FORM.

Sir,—Last week I had something to say to Mr. Beardsley, this time I will try to entertain your readers with some astounding stuff published by Mr. Hampden, one of "Parallax's" apostles. This is the person who recently proved his faith and his folly by staking £500 on the question whether the earth is round or flat. He has published a pamphlet, "God's Truth or Man's Science, Which shall Prevail?" God's truth has no enemy more deadly than the man who sets it up as something opposed to man's science, for man's science, based on facts, is *sure to prevail*, and thus contempt is thrown on God's real truth by its supposed association with proved error. The most remarkable thing about these people, is the cool way in which they misconstrue scientific opinions, and stick up a man of straw for the purpose of knocking it down, and then triumphing in their victory. Thus; Mr. Hampden describes two vessels leaving land, one going out till "all but her mizen masts will have vanished" (whatever this may mean I cannot say); the second, till "just as she appears to be on the crest of the horizon," and both brought to a stand still; the spectators now go to this last, where they "expect to see the first with their topmasts on a level with the decks of the vessel on which they are standing, and they themselves considerably overtopping the level of the coast from which they started." They would expect nothing of the kind if they held the true scientific opinions. "But, oh, their dismay at finding themselves in an apparent hollow, and both the vessel ahead, and the houses on shore, at a considerable elevation above them." They would find nothing of the kind. This miserable farrago is set forth as facts and argument. Surely it would have paid Mr. Hampden to have gone, say over to Calais, before staking his money, he would then have seen what really does occur.

The trial made was this; three marks were fixed at the same height above the water, at distances, I believe, three miles apart, and a telescope at either end, showed the middle one some feet above the straight line joining the two end ones, as of course it must, owing to the curve of the earth. Furious at this, the wiseacres now fall back on the ordinary effect of distance or perspective, which has *no effect on a straight line at the level of the eye*, as in this case. Unable to comprehend the simple fact, they assert that the scientific view of this means that in the first distance there is a *rise* followed by a fall, whereas the simple fact is, that a telescope *levelled truly*, would at any station point considerably *above* any object at the same height as itself from the water; thus Mr. H., after showing the *fall* the curve would appear to produce, triumphantly exclaims, "But mark, when they get to the end they will be required to retrace their steps, and show this time a *rise*, where they showed a *fall*." His mind cannot conceive the curve, or the simplest principles of the spherical doctrine. In his wrath he published another pamphlet, "The Bedford Canal Swindle Detected and Exposed," and I will furnish a few extracts, which will show clearly the remarkable sense, honourable feeling, and Christian charity of this wonderful champion of "Truth."

"Mr. Hampden took up the subject, *simply and solely* relying on the fact, that the Bible, or Scriptural evidence, as far as it went, uniformly ignored, if it did not directly oppose, the notion of a globular earth." Simply enough, goodness knows; on the same grounds we may as well deny the existence of the electric telegraph and the steam engine. I am pretty well versed in Scripture, and to the best of my knowledge, it very thoroughly ignores, "if it does not directly oppose" (as it might very easily be twisted into doing) these samples of man's science. Having issued his challenge, he says, "so little confidence did the pretended philosophers and engineers feel in their theory, that it was not till several weeks that a solitary reply was given to this challenge." Of course not; it was looked upon as a "skit;" no one supposed that there was any one sufficiently foolish to have meant it, and few true men of science would condescend to literally plunder the poor creature. Here is charity: "If there is one class of men, next to horse dealers and jockeys, who bear the unenviable reputation of being the most tricky and unscrupulous in their assertions, it is the members of our scientific societies; to nothing but their unscrupulous falsehoods and boldness of assertion, are the astronomers and philosophers indebted for much of the reputation they possess." "Knaves and liars," and so forth, are abundantly scattered; "the cowardice of the scientific world equal to its knavery;" "shifty, dodgy," &c., one meets every other line, and all this from a man whose sense of truth is so weak, or his knowledge so profoundly little, that he has the assurance to say, "they have never made a single experiment, the truth of which can be incontestably proved, and they stick to their insane theory because it is ingenious." All this, too, about men who spend their lives in experiment, and who deem their greatest triumph, the finding something *new*, never hesitating to attack each other, and about doctrines mixed up with all our knowledge and all the commonest affairs of life, and so brought to hourly tests.

There is just one line of truth in the two pamphlets. "*One* single proof would be worth a thousand mere assertions." Will Mr. H. just take that one piece of truth to his own heart? One rag of an argument this pious philosopher gives. "If, while praying to our Father who is in heaven, during the day, we should raise our hands and eyes towards the sky over our heads, we must, when similarly engaged during the hours of night, direct our eyes and thoughts to a spot down through the floor or over the side of our bed. It is no joke, this is the positive fact." N.B.—These last words are part of the extract; please repeat them and continue. This miserable twaddle is actually offered as an argument on a scientific subject. Does Mr. H. suppose the Infinite Father is in the sun only, or what does he mean by insulting our common sense. Then for honesty, "and 999 men in a thousand, in the possession of their senses, believe these villanous assertions of *less than half a dozen* infidel philosophers, without one atom more proof than they have for believing that every house in London was built by the fairies." This is of what the whole educated world knows to be proved and tested truth.

When gentry like Messrs. Hampden and Beardsley have answered the simple facts set forth in my last letter, page 163, it will be time enough to answer their objections as to what may, might, could, would, or should result from the theory of the earth's globular form. **Sigma.**

PHOTOGRAPHIC.

Sir,—Under the column "Useful and Scientific Notes," and the heading "Something New on Silvering Paper," I read something that I would wish our readers and others to especially avoid.

In my former letters on "Printing," I advised the drawing of the paper over a glass rod at the end of the dish—*i.e.*, for small pieces of paper, on no account for large. Now a glass rod is more easily kept clean, or cleaned at any time, than the side of a dish is, consequently we run less risk of soiling the paper. So much for the first part of the article. Now for the blotting-paper part—by all means shun that. I once tried it,—the result was dull prints. Now, what can be worse than a dull print? Besides that, there is a grave fault with the blotting-paper. As you place sheet after sheet of sensitive paper, the blotting-paper absorbs the moisture, and of course it goes on the back of the next sheet; the consequence is, your silver goes *into* the paper. That is what makes the *dull* print. If it were not to prevent the silver from going *into* the paper we should float longer. I have proved, and can still prove, what I say to be true.

I sincerely hope that our photographic friends will not try it. Better waste a drop or two of solution than turn out bad prints. Let us not be contented with inferior work, There's no medium; a thing is either good or bad, and, above all, let us avoid rushing madly at every new "dodge" that turns up. When you have *good* work, be satisfied.

Photography is an "art-science," and we should do all in our power to promote and show forth the art qualities of it. With a little care and study it is just as easy to take a landscape or a portrait in an artistic manner as in an *in*artistic one. *Apropos* of art, photographers and other artists will do well to read Mr. Robinson's work on "Pictorial Effect in Photography."

Mus.

P. S.—I have tried that method of taking stereos of busts, &c., mentioned a week or two ago, and find it answers very well. I will enclose one later, that you may judge for yourself.

MR. VIVIAN'S REPLY TO "F.R.A.S."

Sir,—Anyone reading that part of "F.R.A.S.'s' letter which refers to mine (p. 135), might imagine that my calculation is incorrect, which I must deny. The rule he states certainly does give the focus of a crossed lens, but it is the geometrical focus, or such as it would be supposing the refractive index to be unity. Now, as the index can in no case be unity, of course the rule given by "F.R.A.S." will not give a proper result, but if such rule is to be made use of, the result obtained must be diminished by dividing it by a quantity to be arrived at by multiplying the actual refractive index, less unity, by 2, for this case 0·524 × 2 = 1·048. If "F.R.A.S.'s" expression be worked out, and the result divided by this number—*i.e.*, 1·048, it will give the true refracted focus, which will be found to be only a very small fraction of an inch more than 82in., or 6ft. 10in. I may add that I have not attempted an independent calculation. All that I have done is simply to adapt Herschel's curves, given in his work on the telescope, referred to by "A Fellow of the Royal Astronomical Society," to the foci referred to by "Neptune," and to offer if that is not sufficient to do more. I do not make light of the calculation. I shall have to go through it if this is required, though I should have thought that a practical astronomer like our friend, who must be used to rather long computations, would not have made much of it. **Henry T. Vivian.**

COTTON SPINNING.

Sir,—It is with great satisfaction I see the above important subject receiving consideration in your columns. Let us hope that every person will write what he knows, and no more. Let him be sure that what he sends is right before he communicates it, and bear in mind that wrong ideas on any subject are something like an infectious disease—very catching, and sometimes doing much mischief. People generally act practically on the information they receive; a false or thoughtless statement may do mischief to no small amount. The boon you are conferring upon us by opening your pages for discussing matters appertaining to cotton spinning is great. In the first place, it will afford us that grand privilege which so many of your readers enjoy, the means of hearing, or rather reading each other's opinions on various subjects, about which (as in all other arts or studies) there is a great difference of opinion. Secondly. It will be the means of showing this branch of our manufacture in its true light, not (as many suppose) as a "slavehouse" for human beings, but as a great school, where there is almost as much to be learned and explained as there is in the Observatory at Greenwich. Thirdly. It will, I hope, be the means of bringing hundreds of fresh subscribers to this "means of knowledge," for it will supply a long-felt want.

"Factory Lad" last week asks how a draught of 7 should be distributed between 4 sets of rollers. It depends upon circumstances. If his carding engine has a draw box, and a draught of about 2, *then* he can handle it pretty strong, as the fibres are already straightened ready for drawing. But if he has no draw-box to his engine, or only one with a draught of say 1·25, if he will examine the sliver, he will find the fibres all ways, and it will be seen that under the above circumstances it would be foolishness to subject it at once to a great draught, therefore it should be "coaxed" straight. Under these circumstances, "Factory Lad" will find the following the best distribution of his draught:—Between back and 3rd, 1·25; between 3rd and 2nd, 1·87; and between 2nd and front 3; total, 6·99.

"B. W.," Rochdale, talks about a draught between lap and feed rollers. Now there is not—or rather, *ought not* to be—any draught at all there. What use would it be? The lap should be delivered just as the feed rollers want it, neither slower nor faster. "B. W." must bear in mind there is no draught between the doffer and delivering rollers, but a *contraction*.

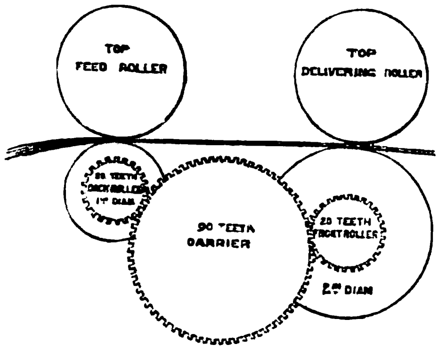
HARMONIOUS COTTON SPINNER.

Sir,—I have read a letter on "Cone Roving Frames," in April 22. "B. W. R." says it is immaterial whether the bobbin leads the flyer, or the flyer leads the bobbin; if that be true, I should like to know the object of the frames being made to gear in that form, which appears to be the general rule according to a Mr. E. Slater, April 29, page 133, if there be no advantage in the make of the thread by running the bobbin quicker than the flyer In my opinion it is a disadvantage to the wear and tear of the machines, besides taking more power to run the bobbin 11 to 1, than would be required to run it 9 to 1 of the roller. My reason for seeking information is because I have been a worker of cone frames 10 or 12 years. In Taylor Wordsworth's make for worsted, the gearing is so arranged that the flyer must lead the bobbin. Multiply the diameter of delivering roller by the revolutions per minute; for a dividend divide by the diameter of bobbin, the quotient subtracted from the speed of spindles per minute will give the number of revolutions the bobbin will make per minute. Since I read "B. W. R.'s" remarks, thinking there was something in the make of the thread, I tried to run the bobbin quicker than the flyer, but on account of the gear I could not.

E. HALMSHAW, Gomersal.

Sir,—If I am not mistaken, "Mutual Improvement," page 111, intended the question propounded by him to be somewhat ambiguous, as the rule he quotes cannot be "strictly correct," because it takes note of no draught in the carding engine, save that between the "feed rollers" and "doffer," although there are two other draughts outside it; so that obviously, the draught of the engine must be the total of the three. The first draught is between "lap roller" and "feed rollers;" the second between "feed rollers" and "doffer" (for finding this one the rule is correct); the third, between "doffer" and "calenders." There formerly was a "draw box" attached to each carding engine, for the purpose of adding to the draught of the engine a considerable amount—some have them still, because they are "penny wise and pound foolish." It may also be said of the draught of any machine, the theoretical draught is not often the working one, as the latter depends upon the qualities of the cotton, and varies accordingly.

A word now for the lads on the subject of draughts. The term, as used in cotton spinning, means the drawing out, into greater length, of the fibrous bands of cotton, by the rollers through which they pass in the process of manufacture. The cause of this drawing out, or draught, is the accelerated surface speed that is given to each "line" or "row" of rollers in a set, from back to front. Now, as you know, the "top" and "bottom" rollers seize the cotton between their surfaces as they revolve, and draw it forward at the same rate of speed as they themselves are travelling, the back ones taking it in, or "feeding," and the front ones sending it out, or "delivering" it. If, then, we wish to find out how much longer the yarn, or sliver, is being made by any set of rollers through which it is passing, or, in other words, if we wish to find the draught of the rollers, we have only to find out how much faster the surface of the front one is travelling than that of the back one, by dividing the speed of the quickest by that of the slowest, and the quotient is the draught. Look now at the sketch, take the back roller to be 1in. diam., and the front one to be 2in.; as the front roller generally drives all the rest, you must take it to have a wheel on the end of it with 20 teeth, this drives a carrier of 90 teeth, which communicates its motion to the back roller wheel, with 20 like the front one. It will be evident to you, that although the carrier has 90 teeth, it cannot give any greater or less speed to the back roller than the speed of the front one, because it transmits its given motion from the same diameter it receives it, and the back and front wheels must both make an equal number of turns in a given time, because they have both the same number of teeth. What is meant by "a given time" is the time you might fix upon if you were making an experiment, as one minute, two minutes, or any time you please. Let us now suppose these rollers are making 40 revolutions per minute, how much farther will the surface of the front one have travelled than that of the back one? If we multiply the diam. of a circle by 3·14, we shall get as near the circumference of it as we require for our purposes, and the circumference of a circle is the distance it would travel if turned once round. Then 1in. diam. of back roller, × 3·14 = 3·14in circum., and 3·14 × 40, the number of turns = 125·60in., the distance travelled by the surface of back roller, and consequently the length of yarn it would take in during a minute; and 2in. diam. of front roller × 3·14 = 6·28in., its circumference the same as before, 6·28 × 40 = 251·20in., the distance travelled by the front one. Now if we divide the latter distance by the former, we evidently get the draught, as 251·20 ÷ 125·60 = 2, the draught of the rollers. They would draw out 1in. into 2in. This example shows us that the draught is the result of surface speed, and not of speed of revolution, as both the rollers make the same number of turns, that is 40. Again, the circumference of a circle is always in proportion to its diameter, so that in this case we could have found the draught by simply dividing the diameter of the front roller by that of the back one, seeing they have a similar speed of revolution, as 2 ÷ 1 = 2. You will observe also, that the draught must *not* be called the difference in the speeds, although it is the result of such difference, because the difference between 1 and 2 = 1, as 2 − 1 = 1, or 10 − 5 = 5; but if one travelled 10in. while the other travelled 5, the draught they would cause would be 10 ÷ 5 = 2, and not 5, which is the difference between 10 and 5. And further, suppose you wish to draw out 5 hanks into 50 hanks, the draught required would be 50 ÷ 5 = 10, not 50 − 5 = 45. You may call it the geometrical ratio between the two travelling speeds, its measure being the quotient obtained by dividing the greater by the lesser. In a future letter, I will endeavour to make you understand the matter entirely. Perhaps some may think that I am treating the subject in too simple a method; if so, I am not writing for such as they, but for the lads, and I know from experience that, to them, the more simply I speak, the more useful the information. There are hundreds and thousands of factory lads, adults if you will, who, like myself, have not had the opportunity of attending a school, or at most, only for a few months at the time, when they were too young to learn anything that required study, or the action of reasoning powers, and what may such as these do but pick up and scratch off information from anything they can? If the thing has too much weight in it, they cannot pick it up, and if it be too hard, they can scratch nothing off. The ENGLISH MECHANIC is doing a marvellous work, and judging from the common sense views of its Editor, and the many gentlemen who contribute to it, it must go on working in the future until it comes to be looked upon as one of the little beginnings that has been developed for a good purpose, and carried out to a great end. The enterprise itself is the fulcrum, its pages are the lever, and all who will may take hold and sway down as much as they can, until we are raised up from a state of chaotic ignorance, to one of scientific knowledge. If now, some of the kindly F.R.A.S.'s, who have such great strong hands, instead of being generous and courteous, were to be thoughtless, and if, when they put their hands upon the lever, they crush and bruise the fingers of their less gifted brethren, so much that they made them tired of the good work, how unfortunate would be the result, and how contracted would be the sphere of its usefulness! Let the MECHANIC, then, come to us like the sunshine, tempered so that the light it diffuses may be gladness in the high places, and health with happiness in the lowly ones.



Edward Habergham seems to have had an idea that the anomaly he speaks of is not anomalous—no more it is. The avoirdupois pound contains 7,000gr., and in weighing cotton, 24gr. make 1 dwt., but 20 dwts. do not make 1oz. He was mistaken, I think, when he said we are told so—$437\frac{1}{2}$gr. = 1oz., and $437\frac{1}{2} \times 16 = 7000$. Have you been trying to work "Egyptian" and "Surat" together, Edward, or avoirdupois and troy, eh? Let "Factory Lad" page 136, divide his 7 by 3, and make the draughts of each line of rollers in the drawing boxes equal, as $2\frac{1}{3} + 2\frac{1}{3} + 2\frac{1}{3} = 7$, or $2\frac{1}{2} + 2\frac{1}{4} + 2\frac{1}{4} = 7$. If he is working "middling American" cotton, and "putting up" six ends, let him, if he can, reduce the total to 6, and get his rollers as near together as he can, unless their diameter be no more than the length of the staple.

E. SLATER, Burnley.

Sir,—The question asked by a "Factory Lad" p. 136, on the proportionate draughts in a drawing frame with four lines of rollers, is one on which he will find much diversity of opinion to exist amongst practical cotton spinners. I willingly give my opinion, and hope others will do the same, although I know that in first-class concerns, where different systems prevail, particulars of this sort are generally regarded of some importance, and as secrets belonging to the business, not to be divulged to rival spinners. Whatever scruples there may be as to furnishing information of this sort between individual firms, with a publication such as the MECHANIC, such scruples are inadmissible, and may be disregarded.

For a medium-stapled cotton, I should place the draughts as follows:—

Between	Front & 2nd rollers		2nd & 3rd		3rd & back
Draught	2·65	×	1·92	×	1·38

total draughts

= 7·02

To keep the ball rolling I should like to see opinions pro and con., on an up or down draught in a scutcher.

B. W. R.

DARK LINES IN SOLAR SPECTRUM.

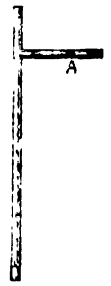
Sir,—In reply to Mr. Proctor, I cannot give any evidence based on my own observations of the dark lines in the spectrum, not possessing instrumental means for taking them. If he does, I fancy the question of their origin can be determined in this way. Suppose such a day as that described in my letter on p. 658, Vol. X., is selected for an examination, commencing with the sun on the meridian. If the dark lines are broad and clear, and they diminish as the sun descends to the horizon, we may safely refer them to solar absorption. If, on the contrary, they are narrow and indistinct, but widen out with the descent of the sun, then their terrestrial origin is plainly shown.

T. A.

["T. A." says he cannot give any evidence "based on his own observations." Does he not know that observation of phenomena is the initiatory step in scientific investigation? Why go on guessing and supposing, without observing? If "T. A." would observe first and infer afterwards—record facts, and then generalise, it would be better for him and others. A man like "T. A." may go on speculating on "ifs," and fancying questions for a lifetime, and still be no wiser. For thousands of years, up to the time of Bacon, men—and great men too—proceeded as "T. A." does. And what did they do? Certainly not much. We mean nothing offensive when we state a million of men might pursue "T. A.'s" method for scores of generations, and Science would be nothing but a chaotic guess.—ED. E. M.]

DRILL FOR DRILLING STONE AND BRICK.

Sir,—I have sent you a rough sketch of a drill which I have used for drilling stone and brick; it is an arm which you hold with one hand to turn the drill whilst you strike with a hammer in the other.



A COUNTRY LAD.

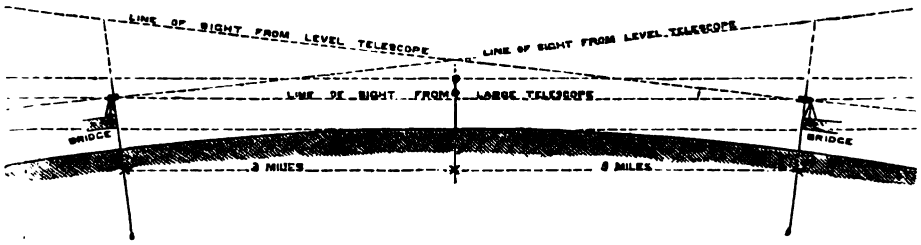
PLUMBAGO v. PLATINA BATTERIES.

Sir,—In your last, T. S. Conisbee refers to the use of plumbago in the place of platina as an aliment and containing cell for the nitric acid battery. I hope for the good of all of us interested, you will find space for my opinion on the merits of plumbago and platina. About 1843 I was experimenting upon the power of various forms of batteries, both platina and carbon, and then discovered that the plumbago could be made the porous cell for holding the acid. I had several forms of them made, round and flat, which gave great power for hours, a description of which was given in the *Practical Mechanic and Engineer's Magazine*, Vols. II. and III. The only difference between my arrangements and the newly-invented one is the putting the stopper upon the old invention, thereby increasing its defects. After years of experience, I am in a position to state what can be got from plumbago or platina. First, plumbago, charcoal, or gas coke, all of which have been found to give a powerful current in contact with strong nitric acid, are by far the cheapest to get up, and work well for some time; but, unfortunately, they get filled in their pores with a glut, get detached from their connections, or crumble down after drying, requiring frequent renewal and repair. Now, as to platina, the first cost is somewhat additional, but if often used it soon proves the cheapest. And here I would advise all who wish to have a good powerful battery not to use the thinnest platina foil; get it somewhat stout; make the connections a short distance from the fluid with platina, coat well with shellac, use the strongest nitric acid, saturated salt and water with the zinc porous tube, soft pipeclay, wood, or vegetable parchment, and you have the simplest and most powerful arrangement yet known.

A. FARQUHAR.

THE BEDFORD CANAL EXPERIMENT—SIX MILES.

Sir.—As a correspondent has asked for some particulars respecting the above, I, having read all the correspondence, and tested the experiment on paper, will, with your permission, reply. In the first place, I may state that the flat theorists cannot seem to comprehend the laws of gravitation and the rule of tangents, together with the laws of perspective. The first experiment consisted of sighting from end to end with a 5-foot telescope, the line of sight forming a tangent with its centre in contact (to a sphere), the centre signal appeared approximately over 5ft. above it, thus proving that the three points were not in a straight line, but that by adding refraction, making 6ft., a curve with the radius of the earth would intersect the three points. The diagram of this experiment was signed under protest by the globular opposer's referee, for what reason would appear strange to us who know the rule of three "boring sticks." The next experiment consisted of sighting from end to end with a Troughton's level, the line of sight (in this case) forming a tangent with its point of contact at the first station. The centre signal (if reversed) appeared below the cross hair, and the end signal below the centre one; thus proving that they were not in a straight line, but dipping from the tangent.


LINE OF SIGHT FROM LEVEL TELESCOPE
LINE OF SIGHT FROM LEVEL TELESCOPE
LINE OF SIGHT FROM LARGE TELESCOPE
BRIDGE
BRIDGE
3 MILES
3 MILES

This experiment was reversed at each end, with the same result. But the globular opponent's referee argues that as the two signals and cross hair appeared equidistant from each other in the telescope, for that reason they must be in a straight line from end to end, and that the apparent dipping must be the result of perspective diminution; but those of us who know anything of the laws of perspective could inform him that all objects standing upon a straight plane with their tops the same height as the eye, must line with and cut each other, and that the bases only will vanish towards a horizontal line passing through the eye. If the signals and cross hairs were equidistant, it would prove curvature; to wit, if the end signal dipped (less refraction) 20½ft., the centre one would dip 7ft. 8in. By making a side view on paper it will be found to be a curve (horizontal scale, say 1in. to a mile, vertical, ¼in. to a foot).

The problem may also be tested perspectively by measuring the dips on the vertical picture line. But as this curve does not give the theoretical value—viz., 5·14ft. in 3 miles and 20·57ft. in 6 miles (refraction deducted), as partly proved in first experiment, we have good reasons for doubting this equidistance. For the theoretical curvature the centre and end signals should appear twice as far apart as the centre signal and cross hair—as may be tried by a perspective problem. In the diagrams of Mr. Wallace's referee they are shown about in that proportion, but as all the diagrams seem to have been rough sketches, they must be taken approximately, otherwise a micrometer should have been used. A curvature has been proved, therefore, on Mr. Wallace's side, although doubted by the opposite side. We may also consider it (in the absence of minute measurement) as the theoretical value, viz. :—

sighting 5·14 + refraction ·86 = 6ft. in 3 miles.
sighting 20·57 + refraction 3·43 = 24ft. in 6 miles.

The diagram represents a geometrical side view of the combined experiment, with refraction lessening the actual dip.

E. Y. POOLE, Grovetown, Weston-super-Mare.

FACTS WANTED.

SIR,—I confess to being somewhat sceptical about the astounding theory put forth by Mr. Henry W. Reveley, of Reading (No. 266), respecting speed and power in locomotive vehicles. If I understand his assertion rightly, he states that the higher the rate of speed at which a vehicle is driven, the smaller will be the amount of power required. If such a theory could be substantiated in practice, it would certainly be a grand thing for we poor velocipedists, who are held down to something like eight miles an hour, by those mortal enemies to progression, gravity and friction. If the statement be true, that the higher the speed the smaller the power required, it follows that there is such a thing as a speed so high, that no power would be required at all. And having got thus far, might it not be possible to coax our vehicle to put on a little additional speed, and so create a little surplus power to be applied to some praiseworthy object, such as grinding the coffee or churning the milk (*vide Punch*), while we were taking a short canter, (50 or 60 miles) on our velocifere, before breakfast. I have read Mr. Reveley's epistle with much interest, and will become a convert to his doctrine when he brings one or two facts of vehicles of any description ever having been driven with less power at a high speed than a slow one. J. HASTINGS.

SCREW IN CHUCK.—TO "HEATHEN JACK."

SIR,—If you study "A. B.'s" drawing you will see that what you suppose to be a left hand screw is a right hand *female* screw *shown in section*, and, therefore, has the lines representing the thread, slanting the same way as an outside male thread. As to the other point, you misquote my letter by leaving out the words "of the mandrel," after "each end." I meant that the mandrel is double ended, and carries a chuck on each end at the same time, which necessitates one being screwed right hand and the other left. Lastly, it is by no means uncommon to find right hand screws inside the cylinders of back centres, and many prefer it, as it renders forcing up a drill easier work, owing to the workmen only having to lay hold of the fly wheel on the screw, and keep pulling. So I don't think it wrong altogether. J. K. P.

JUMPING FROM THE TRAIN.

SIR,—In reference to your correspondent's view on the subject of "Jumping from the Train," will you permit me to suggest what I think is a somewhat different view on this subject, but one that appears to me the correct one, and one that, I believe, has stood the test of experience with guards and persons in a position to need the jump for safety when a train has been proceeding with great velocity. It is to throw yourself with backward jump slightly inclining the contrary way to the direction of the train. Of course it will easily be seen that when the feet reach the ground their motion will be arrested, but the rest of the body will fall violently in the direction taken by the train. If the jumper jump face forwards away from the engine, he will come violently on the back of his head; if his jump be, as I state it should be, his fall will be on his face, but he will have his hands ready to break his fall. If his jump be with the train, forwards, he will add his own velocity to that of the train, which needs no addition. The ordinary idea is to jump forward in the train's direction; this will answer, and is the only way when the jump is from a carriage drawn by a horse; but when the velocity is that of steam, 30 or 40 miles an hour, the action must be different.

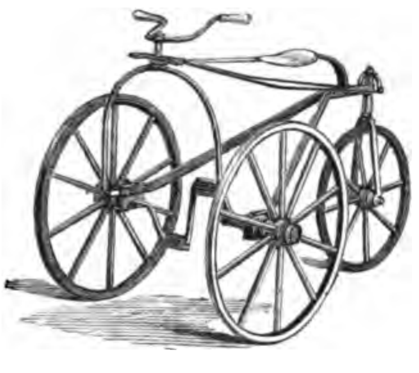
A very active little station master, well known to those who frequented Leicester station 12 or 14 years ago (Mr. Tyers) is, I believe, my authority for this view, and it was more than once tested by his experience. I trust, however, neither I nor any of your readers may ever be in a position to require to try any method of leaving a train, but should it be our lot, there appears to be more philosophy in this one than in any other. O. W. W. G.

SLOT CUTTING.

SIR,—I enclose a couple of tools and sample of work for "F.R.C.S.," which I shall be obliged by your letting him have on application. J. K. P.

TRICYCLE.

SIR,—Enclosed is photograph of a tricycle I have invented. You will perceive it is driven by the front wheels and steered by the hind one. I have tried all ways, but this is the best arrangement. The connecting rods from the hind wheel to the steering handles are not in the way of the legs; 9 miles an hour may be attained with about the same exertion as walking, and with 3ft. driving wheels and a little more power I can drive it 12 miles an hour. I have driven it up all hills I have come in contact with, and have never had a fall from it. This is the effect of having the two wheels in front. JOHN A. LEY.



THE SALTAIRE-WARDOUR STREET LATHE.

SIR,—I am not quite able to make out "Natural Flat's" letter, p. 162, whether he asks for information in good faith, or to rile me by saying I state more than I can prove, or to defend the writer of the article which appeared with the drawing, or to make me commit myself to some further statement that cannot be borne out, with the notion that what I have already written is actionable somehow, only that I am not deep enough in the mud yet. He is enough at home at Mr. Smith's and Mr. Salt's to be able to compare their two lathes, and to promise specimens from—it is not quite clear which. So he can't be at a loss for information.

I am sorry, as he is, that the description given was so meagre, and I am sure that the writer could not know much about the capabilities of the lathe, or he would have felt real pleasure in describing some of its novel features.

Now as to my statement—which I should have been a born fool to make if I did not know what the facts are. I said a "great part" was rejected. Now I might defend the expression by saying that a purely ornamental lathe does not of necessity involve either bed, standards, fly-wheel, crank, treadle, or poppet-head, so long as there is a mandrel with means of driving it either by hand or power, and a slide-rest; but this lathe is equal to a little more than marking crooked lines with pencil on paper, which is about as much as many an expensive geometric chuck can do, and therefore in estimating the "great part," we must take bed, standards, &c., into account. Now the lathe, when it came from Yorkshire, consisted of—firstly, one bed fitted to; secondly and thirdly, two standards; fourthly, one mandrel-head fitted with mandrel and pulley; fifthly, one poppet-head; sixthly, one fly-wheel fitted to; seventhly, one double-throw crank. There was no treadle to it. The rejections were—firstly, one mandrel-head with mandrel and pulley fitted; secondly, one fly-wheel fitted to; thirdly, one double-throw crank: these parts were remade. The leading screw, saddle, and everything else except the poppet-head, which I have since heard was altered to correct the fault I pointed out, were made by Mr. Evans. The saddle to carry the slide-rest was first made to Mr. Smith's design, and had to be altered to make it act. The present fly-wheel is not the one which came up at first, though of the same pattern. I have already spoken of the overhead motion, and see no reason to alter my opinion.

As Mr. Evans's account amounted to some £1200, it is pretty clear either that the lathe was made by him, or else that he had a very large sum of money paid him for not making it. J. K. P.

COMMERCE AND TRADE.

SIR,—Many fallacious ideas are based on such figures as those quoted by "Saul Rymea," p. 161. Statistics are perfect edge tools, and want careful handling, while they can be made to do almost anything. It has been no uncommon thing for even statesmen to cry out because imports exceeded exports in value, *we should be in a bad way if they did not do so.* The difference on the totals, if these could be really ascertained, which is a thing impossible, would represent the cost of carriage, or shipping, and our profit. Would a man of business think himself well off if his sales, or exports, exceeded in value his returns, or imports? Well, the same holds good of the nation's commerce. Further, it is said, "But we have to pay the difference in gold"; be it so. Is the gold we receive or the bills of exchange, *included in the imports?* Australia sends us millions yearly in exchange for goods which count in the exports. Then it must be remembered, England is the banker of the world, her business accounts cannot be balanced at one point, they include those of too many branch houses; her profits can only be ascertained in connection with the operations of the whole empire, nay, the world. Meanwhile, her material wealth is vastly accumulating, and being capitalised in the form of railroads, a commercial navy, such as no other nation, or all other nations together, cannot approach; in constantly increasing loans to foreign nations; in works erected all over the world by her money, and bringing to her an annual return. These facts are much better evidence of the balance of profit of England's trade than any deductions from very imperfect and little-understood figures.

SIGMA.

CHEMISTRY.

SIR,—Lately some articles on various points in chemistry, have appeared in your columns, doubtlessly as cleverly written as usual, although, as a rule, they are more or less superficial; still, though they may be useful as showing their authors' views, they are seldom so for much else, being usually very elementary, are not necessarily the generally received views, and do not often exhibit more than one of the many sides to a question.

Those of your readers who wish for a thoroughly reliable and scientific dissertation on the question of "atoms," &c., had better refer to the "Journal of the Chemical Society" for September, October, December, &c. Despite the fine defence of the "atomic theory," or rather of the single branch of it, it would appear to be doomed as admitting of no proof at present, though it is probable, nay, very probable; therefore we must regard as certain, that the branch of the atomic theory containing the assumption of "*fixed material* indivisible atoms," will gradually be abandoned. But it must be remembered that the assumption of the existence of these, we may term them, "materialistic atoms," as was well pointed out at the meetings of the Chemical Society, "is not necessary to the Atomic Theory," and Dr. Williamson did not even attempt to prove the existence of them. No, the atomic theory is based on a much firmer foundation, that of "chemical equivalentism," which has been so decisively proved by Stas to be correct.

Nature has a paper by Dr. Olding, on "Chemical Notation," an attempt to defend the system of symbolic equivalent notation on a basis apart from the theory of Dalton's materialistic atoms, which he, along with many of our most distinguished chemists, abandons. Though it will fulfil its purpose, it is not a very good defence, though coming from Dr. Olding, of course correct. It is, however, unnecessary; the theory of definite equivalents, which has not been challenged, and on which his own defence rests, is of itself the best and most complete defence of our system of equivalent notation. Neither is the paper in Dr. Olding's usual brilliant and conclusive style, and is not so forcible as would be expected from its distinguished author.

The views originated by Professors Wanklyn and Williamson, radically modified and amended, it is true, are gradually spreading, and give hope that the mist so long persistently enveloping the questions of valency, radicalism, &c., is at length being dispersed. They are, it is true, still in great confusion, and very rough, but this disorganisation is due to the magnitude of the work, and they are gradually being brought into better condition. Undoubtedly it will prove a laborious task to reduce all to a proper system, and all parts may require great revision and amendment. When it is finished, and that I hope before long, we shall have the questions of valency, di-, quanti-, and multi-valency; radicalism, and di-radicalism, polyatomicy, and poly-equivalency, with the innumerable other analogous points, brought into an intelligible form; at present, it is some years' work to even properly comprehend their meaning, much less to understand them.

Doubtless the "Harmonious Blacksmith" and "Sigma," have noticed the letter in *Nature*, of April 14th, on the dinernis. Lately, there has been two papers read before the Zoological Society on the same subject.

Oleic acid (Experiment No. 2617), is obtained by saponifying almond oil, decomposing the soap formed by an acid, and converting the fatty acids into their lead salts by means of oxide of lead. The plumbic oleate is dissolved out by ether, and decomposed by hydrochloric acid, the etherial solution decanted, and the ether distilled off, leaving nearly pure oleic acid. It can be purified by converting it into its baryta salt; treat with alcohol, and decompose with sulphuric acid. Glycerine is obtained by saponifying any neutral fat, and is a secondary produce of the soap works.

"Oculus" (No. 2608), will find that the irritation of the skin caused by sulphate of atropia, can generally be prevented by first adding a little alcohol to it. M. Brandau gives, in his paper on chlorous acid, in the "Annalen der Chemie und Pharmacie," a new method of preparing baric chlorate, which I find to be pretty good. He obtains the salt by digesting well a mixture of sulphuric acid, water, aluminic sulphate, and potassic chlorate, dissolves out with dilute alcohol the chloric acid, neutralises with baric hydrate, and then, distilling off the alcohol, crystallises out the baric chlorate. It yields a salt containing 99·3 per cent. of baric chlorate.

I note the letter of Mr. Edward Richards, in your paper, on page 137, in which he fully details his method of obtaining the percentage of sulphur in iron, by the nitrohydrochloric process. I do not consider the process itself the best, but the system of manipulation is very good, although, for strict accuracy, I prefer a few alterations in it, which I use when adopting it, though I generally use either Rammelsberg's or Mitscherlich's method in preference. For instance, the presence of a little chromic acid during the oxidisation of the sulphur is often an advantage, as effectually rendering the conversion of all the sulphur into sulphuric acid certain, and preventing any fumes of sulphurous or chlorosulphuric acids, while it does not interfere with the after reactions. Likewise, the neutralisation of any free acid (nitric or hydrochloric) is advisable before precipitating the baric sulphate, as they greatly increase its solubility, so if it is not done, and the proportion of sulphur is large, it is advisable to use the acetate instead of the chloride of barium. Even if it is done, it is as well to use the nitrate in preference to the chloride of barium, as it is almost impossible to wash out all the chloride by water alone, from the precipitate of sulphate.

These precautions may appear trivial and unimportant, and perhaps, for rough practical work, where only a certain degree of accuracy is needed, are so. For exact accuracy, such as is essential for reliable scientific work, though, they can not be safely disregarded, as otherwise, as I have known, the sulphur may be considerably under-estimated. The effect their neglect may cause is seen if we remember that a small trace of nitric acid will raise the solubility of baric sulphate from 3 to 30 milligrammes a litre, while a little hydrochloric acid will more than double this; so much so, that sulphate of baryta precipitated by sulphuric acid from the chloride, will often have 10 per cent. held in solution by the hydrochloric acid; indeed, I have known as much as 180 to 220 milligrammes per gramme thus dissolved. Kirwan ("Ann. Chem. Phys."), and Calvert ("Phil. Mag.") well illustrate the need of precaution in estimating sulphuric acid, through the solubility of baric sulphate in dilute nitric and hydrochloric acids. URBAN.

TESTS.

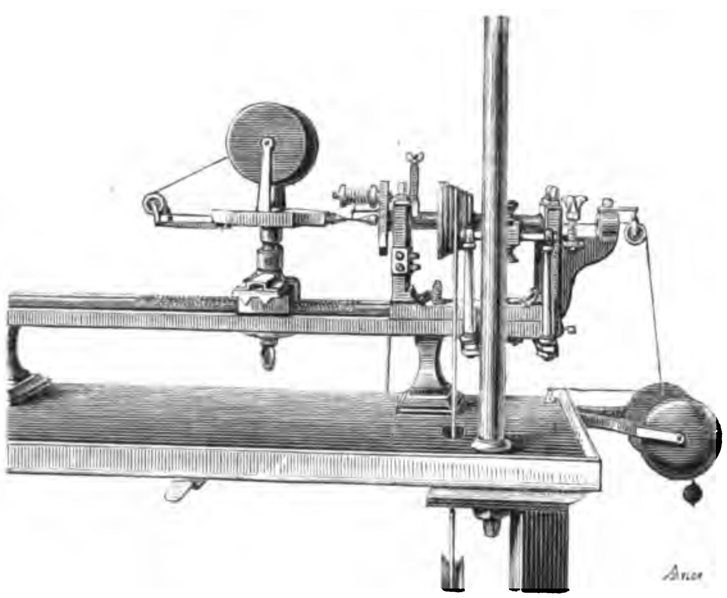
SIR,—I am glad to inform "F.R.A.S." that my 3in. refractor has separated Gamma Leonis, Epsilon Boötis, Delta Gemini; these are all the objects I have been able to try my telescope on, with the exception of Gamma Virginis. On turning my telescope on this star for the first time, I found it double with my highest power 96 times. Is this a favourable result? I should have tried more objects, but was prevented partly by light clouds and partly by the chimney-tops, which form a great part of the scenery from our doorstep. He will excuse my not sending better results, as when there has been a favourable evening I have been prevented from observation by engagements. I am much obliged for his replies to my queries in the ENGLISH MECHANIC of April 22. If "Hugo" (2592) would place a piece of lime on the back of his small mirror it would keep it perfectly free from moisture. This has been put into practice upon the plane of a 7¼ mirror, and gave satisfaction; but a better plan is to take the plane mirror out of the tube, and to place it, silver face down, on a piece of leather well rubbed with rouge. W. BAGULEY.

JOE BARNES AND HIS YORKSHIRE SLAB.

SIR,—The other morning I called upon my friend, Joe Barnes, and found him busy making a *refracting* telescope. Although remembering his success with a 13in. reflector, ground and polished by the most simple means, I was not prepared for what he had now to show me. Having procured a square piece of Chance's camera flint-glass, he had set to work with four pieces of Yorkshire slab, rounded, ground, and polished his flint, added a piece of crown glass, and rounded, ground, and polished that, using no iron tool, not even a correcting tool, nothing but his four slabs, and making a pitch tool for polishing upon them. Being anxious to ascertain the results obtained, he had fitted the glasses into a square tube. This morning (Ap. 28)—the sun completely obscured by clouds—I could read the smallest type in your "Correspondence column," at a measured distance of 100 yards. The diameter of the object glass is 6in., and its focal length about 7ft. 3in., but he says that the colour is yet under-corrected, and expects he shall have to make the combined focal length some few inches longer before the colour is properly corrected. As the construction of an achromatic telescope is always considered a matter of the greatest possible delicacy, and as men of the greatest experience, aided by the best adapted means, sometimes find themselves disappointed in the results of their labours, I think the above shows that much may be done by very simple means, and that if so much can be accomplished by a first attempt, we may expect he will ultimately succeed in his, to me, unheard of speculation. If you think any of your readers would be likely to imitate Joe Barnes, they will certainly feel gratified in reading the above, and should he ultimately succeed in making it to his mind, I will, on some future occasion, report. PROGRESS.

WIRE FOR ELECTRO-MAGNETIC APPARATUS.

SIR,—Some time since an inquiry was made in the ENGLISH MECHANIC for a description of a machine for covering wire for electro-magnetic apparatus. Many years ago I adopted such a machine to my own lathe, of which I forward a photograph. The uncovered wire is wound on the large reel at the back of the lathe; from thence it passes over the small pulley attached to the lathe itself through the hollow mandrel, which has fixed to it the reel or reels of cotton for covering. As the wire is covered it is wound on the reel, which is supported by the rest socket. The wire passes through the base of the winding-off apparatus, the reel of which has fixed to it a handle and click wheel. To the reel on which is the *uncovered* wire, a small pulley is fixed at the outside, over which a cord passes with a weight attached to make it friction tight. This, then is the description of the machine. The other parts, shown in the photograph are those of the rose engine. Of course the machine may be made self-acting by driving the winding-off reel from the overhead motion. N. S. HEINEKEN.



REPLIES FROM "AN ADEPT."

SIR,—Although still an invalid, I must endeavour to reply to the various inquiries addressed to me by several correspondents. With respect to the query of G. M. Little, No. 2410, page 69, No. 263, a Bourdon is the most advantageous as a pedal organ, but if the progress he has made in building his instrument is not too far advanced, I should most earnestly recommend him to carry the principal, twelfth and fifteenth steps down to CC, or at all events to prepare the soundboard for their subsequent insertion, as I fear he has no idea of the effect, of what he proposes to construct, will be, if carried out according to the description he has given.

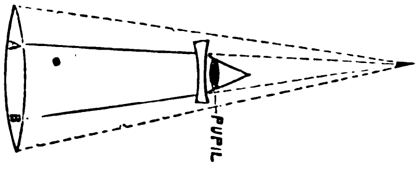
As your correspondent "Siddeley," on page 88, No. 264, asks my opinion upon his proposal to place two feet to, one valved pipe, I consider he would find that the advantage would not compensate for the additional complication, and I presume that he is aware that valved pipes in any form are not in favour in this country, on account of their great liability to derangement, inequality of tone, and general inefficiency.

I beg to refer "Simplex," page 138, No. 266, to the commencement of my instructions on page 67, No. 211, Vol. IX. In the first three or four communications he will find, I trust, a pretty clear account of how to set out his soundboard, and also full details of its construction, which will include his other requirements, only, if I may suggest to him, the substitution of a dulciana, in place of the trumpet, in his specification for the proposed instrument, I think he will find it much more satisfactory.

In reply to W. J. Raybould, No. 2691, page 167, No. 267, the two articles he has described and figured are "concussion bellows," which are generally used in large organs, simply to counteract, the evil effects of clumsy or careless blowing. AN ADEPT.

ON THE USELESSNESS OF OBJECT-LENSES OF LARGE DIAMETERS FOR OPERA-GLASSES.

SIR,—"F.R.A.S." appears to object to the reasoning of my last letter with reference to this subject. He must be aware that to give a power of two diameters it is necessary that the eye-piece should be placed half-way between the object-glass and its focus. In my last diagrams, the eye-lens was omitted; this, however, did not affect the results. If "F.R.A.S." can point out material flaws in my reasoning, I shall be glad to set matters right.



The above remarks may serve as a hint as to the uselessness of expending money for large lenses in such cases. S. T. PRESTON.

TURNER'S PATENT STEAM ENGINE LUBRICATOR.—CARDING ENGINES.

SIR,—The description given by Messrs. Turner of their patent steam engine lubricator, p. 156, is not sufficient explicit.

What capacity is the cylinder? or how often would it require filling during the day for a good-sized engine?

When the ram has driven out all the tallow at the bottom, what contrivance is there for arresting its downward motion, and so preventing it driving out also the bottom of the cylinder? If the engineer is expected to be at hand to throw it out of gear at this particular juncture several times during the day, and to wind up the ram and refill the cylinder, I fear it would not get the attention it would require for its efficient working.

Wherein consists the patent right? as appliances of a nature similar to this have been in operation for some time, with the apparatus, so far as I can see, requiring less attention on the part of the engineer, and costing considerably less.

It is difficult giving a satisfactory reply, without occupying too much of your space, to questions which extend over so wide a field as that of "Excelsior's," (2648), on "the best carding engine at present in operation." Querists should state the class of work to which their questions apply as there is a wide difference in carding for Nos. 10s., and 100s.

For medium numbers I think of no better system of carding than with rollers and clearers, properly set, and kept true, the stripping and grinding being regularly attended to at proper intervals. For finer work, breakers and finishers, breakers with rollers and clearers, finisher engine with revolving flats and self-stripping apparatus.

For the ordinary times of grinding I should prefer stickers to the pulley, one on cylinder and one on doffer, which are also "worked from end to end of the engine by means of a spiral groove in the shaft," because at these times all that is necessary to be done is to brush the dirt out of the cards and to sharpen them up a little, which is done quicker with the sticker than the pulley.

When the emery rollers have been on for grinding true the cylinder and doffer, previous to setting, the pulley might be used for a short time to give better points to the card teeth. B. W. R.

SUNFLOWER.—RUSHES.—STARCH, &c.

SIR,—Having read with pleasure (p. 114, No. 265) an interesting note on the utility of the sunflower, I beg to add a few words to it. The seeds of the sunflower yield 15 to 16 per cent of oil. This oil is extracted in some parts of Italy and Germany; the refuse cake is employed as food for cattle. Samples of the oil, coming from Berlin, were exhibited last year at Amsterdam; the price quoted was, for the yellow. 15 thalers (45s.) per 50kil.; the white, 16¾. It is said that this oil, being very cheap, is employed in many cooking operations instead of butter or salad oil.

Several other seeds of plants of the Composite order have a good produce of oil, for instance, niger seed, or Ram till (*Guizotea oleifera*) yields 35 per cent.; safflower (*Carthamus tinctorius*), 19 per cent.; *Madia sativa*, 32 per cent; Burdock (*Arctium lappa*) 19 per cent.

Another correspondent (p. 115) is quite right in considering rushes a good material for paper making effectively. Some years ago, Chevalier Claussen, at one of the meetings of the British Association for the Advancement of Science, said:—"I found to my great satisfaction that the common rushes (*Tuncus effusus*, &c.), contain 40 per cent. of fibre, equal, if not superior, to the papyrus fibre, and a perfect substitute for rags in the manufacture of paper, and that a ton of rushes contains more fibre than two tons of flax straw." At Paris, in 1867, were exhibited several samples of paper made from Australian rushes, sent by Dr. F. Müller, Director of the Botanical Gardens at Melbourne; those rushes were principally *Scirpus* (Clubrush), *Cyperus* (Sedge or Gallingale), *Heleocharis* (Spikerush), *Xerotes* (dry rush).

We have had several very interesting articles on Starch; let me bring my "brick" also. A thousand pioneers are wanted to discover all the useful substances which remain unemployed in far distant countries. I beg to give the names of some exoti starches, or starch-yielding plants. I have no leisure to add particulars:—

a. Leguminous order: *Parkia biglandulosa*, East Indies.

b. Bindweed order, or *Convolvulaceæ:* The sweet potatoes, *Batatas edulis*, &c., South America, &c.

c. Spurge order, or *Euphorbiaceæ: Manioc manihot utilissima*, yuca amarga of South America; *Obie pagger* of the Javanese; and *manihot aipi*, or yuca dulce.

d. Yam order, or *Dioscoreæ:* The different kinds of yams.

e. Grass order, or *Gramineæ*. Teff (*Poa Abyssinica*), Africa; Durrah (Sorghum div.) do. Tocusso (*Eleusine tocusso*) do. nutchanee, murooa, of the East Indies; Djampang mangong, of Java; (*Eleusine coracana*) Gero of Senegambia, Bujera, East Indies (*Penicillaria spicata*).

f. Arum order, or *Aroideæ:* Colocase or Kuchoo, East Indies; Kolgas, Egypt; Hladdie, Java; Chou caraibe, of Martinique (*Colocasia antiquorum*); Taro, of Oceania; Cocomeal, of the West Indies; taye cochon of French Guiana (*Colocasia esculenta*).

g. Tacca order, or *Taccaceæ*: Pia or South Sea arrowroot, obie Padjai, of Java (*Tacca pinnatifida*).

Plantain meal, arrowroot, Dolichos, &c., have already been mentioned. BERNARDIN.

STRENGTH OF CHAINS.

SIR,—Thanks for Mr. Laidler's first remark, which I duly appreciate.

The first formula referred to ought to have been given

$$(1.)\ d = \sqrt{8 \times 14} = \sqrt{112} = \frac{10{\cdot}5}{8}\text{in.} = 1{\cdot}3125\text{in.} = 1\frac{5}{16}\text{in.}$$

I presume there is a fault of the printer's in $1\frac{1}{18} = d$ of his correction. Something similar appears lower down—namely, for the minus sign read =.

As to his second remark, I leave it entirely to those interested in the subject to multiply or divide by 30 or 32, but I will show that the results are so very nearly the same, that 30, and *not* 32, is the advisable number to take, as by so doing the calculation is much shortened, and the application of the result not in the least impaired.

His formula is:

$$d = \sqrt{32 \times 14} = \sqrt{448} = \frac{21{\cdot}166}{16}\text{in.} = 1{\cdot}3228\text{in.}$$

Adapting my equation, we have

$$d = \sqrt{30 \times 14} = \sqrt{420} \quad \frac{20{\cdot}4930}{16}\text{in.} = 1{\cdot}2808$$

I calculate to 4 decimals, as Mr. L. compelled me to do so in the first place. It will be seen from these two results that Mr. L.'s is by 0·0103 larger, and mine by 0·0217 smaller, than the result in I, and simply differ from each other by 0·01, which, considering the allowances made in the rule, need not be taken into account until experiments lead to a more precise rule, and to which Mr. L. may apply his skill.

In table I. please to correct: 39, in which 1·4 tons = 30215lb., and read for latter 3100lb.

A. TOLHAUSEN, Waterloo-road, Manchester.

TIME.

SIR,—Your correspondent, "Not a F.R.A.S." may be unhesitatingly told that the "Nautical Almanac" is right in the directions it gives in the page of the "Explanations" referred to. "A Fellow of the Royal Astronomical Society" has made the conversion according to those directions, and done so correctly (p. 86). But I must ask the last-named correspondent what he means by the paragraph which follows:—"I have assumed that my querist's longitude is 8m. 7s. in *mean* time west of Greenwich. If it be 8m. 7s. sidereal time, he must convert this into mean time, which he will find to be 8m. 5·7s., and add that." This will lead to a wrong result, as "Not a F.R.A.S." has shown. The fact is, both your correspondents appear a little confused on the subject of the expression of longitude in time. The longitude of a place 15° west of Greenwich is one hour, whether that hour be sidereal, mean solar, mean lunar, mean Jovian, or any other imaginable hour. If a sidereal chronometer and a mean time chronometer were brought from Greenwich to the place referred to by your correspondents, the difference between the two times in the two places would be 8m. 7s. in each case. The conversion of sidereal time at any place into G. M. T. is then a very simple affair. There are two methods. First, convert the sidereal time at the place of observation into the mean time at *that place*, and then get at once the G. M. T. by adding the difference of mean time (or longitude), which in the case referred to is 8m. 7s. This is the method followed by "A Fellow of the Royal Astronomical Society."

The other method is to go at once from the sidereal time at the place of observation to the then *sidereal* time at Greenwich, by adding the difference of sidereal time (or longitude), which is again 8m. 7s., and then find the G. M. T. as if on the meridian of Greenwich. This was Mr. Dawes's plan, as mentioned by "Not a F.R.A.S." (p. 135). It is evidently the better of the two, being rather shorter, and not requiring the introduction of the proportional part of 9·8565.

I observe that Loomis heads one of his tables "To Convert Degrees into Sidereal Time." It would have been better to have omitted the word "sidereal." I have another table before me, headed more generally: 'For Converting Longitude into Time." R. P. D.

P.S.—I have unfortunately not seen your last number yet, in which there may be more on the subject, which would have rendered this unnecessary.

THE HARMONIUM.

SIR,—There are a few queries waiting to be answered; some of them ought to have been attended to long ago, but the cold weather has been too much for me lately, and like "Adept" I had to take to bed. Having got out again, I will with your permission get to business. And first in point of time comes W. Holston who wishes to put a tremolo stop on one of Messrs. Matthews and Scott's patent swell box instruments, a very foolish wish to my thinking, but as that is no concern of mine, I shall tell him how the makers would have done, as I believe their system to be simpler and equally as good as the usual method. First, then, he will have to cover the wind opening in the valve board with a leather-faced and hinged valve in the usual way, carry action for opening and closing the valve out through the back of the pan, connect it to a stop rod by means of the common sticker and flap, with the lever reversed so that when the stop is drawn out the valve will be closed by its spring, then cut an opening in the valve board, 2¼in. long, 1in. wide, out of the line of large opening, so as not to weaken the board too much; cover this small opening on the upper side with a piece of wood faced with leather and hinged at one end like a common valve, take a brass spring 10in. or 12in. long, fasten it to the valve board so that the free end of the spring rests on the free end of the valve. When you draw the stop already finished, and which is labelled "Tremolo," you shut the large valve the wind, in desperation, forces the wicket, the spring attempts to shut it again, and between the two ensues a battle for the mastery; your business now is to see that the spring is not too powerful for the wind; if it is, reduce its thickness with a file until the sound is to your taste. The end can be attained also by using a piece of small wire fixed to the valve itself, and carrying a small leaden weight on its extreme end; but I prefer the spring. There is one thing must be carefully seen to—viz., that the large valve, when closed is perfectly air-tight, any wind getting in there will infallibly neutralise all the work.

"W." No. 255, p. 539, 1730, will most likely have some difficulty in overcoming the defect in his instrument to which he alludes. The top notes of the treble are very often not nearly so well fitted as they might be, and the consequence is that the wind rushes through between the tongue and the frame; moreover, it is a very common fault to have the channels too large; and if both these faults come together, the reed is choked with too much wind, and is utterly unable to speak a syllable. Another cause is the pallet holes being cut too large. The first may be cured by taking a chisel and hammer, lay the reed on some solid article, and placing the edge of the chisel on the frame of the reed about $\frac{1}{16}$th back from the tongue, tap it sharply on the top, thus forcing the metal forward on the tongue, a rub with a fine file will restore the frame to its original appearance. If the pallet holes are too large, cut a sheet of strong brown paper, with the holes a little less, and paste it over the original ones, taking care that it is properly placed, so as to contract all the holes to an equal extent. The fact is, the construction of the harmonium is considerably to blame for this defect; there is too small a space between the valve board and the bass reeds, and a great deal too much space at the opposite end; the space below ought to bear a certain relation to the depth of channel above; now the reverse of this is what obtains, hence the common difficulty of the small reeds not speaking promptly. The only cure I have ever tried with complete success was this: I cut the pan from the centre to the treble end on an angle, leaving it just the depth of the side irons at the ends, then blocked up the valve board to suit the new (patent) pan, and the alteration on the music could be *felt*, so completely did it change it. Now this is a somewhat troublesome and expensive alteration, but *what will you?* If a musical instrument don't make music it ain't worth house room, and even altering to the extent indicated, may in some cases be more profitable than "new stock, lock, and barrel." The channels to be right should be something like the following:

		4th C.		5th C.		Top C.
Depth of 8ft.	..	$\frac{3}{4}$	..	$\frac{1}{2}$	..	$\frac{1}{4}$
„ 16ft.	..	$\frac{7}{8}$	..	$\frac{3}{4}$	..	$\frac{7}{16}$
Length of 8ft.	..	$2\frac{1}{4}$	..	$1\frac{1}{4}$	..	$\frac{5}{8}$
„ 16ft.	..	$3\frac{1}{4}$	..	$2\frac{1}{2}$	..	1

He can easily find out if that is anything like the size of his channels.

"E. J. H.," No. 257, p. 589, 1829.—The springs of the harmonium—I mean the springs below the reservoir, if unequally made, sometimes causes the music to sound in waves. The expression valve in some instruments is placed on the top of the reserve boards, with one spring attached to keep it open; in such a case, if the valve is rather slim, and having a slight tendency to rise higher on one corner than the other, immediately you cease blowing, the wind issuing from the reservoir shakes the valve and thus produces the shaky sound complained of. It will be obvious that the same failing in a register valve would cause the same effect, but I have never met with such a case. The first two mentioned causes being the only ones I have had to cure. In the matter of curing the harshness of the reeds, I am afraid there is no other method available in the present case than the very effectual mode of treatment suggested by the "Harmonious Blacksmith" in the case of baby—viz., get it under the blanket—smother it in short. Thus, if there is room between the ends of the pallets and the inside of the key frame, put a strip of wood along the whole length of the instrument, glued to the top of the pan, and a trifle lower than the key frame, it will be about 2ft. 9in. × ¾in. × ⅜in.; get a piece of stout brown leather (colour no object), 2ft. 9in. × 4½in. or thereabouts, a piece of swansdown, same size, lightly glue the cloth to the rough side of the leather, and when done, glue both on top of aforesaid strip of wood, thus enclosing the pallets (and the sound) in a jacket; this of course softens the flute as well as the clarionette; but as a rule, both are the better of it. Again, if you have no fear of work, and any way handy, a first class method of softening the sound is to lift the key frame up an inch clear of the pan, screw on pieces of wood along the bottom of the key frame 1in. thick, and allow them to project inward about ¼in., make a frame, or rather a cover similar to the swell box cover, figured by Mr. J. Matthews lately; 4 openings in it covered with shutters, glue a sticker rail along top and bottom of it, drill 61 holes, cover under side with flannel or swansdown, place it inside key frame, resting all around on ¾in. plinth, already specified, to which attach it with small screws, insert stickers, adjust the keys, attach stop action to the shutters, and you will have completely metamorphosed the instrument; you will have music as soft as you can desire, or music "rank and strident," fit to ravish the ears of our dear "Alexandras."

"A New Subscriber" (these long names waste ink), No. 260, p. 661, 2107, requires 8ft. reeds, and the pallet hole at lowest C will be 1⅛in. × ¼in., top ⅜in. by $\frac{3}{16}$in., graduated between.

"Vibrator" (same page as last), asks if any reader has met a trumpet stop on a harmonium. I have met with a *stop label* of that name on an harmonium, but nothing beyond that. The sound resembled a trumpet about as nearly as it did a cross cut saw—had it been a good or even a fair imitation, I should have "made a note on't," but as it was I didn't even look how it was done.

W. H. Chorley, No. 258, p. 616, 1976, has precious little use for a tuning bellows. If his reeds are screwed on the pan, he would be foolish to take them off again for tuning. From his statement I am somewhat suspicious of the pan. Reeds generally are not in anything like the deplorable state he mentions, and before he begins to file the reeds, I would strongly advise him to try another pan. If it is the first one he has made, he will only be like his neighbour if it should not be quite up to the mark. Neither do I see what good he is to do with a tuning bellows. If, as I suppose, he is only an amateur making an instrument for his own use, the money spent on a tuning bellows would be just so much money wasted; the tuning bellows is only of service where there are a great number of reeds to tune. A stock of tuned reeds are kept there, and the tuner places one of these and one of the "raw," side by side, and proceeds to make them both speak the same. Having them on a table beside him, he can do it more quickly, but when put on the pan they have to be gone over again, so that W. H. C. will perceive the bellows would be of very little service to him. If after this explanation he is still anxious to make one, I will tell him how to do it; but I do not like to allow any person to go to expense without pointing out, as far as I can, what return they are likely to get for the money. The second part of his query he will have seen an answer for elsewhere.

"Valve," No. 265, p. 119, 2562, will have to find out where he can purchase beech veneers ⅛ of an inch thick and 5in. broad. I cannot tell him where to find them, perhaps "Tremolo" will; I understand he was on the hunt lately; but with what success I do not know. The channels have no connection with each other; a two row pan is best made in two separate halves, and then fitted into the frames; the 16ft. channels being 1¼ deep at the bass end, and ⅜ at the treble (veneers included) the 8ft. channels 1in. at bass end, and the two veneers brought close together at the treble end.

I am making a set of drawings just now for an instrument after a different fashion than usual; but as I am fond of proving before presenting, it will be some time ere I can lay them before your readers. In the meantime, will any of your correspondents who are on the "other form," tell me why a double manual instrument should be preferred to a single, if the single set of keys can be made to do the work as well. For instance, why should 8½ rows of reeds get two rows of keys when one row might do the work? Is it a piece of sham invented for the express purpose of still further harrassing the taxpayer's conscience—his trouser pocket. "The Harmonious Blacksmith," albeit a little "crotchety," being still a matter-of-fact gentleman with a keen eye to superfluities, will, perhaps, on the above point kindly share his superior knowledge with ELEVE.

CHLORATE OF BARIUM.

SIR,—Mr. Davis, as I write *incognito*, is perfectly at liberty to back his experience against mine, though probably mine is ten times as great, and to decline to believe; it is very difficult to separate the chlorate and chloride of barium by crystallisation, or, as in my former letter, "by direct means."

Though with no intention of convincing Mr. Davis, naturally he will put his own experience before that of others, I may remark that Chenevix (Phil. Trans.) declares it is not easy, as Mr. Davis states, to separate the two salts. It is needless, as the correspondents my letter was addressed to can believe who they wish to, or I might quote from the papers of MM. Millon and Surrulas (Ann. Ch. Phys.), Waechter and Vaquelin (Schws. An. Ch.), or others, how they found it impracticable to do so by direct means, and had to employ phosphate of silver or other agents. Rammelsberg, though, goes farther, and denies its practicability, owing to the persistent retention of a certain percentage of the chloride. I quote the above solely to show my assertion does not alone rest on my own experience, and not with any intention of arguing; that I decline pending an answer to, and explanation of, the circumstance compelling my letter of Sept. 10, 1869.

MM. Regnault and Dumas were quite content to accept Chenevix, and Surrulas, and Rammelsberg results on faith; and so was I, even had my own results not fully borne them out.

By repeated crystallisation the per centage of chloride can be reduced to a small percentage, but not to absolute purity. It is perhaps unnecessary to remark that my letter of the 8th ult. referred solely to the salt that would be produced by his method contained in his letter of March 25th, which directs but *one crystallisation*.

Concerning hypochloric acid, its existence is acknowledged by a number of continental chemists, while that of chlorous acid is by most, including Dumas, Gmelin, Regnault, Rammelsberg, and Wanklyn.

Finally, it is quite possible for a very large number of facts to be unknown to young chemists that are not necessarily so to those who for years have had all the scientific works and periodicals, both English and foreign. No extracts in English periodicals, nor the most carefully compiled text book—not even Watt or Gmelin, can supply one-tenth per cent. of the immense amount of most valuable details and facts contained in the scientific periodicals, &c., for the last thirty years. URBAN.

WATER ANALYSIS, &c.

SIR,—In your issue of April 15th, I have read with interest a letter by Mr. G, E. Davis on "Quantitative Analysis." especially that part referring to "estimation of organic nitrogen and carbon." The process there given is that known as "Frankland and Armstrong's." There is also another method known as Wanklyn, Chapman and Smith's, in which the determinations are made in a totally different manner, excepting perhaps ammonia by Nessler test.

In estimating quantitatively the organic matters in water by this mode, Wanklyn first determines the ammonia and urea, and secondly the ammonia derived from decomposition of albuminous substances, and from the relative quantities of each he pronounces the goodness or badness of potable water. This decomposition is effected through the agency of an alkaline solution of potassium permanganate. Of course each inventor claims the superiority of his own discovery over these of others, and I believe that Chapman goes so far as to say of Frankland's process—I write from memory—that the maximum error is greater than the actual amount of organic nitrogen present!

On the other hand, Frankland assumes to show that the permanganate process of Wanklyn is not reliable.

However, I understand that this latter discovery in analysis has been adopted by some chemists, notably by Dr. Angus Smith, in determining the organic nitrogen in air. What I am desirous of obtaining is the candid and unbiassed opinion of your correspondent Mr. G. E. Davis—as well as of others—of the relative capability of these two processes which will give the most accurate results, upon which is the most reliance to be placed, in both cases paying due regard to the time consumed, and easiness of manipulation, together with any other essentail conditions?

Frankland writes that there is no known means of determining accurately the actual amount of organic matter in water, but some general idea may be gathered from the quantities of organic carbon and organic nitrogen present. It will be observed in his reports of water analysis that the organic carbon and organic nitrogen do not bear any relative proportion to each other in different waters; by way of example, the ratio of carbon to nitrogen in A water will be 2 to 1, in B water 5 to 1, in C water 10 to 1, and so on. No doubt this difference in ratio is due to the character of the organic matter, whether of vegetable or animal origin. Now what I am desirous of knowing is, are there any means, and what are they, of approximately comparing the organic carbon and nitrogen of Frankland with the old mode of "organic matter" as expressed in grains per gallon? I am aware it would be necessary in the first place to consider whether the organic matter was a vegetable, animal, or, very possibly, mixed character, and a good idea would be gleaned from the proportion of each constituent present, sufficiently so to approximate to the quantity of organic matter.

This would avoid all necessity of evaporating a known bulk of the water and incinerating the residue, when it is desirable to compare with an analysis under the old process.

There are a few queries I have to put, and to which I shall be pleased in having the opinions of your correspondents.

1st. Are both Frankland's and Wanklyn's courses of analysis suitable for waters containing large quantities of organic matter—for example, sewage—and would the processes differ from those applied to ordinary water?

2nd. Can the Nessler test be applied to the determination of ammonia in ammoniacal salts—with previous distillation if required—and as accurately as by triturating with standard acid?

3rd. Is it practicable to determine the quantity of nitrogen present in manures by Frankland's, and particularly by Wanklyn's process, for water analayis, estimating, in the latter case, the resulting ammonia by Nessler, or trituation?

4th. What is intended to be understood by "one *degree* of organic matter," as stated by Mr. G. E. Davis, page 605, Vol. X. W. R.

THE ENGLISH MECHANIC. — *ENGLISH MECHANIC* MUTUAL IMPROVEMENT SOCIETY, &c.

SIR,—No doubt you have recently had numerous testimonies and congratulations relating to the improvement effected in what may be called, *par excellence*, "our" Journal. From what I hear in Plymouth and neighbourhood, the number of your subscribers and readers has been very much increased. When it became known that Mr. Passmore Edwards had become the proprietor, if not the Editor, of the ENGLISH MECHANIC AND MIRROR OF SCIENCE, many (and I amongst the number) became subscribers. We had not forgotten how manfully he contested Truro at the last general election. It was, taken altogether, a notable struggle, for though he fought almost single-handed against old prejudices wealth and territorial influence, most people felt certain he would have been returned, so strong was the current of popular feeling in his favour. But, like many other able men, he was defeated. Possibly his defeat was not altogether a matter of regret, as what the House of Commons may have lost, the ENGLISH MECHANIC may have gained.

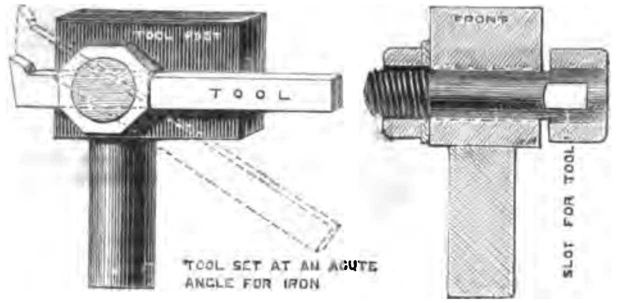
If such improvement can be made in one journal in a few months, what may we not expect by-and-bye, and particularly as new mutual instruction societies are likely to spring up through its instrumentality! It is about these societies that I should like to say a word. It occurred to me that we might establish one in Plymouth; but I found on inquiry that the subscribers here belonged to members of all classes of society, and that, apart of being subscribers to our journal, there was not much community of feeling between them. One gentleman I found took it in for its astronomical information, another subscriber for its microscopical information, though he complained that miscroscopical matters had such sparse consideration in its pages; another for its chemical information, and so on. What rather surprised me was the large number of what I may call well-to-do people, who subscribed, in comparison to those who may be termed workmen. As far as I could ascertain, the ENGLISH MECHANIC is not so much read by intelligent mechanics as by amateurs, and scientifically inclined middle-class people. I am in one respect sorry it is called the ENGLISH MECHANIC, I wish it had a more general name such as the *Scientific Journal*, or something of that kind. However, I suppose it is too late now to alter the title. As our readers and subscribers are in so many respects so dissimilar in taste and occupation, I think it would be very difficult to form out of them a new society, and such I fear will be the case in Edinburgh, Manchester, Blackburn and other places. I don't say this to discourage our friends elsewhere, but to induce them to look at all the facts; for I should not like to hear of them making unavailing efforts to form new societies, much as they may like to promote a friendly feeling and mutually instruct each other in the attainment of useful knowledge. Whatever may be the result of the experiments made, we are all in one sense members, as, Sir, you have said, of a national mutual improvement society. It matters not what we are, or where we live; we may be millers, or cotton-spinners, or electricians, or workmen, or students, we can all be teachers and learners; we can all ask and answer questions; we can all deposit our mites in the treasury; or, as you have put it, bring our bricks to the Temple of Knowledge. W. H. J., Plymouth,

EXTRACTS FROM CORRESPONDENCE.

MR. BEARDSLEY'S LETTERS.—Mr. Dyer says: —"In printing my note respecting Mr. Beardsley's letters, you have omitted the name of Mr. Carpenter, thereby making me say that "Mr. Beardsley is an ardent advocate of the views of 'Parallax,' and has written a book entitled 'Theoretical Astronomy Examined and Exposed,'" &c. What I said was: "It does not appear to be generally known who Mr. Carpenter is, the referee of Mr. Hampden. He is an ardent advocate of the views of 'Parallax,'" &c.

BLUE MAHOE WOOD.—For the information of "The Harmonious Blacksmith," Messrs. Mundy, Harley & Co., of 100, Bunhill-row, state that they imported a little parcel of the wood about two months ago. Mr. C. Nutting, of Digbeth, Birmingham, and Mr. Ogden, of Winchcombe-street, Cheltenham, supply fishing-rods made of blue mahoe. Messrs. M., H. & Co. believe that greenheart stands well for fishing-rods next to blue mahoe wood.

PLAN FOR CUTTER-BAR.—William H. Stone writes:—"As you were good enough, some time ago, to engrave a plan for a simple cutter-bar which I sent you, perhaps the enclosed modification of it for the tool-post of a screw-cutting lathe may not be without value. I use it specially for holding the new tools of 'Mushet's special tool-steel,' which, if set at the proper angle, are remarkable for the amount of work they will do."



THE "PHANTOM" WHEEL.—G. Sykes, of Huddersfield, says:—"Seeing some correspondence in the ENGLISH MECHANIC respecting the 'Phantom' wheel, I beg to state that I am at present using a pair with india-rubber tires, and I never saw anything to surpass them. They are light, strong, and very easy to drive. The rubber tires do away with all the rattle and noise, and are a very great help in uphill work, as they do not slip like the iron tires. They are equally as strong, if not stronger, than the wood wheels, and not much more than half the weight. I do not find the springiness about the front wheel that Mr. Tydeman objects to so strongly, and think it would have been better if he had tried the wheels before condemning them. I have given them a good trial, and find them to be all that the 'Phantom' Company say of them."

UTILISATION OF WASTE MATERIAL.—A new utilisation of waste material is reported, from the Brindisi district, in the oil trade. Formerly the olive husks, as left by the common oil presses of the country, were used by the peasantry only for fuel, but a French speculator is now buying them, at the price of 20f. per ton, and shipping them to Marseilles; where, after undergoing some chemical process, they are put into a steam press and made to yield 20 per cent of oil. The Brindisi people are themselves erecting a press, capable of operating upon 70 tons of husks per em.

REPLIES TO QUERIES.

◆

[2288.]—ADDRESSES WANTED. — I have received four or five addresses for "foreign correspondent." Direct letters, including post-stamp for reply, to J. D., Post-office, Melle, near Ghent, Belgium. —J. D.

[2456.]—OLD COINS.—If the querist had read the note, reply to Query 1243, he would have seen easily that it is a Nuremberg counter; that note giving all the principal characters (H. KRAVWINKEL, NUR. R.PF. &c.); yet several persons made similar queries. Had they observed those characters they would have spared the Editor the trouble of engraving their quite worthless coins.—K. L. M.

[2496.]—PHOTOGRAPHY.—I am sorry that I did not answer this query before, but engagements prevented. A clear glass may be attributed to many causes. 1. The collodion may be insensitive; in that case the same exposure as for sensitive collodion would not do. 2. There may be too much acid in the developer to allow it to work. 3. The bath may be very much too weak to allow of a deposit. 4. There may be under-exposure. Now I suspect that the last mentioned is the real cause. Of course I am taking a view of the case literally—*i. e.*, a *clear* (transparent) plate. In the case of a plate having no image, the causes are exactly opposite to those I have mentioned, but then the plate must be fogged, and would be only semi-transparent. If thorough attention to the formulæ advised by me some time ago in the ENGLISH MECHANIC fails of success, why I do not think that I can suggest where the weak point is. If the querist will write a fuller description of his plate I will try and help him further.—MUS.

[2508.]—FASTENING STENCIL COLOURS ON PAPER.—To fasten stencil on paper, mix the colours with dissolved gum.—J. F.

[2528.]—MUSICAL BOX.—Harry Bertram, p. 164, in his reply, repeats his lesson very well as far as he has learnt it, but makes a mess of the "Geneva stop" and its action as regards, at least, its effect on altering the tunes, with which the *stop* has nothing to do at all. —J. K. P.

[2535.]—OLD COIN.—Perhaps "Bernardin" will excuse my saying that this coin was struck *in* and not *for* Dalikarlen, but for circulation in the whole of the kingdom of Sweden.—D. T. BATTY.

[2537.]—WRITING TELEGRAPH.—The manual "Handbuch der Elektrischen und Telegraphen," by T. Forsach, Vienna, 1854, dscribes the plan of an "American" writing telegraph, of which the two principal parts are two cylinders having an helicoidal isochronical motion, but the name of Meyer is not mentioned in the extract I have seen.—BERNARDIN.

[2540.]—SMOKE ON WALLS.—Where walls or ceilings are cracked, air will pass in or out, according to circumstances. In the case of an ordinary room, having a fire, the air will enter by any or every means to replace the ascending column in the chimney; where rooms are shut in closely these cracks form the readiest means of admission. Besides the column of air in the chimney passing outwards, there is an upward current *in* the room immediately in front of the fire, caused by its rarefaction by the fire. This current, on reaching the ceiling, takes a spreading course towards the extremities of the room, the small currents or tributaries take the same course, and prevent any deposit within the area of their immediate influence, while they somewhat retard the force of the main current immediately behind them, and so allow of a greater deposit; so it will be seen that the edge nearest the fire shows a sharp dark line, the opposite being white, gradually softening into the general tone of the ceiling.—HARVEY SAUNDERS.

[2548.] — GILDING BATTERY.—"One in a Fog" has seemingly made a great mistake, He thinks that it is all done in a hurry; let him use only one Daniell's cell, and use sulphuric acid diluted with at least 3 or 4 times its bulk of water. Fill the copper cell with a saturated solution of sulphate of copper, and only put some spare crystals to keep it concentrated on the outside rim. His great mistake seems to be that he expects gold to be laid before there is any in the solution of cyanide of potassium. On the positive pole put a piece of gold (beaten or rolled out so as to expose as much surface as the piece to be plated), and then on the negative pole put firstly a piece of platina foil until the solution is charged, which can be told by gold appearing on the platinum. Then, and not till then, remove the platinum, and immerse the medal, coin, or whatever it is. If I have time I will send a letter to the Editor next week, containing a few hints which may be useful to him if he means doing the thing practically. Do not have the bath heated above 15° or 20° Reaumur, nor have too great battery power, if you do not wish to waste gold, as it will lay itself in a brown powder if the current be too strong; in fact, with weak currents about 1-50th of the gold is set in powder if you wish to set it any thickness. Carefully weigh your piece, and then you can easily know how much you have laid. As soon as the surface begins to grow dull it would be advisable to take it out and clean it with a stiff brush. This will not be required so frequently if you keep putting from time to time fresh pieces of cyanide of potassium in the bath. Above all things do not be in a hurry and forget to have your article to be gilded quite clean, and of all things free from mercury, which is very liable to get on the hands in putting the battery together, for the smallest particle will spoil the gilding.—TANGENT.

[2547.]—PRINTING NAMES ON PLANS.—Fig. 1 is a tracing of a set square that I made some time since for ruling the slanting strokes of Roman capitals

FIG. 1

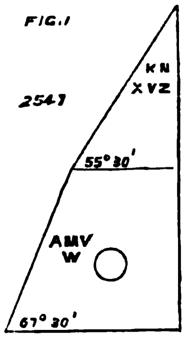


FIG. 2

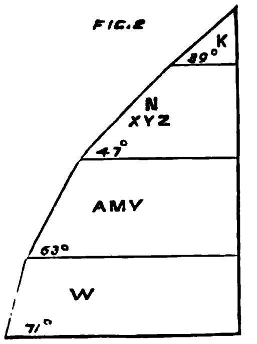


Fig. 2 is a similar one for block printing. I have written in the angles of the different slopes, so that any one can set one out for himself. If block printing is not upright it should slope the reverse way to hand writing, else it looks very bad.—J. K. P.

[2557.]—OLD COIN.—I have pleasure in informing "Flint," from information just gained, that his coin is a Nurnberg counter, copied from a historical jetton of the Low Countries, of the 15th century, particulars of which may be found in Van Mieri's "History of the Princes of the Netherlands." The obv. contains the arms of Burgundy slightly varied. The rev. represents Fortuna. The legend has no meaning.—D. T. BATTY.

[2574.]—BRONZING MODEL VESSEL.—Varnish, and when nearly dry rub on the copper bronze varnish again to preserve the bronze from changing colour. —J. F.

[2582.]—WEIGHT OF FRUSTUM, &c.—Let the radius of larger end = R = 2ft., radius of smaller end = r = 1ft., and let the height be represented by H = 12ft., then solid content

$$= \frac{H}{3}(R^2 + r^2 + R\,r) = 4 \times 3{\cdot}1416\,(4 + 1 + 2{\cdot}1)$$

$$= 125{\cdot}664 \text{ cub. ft.}$$

Thus weight of the whole frustum = 125·664 × 440lb. = 91·894 tons; weight of frustum left = (91·894 − 4) = 87·894 tons. To find the height and radius proceed as follows:—Let the radius of the new upper plane be r_1, and the distance of this plane from larger end of frustum = h. We have again solid content

$$= \frac{h}{3}\,\pi\,(R^2 + r_1^2 + R\,r_1) = 87{\cdot}894 \text{ tons.}$$

$$R^2 + r_1^2 + R\,r_1) = \frac{87{\cdot}894 \times 3}{h\,\pi}$$

Or

$$4 + r_1^2 + 2\,r_1 = \frac{87{\cdot}894 \times 3}{h\,\pi}$$

$$r_1^2 + r_1 = \frac{263{\cdot}682}{h\,\pi} - = \frac{83{\cdot}9 - 4}{h} \qquad (1)$$

We have now one equation with two unknown quantities h and r, and must therefore establish another equation having these two unknown magnitudes. The content of the upper frustum cut off is, if h is its height, and former symbols be retained,

$$= \frac{h_1}{3}\,\pi\,(r_1^2 + r^2 + r_1\,r) = 4 \text{ tons};\; r_1^2 + r^2 + r\,r = \frac{12}{h_1\,\pi}.$$

Or substituting the given value of r we have

$$r_1^2 + 1 + r = \frac{12}{h_1\,\pi}$$

Consequently

$$r_1^2 + r_1 = \frac{12}{h_1\,\pi} - 1 = \frac{3{\cdot}819}{h_1} - 1 \;\ldots\ldots\; (2)$$

Comparing equations 1 and 2 we may write

$$\frac{83{\cdot}9}{h} - 4 = \frac{3{\cdot}819}{h_1} - 1, \text{ or } \frac{3{\cdot}819}{h_1} = \frac{88{\cdot}9}{H - h_1} - 3 = \frac{83{\cdot}9}{12 - h_1} - 3$$

This equation of the second degree gives us

$$84{\cdot}719\,h_1 = 81{\cdot}828\text{ft.} = 981036\text{in.}$$

Whence

$$h_1 = 10{\cdot}9\text{in., therefore } h = 11\text{ft. } 1{\cdot}1\text{in.}$$

And by substituting the value of h_1 in the equation for the content of the upper or lower frustum we receive r = 1·30ft. A. TOLHAUSEN.

[2582.]—SOLIDITY OF FRUSTUM OF CONE.—Is as follows:—

Area of smaller end = $2^2 \times {\cdot}7854 = 3{\cdot}1416$
Area of larger end = $4^2 \times {\cdot}7854 = 12{\cdot}5664$
Square root of produce = $8 \times {\cdot}7854 = 6{\cdot}2832$

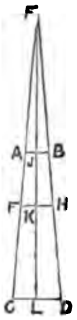
$$21{\cdot}9912 + \text{by } \tfrac{1}{3}\,H$$

$$= 21{\cdot}9912 \times 4 = 87{\cdot}9648$$

$$\text{Weight} = \frac{87{\cdot}6948 \times 440}{2240} = 17 \text{ ton } 5 \text{ cwt. } 2 \text{ qrs. } 4\text{lb.}$$

To find after cutting off 4 tons the diameter of small end and height of remaining frustum, complete the cone

As D G 1 : B G 12 : : B O 1 to A O = 12 or solidity of annexed part — $2^2 \times {\cdot}7854 \times 4 = 12{\cdot}5664$, to which add 20·3636 cubic feet, this represents 4 tons. Therefore the part to be cut off from the whole cone = 12·5664 + 20·3636 = 32·9300



And solids of whole cone = 87·9648 + 12·5664 = 100·5312.

Now solids are to each other as the cubes of their similar sides, hence we have two simple proportion sums.

To find diameter of smaller end—

As 100·5312 : 32·9300 : : 4^3 to cube of diam.

To find height of cone which is being cut off

As 100·5312 : 32·9300 : : 24^3 to cube of H.—R. WILSON.

[2583.]—"ENGLISH" VELOCIPEDE, &c.—If "C. T. W." takes good dry wood, fits the spokes well in nave, just weft the tenant of spoke when driving, he will find that quite sufficient for a small nave. —F. J. D.

[2584.]—SULPHATE OF LEAD BATTERY.—In reply to your correspondent "Carfax," and others, I did not amalgamate the zincs in the sulphate of lead battery, though I think from what I have read it is better to amalgamate all zinc plates, no matter what form of battery it may be. I find my zincs very little worse than when they were put in. I mixed my sulphate of lead with water to about the consistency of cream, and filled each porous pot within half an inch of the top. A friend of mine has a manganese battery of 6 cells, which he says has been in constant use for ringing electric bells in his warehouse for the last eighteen months without requiring one penny outlay or a moment's attention, and is as good now as at first. When next I require a battery I shall try my hand at a manganese, as I believe they are by far the best for any kind of communicating purposes, such as short lines of telegraph or electric bells and indicators. I notice Cox's price is 5s. per cell, but my friend says he did not pay near so much for his.—A GOOD BOY.

[2587.]—CHINA GRASS.—If "Katka," will publish his address, I think I can get him what he wants in a week or two.

[2593.]—DEFECTIVE BATTERY.—I presume that "G. F. L." is using a medical coil, though he calls it an "electric machine." The fault he complains of most likely lies in the imperfect connections of the battery. When he bent the silver plate straight again did he see that it was properly connected with its binding screw, and the pair of zinc plates with theirs? As the silver is doubtless very thin, it is possible that it may have been torn away from the binding screw in the accident that occurred, and that would explain the stoppage of the action. I should advise him to look carefully at his plates, and to see that he has the circuit complete, that each pair of zinc plates are connected with the binding screw of the silver in the next trough, and so on throughout the series, but I expect he has only 2 or 3 troughs. If the plates require platinising, it certainly would render the action more feeble, but it would not stop it altogether. He can easily tell by a look at them; if they are smooth in patches he may be sure that they require it. It is *not* done with mercury, but by an application of the electrotype process. If he wishes it I will send him the mode of procedure. If he attempts to put mercury to silver plates he will spoil them.—AP-RHYS.

[2594.]—BORING WOODEN HANDLES.—"A. B." can make and bore his handles in the following manner:—First turn a cylinder in the usual way between centres, then turn down the end nearest the poppet head, and fit on the ferrule and turn it true; next turn the handle any shape required, leaving the end like A, Fig. 1; now substitute a boring collar for the poppet head, and bring the hand rest round and turn an indent for the augur to enter, and he can then (if the augur is properly entered) bore a hole any length without fear of it being out of truth; the part A, Fig. 1, can then be turned, and the handle cut off. The above is the way I turn long soft wood, turning handles 1ft. or so long; but short handles can be turned quicker without the aid of the poppet head or boring collar. Fix a piece of wood in a wooden cup chuck in the usual way, turn down the end farthest from the chuck, and fit on the ferrule; then turn an indent and bore the hole: afterwards turn the handles the required shape, finishing at A, Fig. 2, where it can be cut off. I shall be happy to answer "A. B." if there is any part he does not quite understand.—KENNINGTON AMATEUR.

FIG. 1

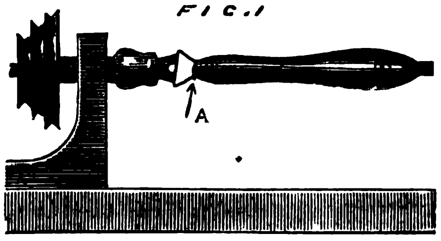
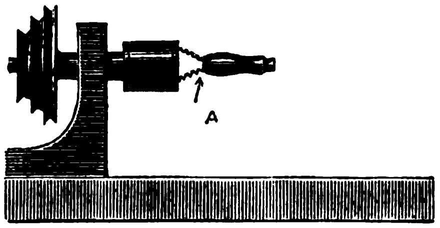


FIG. 2



[2595.]—WORK ON PROJECTION, &c.—An "Elementary Treatise on Descriptive Geometry, &c., to which is added a Description of the Principles and Practice of Isometrical Projection, by T. F. Heather, M.A., Royal Military Academy, Woolwich. London: Virtue and Co., 26, Ivy-lane.—BERNARDIN.

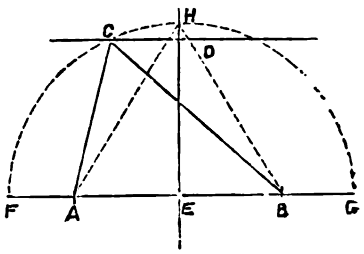
[2598.]—ELECTRIC.—Let "Slasher" at once drop his notions about glass tubing as an electric. This is my experience:—Being of an amateur turn, I love to have everything on a miniature scale. For instance, I have a Grove battery with 1in. by ¼in. platinum foil, a Wollaston element about the same size, &c. I made a small Leyden jar with an ounce medicine bottle, and succeeded with a glass tube and a piece of amalgamated leather in obtaining *perceptible* shocks (if you can call them shocks), and in exploding hydrogen and oxygen mixed. The jar was made thus: The outside was covered with tin foil, and the inside I filled to the required height with brass filings. The top of the wire is bent in a ring. Holding the jar with the thumb and first finger, and the leather (amalgamated) on the palm of the hand and the other three fingers, I moved the tube (⅜in. diameter) backward and forward through the ring. If "Slasher" will be at a little trouble and make an electropher about 12" diameter, he will be able to charge a moderate-sized jar so that he will not want a second shock very quickly.—TANGENT.

[2600.]—CLEANING OF DIATOMS.—After washing away the acids, pour some cold caustic ammonia on the fine sediment, let it stand for a day or two (the mouth of the vessel being closed to prevent the escape of the ammonia); then decant off the ammonia and wash the sediment with water before examination. The diatoms are heavy, therefore the washing waters may be decanted off before the whole of the flocculent matter has settled. Would "Beaten" kindly state from what sort of places he gathers his fresh diatoms, and what forms he has found?—R. G. ANDERSON.

[2600.]—OLD COIN.—Is a Roman coin struck to commemorate the taking of Jerusalem by Titus, then general to Vespasian, Emp. It is thus descried by "Hobler," Vol. I, p. 163, No. 298:—Obv.: "IMP. CAES. VESPASIAN. AVG. P.M.TR.P.P.P. COS. III. The laureate head of Vespasian to the right. Rev.: IVDAEA. CAPTA. In the exergue, S.C. A palm tree rising in the middle of the field, on the left side of which a female captive is seated upon armour, her head reclining upon her left hand in the attitude of grief. The emperor is standing on the right side, bare headed, and in military costume; in his right hand he holds a spear erect, and in the left hand a parazonium; his left foot rests on a helmet lying at the foot of the palm tree; struck about A.D. 71 and 72." He mentions several varieties. It is a coin of some rarity, and is much sought after by most collectors on account of its biblical interest, and is consequently of corresponding value.—D. T. BATTY, 9, Fennell-street, Manchester.

[2615.]—BICYCLE WHEEL.—The less the number of joints in a wheel the better. I do not see what drawing is wanted, or would send one.—F. J. D.

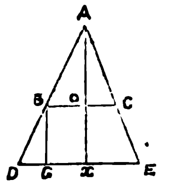
[2623.]—SCIENCE QUESTION.—



$ED = 1\frac{1}{4}$
$AB = 2\frac{1}{2}$
$AH = HB = 2\frac{1}{4}$ $HE = \sqrt{AH^2 - AE^2} = 1{\cdot}871$
$AH \times 2\,FA = 4\frac{1}{2}$

with tranverse axis F G and conjugate = 2 E H describe ellipse F C H, cutting C D in C join A C, C B, then A C + C B = 4½ 2 E F.—J. K. P.

[2582.]—WEIGHT OF FRUSTUM.—Let A B C D be the given frustum complete the cone C D E, then weight of frustum equals



$$CDE - ABE = 16 \times 24 \times {\cdot}2618 \times 440$$
$$= 38707\text{lb.}$$

$$\text{Now to } ABE = \frac{38707}{7} = 5529 \text{ add } 4 \text{ tons} = 8960\text{lb.},$$

which gives 144489 for weight of F H E. Now the solidity of similar cones is as the cube of their height, or their height is as cube root of solidity. Therefore

$$\sqrt[3]{5529{\cdot}0} : \sqrt[3]{144489} :: EJ : EK$$
$$17{\cdot}68 : 24{\cdot}37 :: 12 : 16{\cdot}54$$

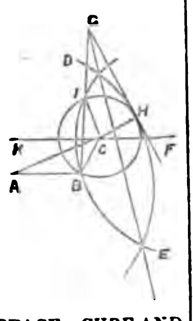
and

$$KL = 24 - 16{\cdot}54 = 7{\cdot}46$$

and

$$FH = \frac{16{\cdot}54}{6} = 2{\cdot}757$$

J. K. P



23.]—SCIENCE QUES- NS.—To construct a ngle A B C, given base, ht and sum of the sides AC + C B = l. Solution: Draw K F parallel to A B at a distance = height, with A as centre and l as radius draw arc D E; mark I symmetrical of B, and with F (*ad libitum* on K F) as centre, draw I B E, hence point G and from G a tangent to the arc D E, hence H, constructing circle through H I B, we have C vertex of the triangle; proof easy by Euc. iii., 36 (*vide* my reply to Query 2604)—another solution on the left side of A B.—**Bernardin.**

[2624.]—PROPORTIONS OF SPACE.—CUBE AND SPHERE.—I suppose a sphere tangent to all the faces of the cube; edge of the cube being D, the volume of the spheres will be $\frac{\pi D^3}{6}$. If now I divide the edge in n equal parts, I can have n^3 spheres tangent to each other and to the cube, volume of each sphere will be $\frac{\pi D^3}{6 n^3}$, and total volume of the n^3 spheres = $\frac{\pi D^3}{6}$ the same as the first sphere inscribed in the cube; this sphere is equal to the volume of the cube × 0·5236; all this is theory: in practice we must account with the more or less sinking of the substance.—**Bernardin.**

[2625.]—BIRDS' EGGS.—Blow out the inside carefully, and then boil them for 10 or 15 minutes; they will then keep many years.—**Semper Pace.**

[2625.]—PRESERVING EGGS.—If "Rustic" will procure some corrosive sublimate dissolved in alcohol, and insert a small quantity into the egg, and shake it after drying, he will find no insect destroy it. If he wishes his eggs to appear bright, he must brush over them very sparingly a little mastic varnish; but if for blue or green eggs, gum arabic must be used, as the varnish is apt to slightly change the colour.—**Oiseaux.**

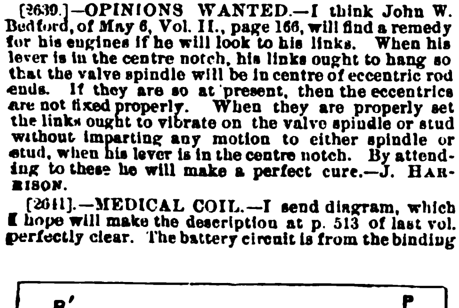
[2628.]—DIMENSIONS OF ENGINE.—I think the following dimensions will give "Cam" satisfactory results:—The steamways should be ⅛in. wide and 1in. long, or exactly ⅛ of a square inch, the exhaust just twice this size, or ¼ of a square inch. The steam-pipe ought to be ⅜in. diameter (inside of course), the exhaust pipe ½in. diameter.—**W. H. Thorpe.**

[2634.]—PAPER HANGINGS.—There are three modes of producing the required effect. 1st. Wooden blocks are carved representing in relief the outlines of the figure; an impression is taken from these blocks, and the device is completed by painting with a pencil. 2nd. A sheet of paper, leather, tin, or copper, is cut out into the required pattern, and laid on the paper to be stained; a brush dipped in a coloured pigment and worked over the surface of the perforated plate, conveys the pigment through all the perforations, and forms a pattern on the paper. 3rd. A block is carved for each of the colours to be employed, and an impression from all the blocks in succession fills up the design on the paper. The first of those methods is too slow and costly for ordinary use; the second produces imperfect outlines; and the third is the method chiefly employed at the present day.—**A. Boughey.**

[2636.]—CEMENT FOR JOINING BOARDS.—Marine glue will join boards so as to resist water.—**J. F.**

[2639.]—OPINIONS WANTED.—I think John W. Bedford, of May 6, Vol. II., page 166, will find a remedy for his engines if he will look to his links. When his lever is in the centre notch, his links ought to hang so that the valve spindle will be in centre of eccentric rod ends. If they are so at present, then the eccentrics are not fixed properly. When they are properly set the links ought to vibrate on the valve spindle or stud without imparting any motion to either spindle or stud, when his lever is in the centre notch. By attending to these he will make a perfect cure.—**J. Harrison.**

[2641].—MEDICAL COIL.—I send diagram, which I hope will make the description at p. 513 of last vol. perfectly clear. The battery circuit is from the binding screw P to S, the stem which carries the screw of the contact breaker, thence along the spring to its stem *a*, thence by wire to the electro magnet 5, 6, and to the inner end of the primary of the coil 1, and from its other end 2 to the binding screw N. The secondary circuit, which is screwed in the coil, goes from binding screw N¹ to 5, in order to utilise the action of the magnet, or it might go to 1 direct, through the primary to 2, and thence to a stud; the secondary wire which is attached to the termination of the primary has its outer end 3 led to a similar stud, and if great force is required several layers may thus be formed, all in a continuous length, but with branches thus led to separate studs arranged on an arc of a circle; this is a commutator arrangement for throwing either length into the circuit; at the centre of the circle is a pivot carrying a spring which may be moved in contact with either stud, from which it carries the current to the binding screw P¹. Of course separate binding screws may be employed for each length instead of this commutator. The core is shown with a handle, by which it can be drawn out partially, to regulate the shocks. The lines formed of dashes show the primary circuit, and those of dots that of the secondary or induced current. Any battery will serve to work such a coil, even a single Smee cell.—**Sigma.**



[2644.]—ADULTERATION OF TURPENTINE.—Apart from the evidence of colour and smell, the use of a specific gravity glass is a certain test for the purity of turpentine. They may be procured at any optician's. The gravity of genuine American turpentine is, of course, the standard to be taken. If petroleum is added, the mixture will show a lighter gravity. If "Russian," "German," "Polish," or other turpentines of a rougher kind, are added, the mixture can be detected and approximated by the increased gravity figures. Field, optician, Birmingham, supplied my gravity glass.—**Llah.**

[2645.]—IMPERFECT ORGAN.—I am very doubtful whether by any alteration the clarion stop will be made perfect. I would not recommend "Anti Discord" to go to any expense in attempting to do so, but he might ask a pipe-maker for what he will supply him with a new one, taking the old pipe as part payment. A wooden flute from tenor E upwards would cost voiced about 45s. The cost of applying them need not be much; any handy carpenter or cabinet-maker could do it in a day or less. Cannot "Anti Discord" do that himself?—**Miles Jennings.**

[2651.]—LECLANCHE BATTERY.—"Telos" should write to the Patent Office, and enclose 9 stamps for the specification. It was patented 10th Oct., 1866 (No. 2628) in the name of Brandon. I have a specification of it which I was recommended to procure by a well-known electrician, who assured me that the system must ultimately supersede all others, but I have tried in vain to understand it. The battery consists of two parts, the "generator" and the "accumulator," both of which have porous cells differently charged. A little light thrown on this matter would much oblige—**Viator.**

[2656.]—BOOKS.—I know of no book better than Culley's "Practical Telegraphy" to "Much-in-Want." **Llah.**

[2656.]—TELEGRAPHIC BOOKS.—Cully's "Handbook" is perhaps the best, and Clark's "Electrical Measurement" would be a valuable addition.—**Sigma.**

[2663.]—QUICKSILVER.—There is no solvent which could be used; heat alone will succeed in driving it off. —**Sigma.**

[2667.]—PAINT TO COVER TARRED WOOD.—I know of no paint that will effectually cover tarred wood, certainly not a light paint. I would recommend your correspondent to clean the posts as much as possible, and then limewash them with a wash having plenty of size or grease in it. This will whiten the post as he required, and the lime would, I think, eventually "eat up" the tar, after which it may be painted. —**Llah.**

[2667.]—PAINT TO COVER TARRED WOOD.—If "Associate," No. 2967, mix some red lead with boiled oil and paint his posts with it, he will find the tar will not burn through. (I speak from experience, having found it stand the hot sun for years.) He can then paint them white, or oxide of iron will answer the same purpose.—**C. H.**

[2671.]—CANOE BUILDING.—"C. D. R." wishes to know how the planks of a canoe are kept to the proper shape while building. He will find that the strakes must be so cut and fitted to each other, that there is no tendency to buckle or twist, and in this adaptation of flat surfaces with curved edges lies the whole mystery and art of boat-building. The skin of a boat may be divided into three parts—the floor, the bilge strakes, and the side. On the shape of the floor depends the form of the boat. The strake next the keel on each side (called the garboard strake) fits the rabbet in the keel. Thus we trace the modelling of the boat to the starting point. If the rabbet is not continued well fore and aft, but bridled up into the stem and sternpost, the canoe will be sharp and crank. The edges of the strakes should be lapped ⅜ or ⅝in., and fastened with copper boat-nails about 2in. apart. The hole must be bored right through, the nail driven, and then a copper burr punched on the point. With a pair of cutting pliers then cut the nail just inside the burr, and rivet. This draws the work together without caulking or any intermediate substance being necessary. The upper edge of the strake is chamfered to the angle formed by the strake above; but this is only required in some parts. When "C. D. R." has his frame ready, he will find it best to get an 1½in. board, rather longer than the frame; fasten the board on its edge near the ground, and "lay down" the canoe on it. As he says he is totally ignorant of the art, I recommend him to set up three or four moulds on his keel to work to, taking care that the strakes do not press too heavily on them.—**Boat Builder.**

[2679.]—UNANSWERED QUERY.—One method of preparing curled hair is as follows:—It is cut from the rumps, washed and dried. It is then spun up into ropes and put into a baker's oven for a while, care being taken that it is not burned by the heat being too strong. It is then teazed out by the hand, and is then ready for use.—**Miles Jennings.**

[2683.]—IRON PALISADINGS.—To this general question only a general answer can be given. If the palisades are painted with the most suitable class of paints, and all the other materials are good, and the work is carefully done, it should stand and look well for at least seven years, and with re-varnishing 10 to 14 years. The most important matter is to have the paint for the first coat of the right kind.—**Llah.**

[2685.]—AMATEUR TURNERS' CLUB.—In reply to Mr. H. Hume's inquiry, I beg to state that the Amateur Mechanical Society was originated in January, 1869; admission by introduction of a member on personal knowledge. I shall be pleased to send a prospectus, &c., to any of your readers on application.—**J. W. Boord**, Hon. Sec., 180, Belsize-road, Kilburn, N.W.

[2688.]—RENDERING WOOD INCOMBUSTIBLE. —I do not know of any preparation that will render wood absolutely fireproof. Alum will, however, if the wood is impregnated with a solution of it, prevent the wood from flaming.—**Llah.**

[2692.]—BOTANY.—Cuckoo flower (*Cardamine pratensis*), root stock short and perennial, stem erect, leaves primate, the segments of the lower radicle ones ovate, the terminal segment being largest. Flowers sometimes pure white, but more frequently tinged with a faint purple, sepals 4, petals 4, stamens 6. Pistils short, almost wanting, seed pod flat, grows in meadows and on the banks of brooks. Hedge mustard (*Sisymbrinya officinale*), an erect annual, about 4ft high, flowers very small and yellow, sepals 4, petals 4, stamens 6; leaves deeply pumatifid, seed in a pod about ½in. long, tapering to a point, hairy, and in long slender racemes.—**Automedon.**

[2695.]—GEOGRAPHICAL QUERY.—Might "key" not have the meaning of "quay" in these words? netherset is evidently an Anglo-Saxon word meaning "to lay down." Hence the quay, where goods are stored; keyhouse, where duty is paid; key-spink, warehouse.—**Franck.**

[2696.]—CLEANING FLAGS.—Use mineral naphtha and a hard brush on a piece of pumice stone. Let the naphtha lie upon the tar for some time if it has been long there. Mind the fire, or a light.—**Llah.**

[2697.]—CANARY.—In reply to "Minehaha," I copy the following from "Bechstein's Natural History of Cage Birds":—"Asthma or hard breathing, which arises from an oppressed stomach, generally yields to plantain and rape seeds moistened with water as the sole food."—**El Hakim.**

[3701.]—KOLA-NUT.—I do not know where to procure it. I asked for it at many places without result last year.—**Bernardin.**

NOTES AND QUERIES.

[3706.]—PANCRATIC TUBES.—Will "Amateur," p. 139, describe the manner of using the pancratic tubes which he employs with his eyepieces: where they may be obtained, and the cost of making?—**T. J.**

[3707.]—TWISTING POWER OF METAL.—Will any of your numerous readers kindly give me a rule by which I can find the relative twisting power of metal, iron, and steel shafts; or what diameter a steel or iron shaft should be to be equal to a given-sized metal one?—**P. P. W.**

[3708.]—CARBONIC MONOXIDE, &c.—How can this gas be prepared otherwise than by depriving carbonic acid of half its oxygen, or by adding carbon to it?—**Carbon.**

[3709.]—TURNING.—Will some of my brother turners inform me the following:—How the sandy surface is taken off metal before turning? I turned some metal, and it continually kept blunting my tools although they were good steel, and left at, I think, about a straw colour. How are cylinders bored out in the lathe? A sketch would greatly assist me, and I think some of my brother readers also. How are cylinder covers turned, both sides and edge (hind ones); they will have no hole in them for a mandrel to go into?—**Amateur Turner.**

[3710.]—ARITHMETICAL QUERY.—Will any of your numerous readers kindly inform me, through the medium of your valuable paper, how the decimal 7854 is arrived at as a multiplier for converting areas of circles into squares; also, how the multiplier 3,1416 is made out so as when multiplied by the diameter of a circle it will give the circumference of the same?—**Falcon.**

[3711.]—CUSTOMS EXAMINATION PAPER.—Could any of your readers inform me where I could get a copy of the examination papers (last time, or last but one), for the Customs service.—**R. P.**

[3712.]—POWERS OF TELESCOPES.—As no one has noticed my communication on the above subject in Vol. X., No. 258, p. 606, I should take it as a great favour if your obliging correspondent "F.R.A.S," would tell me if the method there suggested for the determination of telescopic powers is correct, and if not, to what extent the results so obtained would differ from the true results?—**R. G. Anderson.**

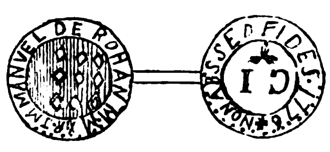
[[3713.—TELESCOPIC.—Will "F.R.A.S," or some gentleman, reply to these queries:—I have been endeavouring to make a 4in. achromatic object glass for a telescope, in the following manner, but at present with slight success; I am acquainted with the theoretical portion of the subject, but I am not yet able to realise my wishes practically. I have used for a grinding tool a piece of glass, 1in. thick, and the same diameter as the lens, 4in., and in this I have ground the convex side of the flint glass with different finenesses of emery, till I thought it was fine enough for polishing. I then covered the glass tool with black pitch, about ⅛th of an inch thick, and commenced polishing with putty power, but I found that the glass would only polish in the centre, the edges remaining untouched (I worked the lens across the tool, and not more than 1in. over the edge); I removed the pitch, re-ground the lens, covered the glass tool with a piece of fine calico, and commenced polishing in the same way as I had done when polishing on the pitch, but the result was still the same. I could not get the edges to polish, and I shall not be satisfied unless I can get a good spherical figure. I have come to the conclusion that the error lies in my grinding tool not being large enough, and I, therefore, wish "F.R.A.S.", or some other gentleman, will tell me whether this is the reason, and give me the diamater of tools for a 4in. lens? I wish they would also tell me of what metal they should be made, whether it is necessary to use brass ones, or would iron do as well? I should also like to know how to tell when my lense is ground fine enough to begin the polishing; and whether it should be ground with anything else besides emery before commencing to polish, and on what it should be polished on, pitch or linen and lastly, whether putty powder is the proper polishing material to use?—**Dioptrics.**

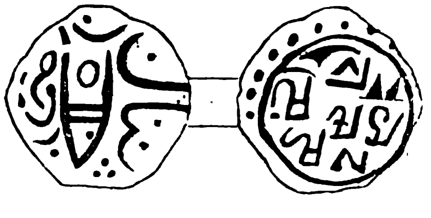
[3714.]—**BACK DRAUGHT IN ENGINE.**—Would some kind brother reader inform me how to prevent what is generally termed back draught in a steam boiler? Ours is an ordinary two flued boiler, and we have a good draught, so much so that the damper is seldom needed to be drawn above one-half, but whenever the coals are thrown on it makes a very oppressive humming noise, and causes the boiler shake very much, and consequently breaks the joints very often, as we have to carry 60lb. pressure of steam. There is a good draught under the furnace, but still it blows out of the apertures in the furnace doors.—ONE IN A FIX.

[8715.]—**COIL.**—Many thanks to Messrs. Conisbee and Tucker for their kindness in replying to my last questions, and as I have made up my mind not to touch the old coil, but make a complete new one, I think I can not do better than ask the gentlemen above mentioned, if they know of anything new in the construction of coils. I made my last one, 12in. long, of gutta-perch, with a disc in the centre dividing the secondary in two, joined by a piece of copper at the bottom of the centre disc going through the disc; the primary I wound on a small reel of lignum vitæ, same length as large reel, with ¼in. hole through for iron core. I covered the primary well with gutta-percha tissue, and pushed it tight into the large reel. Now can any of my two friends suggest anything new? I mean to put 4lb. No. 36 secondary; what will be the best for primary? I intend making the reel 12in. long. —D. FORBES.

[3716.]—**RELACQUERING BRASS WORK.**—Would W. Seabrook, p. 18, No. 1029, kindly say if there is any peculiar pickle or solution for immersing brass work in before dipping in nitric acid, as I have some old brass work I wish to relacquer, and have gone to work as directed, but the work not come clean enough from the boiling in soda process, and I find the acid will turn the brass nearly black if in for 2 or 3 seconds. How is that? I should also like to hear, through our MECHANIC, how "Inquirer" has succeeded? A reply on the above will, I have no doubt, oblige many besides myself.—PRO BONO.

[3717.]—**COPPER AND SILVER COINS.**—Will either of our kind friends, Mr. Henfrey or Mr. Batty, give me any information relative to the two coins of which I send attempts at representations? Of the small copper taken, there are two varieties. the other specimen has the date under the G 1. I have had one specimen many years (17), the other was sent to me a few days since. Of the silver coin I know nothing, but should be glad to learn?—S. SMITH.





[3718.]—**TALL CHIMNEYS.**—Can any of our brother readers inform me the height, with size at bottom and top, of the large chimney at the chemical works of Messrs. Tennant and Co., Glasgow, or one at any other works? A sketch with full particulars through the ENGLISH MECHANIC would be esteemed. —GAINSBORO.

[3719.]—**LACE AND BUTTONS.**—I wish to know if there is any way of cleaning tarnished silver lace on a uniform, and also a recipe for a dark bronze for buttons which have become bright through wear?—REX.

[3720.]—**BONE BLEACHING.**—Will some brother reader kindly inform me how to bleach bone so as to make it like ivory, I have tried hot lime, but did not find it answer?—OS.

[3721.]—**GRINDING.**—I would be greatly obliged if some of our miller friends would answer my query on the above, 2277, p. 45, to which I beg to add, the small stones being driven at 200 revolutions, and the others at 120 per minute.—SERGIUS.

[3722.]—**OLD COINAGE.**—Can any reader inform me if there is any means of getting rid of the old copper coinage, now out of circulation, either for its full value or otherwise?—SERGIUS.

[3723.]—**GLAZE FOR POTTERY.**—Could any fellow reader inform me how to make the different colours of glaze to put on common clay pots?—X. N.

[3724.]—**COTTON.**—Some time ago Dr. Forbes Watson, reporter of East India products, published one or two engravings which show the various lengths of different classes of cotton, if any brother reader would kindly say where they can be got, and price, he would confer a great favour.—GOSSYPIUM.

[3725.]—**OILED PAPER.**—Will any of your readers suggest to me a method of preparing paper to receive oil similar to that sold by artists' colourmen, which is too costly for my purpose?—AMATEUR ARTIST.

[3726.]—**CHROME BLACK.**—Can any kind reader inform me how chrome black is produced?—MORDANT.

[3727.]—**WIRE TACKS AND NAILS.**—Can any reader give me a description of a good machine for manufacturing the above?—C. F. J.

[3728.]—**CURIOUS CHUCKS.**—I have seen in tool makers' shops, lathe chucks like figures 1 and 2, but have not been able to find out how they are constructed; could any of my fellow readers explain it to me, a drawing will be much appreciated? I suppose the flutes round the sides are to grasp it while the work or drill is fixed?—W. T.

FIG. 1

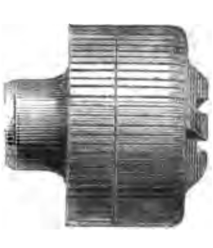
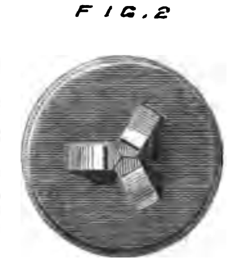


FIG. 2



[3729.]—**SEAMLESS FELT SKIRTS.**—I want a machine for making seamless felt skirts, a description would oblige.—C. F. J.

[3730.]—**PAPER COLLARS AND CUFFS.**—A description of the apparatus used for finishing paper collars and cuffs would be welcome?—C. F. J.

[3731.]—**BLOCKING BLACK LEAD.**—Will some kind friend inform me how to make black lead into blocks and medallions with devices on; all the information to enable me to make them up will very much oblige?—AN AMATEUR.

[3732.]—**TRANSPARENT PARAFFIN.**—Will any of your many readers kindly inform me how I can take pink, green, blue, and mauve colour out of hard paraffin, so as to make it white, or nearly white, and transparent again?—GREEN.

[3733.]—**COTTON SPINNING.**—Can an reader inform me of a good new German book on cotton spinning, price and name, and where to obtain?—OSCAR.

[3734.]—**THE GOAT AND THE GRASS PLOT.**—I have a circular grass plot in my grounds, 45 yards circumference, I want to tether a goat to a peg driven into the edge of the plot in order that the goat may feed over only half the ground. What must be the length of the tether?—CAPTAIN BAXTER.

[3735.]—**ENGLISH VELOCIPEDE.**—Will "A Thinker" kindly say how his machine is steered, and whether the cranks are set at a quarter circle or both or both in one plane?—GARIBALDI.

[3736.]—**GENEVA CYLINDER.**—I thank "Nobody" for the information given, but would like to know the kind of callipers used, and if there is not a Swiss tool used for the purpose of taking the height?—CYL.

[3737.]—**HARDENING PLASTER.**—The plaster on the walls of a mill staircase is being continually knocked off with the boxes and other things that are carried up and down the steps, will some obliging reader inform me of a cheap and simple method of keeping it in its proper place, either by hardening the surface of the plaster or any other plan?—COTTON SPINNER.

[3738.]—**UNNOTICED QUERY.**—Having a few Fitzroy barometer tubes, quite new, but covered with a film inside, would some friend tell me in what way to remove it before filling them?—T. FORTY.

[3739.]—**CHLORIDE OF TIN.**—I find great difficulty in obtaining chloride of tin, I have tried at several chemists, and each have given me different things. Is it better known by some other name?—AMATOR SCIENTIÆ.

[3740.]—**FLOAT FOR BOILER.**—Perhaps some of your correspondents could inform me if there is any material a solid float could be made with to carry its own weight in a steam boiler, pressed say from 30 to 40lb., or can a hollow float be made strong enough to keep from filling with water?—J. K.

[3741.]—**TURBINE.**—Can any one inform me where a turbine is to be seen working in England?—M.R.C.S.

[3742.]—**SEASONING WOOD.**—Would any of your readers kindly tell me the best method of quickly seasoning small pieces of wood for carving or turning, I think I saw some recipe or direction in a former number, but cannot find it now?—BRUIN.

[3743.]—**SYPHON PIPES.**—Will any reader kindly give me a rule to calculate the quantity of water a syphon will discharge in a given time, diameter of pipe, height water rises to in syphon, and length of discharge end being known?—CALCULUS.

[3744.]—**SILVER COIN.**—Will some fellow subscriber kindly tell me what coin this is, and its value? About the size of a threepenny piece, on one side a rose, crowned, inscription—G. ROSA. SINE. SPINA; other side a thistle, crowned, inscription—ATVR. VIT. DEVS.—J. NASH.

[3745.]—**STEAM PIPE JOINTS.**—Will some brother subscriber be kind enough to inform me what quantity of salammoniac should be mixed with 1cwt. of metal borings to make steam pipe joints?—J. E. S.

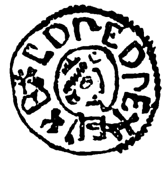
[3746.]—**TESTING BOILER.**—Could any of my brother readers inform me of the best way to test a boiler without taking it out of its bed? My boilers are 6-h p., and I want to work them up to more pressure, but the safety valve blows off at 10lb., and I should like to test them before adding more weight to my lever.—THOMAS EDWARDS.

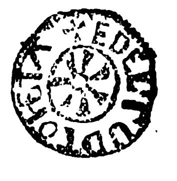
[3747.]—**SITUATION OF PLANETS.—TO "F.R.A.S."**—In what constellation or sign of the Zodiac is Saturn and Mars at the present time; is Herschel *still* in Gemini, although, of course, it is not discernable to the naked eye?—SECUNDUM NATURAM.

[3748.]—**DENTISTRY.**—Will "Portsmouth Chemist" oblige by informing me where I can procure a copy of "Richardson's Mechanical Dentistry," or where the publishers, Lindsay and Blakiston, carry on business? —F. W.

[3749.]—**CENTRIFUGAL FORCE AND THE EARTH'S ROTATION.**—"C. R. O., Hants." in a letter on the "Earth's Rotation," p. 134, seems to imply that the amount of centrifugal force depends, not on the size of the revolving body, but upon the rate at which it revolves, which seems to me to be correct, though I never thought of it before—and that the amount of tendency which bodies on the earth's surface have to fly off is precisely the same as that of the filings on his iron globe, because the revolution of his iron globe occupies the same length of time as that of the earth. Seeing, then, that the centrifugal force of the earth is so small, how is it that its circumference at the equator is so much greater than its circumference at the poles—I believe 25 miles. This is, I have heard, owing to centrifugal force. I wish some one who knows something about it would enlighten me?—SALOPIAN.

[3750.]—**SILVER COIN.**—Could Mr. H. W. Henfrey, or any other kind correspondent, inform me what the silver coin is of which I enclose a full size copy; and if it is of any value; weight 19gr.?—A BEGINNER.





[3571.]—**ASTRONOMICAL QUERIES.**—I beg to inform "F.R.A.S." that I *did* turn my 240 eyepiece round in the tube, while watching the planet Venus, and my "supposititious moon" did not describe an orbit round its primary. Will some kind friend give me some information on the following:—Has D'Arrest's comet been picked up by any one, and whereabouts is it now? Is that the only comet now that is within reach of an 8½in. silvered glass reflector? Where can I find the position of any of the asteroids given in R. A. and D. for any day of the year? What power with an 8½in. With mirror, would be necessary to divide μ^3 Bootis? What is the apparent diameter of the sun, moon, Venus, and Jupiter, to the unassisted eye in inches or parts of inches, and how can such be ascertained from their diameters in minutes and seconds, given monthly in the "Nautical Almanac"?—H. A. C.

[3752.]—**DEPOSIT FROM SODA CRYSTALS.**—I shall be glad if any of your chemical correspondents can answer the following:—In dissolving a quantity of soda crystals without water, and by either fire or steam, there is a sediment left at the bottom of the pan which, when cold, is a hard brittle mass which does not mix with the other part of the soda even if cooled in the same pan, but seems to be quite another material, although the same in colour. I wish to know what it is, and can it be prevented; I have used the best Newcastle soda?—NATRUM.

[3753.]—**BOTANY.**—Would some one of your correspondents who is interested in botanical pursuits, kindly inform me what is the best handbook of botany, or guide to the indigenous plants of Great Britain, for field use? I have used an old edition (the 7th) of Macgillivray's "Abridgment of Withering," but have often found it difficult to determine the species from the short descriptions given.—D. N. E.

[3754.]—**ELECTRO.**—Will Mr. Chapman, or any other obliging reader help me out of the following difficulties:—I have a large Smee's battery for depositing copper. I want to get a deposit on a non-metallic surface a foot square, which I cannot get in less than 30 hours, and not then with any degree of certainty? How can I quicken the deposit? What is used for removing the wax from a shell taken from a wax mould?—J. D.

[3755.]—**TURBINE WHEEL.**—Will "Senex," or any other practical person, oblige me by answering a few questions respecting turbines?—What is the quantity of water per minute required to drive a one-horse power turbine wheel, the height of the fall, diameter of feed pipe or jet, diameter of wheel outside, number of revolutions per minute, or any information concerning the machine.—A. B.

[2756.]—**LAMENESS IN HORSES.**—Having seen a paragraph in your valuable paper last week "Amateur Farming," that a "Country Vet." would at any time be happy to render help towards the advancement of a column respecting the breeding, rearing, and diseases of dogs, &c., I think that a few hints upon the above subject would be very instructive to many. Would the "Country Vet." be kind enough to give me his opinion and a little information respecting that troublesome lameness which the horse is so much subject to in this country—namely, laminitis or founder of the feet, and also the best method of shoeing for chronic laminitis? —J. O. DUFFRYN, Neath.

[3757.]—**BOOKBINDER'S PLOUGH.**—Thanks to "Ab Initio" for his answer to my query. I have shown some samples of books to a printer and a bookseller, and they say they are very fair specimens. I should be obliged if he would describe how to make a plough?—MASCHIL.

[3598.]—**EMIGRANTS' INQUIRIES.**—"F.R.G.S." kindly offers to give some information to those of your readers who require it, and which will most certainly be useful to all of us. As an intended emigrant, I shall esteem it a great favour to obtain some geographical and general information of the colony of South Australia. I am a carpenter, been used to railway work, and desire to fix on some town in that part where the climate would be congenial (as I am not very robust in constitution), and where my trade would be likely to be brisk. If "F.R.G.S." would kindly assist me in my choice of a destination through the medium of your valuable ENGLISH MECHANIC, I should consider it a great boon.—J. FRANCIS.

[3751.]—**ASCARIDES.**—Can one, out of the very many obliging, correspondents of the ENGLISH ME-

[illegible]. answer me the whole or any one of the following questions:—1. What is the primary cause of ascarides, or thread worms? 2. What is a safe and certain cure for these parasites? 3. What is the best preventive against their future generation? 4. What is the cause of their being so seldom felt during the day, but chiefly towards evening?—A GREAT SUFFERER.

[3760.]—CONTRIVANCE FOR HOLDING IRON RODS.—Can any of your correspondents favour me with a sketch of a contrivance for holding round iron rods $\frac{5}{16}$in. thickness. The rods are passed up a hollow spindle into the machine for turning. I want a contrivance at the end of hollow spindle, to lock and unlock as the rods are drawn in. The pieces turned off rods at each stroke will be about ¾in. long. The rods vary a little in thickness. The lock must take up as little space as possible, but must be very strong. The machine is self-acting?—RAYMOND.

[3761.]—EMIGRANTS INQUIRIES.—Will the learned "F.R.G.S." please say whether the climate of Natal is usually much hotter in summer than in England, and whether or not dangerous wild beasts and snakes might be met with there in the woods. I have read denials of this, but the statements of paid advocates, and otherwise interested persons, on all drawbacks, are, of course, worthless, and their silence confirms belief, hence I have been led to believe those drawbacks exist there, though I only doubted it before. The productions of Natal indicate a hot climate. Dangerous animals, including the lion, seem to have been common there some years ago. What will be the best mode of my getting the MECHANIC there if I go?—EMIGRANT.

[The ENGLISH MECHANIC can be had in postal districts at Natal, postage 2d.]

[3762.]—PAINTING AND DECORATION.—Can any of our readers recommend a good book on ornamental painting and house decoration? If so, I should esteem it a favour.—C. H.

[There is a series of articles now being inserted in the *Building News* on this question.]

[3763.]—THEINE.—I have tried several times to isolate the above from various samples of tea, but have failed. I proceed as follows:—Make an aqueous infusion from a sample of good tea, and when cold, precipitate the tannin with plumbic acetate; then remove the excess of lead with sulphuretted hydrogen, filter the solution and neutralise the excess of acetic acid contained in the filtrate with ammonia. I now evaporate the solution to about one-sixth of its original volume with heat, and leave the residue to evaporate at the ordinary atmospheric temperature. By this process I obtain the long needle-shaped crystals, but not thoroughly isolated, for with them I get a gum-like residue, which I can collect and roll up like a pill. Will some of your chemical correspondents kindly point out where my manipulation is defective, or inform me of a process by which I may obtain my obtain my desire in a more effective manner?—A. A. ATTWOOD.

[3764.]—EBONITE.—Can some one of your readers give me any information as to the manipulation of ebonite? Is it possible, without injuring the quality of the substance, to convert a sheet into a cubical block, and if so, how is this done?—S. T. P.

[3765.]—NAVAL ARCHITECTURE.—Will some one give me some information as to joining the evening class for studying naval architecture at South Kensington?—G. E. J.

[3766.]—CLEANING AND REFILLING BAROMETER TUBES.—Can any of your numerous readers inform me the best method for cleaning the inside of barometer tubes and refilling them with mercury?—WATCHMAKER.

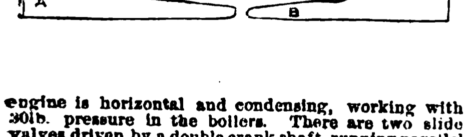
[3767.]—FLY WHEEL ARMS—Why are the arms of a fly wheel made gradually smaller as they recede from the centre of motion?—C. B.

[3768.]—POISONING BY CANTHARIDES.—Will any of your medical readers kindly advise what course should be therapeutically pursued to neutralise the exhausting and debilitating effects presumed to have ensued from surreptitious administration of cantharidian poison?—I. I. D.

[3769.]—STREET TELESCOPES.—Will "G. F." (2580), inform me in what localities in London I should be likely to see a "street telescope?" I am curious to see one. "G. F." should say where he resides, and he would probably meet with a friendly possessor of a good instrument?—F. FOTHERGILL.

[3770.]—SILVERING DIAGONAL PLANES.—I can endorse all Mr. James Gray says in No. 267, page 164, with reference to his difficulty in silvering diagonal planes. I have failed in exactly the same manner, after trying many strengths and temperatures of solutions, and under a variety of changes in the method of manipulation, but always in vain, for I never could get a film other than what he describes. I understand Browning's formula is also most uncertain with amateurs, in spite of the usual precautions with regard to purity of chemicals, &c. Can any reader in the chemical line give a hint or two?—INTERESTED.

[3771.]—FAULTY ENGINE.—Will any of your readers tell me what is wrong with the engine which the enclosed diagrams have been taken from (A taken from the crank end, and B from the back end). The engine is horizontal and condensing, working with 30lb. pressure in the boilers. There are two slide valves driven by a double crank shaft, running parallel with the cylinder, and two cams upon the same shaft working two expansion valves. The shaft is driven by a pair of mitre wheels from the crank shaft. I may state that the engine only indicates about 9lb. on the vacuum gauge. Any hints how to understand the diagram properly, and to make the engine work better will greatly oblige.—NIMROD.



[3772.]—KAPPER'S FIRES.—On page 17 there is a drawing of Kapper's improved fires, given by a Mr. Geo. Huart. Would he be so good as to give us a little more explanation as to Figs. 2 and 3, what cokes they use, and how they hammer the iron, as he says it is more for beams? He says there is no turning the work on edge. G. H. will greatly oblige by giving us a little more about the said fires.—BENDER.

[3773.]—½ PLATE PHOTOGRAPHIC CAMERA.—I should be glad if "Mus" or some other correspondent would, with your permission, give a detail sketch with measurements of the above, stating what size, with probable cost of lens, and any other information he thinks an artisan would require in constructing one, so as to obtain good results. I should like to know if this is the most suitable size for a beginner, and for future use?—SNATCH BLOCK.

USEFUL AND SCIENTIFIC NOTES.

HONEY.—From Queensland we have an interesting note upon honey, which in that colony, and indeed throughout Australia generally, forms an industry of considerable value. A centrifugal machine is used for extracting honey from the combs, the caps being first removed by a sharp knife, so that in less than a minute every particle of honey is taken out. The combs are then turned, and the cells on the other side treated in the same manner. The advantages claimed for this process are, that the larvæ, which are frequently very troublesome, remain in the comb, and that when the latter is replaced in the hives, the bees readily use it over again.

THE SUNFLOWER.—The following description is an extract from the Agri-Horticultural Society of the Pungal on the sunflower:—It is an annual plant. Its seed has an edible kernel, and affords 15 per cent. of a mild oil, which is equally good for food or for burning. If the outer skin is removed it would give a still larger proportion of oil. Although little cultivated as an oil-seed, it deserves to be better known, especially as its seed is very useful for nourishing and fattening poultry. It is said to increase the number of eggs. The roasted kernels are used instead of coffee. The foliage, which is abundant, and may be partially removed without injury to the seeds, forms a good fodder for cows. The stems, which will do for sticks for peas or beans, may be burnt, abd their ashes abound in potash. Sunflowers require good and fertile soil if they are to produce much seed, but they will succeed in very indifferent soil, or even in very moist ground. Their cultivation is very similar to that of Indian corn. They may be sown from April to May in lines or broadcast. It has often been said that large plantations of sunflowers are useful in marshes or places where malarious fever is common, as this plant is a decided remover of malaria.

DOMESTIC RECIPES.

SCOTCH BROSE.—This favourite Scotch dish is generally made with the liquor in which meat has been boiled. Put half a pint of oatmeal into a porringer with a little salt, if there be not enough in the broth, of which add as much as will mix it to the consistence of hasty-pudding, or a little thicker. Lastly, take some of the fat that swims on the broth, put it on the crowdie, and eat in the same way as hasty-pudding.

MADRAS DRY CURRY.—Cut one pound of meat into small pieces, slice one onion and fry it in butter to a light brown, then add one tablespoonful of Madras curry powder, one teacupful of water, one breakfast-cupful of gravy, the juice of one lemon, and a little salt; stew all together till nearly dry, and send it up quite hot.

FOR PREPARING INDIAN MEAL.—While the maize is yet green in the ear, it becomes by boiling a delicious vegetable for the table; and when ripe it is capable, before it is ground, of being prepared for food in a great variety of ways. It makes its appearance in every form,—from gruel, stirabout, and pancakes, to bread in twenty different shapes. In no form in which it is ever used in America is it eaten cold. When wanted in the shape of bread, no more is baked than is necessary for the time being; it is never baked in large quantities, and in the shape of loaves, as ordinary flour is baked into bread. Nor is it mixed with any kind of flour or meal. Indian corn is always best when used by itself, with the exception of such ingredients as eggs, butter, milk, sugar, etc., which are frequently added in its preparation, to give it richness and flavour. It is really never so sweet as when made in the simplest way. In preparing it for their own uses, the negro women generally mix it with water and a little salt, the dough which is thus formed being made up into a roll about the size and shape of a soda-water bottle without the neck. This is enveloped in the hot ashes of a wood fire, which is the simple process by which it is baked. When ready, it is taken to the pump, and, whilst yet hot, the ashes are washed off it. When they wish to be a little particular, they protect it by wrapping it in leaves before covering it with the ashes. The bread produced by this means is, whilst warm, exceedingly sweet. Indian meal should never be ground to fine. It should not have much salt, which spoils its native flavour. It requires a hot oven, or, if baked upon a girdle, a hot, clear fire. It takes longer to bake than wheaten flour bread; and, if boiled, much longer time than oatmeal. For boiling, the more coarsely it is ground the better, if it is long enough boiled. It is sufficient that it is husked. For hominy (a good substitute for rice) the corn is simply hulled or cracked at the mill, and any inevitable meal is afterwards sifted out; or the skins are got rid of by pounding the corn in a mortar and sifting it—a tedious process Indian corn roughly ground may be used for force-meat, instead of bread-crumbs. It makes tolerable gruel.

CONGRATULATIONS.

SINCE the alteration in our form we have received from all quarters thanks and congratulations. We have, in fact, only received one letter expressing anything like sorrow or disappointment. We need scarcely say that our circulation, since the commencement of the present volume, has increased several thousand copies weekly. Any one may verify this statement by inquiring of any of the principal booksellers or newsagents in any of our large towns. It is not, however, merely in our large towns where our influence and circulation has increased, as may be seen from the few extracts from letters given below, which have been taken at random from a host of communications of the same character:—

EXTRACTS FROM CORRESPONDENCE.

"I beg to congratulate you on the enlargement of the ENGLISH MECHANIC, and also on its great improvement in every way. I also beg to assure you that I shall always take great pleasure in answering all questions in numismatics that appear in its columns."—HENRY W. HENFREY, Markham House, Brighton.

"What a vast improvement in a few months! *Then* "dodges" and "fads" were repeatedly *solicited* as well as inserted; *now* the "Notes and Queries" are sifted and classified, trivial correspondence expunged, more and better original matter inserted; in fact, something like a revolution has been effected."—JAMES BELL.

"Not only the biggest but the best scientific paper published."—SUBURBAN.

"I need scarcely say I wish you success. The marvel to me is how it pays. The secret exists, I suppose, in its immense circulation."—KAPPA.

"Too much cannot be said or written in praise of the ENGLISH MECHANIC."—J. B. COCKBURN, 4, Moss-street, Paisley.

"I look on 'our' MECHANIC as the leading scientific periodical."—W. BAGULEY, 5, Garden-place, Tutbary-street, Manchester..

"The success of our MECHANIC is now so complete that it will be a bold venture on the part of any one to attempt to surpass it."—J. H. JOHNSTONE, 17, Crown-street, Aberdeen.

"I believe the ENGLISH MECHANIC serves its purpose better than any similar paper in existence."—R. A. SCOTT, St. Neots, Hunts.

"I certainly must congratulate you on the progress of the ENGLISH MECHANIC, and think it worth three times its price."—R. W. PARAMER, Steam Saw Mills, Margate.

"I congratulate you, Sir, on the improved appearance of the ENGLISH MECHANIC. In fact, it is a most voracious monster, this of ours. Long may its health and appetite improve! I wonder what other journal will it gobble up next!"—C. FALLON, Bathgate, Edinburgh.

"I congratulate you on the great improvement in the appearance of your journal, and on its intrinsic value and interest. I file it each week with undiminished satisfaction."—C. F. JESSEN, Bradford.

"I have taken a great interest in the journal, and particularly since the management was transferred to the new Editor, under whom it has much improved." —ISAAC K. CLAYTON, Stalybridge.

"I am delighted to see such an improvement in our MECHANIC from what it was eight or nine months since, when I began to think it would come to grief." —H. D. FOOT, The Parsonage, Lytchett Minster, Poole, Dorset.

"An exceedingly valuable work for all classes of society."—J. H. MORGANS, Parklands, Clifton.

"Allow me to congratulate you on the improvement of your excellent ENGLISH MECHANIC, which is becoming a great favourite here."—W. WILSON, Surveyor, 9, Orange-street, Canterbury.

"The various and multitudinous contents of the ENGLISH MECHANIC make it, as I think, the most interesting and valuable scientific publication extant." J. H. SYMES, Torquay.

"I am quite surprised at the wide circulation our paper has attained. I frequently receive communications from places thousands of miles distant. I have just received one from the Antipodes respecting the geometric chuck."—GEORGE PLANT, Alsager, Cheshire.

"I have just heard that a wealthy and influential gentleman near here made the remark that 'he could not live without the MECHANIC,' a proof positive, I think, of how much it is liked."—J. M. PROCTOR, 11, Holt-street, Wrexham.

"I beg to assure you that your valuable paper is much read and esteemed here."—E. HALMSHAW, 9, Grove-square, Gomersal, near Leeds.

"Your ENGLISH MECHANIC is most flourishing! What a good thick handful of useful matter it is!"—Rev. E. LUKIN, Stetchworth, near Newmarket.

"The last real improvements, commencing with Vol. II., seem to leave nothing farther to be desired by correspondents or subscribers."—E. A. CROUCH, 239, Brooklyn, New York.

"May I just add that I derive such hours of pleasure from our MECHANIC as I have never before enjoyed!" —C. E. CÆSAR, 3, Raglan-terrace, Highbury.

ANSWERS TO CORRESPONDENTS.

⁂ All communications should be addressed to the EDITOR of the ENGLISH MECHANIC, 31, Tavistock-street, Covent Garden, W.C.

The following are the initials, &c., of letters to hand up to first post, Friday, May 6:—

J. Taylor, P. V., J. G., Ashworth Bros., T. Brown, J. McG., G. G. R., W. G., A. T., J. and H. S., T. J., Dioptrics, C. F. Gordon, R. A. Proctor, J. A. Sales, Elliptic, J. P. H., J. A. F., Rev. E. J., Capt. O. H. S., Hopeful, Jas. Melhune, R. W., Jas. Mansergh, W. Soper, J. Scott, Junr., Pisa, J. Beardsley, Geo. Plant, W. B. D., R. Thomas, J. Grylls, W. M. B., J. T., J. E. T., Rev. R. C. H., S. Taylor, Veritas, S. T. D., J. B. and Son, S. T. D., Charles Kennedy, J. T. W., H. S., H. C. B., H. N. Henfrey with MS., E. E. L., J. B. H., W. C., W. Pearson and Co., Marine, Sidney Beddell, W. Pickering, jun., S. Taylor, S. Bruce, W. Taylor, J. Williams, P. Makin, W. Corbett, Beta, J. H. Twitchell, J. T. Batley, J. N., Valex, Photo, Loder, J. L. Hawkings, Juvenile, E. Y. Herbert, Harmonious Cotton Spinner, M.A., One in Need, E. A., Jas. Linton, H. G. Salop, J. Steel, Exchange, R. A. Proctor, W. Rees, F. T. Henbest, Arthur W. Blacklock, A. Stringer, J. Dyer, C. and C.

THE SALE AND EXCHANGE COLUMNS.—Correspondents are respectfully requested when sending their advertisements to consult the scale of charges prefixed to each of the above columns. Several announcements have been received lately accompanied by an insufficient number of stamps. In all such cases stamps and advertisement are at once returned to the senders. This of course causes delay and disappointment, for which, however, we are not responsible.

CAUTION.—R. Passmore, of Sidmouth, complains that he sent £5 2s. 6d. to a T. Norris for a lathe, and got a miserable mandrel for his money. On demanding either the lathe or his money, he is treated with contempt.

ROTHERWOOD.—Not received. Should be glad to have it.

J. KING.—No room.

J. S. A.—At the Patent Office.

H. M.—See back numbers.

MR. ROBERTSON.—Letter forwarded.

C. SLAGG.—Not suitable.

J. SMITH.—Write the Secretary of the Society of Arts, John-street, Adelphi, W.C.

A. TOLHAUSEN, 18, Waterloo-road Manchester.—We do not know the number of copies of the ENGLISH MECHANIC which circulates weekly in Manchester. As John Heywood, of 143, Deansgate, takes more than 1200 copies of "ours" weekly, we should say that at least four times that number sell in Manchester and the neighbourhood.

J. L. EWEN.—Returned as requested.

FALCON.—Search at the Patent Office. Second query inserted with this signature. Do not assume the name of one of our frequent correspondents, as it may lead to confusion.

SANS AIDE.—Only a portion of our space can be devoted to mathematical queries, and we therefore endeavour to make the best selection. In the present instance you doubt our judgment, but you must give us credit for good intentions. Thanks for good wishes.

A CONSTANT READER.—We cannot give an opinion. The value of an "old dictionary" is probably, like any other thing, "just as much as it will bring."

GEORGE TEMPLETON.—We do not consider ourselves bound to officiate as "referee," or to decide disputes. We are always ready to answer, or to lay before our readers questions of practical interest; besides, your query only "supposes" a variety of circumstances.

J. ENTWISTLE.—There is no such member of Parliament.

F. FOTHERGILL.—W cannot insert queries containing lists of books like yours. An inquiry at some London bookseller's, will procure you the information, and save our space.

ONE IN A FIX.—You or your friends had better consult a lawyer, or better still, get some mutual friend fairly to represent your position to your master. The latter can of course be compelled to act up to his covenants in your indentures.

NIMROD.—Send us the information about the China grass.

W. FREEMAN.—No stamps enclosed for exchange.

W. R. T. AND OTHERS.—Mr. Geo. Plant has written us to say that he will at once get the necessary drawings ready to accompany a description in our pages, of his geometric chuck.

W. H. S.—The manuscript did come to hand.

ANTI EGYPTIAN.—Many answers have appeared on removing paint, and on the preservation of rabbit skins, in back numbers, some very recently. We cannot be always repeating.

A. LINTON.—A good grammar and a dictionary. De Lille's grammar is a good one; can be procured through any bookseller.

DISPUTE.—BICYCLE.—Can you not write to the company whose advertisement appears in our pages, without occupying our space with so trivial a matter?

W. P. MORGANS.—No charge of any kind for inserting queries or letters.

CANTAB.—See back numbers.

E. WILLARS (Leicester).—We cannot say; we have, however, little faith in any such apparently philanthropic announcements. If the advertiser you refer to really desires to benefit suffering humanity there are many cheaper and surer ways of doing it than by advertising his panacea "free gratis for nothing," for one stamp.

J. H. MORGAN.—The photos. did not come to hand. We have written to the Post Office authorities about them.

C. RANDALL.—We said, say "yes."

W. ROBINSON.—No stamps enclosed.

S. BENNETT, who takes in the monthly part, complains "that 'Astronomical Notes for April,' are handed over to the first of May." The best way would be to take in the publication *weekly*. There are comparatively few monthly parts published.

MINNEHAHA.—Erratum too slight for notice.

HEYWOOD.—Your suggestion may be adopted when we make some other improvements.

J. R. W.—The Architectural Exhibition, 9, Conduit-street, has just opened. The conversazione will take place on the 24th inst.

J. T. MILLER.—It is just as you might have expected. The successful man is envied and then misrepresented.

R. W.—Mr. Burgess' letter on the Workmen's International Exhibition, in No. 266, p. 181.

REED.—Yes, in a week or two.

J. H.—The Dialectical Society meets fortnightly, at 1, Adam-street, Adelphi. The annual subscription is 10s. There will be no difficulty in your getting nominated, if you like.

JAMES WARD.—Thanks for your good wishes. Since the commencement of our present volume, the circulation has increased several thousands weekly.

MARINE.—Yes.

H. DOLAN.—Most of them are in print.

W. H. THORPE.—We have no wish for a discussion on loss of power by the use of the crank. We are aware that the crank is a favourite object of abuse with some mechanicians, but we have not seen many successful attempts to do without it.

ALVECHURCH.—We never heard of such a feat.

J. HOOPS.—Rivington and Co., Waterloo-place, Pall Mall, 6s. 6d., or small edition, 3s. 6d.

POMPEY.—We illustrated several wire-covering machines in last vol. All queries respecting addresses of vendors of chemical apparatus, &c., must appear in Sixpenny Sale Column.

H. W. S.—A popular error. For a good account of its origin, and information on the whole subject, see No. 252.

LLAH.—We have repeated your advertisement this week. We hardly expect to be called on to give reasons for our rules, but we may repeat what we have stated many times, that we do not give the addresses of our correspondents, for three very good reasons; first, because many of them object to it: secondly, because in many cases we don't know their addresses; and thirdly, because the ENGLISH MECHANIC is the proper medium for all intercommunication.

W. R. S.—We considered the two queries unnecessary, especially the second. The other query had already been replied to by several correspondents.

THE SIXPENNY SALE COLUMN is the only place in which can appear queries sent by "A. B. (glass pens), John Brown, "A Bird Fancier," "Strong Bow," "F. W.," "Constant Subscriber, Bath (also see back numbers), "Over Sixty," J. Bell, "Inquirer," Samuel Hill.

ELECTRO.—The latter phrase.

W. HALL.—It was a printer's blunder.

THE FORM OF THE EARTH.—We will try to find room for Mr. Beardsley's concluding letter next week.

J. H. E.—Yes, we saw it. Threats are generally the offspring of weak and mean minds.

F. R. A. S.—It is all right.

W. STEVENS.—We will forward a letter to "A Practical Man." We studiously protect the *incog.* of correspondents who desire it.

A BRICK.—Your correspondence is labour lost. Try and work to more advantage in future.

W. WINDHAM.—We have no model of springs.

J. R. B.—A good suggestion—shall have attention.

THE *ENGLISH MECHANIC* LIFE-BOAT FUND

Subscriptions to be forwarded to the EDITOR, at the office, 31, Tavistock-street, Covent-garden, W.C.

	£	s.	d.
Amount previously acknowledged	£179	6	10
A Country Lad	0	0	6
H. Chapman	0	1	6
Claudius	0	2	0
J. D.	0	1	0
E. A. Crouch, New York	0	2	6
	£179	14	4

THE INVENTOR.

IN obedience to the suggestions of a number of readers, we have decided on appropriating a portion of our space to a condensed list of patents as nearly as possible up to the date of our issue.

APPLICATIONS FOR LETTERS PATENT DURING THE WEEK ENDING MAY 3, 1870.

1199 T. Wright and I. Fox, Nottingham, manufacture of lace made on bobbin net or twist lace machines

1200 L. Schad, Warrington, improvements in treating human excrement

1201 R. Birkin, jun., Newdigate-street, Alfreton-road, Nottingham, manufacture of ornamented net or lace

1202 Sir W. F. Cooke, Branksea Lodge, Tooting, and G. Hunter, Aberdovey, Merioneth, stone-cutting apparatus

1203 H. Fletcher, Upper Baker-street, Regent's-park, boot and shoe heels and tips, and shoes for horses

1204 H. Y. D. Scott, Ealing, improved mode of manufacturing cement

1205 H. Y. D. Scott, Ealing, mortar, concrete, and bricks

1206 J. Palmer, 10, Royal Promenade, Bristol, gas cooking stoves

1207 A. Browne, 85, Gracechurch-street, construction of multitubular steam boilers.—A communication

1208 T. Wrigley, Manchester, looms for weaving

1209 W. E. Gedge, 11, Wellington-street, Strand, rolling mills or machines for manufacturing bar iron.—A communication

1210 H. Atkinson, Wharf-road, City-road, breech-loading needle guns.—A communication

1211 W. Hart, Norwich, heels for boots and shoes

1212 B. Wigzell and J. Pollit, Sowerby-bridge, York, improvements in steam engines

1213 F. J. Ortner, 73, Great Titchfield-street, Portland-place, arrangement of pipes for drawing liquids from casks

1214 E. Vimeux, 1, Station-road, High-street, Clapham, musical instruments

1215 C. Wood, Birmingham, apparatus for absorbing the overflow of oil in lamps.—A communication

1216 H. E. Curtis, Llansantffraid, North Wales, oscillating cylinder engines

1217 J. Burnley and W. Nichols, Leeds, steam boilers and furnaces

1218 J. Underwood, 5, Archway-road, Highgate, closing necks, mouths, or openings of bottles, jars, and other vessels

1219 W. R. Lake, Southampton-buildings, improved process for cleaning wool or hair.—A communication

1220 R. H. Kay and A. T. Richardson, Mobberly, manufacture of crape

1221 W. Germain, Brighton, improvement in or an addition to earrings

1222 W. J. Blinkhorn, St. Helen's, improved spool for lock-stitch sewing machines

1223 J. Lee, Hipperholme, near Halifax, apparatus for obtaining motive power

1224 P. Smith, J. H. Leather, and E. D. A. Marriner, Keighley, apparatus for preparing wool for combing

1225 R. B. Hamel and J. B. Holden, Jersey, State of New Jersey, U.S., mechanism for transmitting power

1226 A. V. Newton, 66, Chancery-lane, apparatus for starting treadle motions, applicable to sewing machines.—A communication

1227 C. W. Alden, Charlestown, Massachusetts, U.S., improvements in pipe wrenches.—A communication

1228 M. Jefferson, Bradford, apparatus for preparing and combing wool or other fibrous substances

1229 T. Thorpe, Manchester, improvements in the manufacture of piled fabrics

1230 J. M. Clark, Aberdeen, apparatus for soldering tin cases or canisters

1231 T. Simpson, Birmingham improved button

1232 F. W. Buller, Hanley, attaching door and other knobs and handles to spindles, and in the manufacture of door and other knobs and handles

1233 F. Ransome, 2, Queen-street-place, Cannon-street, artificial stone

1234 H. E. Curtis, Llansantffraid, machinery for cutting slate, marble, and other like materials

1235 R. H. Collyer, Lille, France, breaking, softening, and preparing flax and other fibrous materials

1236 W. Sketchley, Melcombe Regis, Dorset, propelling boats

1237 D. Mills, New York, U.S., apparatus for supporting and guiding the work in machines for sewing boots and shoes

1238 I. Battinson and G. Battinson, Halifax, machinery to be employed for combing wool, silk, flax, and other fibres

1239 A. C. Henderson, 31, Charing-cross, apparatus for breaking and crushing stones.—A communication

1240 V. Bablon, 40, Rue du Roi de Sicile, Paris, apparatus for regulating the pressure of gas in burners

1241 A. Evans, Wolverhampton, automaton vase or depot for holding coals

1242 C. Massi, 1A, Bassett-street, Malden-road, Kentish-town, locks and keys

1243 W. H. Gosling, Calthorpe-street, improvements in sewing machines

1244 W. R. Lake, Southampton-buildings, improved spring fastening for securing purses.—A communication

1245 O. Murrell, Bethnal-green-road, apparatus for generating and heating steam in steam boilers and other vessels

1246 C. N. A. Collett, 21, Cockspur-street, Westminster, counting machines.—A communication

1247 J. H. Kidd, Bangor Iscoyd, improvements in shoes for horses and other animals

1248 J. Christie, Paisley, apparatus for cutting or shearing and ripping and clipping the "whip" of lappet cloth or other fabrics

1249 S. W. Stanbridge, Canal Bank, Camberwell, preparation of malt for brewing, colouring, flavouring, and keeping ales

1250 E. Lowe and H. J. Farmol, New-street, Aston-juxta-Birmingham, brass-headed nails, screw-rings, and rivets

1251 T. Paton and T. Winder, Liverpool, improvements in compound steam and atmospheric engines

1252 W. R. Lake, Southampton-buildings, improved valve or stopcock.—A communication

1253 W. Nunn, 67, St. George-street East, improvements in ships' and other signal lamps

1254 H. Beare, Queen-street, Newton Abbot, Devon, apparatus for pulverising and distributing guano and artificial manure

1255 A. V. Newton, 66, Chancery-lane, improvements in buckles or bale ties.—A communication

1256 W. Anderson, Erith, improved arrangement of gearing for rolling mills

1257 J. J. McComb, Liverpool, an improved hoisting machine.—A communication

1258 J. Leetch, 9, Broadley-terrace, Blandford-square, improved combined self-closing stopper and whistle for the mouth-pieces of speaking tubes

1259 S. R. Wethered, Hythe, apparatus for saving life and property from fire

PATENTS SEALED.

3151 J. C. Mewburn, a new or improved photographic process for preparing printing surfaces.—A communication

3167 J. Hargreaves and T. Robinson, treatment of pyrites and in obtaining products therefrom

3168 A. Thornton and B. Senior, of Heckmondwike, improvements in carding engines or machinery for carding wool

3169 W. Birch, improvements applicable to sewing machines

3173 C. G. Gumpel, improvements in ships' rudders and in steering gear therefore

3177 W. Connell, improvements in water-closets

3180 C. B. Cawley and J. Newton, improvements in tramways, and in carriages to run thereon

3182 S. Leoni, apparatus for cooking and lighting by gas

3183 A. Grothe, apparatus for registering number of passengers travelling in public conveyances

3185 P. F. Samier, and A. Anthoine, metallic vessels intended to prevent all liquid or solid inflammable substances from igniting

3186 H. J. H. King, apparatus for measuring, indicating, and regulating the flow or passage of liquids

3191 J. McDowall, machinery for sawing and cutting timber

3193 W. Gardner, mechanism or tools for the manufacture of parts of watches or timekeepers

3207 J. Turnbull, improved cut-off gears for steam engines

3212 R. Douglas and L. Grant, motive power engines

3219 J. C. Heywood, U.S.A., improvements in weighing machines or scales.—A communication

3246 M. Tuthill, improvements in horse gear

3290 G. Cherpit, construction of healds for looms

3318 W. R. Lake, improvements in harness for draught animals.—A communication

3320 W. R. Lake, apparatus for making and breaking electro-magnetic circuits.—A communication

3397 W. R. Lake, manufacture of steel, and of steel bars, rails, and plates.—A communication

108 J. Greenshields, obtaining oil from carbonaceous substances, in utilising the bye products and residues, and in making manure and moulder's blackening

281 C. Mahler, an improved windmill, which can also be used as a water wheel or as a ship's propeller

665 E. Wood, improvements in potters' glazes

744 W. R. Lake, apparatus for indicating a deficiency of water in steam boilers, and for regulating the supply of water thereto.—A communication

3204 C. Crockford, treating metallic ores and materials, and obtaining metallic and chemical products therefrom

3205 J. Maiden, lubricators

3206 J. M. Stanley, furnaces and crucibles for melting steel

3213 F. Taylor, sewing and embroidering machines

3230 J. Tracy and H. Tracy, improved stick or stem for umbrellas, parasols, &c

3231 A. Bohlken, improvements in terriers or ground augers

3238 J. Ingleton, improvements in waterclosets

3267 W. Gorman, manufacture of iron and steel, and in apparatus therefor

3298 J. G. Jones, apparatus for breaking down coal

3343 W. and J. Edmondson, and R. Cunliffe, machinery for engraving cylinders used in printing

3355 T. F. Lynch, bottles for holding poisons and other preparations

3364 R. Wilson, hydraulic presses and other hydraulic machinery

3373 J. Thomlinson, cements

3396 D. Miles, apparatus for lighting and extinguishing gas by electricity.—A communication

3407 E. F. Goodall, excise ink bottles and other ink bottles and inkstands

3517 A. Ripley, and J. Wormald, pipe wrench

3530 S. Chatwood and J. Crompton, valve for drawing off condensed fluids from steam engines, pipes, and other steam vessels

3582 W. R. Lake, improvements in vices.—A communication

3513 W. E. Newton, apparatus for folding printed sheets of paper as they issue from the printing machine.—A communication

3610 B. B. De Morell, method of raising navigable vessels or other heavy bodies above the surface of the water

521 G. H. Ellis, apparatus for washing, wringing, and mangling

553 H. Bessemer, apparatus employed for the better accommodation of passengers on board vessels and for lessening or preventing sea sickness

556 W. B. Leachman, hydraulic apparatus for raising and forcing water

560 J. Saxby and J. S. Farmer, apparatus for working railway points and signals

592 A. V. Newton, 66, Chancery-lane, improvements in sewing machines.—A communication

594 C. W. Siemens, treating iron ores

621 G. H. Ellis, improvements in ladders

658 K. Stevens, utensils employed with apparatus used in cooking

696 J. Neilson, manufacture of hollow cast-iron cooking utensils

736 J. Polson, application of machinery for treating grain

The English Mechanic
AND
MIRROR OF SCIENCE AND ART.
FRIDAY, MAY 20, 1870.

FIG. 8

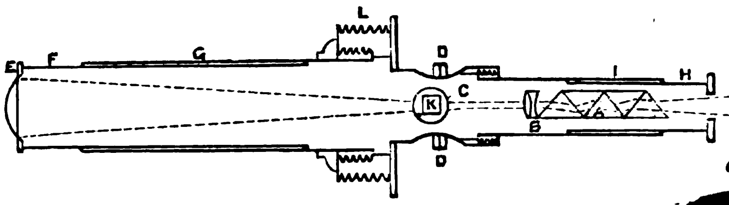
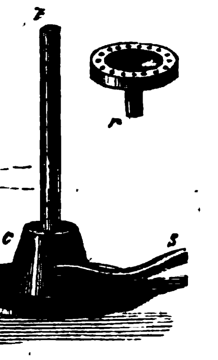


FIG. 4



WHAT STRIPES THE SUNBEAM.

BY A FELLOW OF THE ROYAL ASTRONOMICAL SOCIETY.

(*Continued from page* 173.)

EVERYBODY who has sealed a letter with a lighted taper in a room into which the Sun was shining, must have noticed that the candle-flame cast a perfect shadow; so that such shadow, after all, is only a question of the relative intensity of two lights. We may hence see how it is possible that, although this line D may have some luminosity, yet, stopping out or absorbing a ray of the same refrangibility as itself (in front of which, as we may say, the refraction of the prism has placed it), the surrounding part of the spectrum is so incomparably more brilliant as to give the idea of a black line from the mere effect of contrast. Professor Roscoe, in one of the splendid lectures which he delivered in May, 1868, before the Society of Apothecaries in London, performed a striking experiment to illustrate this. He first produced a large sodium flame, and then in front of it placed a little one. Under these circumstances the smaller flame absorbed the yellow rays from the large one at the back, and looked absolutely dark and smoky when optically superposed on it. He subsequently vapourised other salts in the small front flame; but as the rays emitted were of a different refrangibility to these issuing from the great flame, they no longer absorbed any of its light, and the smoky appearance entirely vanished.

If we thoroughly comprehend the nature of these phenomena, we are now prepared to follow Kirchhoff to the remarkable conclusion which he draws from them. They are shortly these:—It is probable that incandescent gases possess the power of especially absorbing rays of the same degree of refrangibility as those which they emit; *that, therefore, their spectra can be reversed—that is to say, that when light of sufficient brilliancy giving a continuous spectrum is passed through* them, their bright lines are turned into dark ones, and appear on the continuous spectrum, stopping out all those rays whose refrangibility is identical with their own. The way in which this principle is applied to the Chemistry of the Sun and Stars need not now present much difficulty. We have said above that, in order to determine the position of the bright lines in the spectra of various substances, they were compared directly with the dark ones of the Solar spectrum. In mapping in this manner the spectrum of iron, Kirchhoff was extremely surprised to find that every bright iron line had its corresponding dark solar one! Just as we had seen that the Sodium line and the Solar line D were coincident, so with each of the iron lines, of which 460 have been mapped. Nay, further, not only had each of these 460 bright lines its dark counterpart in position in the Solar spectrum, but they agreed absolutely in breadth and depth of shade, the brightest in the iron spectrum being the darkest in the Sun's light, and *vice versâ*, a resemblance, or rather identity, extending to the minutest particulars.

It would be worse than childish to regard this as mere chance. Two lines might agree fortuitously; four would be in a much higher degree unlikely to coincide casually, but when it comes to the perfect and entire agreement of 460, it is absolutely certain that the lines must have a common origin. Let us see now, in the light of the knowledge we have acquired, what such origin is. Obviously, the light which forms the Solar spectrum *must have passed through the vapour of iron,* and must have suffered the absorption which that vapour exerts. Where can that vapour be? It may be in our own atmosphere, or in that of the Sun. That it is not in the Earth's atmosphere is rendered probable by the following considerations. *Imprimis*, it is not very easy to understand how our own atmosphere could contain a sufficient amount of iron vapour to yield such exceedingly sharp and distinct absorption lines as are visible in the Solar spectrum; and, in the next place, the lines remain unaltered when the Sun is close to the horizon, and when we consequently view it through a greatly-increased thickness of air. On the other hand, the very high temperature which it is only reasonable to assume must subsist in the Solar envelope would render it likely enough that such vapours were present in it. "Hence," says Kirchhoff, "the observations of the Solar spectrum appear to me to prove the presence of iron vapours in the solar atmosphere with as great a degree of certainty as we can attain in any question of natural science."

He goes on to add: "As soon as the presence of *one* terrestrial element in the solar atmosphere was thus determined, and thereby the existence of a large number of Fraunhöfer's lines explained, it seemed reasonable to suppose that other terrestrial bodies occur there, and that by exerting their absorptive power they may cause the production of other Fraunhöfer lines. For it is very probable that elementary bodies which occur in large quantities on the earth, and are likewise distinguished by special bright lines on their spectra, will, like iron, be visible in the solar atmosphere. This is found to be the case with calcium, magnesium, and sodium. The number of the bright lines in the spectrum of each of these metals is indeed small, but those lines, as well as the dark ones in the solar spectrum with which they coincide, are so uncommonly distinct that the coincidence can be observed with very great accuracy. In addition to this, the circumstance that these lines occur in groups renders the observation of the coincidence of these spectra more exact than is the case of those composed of single lines. The lines produced by chromium form also a very characteristic group, which, likewise, coincides with a remarkable group of Fraunhöfer's lines; hence I believe that I am justified in affirming the existence of chromium in the solar atmosphere. . . . Barium, copper, and zinc appear to be present in the Solar atmosphere, but only in small quantities; the brightest of the lines of these metals correspond to distinct lines in the Solar spectrum, but the weaker lines are not noticeable. The remaining metals which I have examined—viz., gold, silver, mercury, aluminium, cadmium, tin, lead, antimony, arsenic, stronlium, and lithium, are, according to my observations, not visible in the solar atmosphere."

The following are all the metals which are at present known to exist in the Sun:—1. Sodium; 2. Calcium; 3. Barium; 4. Magnesium; 5. Iron; 6. Chromium; 7. Nickel; 8. Copper; 9. Zinc; 10. Strontium; 11. Cadmium; 12. Cobalt; 13. Hydrogen; 14. Manganese; 15. Aluminium; 16. Titanium.

It must not, however, be supposed that all the dark lines visible in the solar spectrum are referable to vapourised elements in his atmosphere. Some of them, undoubtedly, have their origin in our own. The late Sir David Brewster was the first to point this out. M. Janssen, the famous French physicist, whom we shall have occasion to refer to again further on, experimented on light passed through a column of high-pressure steam, and found that the steam exerted a strongly-absorbing power, groups of dark lines appearing between the extreme red and the line D. As the additional lines seen is the Solar spectrum when the Sun is close to the horizon coincide with those thus produced by M. Janssen, they must evidently have been produced by the absorptive action of the aqueous vapour of our own air.

And now what must we assume to be the physical constitution of the Sun, in order that the appearances and effects detailed may be best explained? Kirchhoff's idea, propounded in his book, is that the Sun consists of a solid or liquid nucleus heated to the brightest whiteness, and giving a continuous spectrum, and surrounded by an atmosphere of somewhat lower temperature, containing the vapours of the various substances, which, by stopping off the rays corresponding in refrangibility to those of their own bright spectra, filter, as it were, the solar light on its way to us, so that its spectrum appears to us crossed with dark lines. On page 200 of our last volume, we have given a figure of the total eclipse of the Sun as seen at Guntoor, in India, on August 18, 1868, and have there very briefly referred to the discovery that the wonderful masses of red flame (which have been at once the greatest admiration of, and puzzle to, former observers), visible when the Sun's disc was finally obscured, consist of stupendous flames of incandescent hydrogen gas. Prior to the date of which we speak, these astonishing objects had never been perceptible, save under the circumstances of a total eclipse, but, finding that they yielded a bright line spectrum, it struck M. Janssen (of whom we have previously spoken, and who went out to Guntoor as the French Government astronomer) that they or rather their spectra, might be observed at a time when the Sun was unobscured—an observation in which he was successful on the very next day. It happened, very curiously, that Mr. J. Norman Lockyer, F.R.S., arrived, quite independently, at the same conviction as M. Janssen, and, without any communication with him, also succeeded in making out the spectrum of these prominences, Mr. Lockyer who finds that these gigantic uprushes of hydrogen are only local aggregations of an envelope surrounding the Sun, proposes to call this envelope the *chromosphere,* to distinguish it from the absorbing atmosphere on the one hand, and from the white-hot photosphere on the other. Into this part of the subject, however, it is not very important that we should enter into much detail. Research is still being sedulously carried on, and the time has scarcely arrived for anything more than a hypothesis which shall account generally for observed appearances. We will turn, then, to the results of spectroscopic research as applied to the fixed stars and nebulæ.

Before, however, we do so, it may be as well to revert to the instrument by means of which our observations must be made, and to say a few words as to the form of it which is adapted for celestial observations. The pattern adopted by our most eminent living observer in this branch of science, Mr. William Huggins, F.R.S., it is needless to illustrate here, as it is only applicable to a telescope of very large size, and as we propose to describe more at length a form of spectroscope with the practical working of which we are ourselves more familiar, and which is infinitely better suited to the possessors of moderate telescopes than the costly and complicated one we have alluded to. It must suffice, then, to say that Mr. Huggins has two prisms (to increase the dispersion) in his instrument, and that, by a very delicate adjustment, he gets and retains a star between the jaws of the slit of it. The star, being a point, will be lengthened into a mere line of light, so has to be spread out by a cylindrical lens into a band. There is the usual provision of a diagonal prism over half the slit for the direct comparison of any particular spectrum with that of a star, planet, or nebula. Premising that a spectroscope is worse than useless with a telescope of less than 4in. aperture, we will proceed to describe the form of which we have spoken, and which, from personal experience, we consider the most suitable for an amateur. It admits of no *measurement* of the spectra, but this, as will be found, can only be effected by instruments of great size and power. It is the invention of Mr. John Browning, F.R.A.S., who read a short paper on it before the Royal Astronomical Society on June 11, 1869. It is shown in section in Fig. 8, and our description shall be in Mr. Browning's own words :—

"In the diagram A is a compound direct vision prism consisting of five prisms. B is an achromatic lens which focuses on the slit C, by means of a sliding tube, H ; both the prisms and lens are fastened in this tube. K is a small right-angled prism covering half the slit, by the aid of which light may be seen reflected through the circular aperture in front of it. In this manner a comparison may be made with the spectra of metals or gases. The reflecting prism, with the ring to which it is attached, can be instantly removed and the whole length of the slit used if desired. D D is a ring milled on the edge ; on turning this round both edges of the slit are made to recede from each other equally, being acted on by two hollow eccentrics. The lines can thus be increased in breadth without their centres being changed—a point of importance. E is a cylindrical lens attached to the tube F, which slides into another tube, G. To use the spectroscope, the adapter L, which is the same size as the Society's thread, has only to be screwed into the eye-drawer of the telescope in the place of the ordinary Huyghenian eyepiece. The drawer must then be adjusted so that the slit G comes exactly to the focus of the object glass. This should be tried beforehand by getting an image of the Sun, and then making a mark on the drawer-tube of the telescope. When this has been done the tube can be set by this mark, and the spectroscope screwed into it at any time without any trouble in adjustment. If the cylindrical lens be removed the spectrum of a star will be a mere line of light. The cylindrical lens is for the purpose of widening this line to such an extent that the lines in the spectrum may readily be discerned. For this purpose the lens must be placed *with its axis at right angles with the slit*, and the best distance from the slit is between three and six inches. The nearer it is brought to the slit the broader will be the spectrum ; but it should not be used too close, on account of the diminution of the light. When it is desired to obtain the spectra of planets, comets, and nebulæ, or, indeed, any heavenly bodies possessing considerable diameter in the telescope, the cylindrical lens may be dispensed with advantageously."

Let us now see what the application of the instrument to the more remote bodies which spangle the firmament, has revealed.

(To be continued.)

COLOUR AND COLOUR BLINDNESS

BY "OMICRON."

(Concluded from page 170.)

PROFESSOR WARTMANN notices that there is prevalent an opinion, that the number of Daltonians who have blue eyes, is greater than the number possessing black eyes, but this opinion he confidently denies, and M. Seebeck entirely coincides with him. In the number of Daltonians examined by him, the majority had black eyes, and in reckoning up all the cases of colour-blindness in which the tint of the iris has been noticed, he finds that the two colours are in equal numbers. Prof. Wartmann noticed, however, without laying any great weight on the circumstance, that Daltonians "whose eyes are brown of the colour which English call hazel (*noisette*) present under an incidence more or less oblique, a golden lustre of a peculiar tint."[*]

Dalton accounted for the peculiarities of his eye on what may be termed the "Chromatic Theory." He noticed "that a sky-blue transparent liquid modified the light of a candle, so as to make it similar to daylight, and of course restored to pink its proper colour by day—namely, light blue."[†] This induced him to publish his theory thus:—"It appears, therefore, almost beyond a doubt, that one of the humours of my eye, and of the eyes of my fellows is a coloured medium, probably some modification of blue. I suppose it must be the vitreous humour, otherwise, I apprehend, it might be discovered by inspection, which has not been done."[*] As Sir David Brewster has said in a paper on "Colour Blindness," that appeared in the "Philosophical Magazine," of 1844, this hypothesis of Dr. Dalton is the only one capable of being proved or disproved. Let us see to what result the attempt to prove it has led.

Mr. Joseph A. Ransome examined Dalton's eyes after he was dead, and declares that the aqueous humour was found to be perfectly pellucid and free from colour. The vitreous humour and its envelope were also perfectly colourless. The crystalline lens was slightly amber-coloured, as usual in persons of advanced age. The tunics retina, choroid, and sclerotic, with their subdivisions, presented no peculiarity.[†] And further, after the posterior portion of the outer coats had been removed, objects of different colours, particularly scarlet and green, both by transmitted and reflected light, were examined without any appreciable difference. Dalton's theory during his life did not gain many supporters, and after his death it may be regarded as completely disposed of. With reference to this hypothesis of Dalton, Wartmann has remarked that if the passage of the luminous rays through a blue medium, sufficed to produce colour blindness, the habitual use of blue glasses for spectacles, would have long ago confirmed this hypothesis, against which it forms, on the contrary, a very strong argument. Perhaps this argument is not of any great value, as colour blindness in one of its many forms, must certainly result from a blue vitreous humour, but we can coincide in the remark with which Wartmann dismisses the theory, that the opinion of Dalton cannot be adopted.

Sir David Brewster, in a paper that appeared in the "Philosophical Magazine," attempted to account for the peculiarity of colour blindness, by a supposition very nearly akin to that of Dr. Dalton, but he rejected the supposition of a coloured vitreous humour, and substituted a coloured retina. We give his conjecture in his own words :—"During the dissection of many hundred eyes, I observed in several cases that the retina had a marked French grey or pale blue tint, which decidedly absorbed red light. I knew that in cases of colour blindness the vitreous humour was not blue, or even greenish blue, as Dr. Dalton conjectured, but I could not assert that in the same cases the retina might not be blue, and hence I was led to hazard the idea of a blue retina, as one which might be admissible as a cause of colour blindness, but *only on the supposition* that the choroid coat should prove to be the seat of vision. The italics are Sir David Brewster's. I do not think that Sir David Brewster ever attempted to extend this supposition into a full conclusion, and even granting that the choroid coat should perform the office usually ascribed to the expansion of the optic nerve, it seems doubtful whether a coloured retina could produce such an effect as that witnessed by the colour-blind.

Many eminent authorities, among whom we may quote Sir John Herschel, are of opinion that this false perception of colours, arises from a defect of the sensorium, by which it is rendered incapable of appreciating exactly those differences between rays on which their colour depends, and though such an opinion does not advance very far in the explanation, it has been almost universally embraced.

The Rev. Philip Kelland has published a theory or suggestion to account for Chroma Pseudopsis, which deserves to be mentioned. He regards the sensation of colour as due to the reception by the retina of pulsations of a given period, and though the manner in which the retina performs its functions is not precisely known, it may be presumed to vibrate agreeably to their period.

In the normal state, the retina is supposed to be capable of responding to pulsations of every period within certain limits, and of conveying to the mind the sensations which we term colour appropriate to each period, but in other states of the retina this appears incapable of being effected, but a vibration occurs more readily in accordance with one period of pulsation than with another. This constitutes one form of chromatic pseudopsis. Another form in which the more strongly marked complementary colours are mistaken, Professor Kelland supposes to arise by the facility possessed by the retina for starting into vibrations of every period, when excited by those of one only, "just as a musical pipe or string gives all the notes of the chord at the same time, or as the different strings of a harp vibrate when only one has been struck." Professor Wartmann, in a second paper, suggested a theory nearly similar to that of Professor Kelland, in which he says, "I admit that the seat of colour blindness is in the retina, and I think it is produced by an abnormal state of this nervous expansion, of such a sort that it reacts similarly, under two or more different coloured radiations. If the vibration caused by a red ray is identical with that which a green produces, there will be confusion of these colours. This theory is independent of every system destined to explain light." Whether the reader may chose to adopt either of these theories or not, it seems generally evident that the cerebro-retinal apparatus of vision in the colour-blind is either through congenital defect, or subsequent morbid change, unendowed with that sensitiveness to colorific impressions, which it possesses in those whose vision is normal.

If any of our readers have discovered that their eyes possess the peculiarity of which this paper treats of, they may desire to know whether their case admits of cure or palliation. We regret not to be able to offer any very great hope respecting an ultimate and complete cure, when the colour-blindness has been congenital, but there are a certain class of diseases which for a time cause the sufferer to experience all the annoyance and confusion that congenital colour-blindness is calculated to produce, and differs from it only in the respect that appropriate treatment may cause it to disappear. In the case of colour-blindness, that was occasioned to a gentleman by a fall from his horse, that we quoted in the earlier part of this article, the peculiarity has irremoveably attached itself, and does not apparently admit of cure. Dr. Erle (himself a member of a family in which seventeen cases of this affection of vision have occurred), holds an opinion which we believe is not generally supported by medical men, or observed fact, that "a succession of years modifies the Daltonism of the same individual," though he does not hazard an opinion as to what extent advancing years induce a change. Dalton was as colour-blind at the Oxford meeting of the British Association, when he compared the colour of his D.C.L. gown to that of the leaves of the tree, as in 1792, when he first discovered his colour-blindness, and as he remained to the day of his death in 1844. Moreover, there is not on record one case where a cure of congenital colour-blindness has been effected, though nearly all would make some attempt to cure themselves of this defect, and, as a rule, the more observant and the better educated the sufferer is, the more decided is he that all attempts to cure him will prove a failure. Since an absolute cure is impossible, the possibility of remedying it by any mechanical means, is a question of the highest importance. Professor Wartmann says that there "exists a very easy means of rectifying, to a certain extent, the error of the appellation of colour," and his suggestion is to examine coloured objects through a transparent medium, "as a glass or a liquid of a certain known tint." Suppose this tint red, the impression of a green body and of a red body, the same at first to a naked eye, will become manifestly distinguished by the use of the transparent screen." Unhappily the tint of the coloured glasses cannot be prescribed in advance, the impossibility of a rigorous classification of the innumerable varieties of Daltonism obliges us to chose them *a postcriori* for each particular case. Perhaps the best means (and which in some cases answers very well) to convince a colour-blind person of his errors, is to make him examine the object both by daylight and artificial light, when often a very great distinction will be evident between the appearance of the object examined, but although the colour is often different under the two lights, it is possible that neither impression is the same as reaches a normal eye; for instance, Dalton says, "Pink appears by daylight to be sky-blue, a little faded ; by candlelight it assumes an orange or yellowish appearance, which forms a strong contrast to blue." As a method of palliation, Dr. Wilson suggested employing glass, stained yellow or orange, by means of oxide of silver, and in many cases he mentions these glasses proved of great service to his colour-blind acquaintance. Such experiments as we ourselves have been able to make on these means, as a palliative to colour blindness, have not convinced us of any utility that they are to the general colour-blind public. Our investigations have led us to conclude that the media employed, to be of any use, must be selected by experiment by the sufferer himself. Let him choose several coloured glasses, and examine objects, the true colour of which he has been told, and when he finds that the employment of a particular glass most generally restores the proper colour to the object, that coloured glass must be retained for general use, though our experience has led us to conclude that a glass of a particular colour is only useful in examining objects that have the same colour, and of course such a plan as carrying varied coloured media is only useful to those who are partially coloured-blind, to endeavour to detect the colour, and not the particular shade or tint, that the colour presents to a normal eye.

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[*] Taylor, "Scientific Memoirs," 1846.

[†] "Manchester Memoirs," 1798.

[*] Op. cit.

[†] Henry's "Life of Dalton."

THE END.

THE INSTITUTION OF CIVIL ENGINEERS.

WE have just received a report of the speeches at the annual dinner of the Institution of Civil Engineers. One would have thought that at such a dinner the chief people present, and the chief speakers, would be engineers, or, at all events, that the chief topic would be Science. Nothing of the kind. We find, from the report, that the speakers were the President of the Institution, Sir Edward Belcher, Earl Granville, Earl of Derby, the Solicitor-General, Lord Chief Justice Bovill, Mr. G. P. Bidder, the Archbishop of York, Mr. Fowler, Sir Francis Head, Professor Tyndall, Mr. Beresford Hope, and the Right Hon. H. A. Bruce. The morning papers, as a matter of course, gave a report of the proceedings, which consisted of a report of the speeches of Lord Granville, Lord Derby, and the Archbishop of York. But scarcely any allusion was made in these reports to the Engineers, or to Science at all—or, in other words, Science, at a meeting of scientific men, was only incidentally alluded to. Now, who is to be thanked or blamed for this? Nobody but the Engineers themselves. One would have thought that at an annual meeting of one of our principal scientific bodies the chief men connected with that body would have had something to tell the world worth listening to about the progress of Science. Instead of this we have men quite able, we admit, to instruct the public on matters legal, social, or political, but altogether inadequate to say anything worth listening to on scientific matters. We should have thought that the Institution of Civil Engineers would have been the very last society that would have permitted itself to be invaded by platform, or bar, or House of Commons talk. We could imagine smaller and weaker societies, that like to bask in the sunshine of patronage, adopting such a policy; but the Civil Engineers can stand alone; they are a numerous, sturdy, aggressive body of men, and some of them are quite able to talk as well as act. It may be all very well to invite a few guests representing the Army and Navy, the Bar, the House of Lords, and the Commons, to respond to toasts in a festive way; but to record verbatim their commonplace talk about nothing in particular, and then point to it as a report of an annual meeting of the Institution of Civil Engineers, is simply ridiculous.

ENGLISH MECHANIC SOCIETY OF ARTS, EDINBURGH.

THIS society held its first monthly meeting on Thursday, the 5th inst, Mr. C. E. Gordon presiding. The minutes of preliminary and committee meetings having been read and approved of, a copy of rules was submitted, which, after a long discussion, were remitted again to the committee. Office bearers were next appointed, when the following gentlemen were elected. J. Passmore Edwards, Esq. Editor and Proprietor of the ENGLISH MECHANIC AND MIRROR OF SCIENCE, Honorary President; Mr. W. T. Williams, President; Mr. C. E. Gordon, Vice-President; Mr. R. Marshall, Secretary; Mr. Bennett, Treasurer. Specimens exhibited (with description) of boomerang, &c., &c.

The business for next meeting was announced to be the President's inaugural address. The meeting then adjourned till 2nd prox.

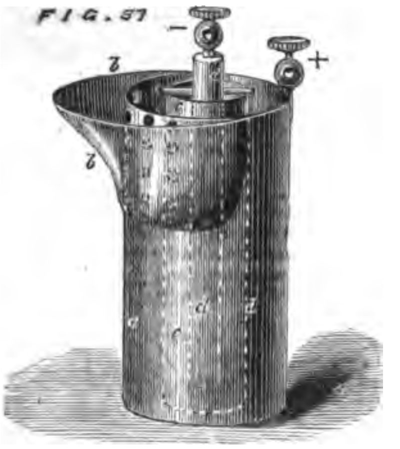
ELECTRICITY—ITS THEORY, SOURCES, AND APPLICATION.[*]

BY J. T. SPRAGUE.

(*Continued from page* 148.)

119. As a suitable appendage to the simple battery described on page 147, a mode of economising in the article of zinc deserves attention. Smee proposed what he called an "odds-and-ends" cell, composed of a jar in which a quantity of mercury was placed with scraps of zinc, broken plates, even raw spelter might be used by floating them in the mercury; a plate of platinised silver was then suspended in the jar and the acid solution added. This has been tried by many, but for many reasons has never given satisfaction, but I have devised a modification which has all its advantages without its evils. I take a cylindrical vessel, such as an old porous jar, and pierce its walls with holes, or, still better, make one of gutta percha, which is stronger; the lowest inch or so is not perforated, as it is to contain mercury, to the bottom of which is plunged a stout copper wire, amalgamated at its end, but covered everywhere else with gutta percha, and cemented to the side of the vessel, reaching to its top, where it is to be soldered to a binding screw which is the zinc connection. All the rest of the surface is pierced with as many holes as possible consistently with strength, to allow free circulation of liquid. It is then filled up with pieces of zinc, amalgamated and in as close contact as may be; the whole acts and is used just as if it were an ordinary plate. The mercury is subject to little waste, but now and then the whole should be removed, well shaken up together, and repacked, and at times the mercury as it becomes charged with metals should be filtered by squeezing through a chamois leather, the residue being preserved, and when a quantity is collected, distilled to recover the mercury, as should be done with all the brushings off plates, &c., of amalgamated zinc. This may be used either in such a battery as my arrangement, or in a Daniell or other cell, within a porous jar.

FIG. 57



120. TWO FLUID CELLS.—All the combinations described so far have two faults. 1. *Weakness*—Owing to the force being largely absorbed by the escaping hydrogen, hence their electro-motive force is low, and any large resistance greatly reduces the current they can yield. 2. *Want of Constancy*—As shown by the rapid fall in the experiments, though in my own form this is in great degree overcome by largely increasing the negative surface. For many purposes, constancy is essential, and it is desirable in all, hence continual efforts have been made to overcome these two defects, and with considerable success, though a really constant battery has yet to be discovered, notwithstanding the praises bestowed by manufacturers and patentees on several forms. As yet constancy is only to be obtained by the use of two agents, one acting on the zinc, the other absorbing the hydrogen at the negative pole, and the success is greater just in proportion to the degree in which this negative pole and liquid can be kept in their normal condition, or, at least, in an unchanged relation to conductivity and chemical action. Hence they all require a separating medium, as to which a few practical observations will be of value.

121. POROUS JARS.—At first, animal membranes, bladders, ox gullets, &c., were employed, and they answer very well. In some cases good paper is useful. In many experiments requiring great resistance, glass tubes plugged with plaster of Paris, or even clay, are employed; for small experiments, or even for platinising silver, the bowl of a tobacco pipe may be used. For all practical purposes, however, unglazed earthenware is the only material of any service, and it is now to be obtained in any form and size, though its prices are unreasonably high. There are many qualities, and they must be adapted to the special purpose. These porous jars act only by the liquid they absorb, and as they very greatly reduce the area of liquid through which the action takes place, of course they greatly increase the internal resistance, and diminish the action; on the other hand, there is no possibility of preventing two solutions thus separated from mixing, and this causes waste by local action, as well as affects the regularity of the actions. Hence for long sustained action a thick and close-grained jar must be used, while an open and more porous one suits best for short periods and strong action. The most porous ones are of a red colour and soft material, the finest and most enduring are close-grained and white, and the best are of French make. There is a cream and orange coloured ware, some of which is very good. The best test is to fill them with water and see how long it is before it forms a dew on the outer surface, if it runs off the jar is not fit for use. It is a great improvement to render the bottom, and still more the part which is to remain above the liquid, non-absorbent, which is readily done by warming and applying carefully sufficient melted paraffin, taking care it does not extend too far; if it does so by accident it is readily driven off by heat. If this is not done the salts rise up, effloresce, crystallise, and disintegrate the jar. For the same reason jars taken out of the liquids must not be permitted to dry, but should be kept soaking in water to prevent their destruction. This is of particular importance with jars used for the Daniell's cell, as they are very apt to get nodules of copper deposited on them wherever the zinc has touched the inner surface, and particularly at the bottom, where drops of mercury or flakes of zinc fall, and then the cell is very soon rendered worthless; if this occurs, the spot of metal should have some cement or gutta percha laid over it, so as to render it non-conducting.

122. THE DANIELL'S CELL.—This, the first devised improvement, is also the most successful attempt to obtain constancy. To it also we owe the discovery of the electrotype process, and all it has grown into. Its principle is, that copper plate as the negative metal, is surrounded by a solution of a salt of copper, which is reduced; instead of hydrogen, copper is set free, and it is deposited on the negative surface, which is thus kept constantly renewed. The acid of the salt is transferred by electrolysis to the positive metal, through the porous medium, hence if a fresh supply of the salt is added to the solution to replace that removed, this part of the arrangement remains constantly in the same condition; but still absolute constancy cannot be obtained, because as the zinc dissolves, the solution belonging to it becomes less active and less conducting. The great drawback to this cell is that the copper salt passes by *endosmose* into the zinc solution, and acts on the zinc where the copper is deposited, and causes great waste by setting up local actions.

This defect may be to a great extent remedied by arranging a piece of wire gauze close to, but not touching the porous diaphragm, on the zinc side, in such a manner that any fluid passing towards the zinc must go through the gauze; this is connected by a wire to the copper plate during action, it thus becomes electrically part of the negative surface, and in some cases will act as a single fluid cell, to some extent contributing to the action; at all events any copper salt which comes in contact with it will be reduced there instead of at the zinc; when the battery is not acting the gauze should be connected to the zinc by a fine wire of iron or brass, so as to keep up a very slight action for the same purpose.

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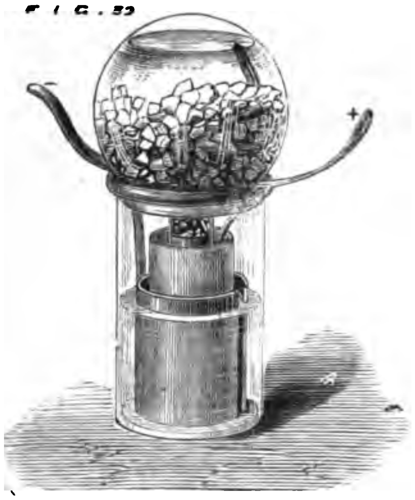
[*] "Sigma."

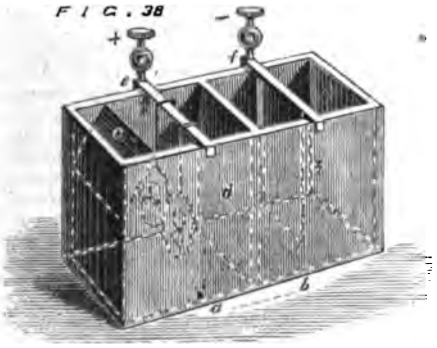
Fig. 37, shows this cell, *a* the copper vessel fitted with a reservoir *b* for the crystals, *c* the porous cell, *d* the zinc rod suspended in it by a bar passing through it. The part of the copper cylinder within the reservoir is of course perforated. Modes of construction may be varied to any extent. Thus instead of a copper containing vessel, a glass or earthern jar may be used with a cylinder of sheet copper, or such a jar may be covered inside with a film of wax, blackleaded, and the deposited copper will form its own surface, but the first is the best plan, especially as the sulphate of copper has a great tendency to climb up glass surfaces, on which it crystallises and finds its way by degrees to the outside.

FIG. 37



123. But instead of cylinders flat plates may be used in a vessel across which a plate of porous material is fixed, and this form has several advantages, among others it is easy to make the cell itself serve as a depositing vessel by using models, seals, &c., in fact any objects we wish to copy, as the negative surface, by suspending these to a rod which forms the + pole of the battery. In this case the cell is best made of wood, lined with a resinous cement; gutta percha may be used, but has the disadvantage of facilitating the *creeping* process of acids and salts, which is troublesome and messy, besides causing loss of power by establishing paths by which the force escapes. I find resin melted with a little gutta-percha, paraffin, and a small quantity of boiled oil answer perfectly; the wood should be perfectly dry and warm when it is applied. Such an apparatus, which also serves for the single cell electrotype process is shown in Fig. 38; *a* — *b* is the box divided by the porous partition *d*; *c* is a place for holding the crystals; *e* and *f* are two bars of metal, to which are hung the objects to be copied and the zinc plate, and each is fitted with the necessary binding screw. The bars being moveable, it is easy to regulate the distances, and so to control the action.

FIG. 38



Many of the telegraph lines are worked by Daniell's cells of this sort, that is to say fitted with plates in cells, either divided by a fixed plate or the zinc contained in a flat cell, only the side of which facing the copper is left porous, the others being smeared with tallow, &c., to diminish endosmose.

(*To be continued.*)

SCIENCE FOR THE YOUNG.*

BY THE REV. E. KERNAN, CLONGOWES COLLEGE.

(*Continued from page* 172.)

Laws V and VI.—The proofs, not astronomical, of these laws, depend upon the apparatus of Law IV., to be seen in the next point.

No 3.—Applications.—When there is anyt l interesting of a historical nature connected w the matter, that too is given briefly under the head of applications.

Application I.—Gravitation, History of.—Although the fact of bodies falling to the earth had been before men from the beginning, there is no record of its having being attended to until the time of Plato and Aristotle. This latter philosopher announces in one of his works (*De Cœlo*) a principle, which, if followed out by experiment, would probably have long before Galileo and Newton, laid the foundation of modern astronomy. He states distinctly that a falling body quickens its motion as it approaches the earth. This motion was like a flash of light in the dark. It showed for a moment and was lost, although Aristotle returns to it again more than once.

FIG. 24

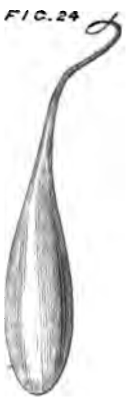


FIG. 26

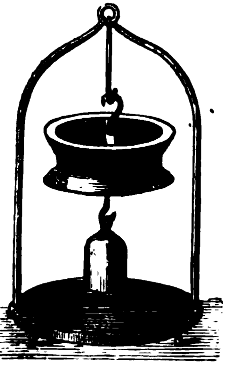
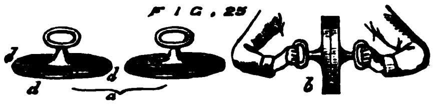


FIG. 25



Others amongst the ancient philosophers, from time to time, seemed to be near what is now held as established.

But the doctrines of Aristotle would appear to have taken most hold of the mind, and ruled supreme with many contained errors, till towards the end of the sixteenth century. Galileo, an Italian philosopher, was the first to show the true principles of gravitation on the earth. Of this more later on. For the present enough to say, that Sir Isaac Newton it was who first declared and proved from the action of gravitation on the earth that all nature might be included in one general law of attraction. A short time ago (1867), the scientific world was startled by a declaration of M. Chasles to the French Academy, that he was in possession of documents which showed that the great Newton's immortal discoveries were due to others, and that, in particular, the fact and laws of universal gravitation were communicated to him by Pascal. Thousands of letters were obtained by M. Chasles, at the price of 140,000 francs, and after a bitter controversy, the Newton Pascal as it was called, of more than two years, he discovered that he was the dupe of a forger. About 22,000 "pieces" of most varied character were produced. A small number, about 500 francs' worth, were genuine.

Application II.—Prince Rupert's Drops.—These curious solids, quickly cooled drops of molten glass, Fig. 24, require more than one branch of science for their full explanation, if such has yet been reached. For the present purpose they exhibit a strange mixture of cohesion and non-cohesion. The outside shell is hard and coherent; inside is supposed to be in a state of aggregated fine particles. The cohesion, too, of the shell is exceptional, for, the slightest bit broken off the tail the whole drop is violently reduced to loose dust.

Application III.—Adhesion plates.—These sometimes called the "Magdeburg planes," are two discs of metal ground perfectly plane and smooth, and provided with handles. Fig. 25 *(a)* rubbed well together, the upper disc will not only carry the lower one, but it will require some force to draw them asunder by a *straight* pull *(b)*.

FIG. 27

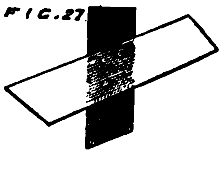
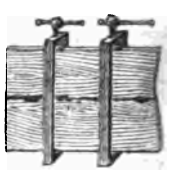


FIG. 28.



To prevent side motion, there are three small buttons *(d)* that can be turned up; or there may be a flange fixed to one of the planes, which however might interfere with their being well rubbed together, and would be in the way of regrinding. The planes are sometimes made of marble or glass, form as in Fig. 26. That their adhesion is not due to air pressure, is shown elsewhere.

App. IV. Smooth bodies.—If left for a long time in contact, smooth bodies with parallel surfaces adhere so forcibly, that it is sometimes not possible to separate them. Thus, Clement found that two pieces of plate glass which had been laid together for a long time, had acquired adhesion such that separation was impossible.

App. V. Uneven bodies.—A thin layer of liquid, water for instance, between two plates of common window glass, will cause them to adhere. The liquid helps to fill up the hollows caused by roughness, and superadds its own adhesion, Fig. 27. This fact is frequently to be met with when solid bodies, wet, are in contact—raise one up *straight*, others adhere. The upper glass (27) will lift the lower one.

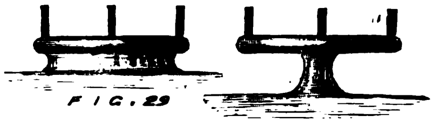
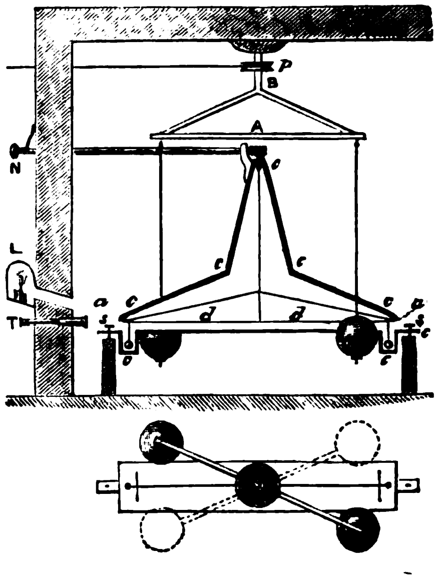


FIG. 29

App. VI. Solder, glue, paste, &c.—There is produced, by means of these, in a liquid state, an adhesion between solids so close, that it almost may be called cohesion. That it is not the glue, the paste, &c., which acts in the holding, is proved by this fact: the more they are pressed out the better the joint. Fig. 28, two boards squeezed in cramps, glue forced out.

FIG. 30



App. VII. Donny's figures.—The changing form of liquids adhering to solids has been clearly examined by Donny. A disc is held perfectly horizontal over the surface of the liquid, by means of levelling screws, and the tray is raised or lowered by a screw beneath. All side motion is avoided, and as the tray is gently lowered, the ever-changing beautiful form of the liquid can be steadily observed, Fig. 29. The apparatus serves also for examining the adhesion (and cobeslon) of different liquids. The supports, tray, &c., are, not shown, to avoid confusion in the figure.

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App. VIII. Cavendish apparatus.—In the mountain experiment, the attraction of the earth for the weight, was a great obstacle to observing the whole effect of the mountain, The first care, then, was to relieve the bodies to be experimented upon from that attraction; next, all external causes of error to be removed, for clarity points,

1. Two great weights of lead, each 250lb. or more, Fig. 30, were suspended from the ends of a horizontal bar A held through angle rods by a perpendicular axis B.

2. Two very small balls hung from the ends of a light rod of wood *d* delicately suspended at the middle by a thread of silver, from the top of a box C C C, which protects the balls from the action of the air. Slits are cut in the ends of the box that the lever points *a a* may be seen. The figure shows the box in section.

3. The box was placed on two massive supports and levelled by screws S S, in a room where no danger of vibration was to be feared. A rod *d* passed through the wall from the top from the box, where an endless screw commanded the fixing of the lever with its small balls. From outside, therefore, by a nut N, the ends *a a* could be brought opposite the slits in the end of the box.

4. To the ceiling of the room, straight over the thread of the small balls lever, was fixed a socket to hold the axis B of the bar A. A pulley *p* on B supplied a means of turning the axis, and with it the great balls. This was done from outside by a cord F passed round the pulley.

5. The room was without windows, the light of a small lamp L was thrown from outside on the slits, and the points of the lever *a a*, observed with the telescope T, passed through the wall. All these precautions were to avoid change of temperature or currents of air; no one entered the room for some time.

6. All being adjusted, the great balls were set at right angles to the small balls, and these brought to perfect rest opposite the slits, which held a divided scale of ivory, the vernier of which was on the ends of the small lever. A ground plan below shows how the great balls could move to the right angle; the dotted lines show their extreme range.

7. The small lever being all but floating in the air, the least ottraction would be observed. All preparations concluded, Cavendish at length moved the great balls near to the small balls; these latter were distinctly attracted, and swung back and forward across a position of rest. There is then the proof of Law IV.

For the present it must be enough to say that Laws V. and VI., could be proved by this apparatus and that it served Cavendish and others to calculate the weight of the earth. Baley, in 1842, made many changes in the small balls, and their arrangement, and gave in his results after 3000 experiments. The weight of the earth being determined, astronomy supplied the means of calculating the mass of the sun, the planets, &c. The Cavendish apparatus has been, then, truly called a balonce to weigh the univesre, This wonderful apparatus was first devised by Mitchel, of the Royal Society, London. He made it over to Wollaston, who gave it, as a present, to Cavendish. This philosopher was the first who brought it to its work. It is, therefore, named after him.

App. IX. Formulæ deductions.—As here are given the first formulæ, it is well to call attention to their use. Therefore, any one of the four quantities can be known by having the value of the three others. Thus, what would be the attraction of the moon and earth if the distance were to be diminished by half? Here the unknown quantity of the formulæ is G′, resolving the equation for G′, its value is found. Again, what is the cause of the difference of tides, high and low, ascribed to the attraction of the moon? The formula indicates that it is the greater or less distance of the moon. What is the difference of the action of sun and moon on the water on the earth? The formula of Law VI. will give the relative attraction of the sun and moon, knowing the mass of both, and the formula of Law V. will give the diminution of the sun's attraction caused by its greater distance from the earth.

App. X. Fall of bodies.—They fall because attracted to the earth. "Terrestrial gravitation," "at length," later on. For the present, it is a force by which bodies are drawn in a straight line to the centre of the earth. The earth being a sphere (more or less) that force acts along an infinite number of radii, Fig. 31, G *a*, G *a*, &c.

App. XI. "Perpendicular."—A body is said to be perpendicular when its axis, or some given side is along one of the radio to the earth's centre. T tower, radius G B.

(To be continued.)

ANCIENT COINS.—II.

By Henry W. Henfrey.

(Continued from page 169.)

We now proceed to describe the series of Roman coins—perhaps the most important of any coinage, either ancient or modern. It is generally divided into two great classes. The first includes all the coins struck under the Roman Republic and before the accession of Augustus, which are generally denominated *Consular* or *Family* coins. "Among antiquaries, those are designated Consular coins which were struck during the Republic with the authority of the Consuls, though probably even then under the superintendence of the *triumviri monetales*—officers in charge of the Mint; those with the name of any Roman family inscribed, the greater number of which were struck about the times of Julius Cæsar and Augustus, are included under the second denomination, but, on account of the high stations held by many of the strikers, the two classes are often grouped together as *Denarii Consulares*. On these the boundless variety of type affords an insight into the incalculable fecundity of the Roman mint, for they present, in a durable and unequivocal form, names and attributes both human and divine, sacred rites and implements, public monuments and edifices, manners and customs, honours and successes. . . . They, therefore, form so sterling a record of interesting facts as to constitute, together with lapidary inscriptions, an incontrovertible evidence respecting ancient occurrences; and they, moreover, become a test of validity in the fuller developement of history, especially in that hitherto neglected but momentous department, the decadence of the Republic and the rise of the Empire."—*(Admiral Smyth.)*

The second division comprises all the coins truck under the Roman emperors, called *Imperial*, and usually bearing on the obverse the bust and titles of the reigning monarch.

The most ancient Consular coins were of copper and brass, and the earliest are probably not older than the third century B.C. They consisted of the "As," and its multiples and divisions. The *as* was originally of a pound weight, and was divided into twelve *unciæ* or ounces. It was, however, as a coin, rapidly reduced; mostly weighing one or two ounces, and in the time of Julius Cæsar it only equalled half an ounce.

The various copper and brass denominations were:—The *Decussis*, or ten asses; the *Quincussis*, or five asses; the *Quadrussis*, or four asses; the *Tripondius*, or three asses; the *Dupondius*, or two asses; the *As*, or piece of twelve unciæ; the *Semis*, or half-as; the *Triens*, or ⅓ of the as; the *Quadrans*, or quarter of the as; the *Sextans*, or one-sixth of the as; the *Uncia*, or one-twelfth of the as; aud the *Quincunx*, or piece of five unciæ.

The types of these coins are as follows:—

Decussis.—Obverse, bust of Pallas or Minerva; X. behind it. *Reverse*, the prow of a vessel; X. above it.

Quincussis.—Obv., a trident. Rev., a caduceus.

Quadrussis.—Generally a bull on each side.

Tripondius.—Obv., head of Pallas; III. behind it; *rev.*, the prow of a vessel; III. above it.

Dupondius.—The same, but with II. instead of III.

As.—Obv., double-faced head of Janus; *rev.*, the prow of a vessel; I. above it.

Semis.—Obv., bust of Jupiter; S behind it; *rev.*, the prow of a vessel; S above it.

The triens, &c., are of various types, but usually have the prow of a ship on the reverse. They are marked with large dots or pellets to indicate their value. Thus the quincunx has five dots; the triens, four; the quadrans, three; the sextants, two; and the uncia, one dot.

The silver consular or family coins are next in antiquity to the brass. Silver was not coined in Rome itself until about 207 years B.C., though there are pieces supposed to have been coined in Campania, under Roman authority, as early as 300 B.C. The first that were coined *in Rome* have *Obverse*, a laureated head of Janus; *reverse*, a quadriga, or chariot with four horses. Inscription, ROMA sunken or in relief. Others have, *obv.*, bust of Jupiter; *rev.*, Victory standing near a trophy. The next in date bear, *obv.*, helmeted head of Rome (sometimes called Minerva), X. behind it; *rev.*, Castor and Pollux on horseback, or a chariot with two or four horses.

The principal Roman silver coin was the *denarius*; so called from its being at first equal to ten *asses*. The average weight of the consular denarii is from 68 to 60 grains troy, and therefore they would be worth in our money about 8d. or 9d. each. They generally have the numeral of value, X., on the obverse. The other denominations in silver are the *Quinarius* and the *Sestertius*. The *Quinarius*, or piece of five *asses*, was the half of a denarius, and, when the type of Victory was represented on the obverse, was called a *Victoriatus*. The *Sestertius* was the quarter of a denarius, and was sometimes marked IIS, behind the bust on the observe. Double denarii or small medallions in silver are not unfrequently found.

The types of the silver consular coins are the most interesting and the most varied of almost any series. The usual obverse type is the head of some deity, but the reverses are extremely numerous. The inscriptions include the names of persons striking the coins, whether consuls or otherwise. Various historical events are commemorated, as for instance, a coin of Brutus has a cap of liberty between two daggers, with the inscription EID. MAR. (*Eidus Martiæ*, the Ides of March). A denarius of the Æmilia family has a representation of the famous bridge, *Pons Sublicius*, built by Ancus Marcius, and afterwards called *Æmilius*. Another exhibits the dream of Sylla, when marching from Nola against Rome, B.C. 83, as related by Plutarch; it is represented by a man lying on the ground, to whom appear Victoria Alata, and Diana. The omen was propitious. A third denarius represents the submission of Aretas, king of Arabia, to Marcus Scaurus.

Among the types are numerous heads of deities, busts, or figures of ancestral personages, events connected with ancestors, as figure of Marcus Lepidus as TUTOR REG. is (the guardian of the king) crowning Ptolemy Epiphanes. Other types are fabulous monsters (as Scylla), personifications of countries or towns (as heads of Hispania, Roma, Alexandria), heads of allegorical personages (Honor et Virtus, Pavor, Pallor), symbolical representations of contemporary events, portraits of illustrious living personages (as Julius Cæsar, Sulla, Pompey), military symbols, (as legionary standards), &c.

Julius Cæsar was the first who obtained permission to put his portrait on coins. His usual titles are "Perpetual Dictator," and "Imperator."

The first gold coinage took place, according to Pliny, in the year 207 B.C. The usual denominations are the *aureus* and the *semi-aureus*, or half-aureus. The earliest gold pieces are of several different sizes. They were struck in Campania, and have the word *Roma* on the reverse. Others bear the bust of Janus. In the time of Augustus 40 aurei were struck out of a pound of gold. In the time of Pompey an aureus weighed about 126 grains troy, and about 125 in that of Julius Cæsar. By a perpetual law the aureus was equivalent to 25 silver denarii. The types of the gold Consular and Family coins are very similar to those of the silver.

(To be continued.)

Erratum.—In our first article, page 169, last line but five, for "Barkobab," read "Barkokab."

ON THE RELATIONS BETWEEN BODY AND MIND.*

Lecture I.

(Continued from page 178.)

What are we to say in explanation of the movements? Are they mental, or are they only physical? If they are mental, it is plain that we must much enlarge and modify our conception of mind, and of the seat of mind; if physical it is plain that we must subtract from mind functions that are essential to its full function, and properties that are the very foundations of its development in the higher centres. Some eminent physiologists now maintain, on the strength of these experiments, that the accepted doctrine of reflex action is quite untenable, and that the spinal cord is really endowed with sensation and volition; and certainly these adapted actions seem to give us all the signs of being felt and willed, except telling us that they are so. Before accepting, however, this explanation of the obscure by something more obscure still, it were well to realise distinctly how dangerous a practice it usually is to apply deductively to the interpretation of simple phenomena ideas pertaining to the more complex, and how essential a principle of the method of induction it is to follow the order of evolution, and to ascend from the interpretation of the simple to that of the complex. The explanation savours of the old and evil tendency which has done so much harm in philosophy, the tendency to explain the facts of nature by what we feel to go on in our minds; because we know that most of our actions take take place consciously and voluntarily, we can hardly help thinking that it must be the same in the frog. Might we not, however, as well suppose and hold that positive attracts negative and repels positive electricity consciously and voluntarily, or that in the double decomposition of chemical salts one acid chooses voluntarily the other base? It is most necessary to be on our guard against the danger of misapplying ideas derived from internal observation of the functions of mind centres to the interpretation of the functions of lower nerve centres, and so of misinterpreting them. Assuredly we have sad experience enough to warn us against involving the latter in the metaphysical haze which still hangs over the functions of the supreme centres.

All the conclusion which the facts warrant is that actions for a definite end, having indeed the semblance of predesigning consciousness and will, may be quite unconscious and automatic; that the movements of the decapitated frog, adapted as they are to secure its well-being, are no more evidence of intelligence and will than are the movements of coughing, sneezing, and swallowing in man. In the constitution of the animal's spinal cord are implanted [the faculties of such movements for self-preservation, which it has inherited as a part of its nature, and without which it could hardly live a day; accordingly it acts necessarily and blindly; though it has lost its foot, it endeavours vainly to act as if its foot was still there, and only when the irritation continues unaffected by its futile efforts makes, in answer to it, those further reflex movements which are the physiological sequences of the unsuccessful movements: it supplements one series of reflex actions by another. But although these purposive movements are not evidence of intelligence and violition in the spinal cord, it is another question whether they do not evince the same physiological properties and the operation of the same laws of evolution as govern the development of intelligence and will in the higher centres.

I have taken the experiment on the frog to exemplify the proposition that designed actions may be unconscious and automatic, because the phenomena are more simple in it than in man, and more easy, therefore, to be understood; but the proposition is equally true of his spinal cord. In its case, however, we have to bear in mind that faculties are not innate to the same degree and extent as in the lower animals, but have to be acquired by education—to be organised, in fact, after birth. It must be taught, just as the brain must, before it can perform its functions as an organ of animal life; and being much more under the control of the more highly-developed brain, feeling and volition commonly mingle largely in its functions, and its independent action cannot be so plainly exhibited. But when its motor centres have been taught, when they have gained by education the power of executing what are called secondary automatic acts, it is certain that it can and does habitually execute them independently of consciousness and of will. They become as purely automatic as are the primitive reflex acts of the frog. To the statement, then, that actions bearing the semblance of design may be unconscious and automatic we have now to add a second and most weighty proposition—namely, that acts consciously designed at first may, by repetition, afterwards became unconscious and automatic, the faculties of them being organised in the constitution of the nerve centres, and they being then performed as reflex effects of an external stimulus. This, as we shall see, is a most important law in the development of the higher nerve centres.

Let us now go a step further. The automatic acts, whether primary or secondary, in the frog or in the man, which are excited by the suitable external stimulus, may also be excited by an act of will, by an impulse coming downwards from the brain. When this happens, it should be clearly apprehended that the immediate agency of the movements is the same; it is in the motor centres of the spinal cord; the will does not and cannot act upon the nerve fibres of each muscle individually, but simply gives the order which sets in motion the organised machinery of the movements in the proper motor centres. This is a consideration of the utmost importance, for it exhibits how great a part of our voluntary acts is really the automatic action of the spinal cord. The same movements are effected by the same agency in answer to different stimuli—in the one case to an external stimulus, in the other case to an impulse of will; and in both cases the mind is alike ignorant how they are done. But while the automatic acts take place independently of will, the will is absolutely dependent on the organised experience in the cord for the accomplishment of its acts; without this it would be impotent to do a voluntary act. When, therefore, we have taken out of a voluntary act the large part which is due to the automatic agency of the motor centres, it clearly appears that we have subtracted no small proportion from what we are in the habit of comprising vaguely under mind. We perceive, indeed, how indispensable an exact and faithful observation of the functions of the spinal cord is to a true physiological inquiry into mind, and what an important means of analysis a knowledge of them yields us. Carrying the knowledge so gained into our examination of the functions of the higher nerve centres, we observe how much of them it will serve to interpret. The result is that we find a great part of the habitual functions of the higher centres to be similarly automatic, and to admit of a similar physiological interpretation.

There can be no doubt that the ganglionic nuclei of the senses—the sensorial nuclei—are connected with motor nuclei; and that we have in such anatomical arrangement the agency of a number of reflex movements. Most of the instinctive acts of animals are of this kind, the faculties being innate in them. In man, however, who is actually the most helpless, though potentially the most powerful, of all living creatures, when he comes into the world, the sensory and associated motor nuclei must be educated, just as the spinal centres must. To illustrate this sensori-motor or instinctive action, we may take the results of Flourens' well-known experiment of removing the cerebral hemispheres of a pigeon. What happens? The pigeon seemingly loses at once all intelligence and all power of spontaneous action. It appears as if it were asleep; yet, if thrown into the air, it will fly. If laid on its back, it struggles on to its legs again; the pupil of the eye contracts to light, and, if the light be very bright, the eyes are shut. It will dress its feathers if they are ruffled, and will sometimes follow with a movement of its head the movement of a candle before it; and, when a pistol is fired off, it will open its eyes, stretch its neck, raise its head, and then fall back into its former attitude. It is quite evident from this experiment that general sensibility and special sensations are possible after the removal of the hemispheres; but they are not then transformed into ideas. The impressions of sense reach and affect the sensory centres, but they are not intellectually perceived; and the proper movements are excited, but these are reflex or automatic. There are no ideas, there is no true spontaneity; and the animal would die of hunger before a plateful of food, though it will swallow it when pushed far enough into its mouth to come within the range of the reflex acts of deglutition. Here again, then, we have a surprising variety of adapted actions of which the body is capable without the intervention of intelligence, emotion, and will—without, in fact, mind in its exact sense having any part in them. The pigeon is brought to the level of the invertebrata, which have no higher nerve-centres than sensory ganglia, no centres of intelligence and will, and which execute all their varied and active movements, all their wonderful displays of instinct, through sensory and associated motor nuclei. They seek what is good for them, avoid what is hurtful to them, provide for the propogation of their kind—perform, indeed, all the functions of a very active life without knowing that they are doing so, not otherwise than as our pupils contract to light, or as our eyes accommodate themselves to vision at different distances without consciousness on our part. The highest specialisations of this kind of nerve-function are displayed by the ant and the bee; their wonderful instinctive acts show to what a degree of special perfection sensori-motor action may be brought.

Unlike the bee and the ant, man must slowly learn the use of his senses and their respondent movements. This he does by virtue of the fundamental property of nerve centres, whereby they react in a definite way to suitable impressions, organically register their experience, and so acquire by education their special faculties. Thus it is that many of the daily actions of our life, which directly follow impressions on the senses, take place in answer to sensations that are not perceived—become, so to speak, *instinctive*; some of them being not a whit less automatic than the instinctive acts of the bee, or the acts of the pigeon deprived of its hemispheres. When we move about in a room with the objects in which we are quite familiar, we direct our steps so as to avoid them, without being conscious what they are, or what we are doing; we see them, as we easily discover if we try to move about in the same way with our eyes shut, but we do not perceive them, the mind being fully occupied with some train of thought. In like manner, when we go through a series of familiar acts, as in dressing or undressing ourselves, the operations are really automatic; once begun, we continue them in a mechanical order, while the mind is thinking of other things; and if we afterwards reflect upon what we have done, in order to call to mind whether we did or did not omit something, as for instance to wind up our watch, we cannot satisfy ourselves except by trial, even though we had actually done what we were in doubt about. It is evident, indeed, that in a state of profound reverie or abstraction, a person may, as a somnambulist sometimes does, see without knowing that he sees, hear without knowing that he hears, and go through a series of acts scarcely, if at all, conscious of them at the time, and not remembering them afterwards. For the most distinct display of sensori-motor action in man, it is necessary that his cerebral hemispheres, which are so largely developed, and intervene much in the functions of the subordinate centres, should be deeply engaged with their own functions, or that these should be suspended. This appears to be the case in those brief attacks of epileptic unconsciousness known as the *petit mal*, in which a person will sometimes go on with the work he was engaged in at the time of the attack, utterly unaware of the momentary interruption of his consciousness. There are many instances of this sort on record, which I cannot stop to relate now; they prove how large a part sensori-motor functions, which are the highest nerve functions of so many animals, play in our daily actions. We ought clearly to apprehend the fact that, as with the spinal cord, so here, the movements which take place in answer to the stimulus from without may be excited by the stimulus of the will descending from the hemispheres, and, that, when they are so excited, the immediate agency of them is the same. The movements that are outwardly manifest are, as it were, contained inwardly in the appropriate motor nuclei; these have been educated to perform them. Hence it is that, when the left corpus striatum is broken up by disease, the right cannot do its special work; if it could, a man might write with his left hand when his right hand was disabled by paralysis.

Thus much, then, concerning our sensori-motor acts, When we have yielded up to the spinal cord all the part in our actions that properly belongs to it, and to the sensory ganglia and their connected motor nuclei all the part that belongs to them, we have subtracted no inconsiderable part from the phenomena which we are in the habit of designating mental, and including under mind. But we still leave untouched the highest functions of the nervous system—those to which the hemispherical ganglia minister. These are the functions of intelligence, of emotion, and of will; they are the strictly mental functions. The question at once arises whether we have to do in these supreme centres with fundamentally different properties and different laws of evolution from

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[*] Two lectures delivered at the Royal College of Physicians in 1870. By HENRY MAUDSLEY, M.D., F.R.C.P., Professor of Medical Jurisprudence in University College, London.

those which belong to the lower nerve centres. We have to do with different functions certainly; but are the organic processes which take place in them essentially different from, or are they identical with, those of the lower nerve centres? They appear to be essentially the same: there is a reception of impressions, and there is a reaction to impressions, and there is an organic registration of the effects both of the impressions and of the reactions to them. The external stimuli do not, it is true, ascend directly to the supreme centres as they do the spinal centres and the sensory centres; they are transmitted indirectly through the sensory ganglia; it is through the senses that we get our ideas. This is in accordance with the anatomical observation—which, however, is disputed—that no sensory fibres go directly through to the hemispheres, and no motor fibres start directly from them; both sensory and motor fibres stopping at the corpora striata and thalami optici, and new fibres connecting these with the hemispheres. But this does not alter the fundamental similarity of the organic processes in the higher centres. The impressions which are made there are the physiological conditions of *ideas*. The feeling of the ideas is *emotion*; for I hold emotion to mean the special sensibility of the vesicular neurine to ideas. The registration of them is *memory*; and the reaction to them is *volition*. *Attention* is the maintenance of the tension of an idea or a group of ideas—the keeping it before the mind; and *reflection* is the successive transference of energy from one to another of a series of ideas. We know not, and perhaps never shall know, what mind is; but we are nevertheless bound to investigate, in a scientific spirit, the laws of its functions, and to trace the resemblances which undoubtedly exist between them and the functions of lower nerve centres.

(To be continued.)

STRENGTH OF MATERIALS.

BY A. TOLHAUSEN, JUN.

(Continued from page 124.)

IT is not every kind of tar that destroys the durability of the fibres, for the Archangel and Stockholm are said to preserve the rope, so that in the execution of important works it is recommended that the ropes should have been recently manufactured, and be made of the best Petersburg hemp, with Archangel and Stockholm tar.

The tar applied to ropes made by the warm register is more fluid than in those made up with the yarns cold, and therefore penetrates every fibre of hemp completely. Again, as the heat drives off both air and moisture, each fibre is brought into closer contact by the twisting and compression of the strand, and the strength of the rope is greatly increased. Another advantage is derived from the warm register, as ropes made by the same are almost impermeable to water, so that it is absolutely necessary in places where they are exposed to the wear and tear of the weather to have them made by the new process.

The dimensions of ropes are generally stated in terms of their girth or circumference, and worked to about one-sixth of their breaking strain. The weight of hempen ropes (in lbs. per fathom) is approximately found by multiplying the square of their circumference by 26.

Flat ropes, made by placing four round ropes side by side, and stitching them up by machinery into a flat band, are now used for many purposes where great lengths or depths, such, for instance, as in raising coal from pits, have to be attained.

They possess great strength and flexibility. In some cases, if ropes were applied they would be cut to pieces in a very short time, and the weight of chains might also be inconvenient; it is in such instances that *wire* ropes are used, and have proved to answer the purpose very well in working inclined planes, &c. On the Durham-Sunderland railway, trains are drawn up and let down an inclined plane of 4½ miles length by means of an endless wire rope, made of three pieces.

The two practical rules for computing the strength of ropes are sometimes ennunciated to be:—

To find the breaking weight in tons of a rope made of common hemp, multiply the square of the circumference (in inches) by ·288; conversely to find the circumference (in inches) of a hempen rope whose ultimate strength is given; extrac the square root of; the ultimate strain divided by ·28, or if C = circumference, B = breaking weight in tons:—

$$B = C^2 \times {\cdot}28 = C = \sqrt{\frac{B}{{\cdot}28}}$$

Note—For common cables ·28 may be replaced by ·2.

The following table* shows the weight and strength of round ropes of hemp and wire:—

Table III.

Hemp.		Iron Wire.		Steel Wire.		Equivalent strength.	
Circumference.	lbs. weight per fathom.	Circumference.	lbs. weight per fathom.	Circumference.	lbs. weight per fathom.	Working load per cwt.	Breaking strain per ton.
2¾	2	1	1	—	—	6	2
—	—	1¼	1½	1	1	9	3
3¾	4	1⅜	2	—	—	12	4
—	—	1½	2½	1¼	1½	15	5
4½	5	1⅞	3	—	—	18	6
—	—	2	3½	1⅜	2	21	7
5½	7	2⅛	4	1½	2½	24	8
—	—	2¼	4½	—	—	27	9
6	9	2⅜	5	1⅝	3	30	10
—	—	2½	5½	—	—	33	11
6½	10	2⅝	6	2	3½	36	12
—	—	2¾	6½	2⅛	4	39	13
7	12	2⅞	7	2¼	4½	42	14
—	—	3	7½	—	—	45	15
7½	14	3⅛	8	2⅜	5	48	16
—	—	3¼	8½	—	—	51	17
8	16	3⅜	9	2½	5	54	18
—	—	3½	10	2⅝	6	60	20
8½	18	3⅝	11	2¾	6½	66	22
—	—	3¾	12	—	—	72	24
9½	22	3⅞	13	3¼	8	78	26
10	26	4	14	—	—	84	28
—	—	4⅛	15	3⅜	9	90	30
11	30	4¼	16	—	—	96	32
—	—	4⅜	18	3½	10	108	36
12	34	4½	20	3¾	12	120	40

Table IV. shows the weight and strength of flat ropes of hemp and wire:—

Hemp.		Iron Wire.		Steel Wire.		Equivalent Strength.	
Size in inches.	lbs. weight per fathom.	Size in inches.	lbs. weight per fathom.	Size in inches.	lbs. weight per fathom.	Working load per cwt.	Breaking strain per ton.
4 × 1¼	20	2¼ × ½	11	—	—	44	20
5 × 1¼	24	2⅜ × ½	13	—	—	52	23
5½ × 1⅜	26	2⅝ × ½	15	—	—	60	27
5¾ × 1⅜	28	3 × ⅝	16	2 × 2½	10	64	28
6 × 1½	30	3¼ × ⅝	18	2¼ × ½	11	72	32
7 × 1⅞	36	3⅜ × ⅝	20	—	—	80	36
8¼ × 2¼	40	3¾ × 11-16	22	—	—	88	40
8½ × 2¼	45	4 × 11-16	25	2¾ × ⅝	15	100	45
9 × 2¼	50	4¼ × ¾	28	3 × ⅝	16	112	50
9½ × 2⅜	55	4½ × ¾	32	3¼ × ⅝	18	128	56
10 × 2½	60	4¾ × ¾	34	3⅜ × ⅝	20	136	60

RIGIDNESS OF ROPES AND STRAINS.

Till now we have considered ropes and chains to be perfectly pliable, which, however, in practice is not the case; for daily experience shows that any rope of ordinary dimensions requires a certain amount of force to be applied to twist it in any direction, and this force is called the *stiffness*, or *rigidness* of that rope.

It is obvious that this force will chiefly depend on the intensity of that force W stretching the rope, on the radius of curvature, and the thickness of the rope itself. Again, it will depend on the material of which the rope is made, on the number of fibres and twists given to the same, as well as whether the rope is new or old, tarred or untarred.

Amonton† and Coulomb (celebrated French engineer, born 1736 in Angoulême, and received the first prize of the Paris Academy of Sciences for his "Théorie des Machines Simples;" died in 1806) were the first who investigated this force, and the experiments of the latter, which follow, led him to the mathematical formula:—

$$(1.)\ S^n = \frac{\delta^n}{2r}(+ b\,W)$$

Whereby S is the registry of the rope, δ the diameter of the same, r the radius of curvature; n an integer; a co-efficient, both varying with the quality of the rope, and b a magnitude merely depending on the increase of rigidness called forth by the force W.

Gerstner found all the values in Coulomb's formula too great; we shall therefore find another value for S.

Some of Coulomb's experiments are shown in the annexed Table*, showing the power required to draw a rope round a cylinder having one metre diameter:—

Untarred new ropes made of	Diam of rope = δ in metres.	Weight of rope pro. 1 metre length in kilog.	Value of a δn in kilog.	Value of C δn in kilog.
30 twists	0·0200	0·2834	0·2225	0·0097
15 twists	0·0144	0·1448	0·0035	0·0055
6 twists	0·0088	0·0522	0·0106	0·0024

Should the diameter of a rope not occur in the table, Coulomb gives the rule n multiply the next approaching value by $\left(\frac{\delta'}{\delta}\right)^n$ whereby δ' is the diameter of the rope whose rigidness is required.

The power n varies from 1 to 2, according to quality and strength of the rope.

The same found also that ropes, when moist, possess less rigidness when of large diameter, and greater stiffness when of small dimensions.

But although rope made by the warm register is both stronger and more durable, it is less pliable, and therefore the cold-registered rope is more generally used for crane-work, where the rope must be wound round barrels and passed through pulleys, as in these cases the radius of curvature is very small.

A formula more applicable to practical purposes is one proposed by Eytelwein† and symbolically demonstrated by

$$1\,S = R\frac{\delta^2}{r}W$$

r being the radius of barrel + half the rope's diameter.

When δ and r are given in metres and W in kilog., R = 18, and then we have

$$1\,S = 18\frac{\delta^2}{r}W$$

Redtenbacher proposes to use when δ and r are in terms of centimeters

$$S = 0{\cdot}26\frac{\delta^2}{2r}W^2$$

If instead of a rope, a chain be wound on a barrel of radius r, then the friction acting at the links has to be added to the stretching load. If the diameter of a link be represented by δ, and the coëfficient of friction by f, then we may write for the statical moment of rigidness S,

$$S\,r = \tfrac{1}{2} f\,\delta\,W.$$

For the statical moment, however, of the force P, overcoming this resistance of the chain

$$P\,r = W\,(r + \tfrac{1}{2} f\,\delta).$$

Nevertheless, as the chain has to become straight on the other side, we may assume the moment of the whole to be

$$P\,r = W\,(r + \tfrac{1}{2} f\,\delta),$$

which may, for practical purposes, be written

$$P = W\,(r + f\,\delta).$$

Weisbach‡, who made several experiments on the flexibility of wire ropes, found

$$S = (0{\cdot}49 \times 0{\cdot}00238\frac{W}{r}\ \text{kilog.}$$

whereby r was given in metres.

Experiments made in Germany (Freiberg§) have shown that the rigidness of wire ropes, in being drawn over barrels is almost overcome by the following formula:—

$$D = 0{\cdot}24\,\delta^2\sqrt{n}$$

whereby D is the diameter in feet, δ the diamete of the wire used in millimetres, and n the number of threads the rope is composed of.

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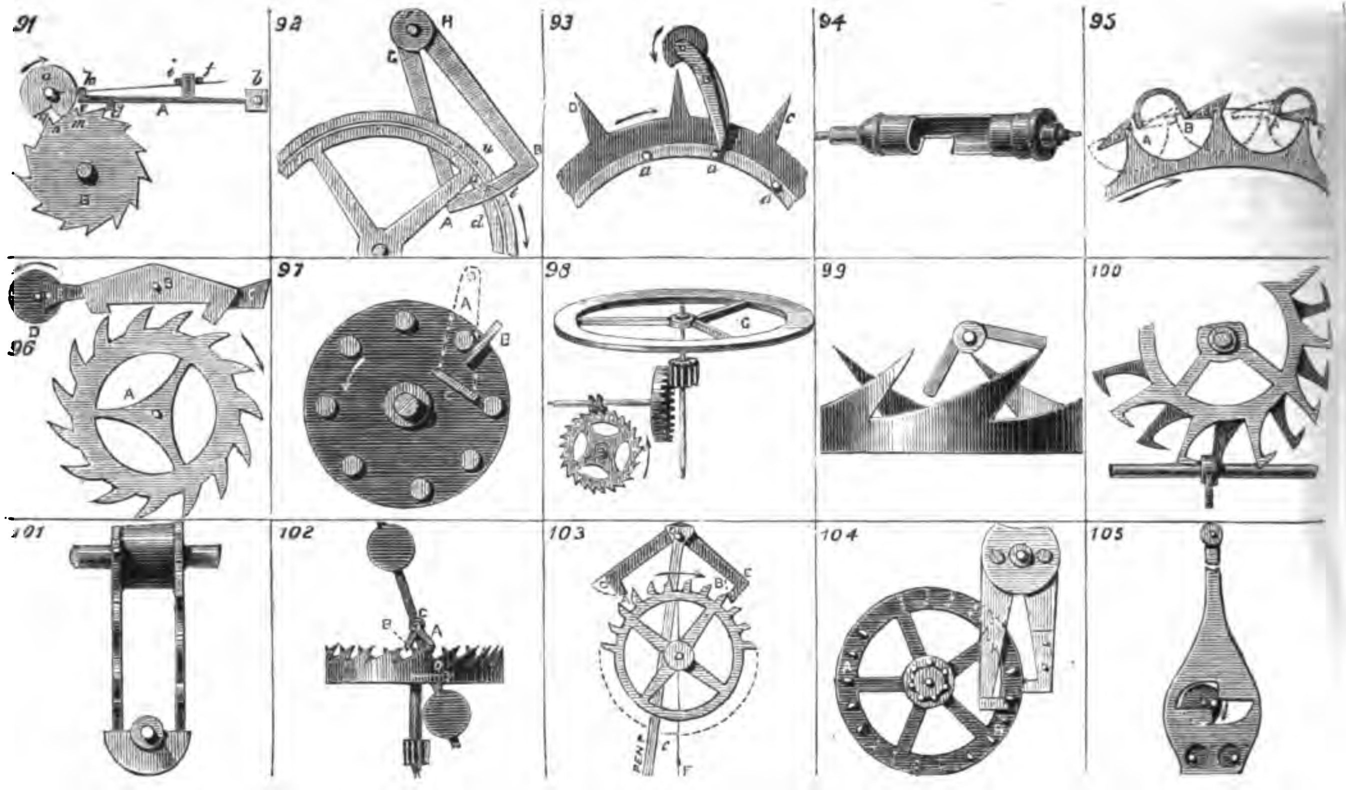
* "Molesworth's Engineerin Pocket
V iz., Prof. Ru hlman's "Mechanick," p. 250.

* For those not accustomed to work with Frenc measures, the following may prove useful:—1 metre = 39·371in, and 1 kilogramme = 2·2048lb. 1in. = 0·0254 met., and 1lb. = 0·4535 kilog.

† "Handbüch der Statikfester Körper," Vol. II. p. 320.

‡ "Ing Mech.," Vol I., ed. 3, p. 186.

§ "Jahrbüch für den Berg und Huttenmann," 1812, p. 16.



MECHANICAL MOVEMENTS.

By means of this formula we may now give an example of its application.

Example:—What is the intensity of rigidness in an untarred rope of 0·023 met. diam, wound round a barrel 0·28 met. radius, and sustaining a weight = 400 kilog ?

Our Formula 1 gives :

$$S = 18 \times \frac{(0\cdot023)}{0\cdot28 \times 0\cdot011} \times 400 = 12\cdot96 \text{ kilog.}$$

By means of Coulomb's table, if we take $n = 2$ in 1 , we find S as follows :—

$$\frac{a\,\delta^2}{2} = \left(\frac{0\cdot023}{0\cdot02}\right)^2 \times \frac{0\cdot0225}{2} = 0\cdot147$$

$$\frac{b\,\delta^2}{2}\,W = \left(\frac{0\cdot023}{0\cdot02}\right)^2 \times \frac{0\cdot0097}{2}\,400 = 2\cdot6$$

Hence $$S = \frac{2747}{0\cdot291} = 9\cdot44 \text{ kilog.}$$

This result is smaller than the first, and as it is better to calculate the strain larger than it actually is in practice, Formula 1 may with advantage be adopted.

MECHANICAL MOVEMENTS.*

(*Continued from page* 177.)

91. Arnold's chronometer or free escapement, sometimes used in watches. A spring A is fixed or screwed against the plate of the watch at *b*. To the under side of this spring is attached a small stop *d*, against which rest successively the teeth of the escape wheel B ; and on the top of spring is fixed a stud *i*, holding a lighter and more flexible spring which passes under a hook *k*, at the extremity of A, so that it is free on being depressed, but in rising would lift A. On the axis of the balance is a small stud *a*, which touches the thin spring at each oscillation of balance-wheel. When the movement is in the direction shown by the arrow, the stud depresses the spring in passing, but on returning raises it and the spring A and stop *d*, and thus allows one tooth of escape wheel to pass. letting them fall immediately to arrest the next. At the same time that this tooth escapes, another strikes against the side of the notch *g*, and restores to balance-wheel the force lost during a vibration. It will be understood that only at one point is the free movement of balance opposed during an oscillation.

92. Stud escapement, used in large clocks. One pallet B, works in front of the wheel and the other at the back. The studs are arranged in the same manner, and rest alternately upon the front or back pallet. As the curve of the pallets is an arc described from F, this is a *repose* or *dead-beat* escapement.

93. Duplex escapement, for watches, so called from partaking of the characters of the spur and crown wheels. The axis of balance carries pallet B, which at every oscillation receives an impulse from the crown teeth. In the axis A of balance-wheel is cut a notch into which the teeth round the edge of the wheel successively fall after each one of the crown teeth passes the impulse pallet B.

94 and 95. A cylinder escapement. 94 shows the cylinder in perspective, and 95 shows part of the escape-wheel on a large scale, and represents the different positions taken by cylinder A B during an oscillation. The pallets *a b c* on the wheel rest alternately on the inside and outside of cylinder. To the top of cylinder is attached the balance-wheel. The wheel pallets are bevelled so as to keep up the impulse of balance by sliding against the bevelled edge of cylinder.

96. Lever escapement. The anchor or piece B which carries the pallets, is attached to lever, E C, at one end of which is a notch E. On a disc secured on the arbor of balance is fixed a small pin which enters the notch at the middle of each vibration, causing the pallet to enter in and retire from between the teeth of escape-wheel. The wheel gives an impulse to each of the pallets alternately as it leaves a tooth, and the lever gives impulse to the balance-wheel in opposite directions alternately.

97. An escapement with a lantern wheel. An arm A carries the two pallets B and C.

98. An old-fashioned watch escapement.

99. An old-fashioned clock escapement.

100 and 101. A clock or watch escapement ; 100 being a front elevation, and 101 a side elevation. The pallet is acted upon by the teeth of one and the other of two escape-wheels alternately.

102. Balance-wheel escapement. C is the balance ; A B are the pallets ; and D is the escape-wheel.

103. A dead-beat pendulum escapement. The inner face of the pallet E and outer face of D are concentric with the axis on which the pallets vibrate, and hence there is no recoil.

104. Pin-wheels escapement, somewhat resembling the stud escapement shown by 92. The pins A B of the escapement wheel are of two different forms, but the form of those on the right side is the best. One advantage of this kind of escapement is that if one of the pins is damaged it can easily be replaced, whereas if a tooth is damaged the whole wheel is ruined.

105. A single-pin pendulum escapement. The escape-wheel is a very small disc with single eccentric pin ; it makes half a revolution for every beat of the pendulum, giving the impulse on the upright faces of the pallets, the horizontal faces of which are dead ones. This can also be adapted to watches.

(*To be continued.*)

DRESSING MILLSTONES WITH THE DIAMOND OR "BORT."

(*Concluded from page* 179.)

FIG. 8 is a plan of the dressing apparatus as applied upon a millstone, and Fig. 9 is a corresponding vertical section. Fig. 10 is an inverted plan of the bottom of the tool or bort holder, and Figs. 11 and 12 are an end and a front elevation of the slide as fitted with a single tool ; whilst Figs. 13 and 14 are sectional elevations of a modification of the slide *fitted* with two tools.

The framing of the machine consists of a central boss 1, made hollow to go over the head of the millstone spindle when operating on the bed stone, and this boss is connected by arms 2, to a segmental ring 3, accurately turned, or otherwise made flat on its underside to rest on the surface of the millstone 4, near the outer edge thereof, that being the part of the millstone surface that can be most relied upon as being truly level. To facilitate the placing of the frame on the stone three adjustable claws 5, are fixed on the segmental ring 3, and catch upon the top binding hoop ; accurate centering, however, of the frame on the stone is not essential. Two of the frame arms 2, are made in the same line tangential to the boss, and to them there is fixed a horizontal guide 6, made with V rails to receive a saddle 7, which can be moved along the guide 6, by means of a screw spindle 8. A horizontal arm 9, is fixed to the saddle 7, so as to stand out at right angles from the guide 6, and this arm is made with horizontal V rails to guide a slide 10, in which is adjusted the tool or bort holder 11. The bort holder 11, is a spindle screwed at its upper end to receive a nut, and formed at its lower end with a cross plate to fit a rebate in the bottom of the slide 10, and with a boss in which a socket is bored to receive three angular steel bits by which the bort is fixed. The three steel bits are shaped to build together into a cylindrical form a little less than the socket, and the bottom corners of their central meeting edges are hollowed to grip the bort, whilst they are adjusted upon it by screws tapped through the sides of the socket. With this simple con-

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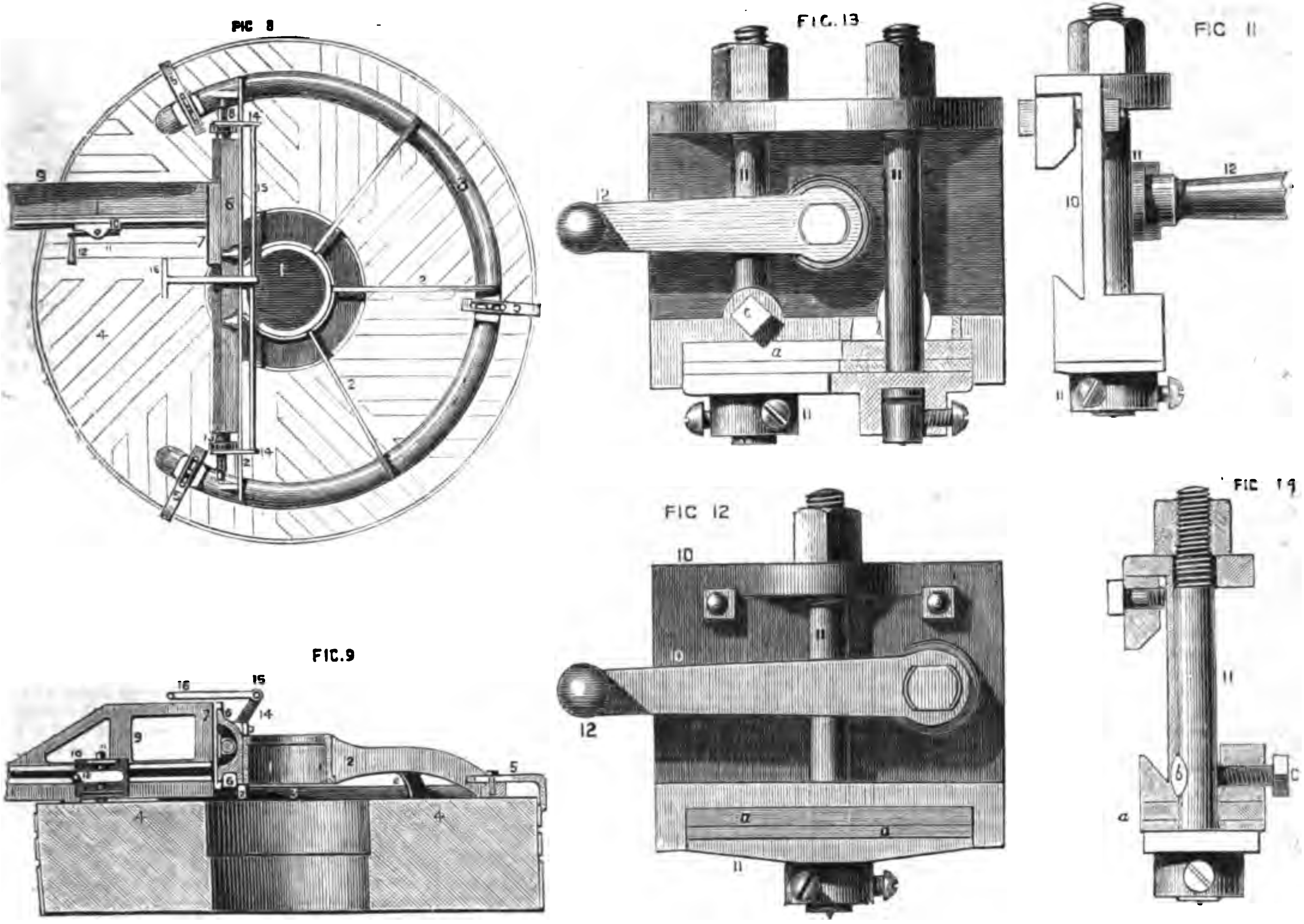
* Extracted from a compilation by Mr. H. J. Brown, Editor of the *American Artisan*.



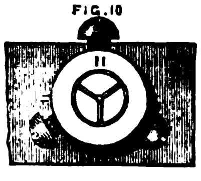
DRESSING MILLSTONES WITH THE DIAMOND OR "BORT."

struction the bort can be gripped in any position by the steel bits, and the whole can be turned in the socket so as to present the cutting angle of the bort in the most advantageous manner. One or two pieces of vulcanised rubber *a* are applied between the bottom cross plate of the tool 11, and the slide 10, and may be more or less compressed to modify the elasticity of the tool by means of the screw nut which holds the tool in the slide. A handle 12, is jointed upon the slide 10, and by means of it the operator draws the slide along the guide arm 9, and so causes the bort to cut a minute groove on the surface of the millstone. The dressing for one sector of the millstone surface is done with the frame 1 2 3, in one position, the arm 9, being shifted or fed across after the formation of each groove by means of the screw spindle 8. Toothed feed wheels 13, are fixed on the ends of the screw spindle 8, and are acted upon by feed catches jointed to levers 14, set loosely on the spindle and connected by means of a horizontal rod 15, above. A handle 16, is set loosely on the rod 15, so that it can be moved into the most convenient position for the operator, who works the tool slide 10, with one hand, and the feed handle 16, with the other. The feed may be effected either when the slide 10, is at the inner end of its traverse, or when it is at the outer end thereof, the bort being moved in both directions along each groove; or the feed may be effected both when the slide is at the inner end and when it is at the outer end of its traverse, in which case the bort will be moved only once along each groove. When the dressing of one sector of the millstone surface is completed the entire machine is shifted round, to bring the arm 9, parallel to the grooves of the next sector.

Two borts with their holders may be carried on the slide 10, as shown in Fig. 14; and this modification may be used when a deeper cut is required than that which a single bort will give, one of the two borts being adjusted slightly lower than the other. When applying two tools in this way the spindles are fitted somewhat loosely into the slide 10, and small cushions *b* of vulcanised rubber are placed behind them, whilst small pinching screws *c* are inserted in front, and by turning these more or less the two bort points can be adjusted so as to cut accurately in the same line. The two tools may also be adjusted to cut in two separate lines if preferred.

A comparison with Golay's machine will render obvious the superior construction of Young's, its remarkable simplicity, and its freedom from various drawbacks associated with the earlier machines. The dress or cracking which Young's puts into the millstone, consisting of straight horizontal cuts, is cleaner and neater, and has not the ragged or fractured appearance caused by the chipping action of the rotating tool. It is especially superior in indicating and discovering any inequality or want of truth in the grinding surface, doing this with a precision and accuracy not hitherto attained, and which necessarily arises from the machine being formed with a turned bearing ring, which rests on a large portion of the millstone surface near the outer edge. This is confirmed in practice by the machine discovering many imperfections of surface which the proving staff allows to escape notice. Requiring no driving power, it can be worked whether the mill is running or standing. It requires no gearing whatever, and is much less dependent on individual skill, as it can be actuated by a lad or inexperienced workman. It cannot get out of order. It dresses the stone in less time than Golay's, and, as compared with ordinary handwork, requires the service of fewer stonemen. Immediately that the stone is set to work after being re-dressed, it grinds perfectly, making much fewer flour sharps, or middlings, and, in consequence, a larger proportion of fine flour. The bran is broader and better cleaned, and the flour of purer colour and more regular. The amount of feed, or rate of grinding, is not decreased; whilst, in consequence of the ease and rapidity with which the operation can now be effected, the millstones are sometimes re-dressed after running four days and nights. This more frequent re-dressing is found advantageous where the mixture of wheat is soft and tough, but where it is dry the stones are re-dressed only after running six days and nights. When the stones are lifted for re-dressing they are found to be in perfect trim, having a beautiful straight level face, and with much of the former dressing still clear and distinct. One miller using Mr. Young's machine found, on a careful comparison with the results of the ordinary handbill dressing, that out of every hundred boll of wheat (1 boll = 240lb.) he obtained a bag and a-half, equal to 420lb., more fine flour, with proportionally less seconds.

FIG. 10



A great variety of millstone dressing machines have been brought out and patented since those to which we have referred, but they are all comprised in the "rotatory" and "rectilinear" classes, of which Golay's and Young's are respectively the chief representatives; and they differ amongst each other mainly as regards minor details, a critical comparison of which would not only be tedious and uninteresting, but it is also incapable of being satisfactorily made at present on account of the small experience as yet had with most of them.

Naturally, where several patented machines for the same purpose compete, questions must arise as to the novelty and validity of each, and as to whether the more recent are infringements of the earlier patents. The main competition is practically between the two most successful machines, Golay's and Young's; and we believe that the great hindrance to the more general adoption of one or other of these machines has been the doubt whether Golay's patent is valid, and whether Young's machine, as has been openly asserted by persons interested in Golay's patent, is an infringement of it. At the same time many of the most extensive millers in the United Kingdom have adopted one or other of the machines, convinced of the great superiority of the dress over hand dress. As regards the diamond itself, Golay does not claim to use the diamond except when acting with rapid blows, and clearly could not validly claim the plain, continuous, rectilinear cut of the diamond in face of the earlier patents of Childs and Knight; whilst as both Young and Golay are obliged to use bort instead of the common clear diamond, it is plain neither of them is clear of Jobin's patent. As regards the necessary apparatus, Young's only resembles Golay's in having a horizontal guide and slide with a screw feed motion at right angles thereto; but in this respect both Golay's and Young's resemble Morisseau's, whilst Young's arrangement is in fact more like Morisseau's than it is like Golay's. We will not take upon us to certify how the lawyers will decide the questions, but they appear to us very simple ones, and plain common sense answers to them sufficiently obvious.

We have applied the term "bort" to the substance now used for dressing millstones, as being the best and most distinctive appellation without coining a new word; it is, however, also used to designate the impure fragments and excrescences which are removed from the rough diamond in the process of cutting, and which are not so hard or suitable as the stones originally found in a detached state.

The End.

CAPTAIN PETERSON'S STEAM LIFE-BOAT.

It is said the invention of C. W. Peterson, of No. 7, Oakley-crescent, City-road, London, for the application of steam power to lifeboats, is destined to effect an important improvement in our lifeboat system, and consequently to increase very considerably the means at our disposal for saving life at sea. The Committee of the Shipwrecked Mariners' Society, after examining the models and drawings of the invention, have expressed themselves pleased with it, and are anxious that it should have an adequate trial. Captain Peterson is confident that his boat will be able to put to sea in all weathers, and that, if upset, it will instantly right itself without losing its motive power. The advantage it will possess, both in respect to increased speed and power, over the lifeboats now in use must, of course, be self-evident, but the great thing is to put the invention to the test. The cost of building a trial boat will be about £600 or £700, towards which the Committee of Lloyd's have subscribed £50, the Salvage Institution in £52 10s., the Shipwrecked Mariners' Society, £50, the Royal National Lifeboat Institution £100, Miss Burdett Coutts £100 and about £50 has been contributed by merchants and others, making altogether upwards of £400. The names here mentioned as subscribers afford a guarantee for the practicability of the proposal, and we trust their liberality will at once be supplemented to such an extent as to insure the complete realisation of Captain Peterson's intentions. The object is one of such national importance that it ought to command universal sympathy and support, and to be received with special favour and interest by maritime communities directly concerned in the welfare and safety of our seamen. This being so, Captain Peterson may reasonably expect such an amount of assistance—and that, too, within a very short time—as will enable him to put his invention to the test.

We should like to know what Mr. Lewis, the zealous Secretary of the Royal Lifeboat Institution, or any one else who has paid attention to the subject, has to say about these lifeboats. If the thing be practicable, we see no reason why the English Mechanic Lifeboat should not be propelled on its beneficial errands by steam.

POPULAR FOOD ANALYSIS.—COCOA.*

(*Continued from page* 175.)

Let us see how far this dreadful programme is in reality carried out nowadays, by glancing at the following results of our analysis. But before doing so, we will explain the simple process we have adopted for obtaining our results. The mode of procedure does not pretend to absolute accuracy to a fraction, but will be found in practice easily performed and understood. It is as follows:—

1. Twenty grains of the cocoa are weighed out and dried for some hours at a steam heat. The dry cocoa is then weighed, and the loss of weight, multiplied by 5, gives the moisture,

2. The residue (from 1) is digested for two hours, with frequent agitation, in four ounces of ether, and the latter having been poured off as closely as possible, the cocoa is again dried, weighed, and the loss of weight ascertained and calculated as above. The loss equals fatty matters.

3. The residue (from 2) is digested for six hours in ten ounces of cold water, and again dried and weighed as before. This loss represents sugar, theobromine, and other soluble constituents; and it is evident that if sugar of adulteration be present, the loss of weight will be greatly increased.

4. The residue (from 3) is boiled for an hour in ten ounces of water, to which half an ounce of hydrochloric acid has been added, and once more dried and weighed. The loss in this case consists of starch, cocoa red, &c., and here the starch which has been purposely added is discovered.

5. A few grains of the cocoa are burned on a crucible lid, and the colour of the ash is observed. If this be decidedly red, then ochre or some such colouring matter has been employed.

As we have already remarked, although the process cannot pretend to absolute truth, yet a very close approximation can be thus obtained, especially if samples of pure cocoa be first treated in an exactly similar manner. This we have done and the following results represent an average of several such experiments:—

Moisture	4·5
Soluble in ether (fat) ...	48·5
Soluble in water (sugar, &c.)	11·8
Soluble in acid (starch, &c.)	18·8
Residue insoluble (cellulose, &c.)	16·4
	100·0

The colour of the ash was a light grey, and no foreign starch was visible under the microscope. With this explanation we proceed to the

Analysis of Thirty-one Samples of Cocoa.

No	Moisture.	Soluble in Ether (Fat).	Soluble in Cold Water (Sugar &c.)	Soluble in Acid, Starch &c.	Insoluble (Cellulose, &c.)	Colour of Ash.	Nature of Chief Foreign Starch, by Microscope.
1	4·6	53·2	20·5	15·0	6·7	Grey.	None
2	3·2	53·6	9·7	22·6	10·6	"	"
3	4·2	46·9	22·7	14·2	11·8	"	A little Arrowroot.
4	3·4	40·5	18·6	28.0	9·3	"	"
5	5·4	26·2	34·5	24·8	9·0	"	Sago.
6	6·4	20·0	38·6	29·0	5·9	"	"
8	4·8	24·9	38·5	20 4	11·0	"	Arrowroot.
9	5·6	34 0	20·0	23·6	18·0	"	Sago.
10	4·5	26·6	33·3	28·6	6·8	"	Arrowroot (large).
11	4·1	31·5	16·6	25·7	22·0	"	None.
12	5·6	32·4	20·3	20 9	20·8	"	Almost none.
14	11·2	20·6	47·0	10·0	10·9	"	None.
15	4·5	27·1	35·2	25·9	7·2	"	Arrowroot.
16	5·0	21·0	38·0	30·0	6 0	"	"
17	4·8	29·4	28·9	28·9	7·9	"	"
18	6·0	20·2	42·3	24 8	6 6	Red.	"
19	5·7	17·4	68·4	1·9	6·4	"	"
20	9·5	8·0	39·5	39 5	4·0	"	Sago.
21	5·1	48·2	11·8	18·6	16·7	Grey.	None.
22	7·1	11·6	38·8	37·0	5·1	"	Sago.
23	10·4	11·9	26·2	42·1	9·2	"	"
24	7·0	14·7	33·4	39·5	5·3	"	"
25	6·1	13·9	38·9	34·2	6·6	"	"
26	6·2	14·9	44·6	28·2	5·9	"	"
27	4·3	16 8	44·3	20·8	13·3	"	"
28	5 0	16·8	41·3	29 8	6·6	"	Arrowroot.
29	7·5	11·2	36·0	41·0	4·9	"	"
30	5·9	16·2	41·0	30·0	6·8	"	Sago.
32	4·0	12·7	24·7	54·5	4·0	"	Arrowroot.
33	10 4	14·6	22·0	48 4	4·6	Red.	Sago.
34	5·0	43·2	10·8	20·0	21·0	Grey.	None.

It will thus be seen that, out of all the samples examined, the only one which answers to the analysis of pure decorticated cocoa is No. 21. Nos. 2 and 34 are, however, also good samples of cocoa, while Nos. 11 and 12 must be noted as specimens of pure cocoa deprived of its oil. No. 1 is a pure cocoa to which desiccated milk has been added, thereby slightly increasing the fat and sugar. The worst of all are Nos. 18, 19, 20, and 33, in which not only is the quantity of real cocoa reduced to a minimum, but ochre, or some such ferruginous earth, has been added for colouring. On the whole, the picture is one not calculated to reassure the the cocoa-consuming portion of the public. We append recipes for the manufacture of cocoas which would be similar to three of the most adulterated samples:—

Cocoa...	100lb.	... 100lb.	... 100lb.
Sugar...	40lb.	... 36lb.	... 87lb.
Starch...	15lb.	... 30lb.	... 30lb.
Water...	—	... 6pt.	... 7pt.
Ochre, or some such earth.	—	... a little	... a little.

The addition of water would be unnecessary if nice damp raw sugar were used in slightly increased quantity. By following these recipes, our readers who like "soft tasting cocoa" (as we heard a lady call her favourite manufacture the other day) can make their own composition much more cheaply than they can buy a packet of the "genuine" article they use at present.

Now we are brought face to face with the question: Ought this addition of starch and sugar to cocoa to be regarded as an adulteration? If, on the one hand, we take the word adulteration to mean the mixing of anything hurtful or deleterious with an article of food, the answer must be in the negative, because not only is the starch harmless, but it supplies a want in the article itself, besides diluting its rich and somewhat dyspectic qualities. Indeed, this admixture has been regarded by an eminent food authority, as "a skilful chemical adjustment, made without chemical knowledge, as the result of long and wide experience." But, on the other hand, if we take adulteration to mean the mixing of anything (even if it should be beneficial) with an article of diet, without distinctly setting forth the fact, the present style of cocoa manufacture becomes a sophistication. With the greatest desire to let this matter down gently, as we have no wish to hold almost all the cocoa manufacturers in England up to public reprobation as sophisticators, we cannot escape the fact that many *prepared* cocoas are advertised as "genuine," nor can we help harbouring a shrewd doubt, that the comparative prices of cocoa and starch had much more to do with the "skilful chemical adjustment," than a real desire to benefit the public. We should advise the many respectable firms engaged in the cocoa trade to call their cocoas plainly and distinctly *prepared cocoas*, or by some such term as would convey the true impression of their nature. This would be very much more sensible then denominating them "genuine," "soluble," or "homœopathic," &c., when all the connection they have with solubility simply consists in the amount of soluble matter added as a diluent, and with homœopathy in the small amount of real cocoa which they give at a dose. In a word, we are once more brought back to the necessity for an "Adulteration Act," such as we have all along steadily advocated—namely, a law to compel everything to be sold under its own name, with proper officers to see the Act carried out; but to hope for such a thing under the present *regime*, seems almost Utopian; and we have no resource but to follow the dictum of an eminent statesman, and to "agitate and agitate."

In our next article we will conclude the subject by giving directions, illustrated by engravings, for the detection of adulterations of cocoa, by means of the microscope.

THE PATENT LAWS.

A SHORT time since a meeting of the Manchester Patent Law Reform Association was held, Sir William Fairbairn in the chair, when the following petition to Parliament was discussed and adopted:—

"That your petitioners being persons engaged in various branches of industry and commerce in the city of Manchester and the surrounding district, formed themselves, with others, in 1850 into an association for procuring a reform of the patent laws as then existing and administered, the evils of which and the remedies therefor, they set forth in memorials to the Board of Trade and petitions to Parliament in 1850, 1851, and 1852, and, after incessant labour and expense, were the principal means of obtaining the Patent Law Amendment Act of 1852. That Act, although it did not adopt all the recommendations of your petitioners, provided remedies for some of the then existing evils, such as granting immediate protection to inventors on application, a large reduction in the amount of fees paid for obtaining letters patent, and the publication of all specifications and indexes thereto; but it left untouched many of the evils for which your petitioners pointed out remedies, which had they then been provided for, would have satisfied the public and prevented the unreasonable outcry now raised for the entire abolition of the present patent laws. That your petitioners are fully of opinion that the fees may be considerably reduced, as they consider the cost of obtaining letters patent should not exceed what is absolutely necessary for the maintenance of the Patent Office and printing the specifications and indexes. That your petitioners, fully sensible of the advantages of a well-devised patent law, are decidedly of opinion that any attempt to abolish these laws would prove not only highly injurious to the best interests of the country, and destructive to the inventive powers of the nation, but would ultimately destroy the high position this country has attained in the prosecution of the useful and industrial arts. That your petitioners have invariably protested against the abolition of these laws, as being suicidal and unjust to the nation, both as regards the protection of property in patents, and the mental acquirements of the honest inventor. That your petitioners sensibly impressed with these views, humbly request that your honourable House will confirm by law the following recommendations, and rectify such other abuses as have been found detrimental to the working of the patent laws.

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* By J. Muter, Ph.D., in the *Food Journal*.

"1. That scientific assessors be appointed to represent mechanical, chemical, and natural science, to assist the judges and law officers of the Crown in deciding patent cases, oppositions, and infringements, so as to render their decisions more certain and in unison with each other, and thereby prevent litigation and uncertainty. 2. That the said assessors be assisted by a competent staff of examiners to report on the novelty of all applications for letters patent, and thus prevent a number of patents being granted for the same invention. 3. That the present system of provisional specifications and six months' protection to be abolished, and in the place thereof a system of registration be adopted at a trifling cost, giving a more extended time, say twelve months, or perfecting inventions before application is made for letters patent, and during the twelve months the inventor to have the power to amend his registration if he finds it necessary. 4. That letters patent shall continue in force, by the payment of an annual tax, for 15 years from the date of the first registration. 5. That a fine be imposed upon any person selling or exposing for sale any article as patented when it is not so, and that the date and number of the patent be affixed to all articles sold as patented where practicable; this would prevent many frauds being practised on the public. 6. That a special judge be appointed for the trial of patent cases, and that on such trials the judge be assisted by the assessors, and all questions of fact, as well as of law, be decided by a judge without a jury. 7. That patents ought not to be granted to importers of foreign inventions. 8. That the granting of licenses shall be compulsory under the approval of the assessors. 9. That the Lord Chancellor shall not be limited to one month only for sealing a patent after the proper time in cases of opposition, and also that he should have power to extend the time for the payment of subsequent taxes in cases of accident or extreme necessity."

USEFUL AND SCIENTIFIC NOTES.

ARTIFICIAL PRODUCTION OF ICE IN INDIA.—Dr. Janssen relates that, in many parts of the Indian Continent, the natives dig shallow pits in such localities which are quite freely open to the sky, and distant from trees. The pits are lined with straw, and upon the straw are placed dishes (made of a very porous earthenware) filled with water. During the calm and clear nights prevailing during the period from November to the end of February, the water placed in the dishes freezes, yielding a solid cake of ice, while the temperature of the air is + 10°. Dr. Janssen has investigated this curious subject experimentally, and has found that the freezing is principally due to the radiation during the night; but the evaporation of the water, aided by the porosity of the earthenware employed, is not to be overlooked, at the same time.

MACHINE FOR PEELING POTATOES.—The Rev. Liévin Bouteca.—The author (Director of the Convent of St. Joseph-de-Notre-Dame-de-la-Trappe, at Forges (Hainaut, Belgium), has contrived a machine, by the aid of which one man can peel, without very hard work, from 250 to 450 kilos. of potatoes in a hour's time. After the tubers have been first roughly washed, they are placed in a cylinder pierced with holes in such a manner as to form a rasp; the bottom of this cylinder is made movable, and also pierced with holes, as just stated. Motion is imparted to the bottom of the cylinder by suitable means; and, by this means, the potatoes, by the friction against each other and the rasps, are rapidly peeled, while a jet of water is at the same time applied to wash the peelings down.

GOLD COINS.—These were first issued in France by Clovis, A.D. 489. About the same time they were issued in Spain, by Amabric, the Gothic king. In both countries they were called *trienties*. They were first issued in England in 1257, in the shape of a penny, of the value of 20d.; only two specimens have come down to us. Florins were next issued, in 1344, of the value of 6s. The noble followed next, of the value of 6s 8d.; being stamped with a rose, it was called the rose noble. Angels, of the same value as the latter, were issued in 1465. The royal followed next, in 1466, of the value of 10s. Then came the sovereign of 20s., in 1489. The gold crown, of the value of 10s., followed in 1527. Unites and lions were issued in 1603, and exurgats in 1634. The guinea was first issued in 1663, of Guinea gold. In 1733, all the gold coins (except the guinea) were called in, and forbidden to circulate. The present sovereign was first issued in 1817. The American half-eagle was first issued in 1793.

LETTERS TO THE EDITOR.

[We do not hold ourselves responsible for the opinions of our correspondents. The EDITOR respectfully requests that all communications should be drawn up as briefly as possible.]

*** All communications should be addressed to the EDITOR of the ENGLISH MECHANIC, 31, Tavistock-street, Covent Garden, W.C.

All cheques and Post Office Orders to be made payable to J. PASSMORE EDWARDS.

I would have every one write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that, as to other things, knows no more than what everybody does, and yet to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks: a vice from whence great inconveniences derive their original.—*Montaigne's Essays.*

DE OMNIBUS REBUS CÆLESTIBUS—ET QUIBUSDAM ALIIS.

SIR,—My knowledge of the views of Mr. Williams with reference to "the Fuel of the Sun" is wholly derived from the letter of "The Harmonious Blacksmith" on p. 160. Judging from the précis of the work there contained, I should say that it consisted of a little Laplace, a trifle of Mayer some Proctor, and a good deal of Sir William Thomson; the whole simmered together and (as the Cookery books say) "served up hot" with Williams.

It is extremely hard to pronounce any opinion upon an hypothesis—or rather upon hypotheses—coming before one in such a form; but certainly a difficulty or two suggests itself to my mind in perusing the abstract of Mr. W.'s book which "The Harmonius Blacksmith" has made. And firstly, it is perfectly easy to conceive that the attractive power of the Sun should cause the descent on to his surface of any amount of cosmical matter (call such matter planetoids, aërolites, or what you will) which comes within the sphere of such attraction. The mass of the body or bodies so attracted, being assumed or known, and their velocity on reaching the Sun's surface, also determined, the amount of heat generated by their impact becomes a matter of relatively simple calculation. Well, but then, how does the Sun "*leave behind him*," what is termed in Mr. W.'s book, his "Exhausted fuel?" Confining ourselves to one single fragment of this effete matter, say a globe of 1ft. in diameter, can we conceive any force which is capable of projecting it vertically from the surface of the Sun (whose mass is, bear in mind, some 317,000 times that of the Earth) to a sufficient height to place it sensibly beyond his attractive power? Were such globe shot off tangentially, one of two things must happen, dependent upon the ratio between the force of propulsion and that of gravitation. Either our assumed particle would describe a parabola, and fall on to the Sun's Surface again; or, if it were projected with sufficient velocity to carry it once round the globe of the Sun, it would go on describing that orbit *ad inifinitum*—or until some fresh force came into operation to deflect it from it. At all events it would become permanently attached to the Sun, either as a part of his own Globe, or as a body circulating round him. This is my difficulty about the "leaving behind" hypothesis. Then, again, I confess, that, in common with "The Harmonious Blacksmith," I utterly fail to see why the Sun should be held to be the parent of the Asteroids, and only, so to speak, the father-in-law of the other members of the system of which he is the great centre. (Here we lose the flavour of Laplace, and detect a very pronounced one of Williams.) Nay, I go farther than your correspondent; and would ask, why, if we assume the various planets to be portions of the primal matter of our system; and, to use a very homely simile, flirted off the Sun during his original process of condensation from nebulous matter, like water off a mop; why, I say, may we not credit the various planets with the production of their respective satellites in the same way? There is certainly nothing in observed appearances to militate against this idea.

Then again the invitation to believe in the existence of "aqueous vapour, &c.," in "interplanetary space" seems to make an extraordinary demand on our credulity. Certainly its tension cannot be very great with a temperature according to Hopkins of—37°·3 Fahrenheit, and of Fourier of—59° Fahrenheit! It is, however, a little idle to argue on a large proportion of such assertions as Mr. Williams's books appears to contain, for the simple reason that they are neither susceptible of proof nor disproof. If a man were to tell me that the inhabitants of Mars had nothing to read but "Tupper's Proverbial Philosophy," I could not contradict him. I could obviously only answer that, *if so*, I pitied them from the bottom of my heart.

I am rather afraid that there is no single work containing the information asked for by Mr. D. Jenkins (2659) p. 166, in an available form. Denison's capital book, "Astronomy without Mathematics," has a table of the data Mr. J. requires; but this does not include the elements of the individual asteroids. It is a 4s. book published by the Christian Knowledge Society. "Loomis's Treatise on Astronomy," another most interesting book, published (at, I think, about 8s.) by Harper Brothers, of New York, contains somewhat extensive tables of the elements of Solar system, including ninety of the planetoids; but, wherever quantities are given in *miles*, they are calculated on the old, and certainly erroneous, Solar parallax of of 8"·58. It has, by-the-bye, just struck me as possible that Mr. J. Norman Lockyer's "Elementary Lessons in Astronomy," price 5s. 6d., Macmillan and Co., will be found to have what your correspondent wants, in it; but as I do not possess the book itself, I cannot assert positively that it does so.

I need only refer "R. P. D.," (p. 186), to p. 159.

I may tell "Secundum Naturam," that on the 20th of May, Saturn is on the N. W. boundary of Sagittarius; and Mars in Aries. Uranus is still in Gemini, but will move into the confines of Cancer towards the Autumn.

With regard to the queries of "H. A. C." (p. 190), I do not believe that anyone has yet picked up D'Arrest's Comet; or, at all events, has made any announcement of having done so. *If* it be visible, it is the only one, great or small, in the night sky at this present writing. In the Supplement to the "Nautical Almanac" will be found Ephemerides of Ceres, Pallas, Juno, Vesta and Astræa for every tenth day during the year; and during certain months for every second day at Transit. Your correspondent's query as to the apparent diameter of the various members of the Solar system in inches, is a really senseless one. Accepting, however, with the ordinary works on Optics, 10in. as the standard of distinct vision, all he has to do is to take out the tangents of the angular diameters from a table of Natural Tangents, and multiply these by 10. For example, suppose the Sun's apparent diameter to be 32', what is its apparent size in inches? Turning to our table we find the Natural tangent of 32' to be ·0093087, of the radius, whatever that may be, and multiplying this by 10, we shall at once obtain this result, that the Sun is apparently ·093in. in diameter. So that if we cut out a little disc of paper 0·1in. in diameter, and place it 10in. from the eye it will just cover the Sun. Venus at present, measured in the same way, will appear only ·00007in. across; and so on. All this, nevertheless, as I pointed out in answering a cognate question some two or three weeks ago, has little or no meaning, but it is the only reply of which "H. A. C's" demand is susceptible.

"Salopian" (3749), same page, appears to be a little vague in his notions as to the centrifugal tendency of bodies on the Earth's surface. The centrifugal "force" (as it is called) varies as the square of the velocity of the body, and in the inverse ratio of the distance from the centre. At the earth's equator this is by no means an inappreciable quantity; as a very little reflection will show that while a man standing on one of the Earth's poles had merely turned once round, another on the equator will have flown through some 25,000 miles. As every particle at the equator, then, is travelling round at the rate of more than 1000 miles an hour, this effect becomes very appreciable; in fact a body transferred from the pole to the equator loses something like $\left(\frac{1}{17}\right)^2$ or $\frac{1}{289}$ part of its weight from this cause alone. If we assume the Earth, then, to have been in a plastic state it is easy to see how it would be, so to speak, squeezed out where the pressure was least. Were the rotation of our globe to increase about seventeen fold, everything merely resting on its surface at the equator, would fly off.

A FELLOW OF THE ROYAL ASTRONOMICAL SOCIETY.

THE TELESCOPE.

SIR,—It happened that some time since, two different friends whom I recommended to go to Slater, of 136, Euston-road, London, each complained to me that he could get nothing whatever done by that optician; and that he had written and waited, waited and written for what he had ordered, ineffectually, and in vain. Speaking, then, of Slater, on p. 130, I applied the epithet "dilatory" to him. I have just learned from one of the gentlemen referred to, that he now finds out that Slater was seriously ill at the time of which I have spoken. This being the case, I feel that I was scarcely justified in using the word I did, to describe a man who was, as it now seems, sick, and physically incapacitated at the time from doing any work; the more especially as I never saw Slater in my life, nor have ever had any communication, oral or literal, with him. Without, then, waiting for any disclaimer on his part, I will ask my querist, Mr. Baguley, to erase the words "were he a little less dilatory," as applied to Slater, and to read the sentence in which they occur straight on without them.

"Ignoramus 2" (2658), p. 166, can have an object glass of longer focus, and consequently higher magnifying powers adapted to his present telescope; but this will involve a corresponding lengthening of the tube. "The other glasses in the inside" form the eyepiece, and could be used with *any* object glass.

As "Neptune" gave no data whatever for the computation of the curves of his object glass, save the focus of his crown lens, and that of the whole combination, I regarded Mr. Vivian's reply as an absurd one; and (believing that, like many other people, he thought that he had nothing to do but to take out the quantities by inspection from Herschel's table) attempted, not very dexterously I must admit, to "chaff" him. I see, however, by his letter on p. 182, that he really does know something of the subject, and must express my regret for having done so. If Mr. Vivian after this admission will condescend to take my advice, though, I would commend Coddington's formulæ to him in preference to Herschel's, as being, I think, more manageable. Mr. V. is probably familiar with the "Treatise on the Reflection and Refraction of Light." It was published at Cambridge some forty years ago. I am a little amused at your correspondent's idea that because a man, of necessity, has a good many "rather long computations" to make, it is only reasonable to expect him voluntarily to undertake more.

I may just tell Mr. Baguley, p. 185, that his resolution of γ Virginus with the power he specifies does not prove much one way or another.

Mr. S. T. Preston, p. 185, apparently proceeds on the assumption that all opera glasses give a power of two diameters only; an assertion to which (with a glass magnifying four diameters now before me) I demur. Of course, in the Galilean telescope, the distance between the glasses is the difference of their focal lengths, and the magnifying power is obviously the ratio of these focal lengths; so that the focus of the eye glass enters as an element into the calculation. The shorter such focus is, the farther from the object glass will the lens be placed, and the narrower consequently that part of the cone of rays from the objective which it intercepts. Nevertheless, your correspondent is perfectly correct in his assertion that their is a practically useful limit, very soon reached, to the aperture of the Galilean form of instrument.

At the request of Mr. R. G. Anderson (3712), p. 180, I have turned back to the volume and page of our magazine which he specifies, and can only say that his method appears to me to be capable of affording results at least as correct as those obtained by the method of measuring courses of bricks, &c., and that where, as in his first case, an image of the whole solar disc could be made to coincide accurately with a circle of known diameter, at a carefully determined distance from the place where the rays from the object glass cross, I should expect to obtain a very good determination. In his second more complicated case, I should not be quite so hopeful of the ultimate *practical* result.

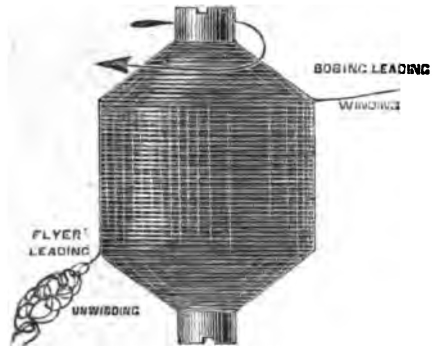
Myself a mere Amateur, I should prefer that some working optician should answer "Dioptrics" (3713), p. 189, but I may just say that I never in my life heard of grinding a lens on a *glass* tool. In the case of my sole attempt in object glass making, I first computed the curves, and then made my own *brass* tools in the lathe. These latter were about half an inch greater in diameter than my intended lens. I do not think that iron would come up to a sufficiently fine surface. I can get quite a semi-polish on a lens by the aid of fine flour emery alone, and the brass tool itself, and when it has arrived at this stage it may be transferred straight to the polisher. I was once told, as a great favour, that Alpaca was the best material to construct the polisher of. Putty powder and rouge are the polishing materials.

—I may tell "H. A. C." (3571), p. 190, that I rather question the power of an 8·5in. reflector to divide μ^1 Boötis at all just now, if Secchi's last measures of it are to be trusted; but that, as soon as the distance of the components exceeds 0″·5, any power over 200 ought to divorce them. I must add that I have not looked at this star for a long time with any instrument which has a ghost of a chance of separating, or even elongating it, and that therefore my reply is a purely theoretical one.

A FELLOW OF THE ROYAL ASTRONOMICAL SOCIETY.

COTTON SPINNING.

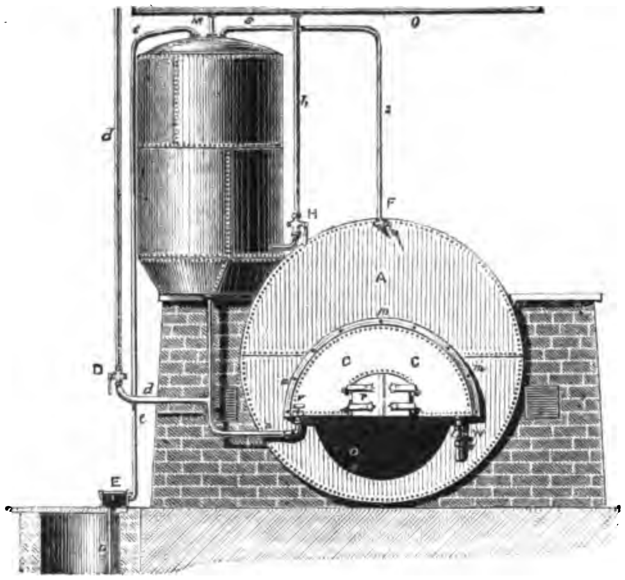
SIR,—Your correspondent, E. Halmshaw, page 183, asks a very reasonable question, when, in reply to "B. W, R.," he asks the object of some jack frames being made for the bobbin to lead, and others for the flyer to lead, if it is immaterial. The result of the bobbin leading has not any effect on the thread, as E. Halmsley supposes. Having frames of both kinds, I will just state my experience with them, and my brother Cottonians can draw their own conclusions. The advantage arising from the bobbin leading, can soon be proved as follows. Break down an end from two frames, one of each kind, and let the frames continue running, and you will find the frame where the flyer leads, making the roving into waste, whereas the frame where the bobbins lead, will not make any waste at all; to those that have not the means to try this practical test, the enclosed sketch will explain all that is required. So much for the advantage. Of course there may be more, and perhaps even greater advantages than this, but if there is, unprejudiced trials and close observance, have failed to make them known to me. Now for the *dis*advantages. 1st. You can drive your frame at a greater speed when the flyer leads. If there is any doubt about it, let anyone try to start a frame with the bobbins leading, and the spindles running 900 per minute. 2nd. It is evident that to run any part of a machine faster than is required, and only get the same weight made that you would if you run it slower, is a disadvantage. Extra wear, tear, power, and oil, are the results. 3rd. The "tenter" has to use her left hand in piecing the ends up. This is the sum and substance of my experience—I prefer the "horse before the cart," or the flyers to lead. Can any of your correspondents furnish me with a recipe for making size for the bottom of cops? I have tried several different mixtures, but I cannot get anything to act to my fancy. I shall be glad to receive any reply.



HARMONIOUS COTTON SPINNER.

SIR,—I am greatly obliged to E. Slater for his explanation of the weights used in cotton spinning. I have been very much puzzled with a roving table, in Alexander Kennedy's "Cotton Spinner," second edition, page 118, and by it I have been misled. I also feel obliged for the very good explanation of the cone, and the sun and planet motion. I am sure your paper must circulate in Lancashire, if you can get such correspondents to continue their labours. I am very anxious to understand the baking off motion of a self-acting mule, and also the operation of the cam shaft. I find when the carriage is at full stretch, the rim pulley reverses about a quarter round, but I cannot find the moving power or connection with the driving pulley. Will some one explain them?

EDWARD HABERGHAM.



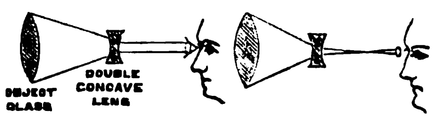
STEAM BOILER FEEDING.

SIR,—As a conciliate between me and several of my brother readers respecting a system of feeding steam boilers without the use of pumps, &c., illustrated on page 506, No. 254, Vol. 10, I beg that you will kindly afford a little of your valuable space to describe a system which I have gone to the pains and expense of proving, that a boiler may feed itself out of a well or tank even 16ft. deep, by simply shutting and opening one cock, instead of using regularly four for the purpose of feeding one boiler, as previously described by me, and six as described by Messrs. Shand and Mason; and that one cock is simply a ¾in. steam-cock. A shows the end of a 20-horse boiler, 6ft. in diameter. B shows the feeding vessel or bottle, set on the boiler wall, and shaped at each end as seen, well made; and C C is the fire-front, made of the same plate iron as the boiler into a water case around the door entrance *r*, 6in. wide inside. The vessel B is 2ft. 9in. diameter, and 5ft. 6in. high. *s s* is the ¾in. steam pipe, with cock at F, which pipe enters the top of the vessel. *e e a* is the suction pipe from the bottom of the well or tank into the top of the vessel, 1¼in. size inside, with valve or clack box at E, in which is fixed on the pipe *a* a brass-backed leather clack. *n n* is an inch pipe from the bottom of the vessel into the bottom of the case C C, and W is an inch pipe from the case the other side of the doorway into a low part of the boiler, with a safety cock W. *d d* is an inch branch pipe from the pipe *n* into the cistern O, and the pipe *h* with cock H is a 1¼in. pipe from the bottom of the cistern into a low part of the vessel, and continued inside in a spiral form upwards and out at the top, and again joining into the cistern bottom at M, which cistern must be large enough to hold sufficient to fill the boiler for starting. The boiler, in the first place, after being fixed and filled by some means, the steam being got up, the vessel is blown full by opening the cock F, which is then shut. The steam, on condensing, sucks water up the pipe *a* until by the pipe *e* it reaches the vessel. Then immediate condensation takes place and rapidly sucks up the water, which, when spent, the pipes *a e* keep full by the clack E. The steam having been put on again, the water in the vessel raises the valve V and passes into case C C, where it is heated before entering the boiler by the pipe W. (The cock at W is only to be used should the valve V fail.) When the vessel is empty, the steam will cause a rumbling noise in the heating case. Then shut off the steam. Having raised water into the cistern O by opening the cock D, when forcing the water out of the vessel, the condensation of the high pressure steam may be facilitated by opening the cock H and letting the cold water travel through the spiral pipe in the vessel, the heated rising into the cistern at M, which cock must be shut before putting on the steam. Thus the water is raised and forced into the cistern O or boiler A, before entering which it is heated.

JOHN C. SHEWAN, Pitchcombe Works, near Stroud, Gloucestershire.

TELESCOPE CONSTRUCTION.

SIR,—Many letters appear in your columns on the above subject, but they deal mainly with the mode of working the lenses into form, and mounting them. Will any of your learned contributors tell me if there is any theoretical objection to a telescope made thus:



The object glass of short focus, the rays intercepted before they reach a focus by a double concave lens, of such a curve as to transmit the rays parallel, or very gradually converging, and then a suitable eyepiece, thus?

It appears to me that this construction would obviate the difficulty experienced in grinding object glasses of long foci.

HERBERT.

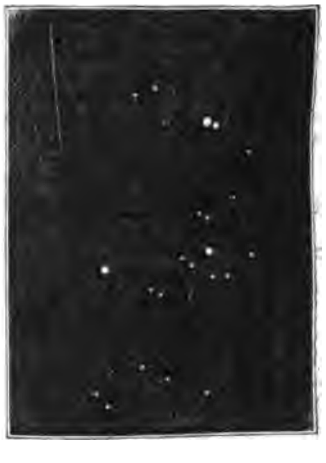
MR. PROCTOR AND MR. DYER.

SIR,—Mr. Proctor says: "Mr. Dyer must be a very young man not to know that 'Parallax' and Co. are merely types of a class which will always exist. Suppose 'Parallax' *does* unsettle the minds of many people who have not studied the subject, what then? It serves them right for leaving the subject unstudied." I think the closing part of this statement ought to have been qualified. It doubtless does serve those persons right who have had opportunities of acquiring the kind of knowledge in question, and have neglected to do so. But Mr. Proctor must be a very young man not to know that there are thousands who have not had such means at their disposal, but who are very anxious to be set right, not only upon the subject of astronomy, but upon other departments of knowledge; and to do so is, I conceive, a duty incumbent upon all those who have time and ability. While I should be one of the first to denounce captious objections and frivolous questions, it would give me pleasure to hear, and, were I able, to answer the objections of the inquirer upon any subject. If it be desirable to enlighten men's minds upon the constitution of the universe by books and lectures, it surely cannot be thought unnecessary to meet the objector, or remove the doubts of the wavering. And for what purpose did Mr. P. write those admirable papers on "The Earth, its Figure and Motions," published in the ENGLISH MECHANIC, but to upset the notions of "Parallax" and Co., and to settle the minds of those whom that gentleman had unsettled? In reading those papers, one could scarcely draw any other conclusion, especially as Mr. P. mentions such persons several times therein.

J. DYER, Brunswick House, Tanner's Hill, New Cross.

ASTRONOMICAL.

SIR,—While on my journey from Aberdeen to Brighton, I stopped at Preston, and had the pleasure of some three hours' work with a Newtonian Equatoreal, made by Mr. James Cook of that town, 10in. aperture, with glass prism, instead of the ordinary silvered plane. There had been a heavy rain during the afternoon, and the ground was quite wet; the telescope was used in the open air, yet there was not the slightest film of dew on the prism. Hence I think that "Hugo," 2592, will not need a dewcap for his Newtonian of 6in. aperture. The air was somewhat unsteady, but the stars were exquisitely brilliant, as the rain had washed all the soot out of the atmosphere. After examining several objects, we turned the instrument on ζ Ursæ Majoris, and made independent sketches of the minute stars between Mizar and Alcor. The sketches were then compared, and the accompanying drawing represents the result of our work. It will be observed that several minute stars, not seen by "F.R.A.S.," are shown in this drawing, also that some given by him are omitted. I do not pretend to explain this except by supposing that we devoted our attention more especially to the right side of the field. The powers used were 90 and 200. If we had been able to compare our sketches with that by "F.R.A.S." at the time, I have no doubt that the omissions would have been supplied.



ARTHUR W. BLACKLOCK, 32, Old Steyne, Brighton.

P.S.—In reply to James Gray, p. 164, I am unable to tell him whether glass discs, suitable for specula, can be obtained in Aberdeen; I do not think they can, but should think that Glasgow was a much more likely place. I will send a description of the method I have adopted for supporting my speculum, but I am not quite satisfied with it at present. As soon as I can get to work with it again, in June or July, I hope to improve it.

IMPROVEMENTS IN GUNPOWDER.

SIR,—The problem how to project shot from great guns with the received velocity without subjecting the gun to dangerous strains, has engaged the attention of artillerists ever since cannon have been in use; but until lately but little progress has been made towards its solution. The ranges have indeed been enormously increased; but this has been done by using high charges of quick-burning powder, and proportionably increasing the strength of guns, rather than by a more gradual evolution of the force which impels the shot.

Ancient artillerists employed slow-burning powder, something like our rocket composition, and when they wanted to increase the range they added to the length of the gun, so that a larger quantity of their powder might be burned and converted into gas before the shot was expelled from its chase. The Egyptian bronze piece, at the Horse Guards, and Queen Elizabeth's Pocket Pistol, at Dover, are examples of the carrying out of this idea, and I doubt not that what in those times were considered long ranges were obtained, for they did the right thing, inasmuch as the pressure of the gases evolved must have gone on increasing, until the shot had travelled a long way towards the muzzle, even if it did not increase until the shot arrived there.

Modern artillerists have done just the contrary thing. Instead of adding to the length—which makes guns extremely unwieldy and inconvenient to load at the muzzle—they added to their thickness, especially at the breach, and employed powder which burned so rapidly that the shot was expelled with the required velocity from a short, heavy gun. So far as regards mere range, one system seems as good as the other, and although I have classed as modern the short, thick guns—whose hinder parts are similarly proportioned to those of the heavy-*sterned* Christians, which the old divine wrote what he termed a *shove* to *expedite* the progress towards future bliss—this must be taken *cum grano salis*, for the bronze gun at Bhurtpore is almost as well proportioned as a modern brass field piece, and, as a specimen of ornamental founder's art, it would be difficult to surpass it, although the casting is far from sound. Its length is 16ft. 4in., diameter at breach, 3ft. 3in.—See Robert Mallet's work "On the Construction of Artillery."

Probably modern artillerists have carried the reinforcement of the breach to its greatest useful extent, and the Dahlgren guns in the American service, which resemble huge soda water bottles in form, are perhaps the strongest cast iron guns yet made, but, as every engineer well knows, there is a practical limit to the additional strength which can be obtained by mere addition to the mass of a gun, for when the diameter is very great, the interior cools so slowly that there is considerable danger of the material giving way under comparatively slight strains, from the fact that the irregular shrinkage tends to separate the inner from the outer parts. Hence the advantage of building up guns in successive layers; and this also enables us to employ tough wrought instead of brittle cast iron.

The repeated failures of heavy cast iron guns induced a 'cute Yankee to revert to the principle of gradual evolution of force, which he carried out by making lateral powder chambers communicating with the chase of the gun. These lateral chambers were charged with powder, and each charge was successively ignited (after the projectile had passed it) on its way towards the muzzle. This is employing many charges of quick-burning powder to do the same work that one large charge of slow-burning powder does equally well without the inconvenience and loss of strength which must result from making and loading many powder chambers. Like slow-burning powder, it prevents the gun from being subjected to sudden destructive strains, but the invention certainly *does not* resemble its inventor in being simple.

Gunpowder being only a mechanical mixture, and unlike gun cotton, and most other explosive substances, a chemical compound, it is not subject to the law of definite proportions in other words, we can use any proportion of; its ingredients we find most suitable for the especial work we want it to do. In addition to the command this fact gives us over the rate of its combustion, we can further modify that rate by varying the size and form of its grains. When reduced to dust it cannot be made to explode at all unless the mass be sufficiently heated for ignition throughout; lighted at the surface it only fizzes, as every schoolboy knows. As we increase the size of its particles, so do we afford more room for flame to be propagated between them, and the more rapidly is the mass burned and converted into gas, which is only saying, in other words, it explodes, for explosion differs from combustion only in the rapidity with which its products are evolved; but this must be taken *cum grano*, for it is obvious that if instead of being made into grains it were in one mass, it could only burn at its surface, and would be very slow burning stuff—we can hardly call such masses powder.

As usual, success is only to be achieved by compromise, and the practical problem is, to find the proper size of the grains so that they shall burn rapidly enough to induce a *constantly-increasing pressure* in the chase of the gun, while the shot travels along it without causing a very sudden and intense pressure before the inertia of the shot is overcome and its motion commenced. When we can make gunpowder which will not only begin to move the shot slowly, but also communicate a sufficiently accelerated velocity to it during its progress towards the muzzle of the gun to expel it at the required velocity, the problem of long ranges from light guns will be solved. From the report of some late experiments at Shoeburyness on different kinds of powder, it is evident that that problem, if not yet quite solved, is near its solution.

THE LITTLE WONDER.

CONSTRUCTED ON FAIRLIE'S DOUBLE ENGINE SYSTEM.

(Described on page 208.)

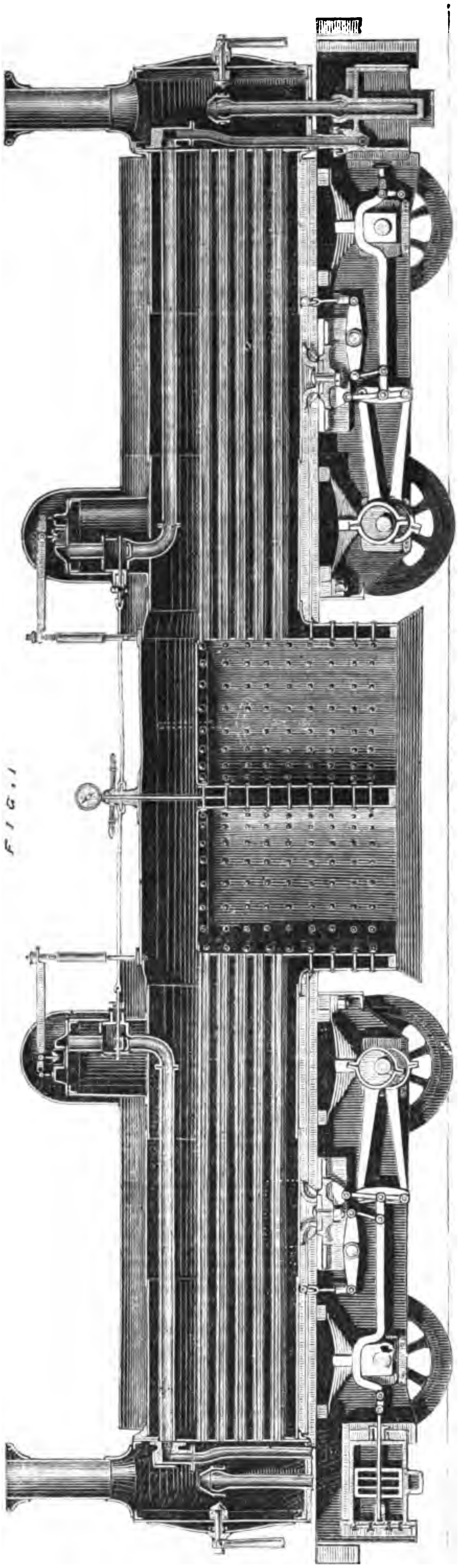


FIG. 1

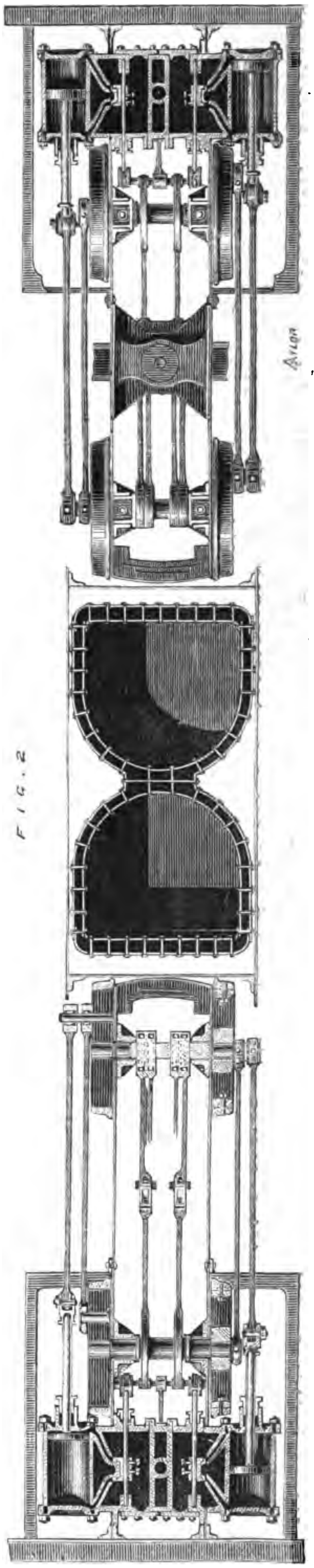


FIG. 2

The range of a projectile, *cæteris paribus*, depends on the velocity with which it leaves the gun, and when the force which impels it is *gradually* increased during its progress along the chase, it would appear that its greatest velocity—*i.e.* that with which it quits the gun, may be greatly increased beyond anything which can safely be obtained when, as usual, the pressure of the gases is greatest before the shot has travelled halfway along the chase. In the latter case, that pressure acts on the shot much as a bow acts on an arrow—*i.e.* it drives it with the greatest force at first, and with a constantly diminishing force until it ceases to act; it *kicks* the projectile instead of impelling it with increasing velocity; but whether it makes the gun *kick* also is doubtful. Probably the total recoil, if less sudden, would be rather greater in amount if the force be evolved gradually, and continually increases in intensity; for, from the same causes which will give a longer range *forward* to the projectile, we may expect a somewhat longer range *backward* of the gun—*i.e.*, increased recoil—for the inertia of its mass would be more gradually overcome, and the force which causes it to recoil continually increase during the passage of the shot along the chase.

When solid steel guns were first introduced, our quick-burning powder almost invariably burst them unless made very massive at the breach; in fact, the evolution of force was so sudden that the surface of the powder chamber was burst from within; the material was disrupted before the strain could be communicated to the outer portions of it, and, for capability of resistance, the outer parts might as well have been absent. It was this "busting up," as the Yankees call it, which induced the Prussian artillerists to decline trying Krupp's solid steel guns with English L.G.R. powder, for they, being reasonable men, only wanted to expel the shot with sufficient velocity, and did not want to burst their guns. They did not see the economy of the British custom of making very costly guns and then subjecting them to strains not required for any practical purpose, so, instead of English L.G.R., they used their own *prismatic* powder, which sent the shot quite as far without "busting" the gun. So long as the required range is obtained, what more do you want? Surely, even those destructive English artillerists ought to be contented with this!

After a reasonable—perhaps I ought to write unreasonable—time had been taken for consideration, our sapient authorities seem to have found out that it is desirable to avoid destroying wantonly our very expensive wrought iron and bronze guns by subjecting them to needless strains, which *don't* increase the range of the shot, but which *do*, sooner or later, burst the gun; so at last they have followed the Prussian example of making prismatic powder, whose grains are somewhere about the proper size to burn at the required rate, and having provided the means of ascertaining (approximately) the pressure of the gases in the chase at the intervals of the shots successively passing certain portions of its length, they found the strain on the gun was reduced from 4·500 atmospheres when L.G.R. powder was used to 15 atmospheres when prismatic powder was employed. Need I add that by the employment of the latter, not only will the "life" of our guns be prolonged, but that it is very probable the multitude of cast iron guns in store may—especially if they be treated *a la* Palliser—be rendered available for the *extremely* Christian work of killing the Queen's enemies without much danger to those of her subjects who may have the blessed privilege of doing that work of necessity, if not of mercy, when the occasion warrants that work to be done. May that occasion be far distant, or rather, Heaven forfend its occurrence!

THE HARMONIOUS BLACKSMITH.

MESMERISM.—REQUEST TO "SIGMA."

SIR,—I much doubt if among all my fellow correspondents in our journal there is another who writes in a more truly philosophical spirit than "Sigma," and had I not before been acquainted with the facts which are commonly termed mesmerism, to which he bears testimony in No. 257, I do think his testimony would have compelled my credence, for all his communications exhibit plenty of internal evidence that his mind is not one likely to be deceived into belief on insufficient evidence, and that he would wilfully deceive others I deem quite out of the question.

Improbability means little else than unexpectedness. To me, the facts he avouches seem no more wonderful than any other facts with which we are familiar. Wonder is but the usual expression of ignorance when the unexpected transpires, and improbability seldom means anything more than the incongruity of the unexpected with our very limited knowledge; strictly speaking, we can hardly be justified in saying that any alleged new fact is improbable, however little we may expect its discovery; in fact, this allegation of improbability is only the old fallacy of making our ignorance a measure of the probability of what we don't know, and I am sorry to add that from the reproach of doing this I cannot entirely acquit "F.R.A.S.," who—on the subject of mesmerism *only*—seems to assume that what he is not convinced of, must be at least improbable, if not absolutely false. See his communication in a recent number.

Having had but little personal experience of the higher phenomena of clairvoyance, I should, I trust, in common with many of my fellow readers, who are earnest seekers of truth, be very glad to be further enlightened concerning those phenomena; may I therefore, in their behalf, as well as mine, request "Sigma" to inform us what instances of the perception of things and occurrences at distances far beyond visual ken, and notwithstanding the interposition of opaque substances, he has witnessed. "Sigma" will of course understand I allude to such phenomena as the perception of the fire raging at Stockholm, by Emmanuel Swedenborg, when he was dining in Berlin; or the celebrated case of the young girl, whose name I forget, who accurately described the furniture and contents of a room many miles distant from her, which she had never seen by ordinary vision, or indeed knew the existence of, until placed *en rapport*.

I greatly fear some of the intellectual descendants of unbelieving St. Thomas will be tempted to cast ridicule on me for asking for such information in serious soberness. The minds of these not very philosophical sceptics, who assume they know all Nature's possibilities, seem to the unlearned Blacksmith, in relation to this subject, to be very like those of the blind and deaf in relation to the phenomena of light, colour, and sound. The said Blacksmith supposes he must "grin and bear it;" in fact, he is used to it. Having been blessed by Providence with a rather broad back, and being, as regards ridicule, a pachyderm, he can well afford the sneerers should have their enjoyment—like Dickens' good natured coal-heaver, whose wife "*wopped*"—"it pleases she and don't hurt I." and if my queries elicit useful information, their purpose will be fulfilled, however much ridicule the questioner may be called on to bear; moreover, if it will afford any additional gratification to the sneerers, I am willing to admit that my mind is so shallow that to me our ordinary vision and other perceptions, are quite as wonderful as any of the alleged wonders of clairvoyance, and, that I believe we don't wonder at vision, hearing and feeling, only because we have been familiar with them from childhood.

THE HARMONIOUS BLACKSMITH.

WHY I DESIRE TWO RANKS OF MANUAL KEYS TO MY HARMONIUM.—REPLY TO "ELEVE."

SIR,—"Eleve" asks why should 8½ rows of reeds get two rows of keys, when one row *might* do the work? Now, however crotchetty I may be—and, like all hardened sinners, I glory in mine iniquity—I am "free to confess" that I don't know why the aforesaid 8½ rows of reeds should get two ranks if one row *can* be made to do the work; but that it *can* is just the thing I have not yet been shown. I should like to be.

That there may be no possible misunderstanding, I will specify the *work* I want my harmonium to be capable of doing. N.B.—It is, when properly done, really *work*, although usually designated by the term *playing*. The work wanted is to *play* a melody with *true vocal expression* (whether that expression be obtained by the usual means or *à la main*, which I greatly prefer), and the accompanying of that melody by the sounds of other reeds, without the possibility of these sounds being *swelled* to any objectionable extent. I also require that in the performance of the said accompaniment I shall *not* be limited to F first space, or any other note within the compass of my harmonium, for the sound of highest pitch with which I may fancy to accompany the said song or melody.

In this I require no more than every organist can do, if he plays his melody on the swell organ, and accompanies it on one of the other organs whose keys are beneath his fingers. If "Eleve" can show me how to do this on an harmonium with only one manual rank, that matter-of-fact character and *remarkable economy* in the matter of £ *s. d.*—however liberal I may be of words—for which he gives me credit (I only wish I deserved it) will compel me to admit the second manual rank to be quite superfluous; but until he does this I can no more *work* or *play* without my second rank of manual keys than I can without that *third* rank of keys yclept pedals.

It is a great consolation to me to find "Eleve" supports my humane (suggested) treatment of reeds, babies, and paupers, but I fear he is hardly prepared to go what our American cousins term "the intire animal." Some reeds, like some babies, *squall* so horribly, that I fear they must, like the niggers, come of an inferior race, utterly incapable of civilisation. I am quite hopeless that either these cantankerous reeds or those yet more cantankerous babies ever can be educated by any amount of scientific "treatment" to utter agreeable sounds. The sooner such "vessels of wrath" are improved off the face of the earth the better for us all; and in mercy to our weaker brethren, or rather those brethren whose ears are weak and cannot bear "rank and strident tones," both reeds and babies ought to be smothered *intirely*, as the "finest pisantry" express it. Were some of the pipes of our old city organs served that same, it would be no great loss to the musical world; but perhaps, like certain other utterers of evil, it is best they should go to the *hot* place, for then they might be "purified by fire," and their material be converted into virtuous pipes, which *might*, if well voiced, utter angelic sounds. But, after all, it is best not to be too sanguine; and blessed is he who expecteth nothing, for verily *he* shall not be disappointed.

THE HARMONIOUS BLACKSMITH.

P.S.—Perhaps "Eleve" may say that if the expression be *à la main*, which, by the way, most modern harmonium makers seem very shy of attempting, I could swell the melody and refrain from swelling the accompaniment—I don't feel quite certain; "swelling," however common as a noun substantive, is a correct English verb; but no matter, I shall be understood—true; but then I am precluded from accompanying with tones of different quality or timbre, unless I limit the accompaniment to the highest note in the bass half-rank—say F, or wherever the ranks of reeds are divided. So "Eleve" will see that my favourite crotchet of expression *a la main*, such as I obtain in the celestina, terpodian, euphenon, or sostinente pianoforte, will not fulfil my requirement.

COMMERCE AND TRADE.

SIR,—Under the above title—which, by the way, is very much like two names for one thing—"Saul Rymea" says we are exporting less, and importing more, than formerly, and he asks what kind of prosperity this indicates. I hasten to assure him that he may be "quite easy in his mind," notwithstanding the above is a true statement of *declared* values, and may be temporarily true of *real* values. That it cannot continue long is obvious, because however good John Bull's credit may be, the foreigner won't trust him *ad libitum*, but the great probability is, that the declared value of our imports is above, and that of our exports less than their real values.

If our imports are of greater intrinsic value than our exports, it is obvious we must be running into debt, and we shall have to export more to balance the account. The foreigner will no more trust John Bull without limit, than that first cousin of the ornithorynchus, our tailor,—Punch defined *him*, like the Australian animal, to be a *beast* with a *bill*. Like Sartorius, the foreigner will, sooner or later, demand payment, and just as I should be compelled to "export" some medium of exchange—say sovereigns or bank notes—from my pocket, or the balance at my banker's, and deliver it into the *pocket* of the ornithorynchus—I mean the tailor—in satisfaction of the claim in his "little bill," so must we, sooner or later, export some kind of wealth to satisfy the foreigner's claim for the balance due to him from our excess of imports over exports.

This balance may be paid in a great variety of ways. Thus, it may be a *direct* remittance of goods of British manufacture, or of coal raised in Britain, to the foreign merchant to whom the balance is due. It may also be in the form of the precious metals not raised in Britain, but purchased with the products of British industry—for, be it remembered, gold and silver are as certainly, and only can be, purchased, by exchanging British manufactures for them, as French, Portuguese, and Spanish wines, American cotton, Chinese tea, or colonial sugar, are so purchased. Direct trade may be easier to comprehend by those who have not studied this subject, but it is not necessarily more profitable than indirect trade, and, whether we buy tea with silver, previously purchased in Mexico with British manufactured produce, or with calicoes in Canton, it makes no essential difference; in both cases they are ultimately paid for by British produce, exchanged for the foreign produce, and I may add, that just as the export of silver is a positive good to Mexico, which has more silver and less cottons and hardware than her population requires, so is the export of silver from England to China a positive good, both to the Chinese and to us. They have tea to spare, which we want; we have got more silver than we require from Mexico. The Chinese fancy they want more silver than they have, so we indulge their argentiferous fancy, and obtain in exchange "the cup which cheers but don't inebriate." Verily we have our reward.

From the above it will be seen, that no so-called adverse "balance of trade" can continue long to affect us injuriously. Silver and gold are, commercially speaking, mere *commodities*, and as properly the subjects of trade as the food and clothing of those who obtain them by mining. No doubt there are some political considerations involved, to which I, who have treated this subject from a purely commercial standpoint, and assumed the continuance of *peace* on earth and *good will* to mankind, have not adverted. Perhaps the latter is rather too much to assume yet, for we have not quite arrived at the Millennium. War disturbs commercial exchanges, and when we have to provision an army in the enemy's country, we can hardly expect its native hostile population to accept bank notes or bills on our government, in payment for supplies. In this case, of course, only the precious metals will be accepted, and those, unless in the form of coin current in the country, only as so much bullion, for it is obvious that the possession of British coin, or its paper representative, would be *prima facia* evidence of treasonable correspondence with the invading army, and war makes short work of treason.

From these considerations, it follows that we *must* have a store of gold and silver, just as we *require* a store of gunpowder, they, like it, being munitions of war. Whether these especial metallic munitions are best kept ready for warlike service by being coined, allowed to circulate as a medium of exchange—*i.e.*, as money, and become depreciated, is quite another question. As paper, which *cannot* become *depreciated*, is a yet more convenient medium of exchange than either gold or silver, and, as I have long ago shown, that the only condition required to prevent that depreciation, is convertibility into anything the holder prefers to his paper money. I think it may be assumed that instead of stamping the image and superscription of the reigning Cæsar, or sovereign, on gold, and then allowing it to be wasted by use and loss, that I am justified in believing it would be more economical to store the gold and circulate the paper. But I refrain from boring my fellow readers with my somewhat peculiar notions on the currency question.

Why men should understate the real value of exported goods is a mystery, perhaps its solution may, in some instances, be found in the fact that some unenlightened foreign governments levy *ad valorem* duties on the importation of British manufactures. If these are passed at their declared, instead of their real values, of course they reach the native trader cheaper, but it has been suggested that although this may partly account for the different apparent value of our exports and imports, it is to a considerable extent compensated for by the common practice of declaring the value of exports greatly in excess of its real amount, which is said to be frequently done by that race of *'cute* merchants who insure ship and cargo at three times their value, in the hope they may never arrive at the port to which it is pretended they are consigned. I am told this little game pays very well when you are not *found out*, in which case you are "paid off" instead. As Hercules was said to help the industrious who had a habit of helping themselves, so, perhaps, Satan helps—through the instrumentality of the trusted captain or mate—those who help themselves to the underwriter's money in this honest way. Verily, I hope they also may have their rewards, a hope that I am confident "Sigma," and every other honest mariner, who has a reasonable prejudice against drowning half the crew to enrich scoundrels, must share.

THE HARMONIOUS BLACKSMITH.

P.S.—Since the above was written, I see "Sigma" has taken this subject in hand, on page 184. It is said that if you mention a certain much maligned person's name, he straightway appears; and in this respect "Sigma" emulates him in playing the d—— with the popular fallacy of the balance of trade, but may I ask him if—in a scientific sense of the word—any profit, other than mutual benefit, ever *can* result from trade, foreign or domestic? I trow not; if by profit we mean getting the greater value for the less. When I exchange half-a-crown for a pound of tea, the seller gets no profit in that sense, for he has given me half-a-crown's worth of tea for two shillings and sixpence; truly, it did not cost him so much in money, and the difference is commonly called his profit; but it might be more truly termed his *wages*, or remuneration for selecting, preparing, and supplying the tea. Perhaps, also, some part of the difference between its cost and selling price is payment for gratifying our *æsthetic* taste by the extremely *artistic* decoration of his shop. Surely, when much gold leaf and artificial mahogany are exhibited for our gratification, we ought, like the frequenters of that temple of delight, the gin palace, to contribute our proportion of the cost of these decorations which we enjoy. This is no more than justice to their purveyor; but perhaps the great profitableness of co-operative stores, in which such decorations are as rare as stained windows and pictures in a Dissenting chapel, might go far to teach us that such gorgeous decoration is not absolutely essential for retail trade, and that people of more quiet tastes, may even manage to get their tea, &c., without them. But whatever the concurrent conditions, the fact remains, that we somehow get the same value in another form that we part with in coin. As the authorities on political economy express this fact, "all honest commercial transactions are exchanges of things of equal value" in the aggregate. So I trust "Sigma" will see, that although our foreign trade yields no profit, in the sense of our imports being of greater total value than our exports, that fact does not necessarily cause us to be in what he terms "a bad way."

As it is said the absence of condemnation is = approval, so "Sigma" is quite welcome to assume that all the rest of what he says on this subject will pass muster; in fact, his conclusions regarding the accumulation of wealth by Britons, and their proclivity to waste it in foreign loans, when the most promising works at home are languishing for want of capital, now lying idle, which might be *profitably* invested in them, are quite indisputable, but he will allow me to remark, that this is rather the result of our experience of trade morality (Query, immorality) than any prejudice the British capitalist has against investing his money in home works. We have not yet forgotten Black Friday in 1866.

INDUCTION COIL.

SIR,—I am building an induction coil, of which the reel is 9in. long, with gutta percha ends ⅜in. thick, 4½in. diameter. Arguing, in my own mind, that the spark may escape as easily in a lateral direction from one convolution to the next, as from one layer to another, I have begun laying the secondary wire with a strand of cotton thread interposed between them, and this separating of the coils I intend to increase as I increase the insulation between the layers. I calculate on thirty layers, and the first ten are insulated thus: First well coated with shellac, next a piece of the soundest brown paper procurable, is cut the exact size, that is softened in water, glued, and wrapped round as carefully as possible, and when quite dry, thickly varnished. The second ten will have two thicknesses of paper, and the third three. The primary is two layers, No. 16, and the core an inch and an eighth diameter. I find the work one demanding, above all things, patience, as, taking stoppages into account, three layers a week are as much as one can manage. The opinion of fellow workers in the mechanics of science, will oblige.

M. G. CUNNINGHAM.

STRENGTH OF CHAINS.

SIR,—As my only desire was to correct an error in rule, not to point out so small a discrepancy as 0·01, nor yet cause Mr. Tolhausen to work to 4 places of decimals; I took in hand the examples as given by him page 123, and gave my reason (why and wherefore) 32 should be used as a divisor or multiple in working out correctly the examples, page 163. As Mr. T. invites me, page 186, further to use my skill in working out a more precise rule, I prefer choosing, as an example of rule given by me, a 2½in. chain, and show the result in figures without remainder, so that it may be easily understood:

$$\text{Rule by eighths (as given)}\ \frac{20^2}{8} = 50 \text{ tons.}$$

$$\text{Rule by sixteenths (as given)}\ \frac{40^2}{30} = 53\tfrac{1}{3} \text{ tons.}$$

Will any of your readers say this is correct, or immaterial, showing a difference in this example of 6⅔ per cent.:

$$\text{Corrected rule by sixteenths}\ \frac{40^2}{32} = 50 \text{ tons.}$$

(Given by me, p. 163.)

There is no necessity here for a more precise rule, as this is mathematically correct, and will prove in every case the divisor 32 the only true one worthy of adoption. There is not, and cannot be, any other, not even the nearest approximation (for a rule).

W. N. LAIDLER.

TIDE TABLE.

SIR,—I cheerfully respond to "Maschil's" request, and I shall be pleased to give him any further information he may require on the subject. I am afraid our courteous friend, "F.R.A.S.," has entirely overlooked the request of "Saul Rymea" and myself respecting the tide tables. I enclose an excerpt from the *Thanet Guardian* for April 2, which indicates the time of high water at Margate to be exactly two hours earlier than at London Bridge. When doctors disagree, who *is* to decide?—

AB INITIO.

MARGATE TIDE TABLE.—HIGH WATER.

		A.M.	P.M.
Saturday,	April 2	1. 5	1.20
Sunday,	" 3	1.34	1.39
Monday,	" 4	2. 3	2.17
Tuesday,	" 5	2.32	2.46
Wednesday,	" 6	3. 2	3.16
Thursday,	" 7	3.34	3.53
Friday,	" 8	4.11	4.34

TIME.

SIR,—The question of x longitude when expressed in mean time, not being equal to x longitude when expressed in sidereal time, admits of a fuller development than has been made on pp. 70, 86, 135, and 159. See letters of "F.R.A.S." and "Not an F.R.A.S." Thus—180° = 12 hours of longitude, whether the instrument used for measuring it be a theodolite, a mean time, or a sidereal time clock, because the idea of *duration* is excluded. It is *angular* magnitude, and the *velocity* of the clock's hand in revolving through the angle, does not affect the equation. In illustration of this, I append the example of page 86, wrought out as nearly correct as I can do it, to 4 decimal places of a second, by three different methods.

1st Longitude, considered as Mean Time.

	h.	m.	s.	
	1	33	46·0710	= Greenwich sidereal time at noon.
			1·3333	= Correction for 8m.7s. of longitude.
	1	33	47·4048	= Local sidereal time at noon.
	6	14	50·3900	= given sidereal time.
	4	41	2·9857	= Sidereal interval after noon.
=	8	59	20·6818	Mean time equivalents.
+		40	53·2831	
			1·9945	
			·9830	
	4	40	16·9424	= Local mean time.
+		8	7·0000	= Longitude.
	4	48	23·9424	= Greenwich mean time.

2nd Longitude considered as Sidereal Time.

	h.	m.	s.	
	6	14	50·3900	= Given sidereal time.
		8	7·0000	= Longitude.
	6	22	57·3900	= Greenwich sidereal time.
=	5	59	1·0226	= Mean time equivalents.
+		21	56·3958	
+			56·8414	
+			·3889	
	22	26	29·2907	= Transit of Aries on 14th.
	4	48	23·0424	= Greenwich mean time as before.

3rd Longitude considered as Mean Time.

	h.	m.	s.	
	22	26	29·2907	= Transit of Aries as before.
			1·3297	= Correction for 8h. 7m.
	22	26	27·9610	= Local transit of Aries.
+	5	59	1·0226	Mean time equivalents of given time.
+		13	57·7064	
+			49·8635	
+			·3889	
	4	40	16·9494	= Local mean time.
		8	7·0000	= Longitude.
	4	48	23·9494	= Greenwich mean time as before.

The very small difference 0s·02, between this result and that given in the ENGLISH MECHANIC, is due wholly to the unavoidable inaccuracies in the last decimal in the "Nautical Almanac."

J. STEEL.

RUSHES.

SIR,—If any paper-maker is disposed to try the common rush for manufacturing purposes, I shall be happy to arrange to send him a supply from Cornwall. Your correspondent, "Bernardin," will much oblige if he will say how the rush should be prepared for the paper-maker—whether simply to cut and dry it (as hay) would be sufficient, or should they be supplied in the green state? Also, what would he consider them worth per ton?

CAMELFORD.

FUNCTIONS OF FOOD.

SIR,—Your remarks on "The Value of Different Articles of Food" (p. 107), are replete with interest to those that have devoted any attention to the subject. The fallacy of Liebig's classification of the functions of food has of late been shown by the most conclusive experiments of many chemists and physiologists. Their researches have entirely broken down the distinction between the so-called "flesh formers" and "heat givers" by proving that the former, or nitrogenous, principles are also capable of developing a certain amount of muscular force and heat in the system. Hence they are now appropriately termed, "flesh and force producers." On the other hand, the hydrocarbons or "heat givers" generate heat and muscular or mechanical force, and are consequently now called "force producers."

Sometime since Professor Frankland, who has devoted much attention to this matter, published the results of a series of investigations made for the purpose of ascertaining the maximum amount of power or force which it was possible to obtain from a given quantity of different foods. A notice of these investigations would, I think, be a valuable sequel to your excellent article. In introducing the subject the learned Professor observes:—

Both the heat force and the mechanical force generated in the bodies of animals are derived from food. An animal, however high its organisation may be, can no more *generate* an amount of force capable of moving a grain of sand, than a stone can fall upwards, or a locomotive drive a train without fuel. All that such animal can do is to liberate that store of force which is locked up in its food. It is the *chemical change* which food suffers in the body of an animal that liberates the previously pent-up forces of that food, which then make their appearance in the form of heat and mechanical motion.

All the combustible ingredients of food, whether nitrogenous or not, are capable of yielding mechanical force and heat force; but the nitrogenous constituents, such as albumen, fibrin, and casein, can also be used in the body for the building up of muscle or flesh, hence these constituents are termed *flesh and force producers*. The non-nitrogenous ingredients of food, such as starch, sugar, and fat are incapable of forming flesh; they are *force producers* only. It is the oxidation of the non-nitrogenous matters in the body which constitutes the chief source of muscular power. The muscular force expended within the body takes the form of heat, and is the chief if not the only source of animal heat.

The following table exhibits the results of actual experiments made to ascertain the maximum amount of force produced by 1lb. of various articles of food when oxidised in the body:—

Name of Food.	Tons raised One Foot high.
Cod-liver oil	5649
Beef fat	5626
Butter	4507
Cocoa nibs	4251
Cheshire cheese	2704
Oatmeal	2439
Arrowroot	2427
Flour	2383
Pea-meal	2341
Ground rice	2330
Gelatin	2270
Lump sugar	2077
Yolk of egg	2051
Grape sugar	2033
Hard-boiled egg	1415
Bread crumb	1333
The lean of boiled ham	1041
Mackerel	1000
The lean of beef	885
The lean of veal	726
Guinness's stout	665
Potatoes	618
Whiting	491
Bass's ale	480
Apples	400
Milk	390
White of egg	367
Carrots	322
Cabbage	261

The maximum amount of *mechanical work* which 1lb. of each of the above substances can enable a man to perform (external work) is about one-fifth of the amount mentioned in the above table.* The following tables further illustrate the application of these experimental data:—

Weight and cost of various articles of food required to be oxidised in the body in order to raise 140lb. to the height of 10,000 feet.

External work = ⅕th actual energy.

Name of Food.	Weight in lb. required.	Price per lb. s. d.	Cost. s. d.
Cheshire cheese	1·156	0 10	0 11½
Potatoes	5·068	0 1	0 5¼
Apples	7·815	0 1½	0 11¾
Oatmeal	1·281	0 2½	0 3¼
Flour	1·311	0 2½	0 3¼
Pea-meal	1·335	0 3½	0 4¾
Ground rice	1·341	0 4	0 5½
Arrowroot	1·287	1 0	1 3½
Bread	2·345	0 2	0 4¾
Lean beef	3·532	1 0	3 6½
" veal	4·300	1 0	4 3½
" ham, boiled	3.001	1 6	4 6
Mackerel	3·124	0 8	2 1
Whiting	6·369	1 4	0 4
White of egg	8·745	0 6	4 4½
Hard-boiled egg	2·369	0 6¼	1 2¾
Isinglass	1·377	16 0	22 0¾
Milk	[illegible]	5d. per quart.	1 3½
Carrots	9·685	0 1½	1 2½
Cabbage	12·020	0 1	1 0¼
Cocoa-nibs	0·735	1 6	1 1¼
Butter	0·693	1 6	1 0½
Beef fat	0·555	0 10	0 5½
Cod-liver oil	0·553	3 6	1 11¼
Lump sugar	1·505	0 6	1 3
Commercial grape sugar	1·587	0 3½	0 5½
Bass's pale ale (bottled)	9 bottles	10d. per bottle.	7 6
Guinness's stout	6¾ "		5 7½

Weight of various articles of food required to sustain respiration and circulation in the body of an average man during 24 hours.

Name of Food.	Weight in oz.
Cheshire cheese	3·0
Potatoes	13·4
Apples	20·7
Oatmeal	3·4
Flour	3·5
Pea-meal	3·5
Ground rice	3·6
Arrowroot	3·4
Bread	6·4
Lean beef	9·3
" veal	11·4
" ham, boiled	7·9
Mackerel	8·3
Whiting	16·8
White of egg	23·1
Hard-boiled egg	5·8
Gelatin	3·6
Milk	21·2
Carrots	25·6
Cabbage	31·8
Cocoa-nibs	1·9
Butter	1·8
Cod-liver oil	1·5
Lump Sugar	3·9
Commercial grape sugar	4·0

BETA.

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* It is not to be understood from this that taking 1lb. of cod-liver oil would enable a man to lift one-fifth of 5649 tons (that is, 1130 tons) one foot off the ground. What is meant is, that that is the total mechanical work which the combustion in the body of 1lb. of the oil is capable of producing outside the body, supposing its effect to be wholly expended in the production of this mechanical work without any *waste*. Moreover, this statement of the amount of work in tons lifted one foot does not take *time* at all into account. It simply reckons the total work which it is possible to get out of the combustion of
cod-liver oil, no matter how long it may take t

THE "LITTLE WONDER."

(Illustrated on page 205.)

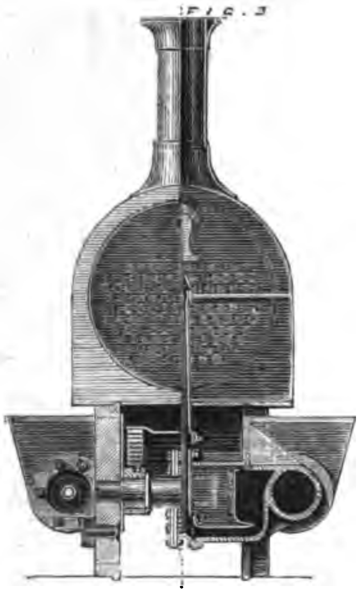
Sir,—So much discussion has been rife lately as to the merits and demerits of Mr. Fairlie's double engine system, that the reproduction of the enclosed from *Engineering* may please many of your readers. The principal dimensions of the "Little Wonder" are as follows:—

	ft.	in.
Diameter of cylinders	0	$8\frac{3}{16}$
Stroke	1	1
Number of cylinders	4	
Distance apart of cylinders transversely from centre to centre ..	3	1½
Length of connecting rods between centres	4	9
Diameter of wheels	2	4
Wheel base of each bogie	5	0
Distance between centres of bogies	14	1
Total wheel base	19	1
Distance apart of frame plates ..	1	7¼
Diameter of boiler barrels	2	6
Length " " (each) ..	7	6
Length of firebox casing	6	0
Total length of boiler between smoke-box tube-plates	21	0
Width of firebox casing	3	0
Width of inside fireboxes	2	7
Length of inside fireboxes (each) ..	2	5¾
Height " "	3	6
Length of tubes	7	10
Diameter of tubes outside	0	1¼
Number	2	18
Heating Surface.		
Tubes	670 sq. ft.	
Firebox	60 "	
	730	
Firegrate area	11 square ft.	
Pressure of steam	160lb. per sq. in.	
Capacity of tanks	90 gallons.	
" coal bunkers ..	15 cwt	

Weight of engine in working order about 19¼ tons.

It will be noticed on reference to the sectional plan that the firebox casing is curved inwards at the sides, and that the two inside fireboxes are made semicircular at their adjacent ends. The boiler shell is made of steel plates. The regulator handle is placed on the top of the firebox casing, the two regulator valves, which are contained in the domes, being connected, as shown, so that they open and close simultaneously.

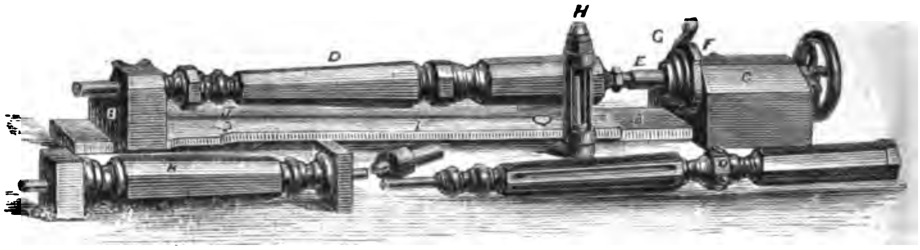
FIG. 3



The valve gear is of the "stationary" link type, and the motion is communicated to the valve spindles through rocking shafts, as shown. The arrangement of steam and exhaust pipes will be readily understood by an inspection of the engravings without special explanation.

The connection between the two boges is effected in the plan adopted by Mr. Fairlie for all his later engines, the two bogie pins being connected by a pair of side or carrier frames. In dealing with such a narrow gauge as 1ft. 11½in., Mr. Fairlie had many difficulties to overcome; but he has shown by the performance of the "Little Wonder," that his system of double engine is eminently fitted for use on narrow gauge lines, and there can be little doubt that as such lines are more extensively constructed, the employment of the Fairlie system will increase also. **Admirer.**

MACHINE FOR CUTTING IRREGULAR FORMS.



Sir,—I send illustration, with description, of machine for cutting irregular forms, which has recently been patented through the *Scientific American* Patent Agency Office, New York.

The main features of the device are, the attachments for holding, adjusting, and feeding the pillars, balusters, &c., to be cut into irregular forms or plane sides, on a table past a rotary cutter. The invention may be said to consist of a bed, with centres, for holding the blank; one of the centres being adjustable longitudinally, and furnished with a dividing plate for adjusting the blank to the cutter, and a pattern for governing through the table of the machine. A guide plate, I, or pattern adjustably attached to the bed A, serves to direct the cutting. The operator takes hold of the baluster at B, with his right hand, and with his left hand on a hand rail J, pushes the machine from him, and at the same time against the mandrel; the machine is then pulled or drawn back, and lifting the spring catch G with the left hand, and turning the baluster with the right, one space, another side is presented to the cutting tool, thereby dressing the sides all alike, and making a thousand pieces exactly similar. After the required number have been shaped the straight bits are removed and properly shaped ones take their place, and the guide pattern is changed for one corresponding to the desired ornamental design. When this is effected, one man can do the work of twenty men, and with greater neatness and accuracy than can possibly be done by hand. At the same time the hands of the operator are perfectly safe from injury. For dressing stuff like the piece K, with squares at both ends, the centre pin, seen at the end of the piece, is inserted in the hole through the centering head B. This machine is capable of dressing not only balusters and chair, table, desk, and counter legs, but can be used to dress hay-rake and grain-drill spokes; and stuff that has to be thrown away when finished by hand on account of knots and curls (the handsomest when finished), is dressed almost as readily as straight grained wood. J. H. T.

GLASS BURNING.

Sir,—I beg to return my sincere thanks to Mr. Jos. Leicester, for the trouble he has taken to answer my Query on "Glass Burning." The form of oven or kiln is quite correct; the iron slabs or trays that slide in the kiln are first covered with sifted whiting, and then smoothed off with what is called a sand plane, and then the pieces of glass are laid flat on the whiting; the process of burning can be watched by a square hole in front of the kiln, which can be closed at pleasure. I have seen pieces of glass 2in. or 3in. long and ½in. wide, with the flux painted on, and laid on one of the slabs, and called tests; they are taken out, tried, and by them may be known when the glass is sufficiently burnt.

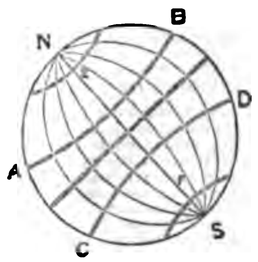
The letter to the Editor, in answer to me, describes the silver melted in a crucible, and antimony as a flux, but did not say whether they are to be melted together or in what proportions; if the writer would kindly say something upon the subject through the medium of the Mechanic, it will greatly oblige me, and perhaps many others. **Gustava Knox.**

DARK LINES IN THE SPECTRUM.

Sir,—In reply to your observations on my letter, p. 183, I beg to observe I did not state my inability to give any evidence at all to Mr. Proctor, as that would not be true, but the spectroscopic evidence required from me in the letter on p. 130. I have, however, no objection to give reasons for considering the dark lines in the solar spectrum entirely atmospheric. When Bunsen and Kirchhoff arrived at the conclusion that the dark lines were of solar origin, they considered the sun an incandescent body surrounded by a luminous atmosphere; but later researches represent it as a non-luminous globe, surrounded by matter in a state of intense chemical action. If this is correct, the only foundation for the supposition of the dark lines being solar is the great depth of the photosphere and the outer and less luminous envelope absorbing certain of the rays emitted by the inner and brighter portion. Before adopting this hypothesis, would it not be well to ascertain whether the earth is not also enveloped by matter capable also of a similar, though less intense, chemical action? I apprehend there is sufficient proof that such is the fact; and if so, the origin of dark lines in the spectrum of any luminous body outside the earth's atmosphere is unmistakeable. T. A.

READINGS FROM THE GLOBES.

Sir,—It may not be out of place at the present time when some of your subscribers are inquiring about globes and longitude, to offer a few remarks (addressed chiefly to juniors), on the uses of those instructive instruments. The proofs of the rotundity and motions of the earth which have been lately given in these columns by Mr. Proctor, have shown that the earth is of a globular form, and the phenomena which the globes illustrate, rest upon this supposition, and can be accounted for easily on this principle, for if the earth were not round, the time would of course be the same in all parts of the world at the same time, and we should have no difference in longitude. Different countries take different meridians, as the line from which to reckon longitude; generally speaking, the capitals of their own country, whilst England reckons her longitude from Greenwich Observatory; hence, if we wish to know the difference of time or longitude between two places, we have only to ascertain the longitude of each, which, supposing the globes are accurate, is a very simple process, and then subtract them, if they are of the same name, but add them if one is east longitude and the other west longitude. As the globe turns on its axis from west to east, those who live in west longitude must have their time earlier than those living in east longitude, because they will not come into the enlightened hemisphere so soon. Having, then, ascertained the difference of longitude by bringing each place to the brazen meridian, and then noticing the figures on the equator, we can obtain the difference of time, and vice versâ. Longitude may be converted into time by dividing by 15, and reckoning each degree over as four minutes; and time may be converted into longitude, as every sailor knows, and hence vessels take out chronometers with them for this purpose. To convert time into longitude we must multiply each hour by 15, and reckon every four minutes over as one degree. The difference in longitude gives rise to other differences, as periœci, antœci, and antipodes. The periœci, for instance, are those who live in opposite longitudes, but in the same latitude. By noticing the etymology of the word *περι* around, and *οικεω* to dwell, we shall the better comprehend its meaning; thus in the figure, suppose we lived at B on the globe, our periœci would live at A, just 180° away from us, and nothing can show more clearly than this, that the earth is round, and turns on its axis, for in consequence of doing so, when it is 12 o'clock at noon at B, it is 12 o'clock at night at A, and vice versâ, but since all in the same latitude must have an equal share of the sun's rays during the day, the length of the day to the one is the length of night to the other, and of course the seasons to each of these must be the same, for all those in the same latitude have winter at the same time, as well as the other seasons. The antœci, however, derived from *αντι*, opposite to, and *οικεω* to dwell, are those who live in the same longitude but in opposite latitudes: that is, the people who live at E. have their antœci at F, and the antœci to N are those, supposing there are any, who live at S., and the antœci to 23° N. latitude, are those living at 23° S. latitude, and the consequence is, that their time is exactly the same, but the length of the day to the one, forms the length of the night to the other; that is, if E has two months' day, F has two months' night at the same time, but their seasons are opposite, because they live in opposite hemispheres, and when Boreas, bringing snows, reigns in one, the mild breezes of summer blow in the other. But again, if people live in opposite latitudes and longitudes, they are called antipodes, from *αντι* opposite to, and *πους*, the foot, because their feet are opposite to ours,



and as the sun, owing to the rotundity of the earth, can only shine over half the globe at once, it is night with our antipodes when it is day with us; and if their manners and customs are the same, when they are enjoying

> "Tired nature's sweet restorer, balmy sleep,"

we are busy at our several duties, either in work, business, the counting-house, or the Stock Exchange; and the seasons are also different. This interesting subject might be carried farther, and although elementary truths, familiar to the astronomer and geographer, they might still prove of service to some whose pursuits prevent them from consulting and studying larger treatises. Should you deem these few remarks worthy of a place in your periodical, I will follow them up with more observations upon the same subject. T. S. H.

THE SALTAIRE LATHE.

Sir,—I received your last monthly number only a few days ago, and to my great surprise saw on page 52, an illustration of Titus Salt, Esq.'s, lathe, as it was published without my knowledge or consent.

In November last Mr. Northcote wrote to me requesting the loan of the drawings of Mr. Salt's lathe, for the purpose of publishing them, together with a description of the working of the lathe, &c. Mr. Northcote being a perfect stranger to me, I answered that I had a decided objection to do so, unless it was done efficiently, with details, and a full description, accompanied with specimens of work produced by means of the different parts of the lathe and apparatus, and I added that I thought it could only be done in a separate publication, and that I should require some time to put it together, so as to render it intelligible and useful to amateurs and others; these conditions did not meet Mr. N.'s views, and there ended the matter.

I afterwards read a letter from Mr. Evans to the Mechanic, in which he says that the lathe belonging to Mr. Salt was almost exclusively made at *his* factory, the *outlines* of the designs having been prepared by Mr. Smith, of Jersey. Now, I beg to state, the most part of the lathe was made at Saltaire. Mr. Salt, having decided to have the lathe finished in London, went to Mr. Evans, and referred him to me. I give you a copy of Mr. Evans' letter to me:—

"London, Feb. 24, 1866.
"104, Wardour-street, Soho.

"Sir,—Some days ago I had the honour of a visit to Saltaire, to consult with Titus Salt, Jun., Esq., respecting the making and completing his lathe, which he had begun under your directions; we inspected all the drawings you had sent him, and I was put in possession of your ideas upon the several motions and applications to be attached thereto, and he has forwarded the lathe to town; he has suggested also that it would be advisable for me to pay you a visit to consult with you, which I purpose doing with your kind permission.

"Since the receipt of the lathe I have received a letter from Mr. Salt, wherein he mentions that without an understanding with me that your ideas should be kept private you are not disposed to give the benefit of your experience.

"Now, Sir, I trust I shall be able to entirely remove any scruple you may have in the matter. I have been engaged for many years in the making of models and machinery, and carrying out the ideas of inventors and gentlemen amateurs; and I will undertake that no original idea of yours shall be made public or manufactured without your permission first had and obtained. I hope and trust you will not have any doubt on the subject, but permit me the honour of waiting upon you at your residence, so that I may have the benefit of a personal interview. From your drawings and particulars given in detail, your experience must be mature, and of great value. I hope to have the honour of a reply, stating when it will suit your convenience to receive me.—I have the honour to be, Sir, your most obedient servant, W. J. EVANS.

"To John Smith, Esq., Jersey."

Now, in presence of such assurances, I wrote to say I was ready to receive him. He came over to Jersey; I showed him my own lathe, and all the apparatus (my own work, and the result of many years' experience); he had all the information that was necessary; he noted all the details, and made many sketches and memoranda; I afterwards sent him many drawings of details, and the whole of the work was carried out under my supervision; I visited London many times for that purpose, and it was with great difficulty I got the lathe as complete as it is now, having been obliged to order many parts to be cast aside and replaced by others, according to my original design.

I also took Mr. E. to see a lathe that I had made for a friend of mine in Jersey, the same in nearly every point as Mr. Salt's. Now, Sir, I think this is rather more than mere outlines.

On page 88, your correspondent 'J. K. P.," says:—"I happen to know that a great part of the lathe which was made at Saltaire, and which came to Mr. Evans', 102. Wardour-street, to be finished, was put on one side, and entirely remade"; this statement is not true.

I am not aware that the slide rest has any steel wheels; the saddle has.

"J. K. P." hopes that his (Mr. E.'s) mind is not oppressed with the recollection of having made for such a lathe such a chuck as the face plate with four dogs sticking out of it, which is shown on the floor in the picture. Allow me, Sir, to tell "J. K. P." that the chuck was not mine, nor made with my consent or knowledge.

On page 114, "J. K. P." again states that there are several small wheels in the slide rest. I am not aware that there are either wheels or rack. The saddle was from my design; the slide rest was not what I wished to have made, but very different, and on Mr. Evans' plan.

Now, Sir, I will put a question to "J. K. P." How came he to know all this in presence of Mr. E.'s engagement not to show the lathe, or make it public? Either Mr. E. must have forgotten his promise, or "J. K. P.'s" letters are manufactured at 134, Wardour-street. JOHN SMITH, St. Heliers, Jersey.

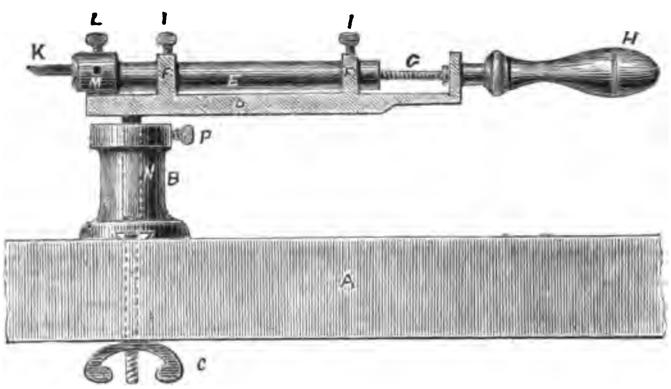
[Most assuredly our readers have heard enough about the designer and inventor of this lathe.]

COMMERCE AND TRADE.

SIR,—Questions in political economy are, I fear, hardly suited to your columns. To admit the discussion of them would be like the "letting in of water." The deduction I should draw—briefly stated—from "N. Rymea's" statistics of the trade of the United Kingdom for the year 1868, is, that for £179'000,000 of exports, we managed to purchase £294,000,000 of imports; a profitable year's business, surely. I have no doubt, however, that there was a considerable export of gold, of which no mention is made in the statistics given, and without which no conclusion can be arrived at as to the net results of the commercial transactions of that year. EXCHANGE.

TOOL HOLDER.

SIR,—The enclosed rude pencil-sketch represents a tool-holder or simple slide-rest which I have constructed. It will be found useful to amateurs in the absence of a regular one. I think the following description will explain it:—A lathe shears; B socket or holder, which can be adjusted to the shears in any position by the nut C; D frame of slide-rest, forged out of malleable iron, ⅜in. by 1¼in.; E slider made of iron tubing, with a square flange soldered to the under side, which slides in grooves or key-seats in the eyes F F; G the screw upon which the slider travels, and which can be brought to bear upon the work with the requisite pressure by turning the handle H.; I I two pinching screws, which can be pressed gently against the upper surface of the slider, so as to prevent vibration while at work; K the cutter, which is held in position by the screw L. I have several cutters, all of which are chamfered differently at both ends, so that either end may be used, according to the work required. It will also be seen that the cutter may be placed at right angles to the slide by putting it through the hole M. It will then cut parallel, by tightening up the screw P, and turning the handle.



This little slide-rest is particularly adapted to work to be turned on the face-plate, such as small cylinder covers, &c., where ornamentation by beading or grooving is required. As a kind of circular motion may be given by turning the slide-rest on its shank N, all kinds of OG patterns similar to the handle may be turned by feeding with screw G. Of course the holder must be bored out true, and the shank turned down to a good fit, in order to ensure stability and freedom from vibration; and when required to be rigid, it can be held quite tight by the screw P. I have done several jobs with it, and I find it a great improvement on the hand-tool system, as it permits the operator to turn the lathe for himself.

I don't know whether this idea is original or not, but I assure you it is quite new to me.

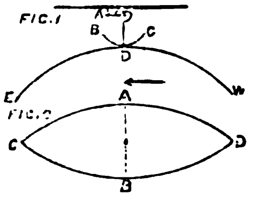
CHRISTOPHER FALLON, Barthgate-by-Edinburgh.

THE REPUTED FIGURE AND MOTIONS OF THE EARTH.—THE EARTH'S ROTATION.

(*Third and concluding Letter.*)

SIR,—I shall have occasion again to revert to the optical deception I noticed in my last, when I come to consider the question of "Parallax," and will not now say anything further on the measure of a degree, except just to notice that if we take anything short of the true diameter of the circle as the base, the division of less than one-half of that circle into 180 parts is an error, and that the arguments adduced by Mr. Proctor in his fourth chapter on the "Determining the Shape of the Earth," are consequently equally erroneous.

I have noticed Mr. Proctor's arguments on the "Diurnal Motion of the Sun and Stars," and also his admission with reference to the system advocated by Tycho Brahe, which, to a great extent, renders further reply on my part superfluous, I shall therefore at once examine his arguments on the gyroscope and pendulum experiments, in proof of the earth's rotation.



Suppose we set a pendulum swinging due north and south in a carriage running due south, and suppose the horses' heads are all at once turned to the west, is there anything wonderful in the pendulum (freely suspended) still continuing to oscillate due north and south? Would not the force caused by the falling weight be still in the same direction, although the direction of the course pursued by the carriage be changed 50 times? Such direction of such force would be the same, and the greater wonder would be if it were not so.

But how does this argument fit when examined fairly? If we are really passing from west to east at the rate of nearly 1500 feet in a second of time, how comes a pendulum, set swinging due east and west to continue to do so? Would not such a speed cause a greater impulse to be imparted to it one way than the other? As we must bear in mind that the point of suspension is attached to the supposed rotating body, and also with a string from a suspension of 17ft. 9in., as in the experiment noted.

When the pendulum was at the limit of its swing to the east, the support will have passed nearly 1500ft. in far less time than the pendulum swing will complete the proper arc of a circle B C (Fig. 1). For instance, let W E be the direction of the earth's rotation, as shown by the arrow, then supposing the pendulum bob is at B, the support will have passed nearly 1500ft. towards E *in far less time* than it will take the said bob to reach C. We will suppose, for the sake of easy illustration, that the pendulum makes one swing from B to C in a second of time, how is it possible for it ever to reach D, to say nothing of its reaching C, when we find that the support itself has travelled more than 80 times as far as the length of the pendulum during the time taken by one motion of the same?

But we will further suppose the pendulum to be set swinging due north and south, and the earth rotates from west to east, how are we to account for this great speed not interfering with the oscillations of the same? as the current of motion will act directly across the plane of its oscillation, and, as a matter of course, would materially interfere with its so-called gravity, and alter its course to the west and not to the east, out of all proportion to anything noted in the experiments adduced by Mr. Proctor.

I am aware that it is said that the pendulum experiments prove that the alteration in the plane of oscillation, proves that the earth rotates about an axis, causing our day and night; that if a pendulum could be adjusted at one of the poles, or at the equator, the oscillation would continue true, and that because we are situated midway between these two points of the earth's surface, this alteration in the plane of oscillation is attributed to the earth's moving from west to east; but, as I have before shown, it is impossible between our position and the equator.

I now ask, would it not be strange (putting aside the question of rotation altogether) if a pendulum, such as Mr. Worms made use of, did not vary in its oscillations place it where he will, with a ball of brass 40lb., and a steel wire 17ft. 9in. long, both liable to magnetic influence. The greatest wonder is that we find men so wedded to theory as to apparently overlook perhaps the most important and least understood principle in nature, and by silence disclaim, as it were, the existence of such a force and principle as terrestrial magnetism—a force continually changing both in direction and power—a principle whose source and mode of action our best philosophers cannot explain.

The gyroscope is but another repetition of that force and direction of motion we have seen depicted by the pendulum experiment. Who ever imagined that if any disc or wheel, for instance, was firmly fixed to an axis, and free to rotate upon it, that it would not do so, if sufficient force were given to it? And we know well where force is applied to weight, and this moves in a given direction, force must be applied to alter that direction, or it would continue to move in the same course until such force is spent. It is when a combination of forces and motions are called forth, which renders the matter somewhat perplexing, as the gyroscope, for instance. But to treat of this principle fully would occupy a volume itself, and cannot, therefore, be satisfactorily treated here, but I may just say, when the action of the gyroscope comes to be fully understood, and worked out in detail, our present dynamical theories will not only be found wofully incomplete, but erroneous also.

If this experimental gyroscope had been placed on a rapidly rotating sphere, which is the only way in which the experiment can be fairly tried, would it "travel against" the sphere in rapid rotation? I maintain that it will not. Suppose the direction of the earth's rotation is from west to east, and that the speed is after the rate of 17 miles per minute, and let the line of motion be perfectly straight, for the sake of simplicity, what instrument, supported on a "pointed pivot," could remain true for an instant, or withstand the directive force of such a motion?

But how is it that this instrument gives the same result relatively, no matter in what direction it is put into action, if its motion is "against the direction of the earth's rotation?" How is it that it can travel at all in other positions with such an enormous speed to overcome, especially when we consider the great nicety, and such slender connection through its supports that it has with the earth?

Again, there must be continual application of power if the motion of a gyroscope is to be of long duration, otherwise the disc will cease to act. Here, then, two questions present themselves:. 1st, Does the continued application of power tend to alter the direction of the axis of the disc; and 2nd, Does not the influence of motion by a species of centripetal force give the results as seen? It is plain it is more owing to the unexplained laws of motion than to the earth's rotation.

I come now to consider the other reasons given by Mr. Proctor in support of the assumption that the earth is globular, and, therefore, that it rotates about its axis. He remarks that the "sailor voyaging in the southern seas, estimates his progress strictly according to those results which follow from the globe figure of the earth," when the sky is clouded. I may ask, Is there anything remarkable in his being able to accomplish this, with proper means and appliances at his disposal? He knows by the chart the relative position of one country or island to another, and whether he goes in a straight line, or straight round, it really matters not, so that his position is clearly known and the relative distances correctly recorded. The greater wonder would be if he could not do so.

The fact that the "upper masts of a vessel" outward bound "may be out of focus when the sea horizon is brought into focus" is fully explained in my remarks on Fig. 3, in my last letter (ENGLISH MECHANIC, page 135), and has simply reference to the limit of vision as the observer's horizon. But in order to show clearly that the lines of vision generally appear curved, we must examine their bearing in reference to distance. I say "generally," because there is on record extraordinary peculiarities in some people's power of vision (see Dr. Ussher's papers on "The Eye, and Something About It," ENGLISH MECHANIC, Vol. X., page 295). The man in the Mauritius who "was able to announce the approach of vessels days before they arrived" had a peculiar power of vision, which, so far from being general, is entirely exceptional, and the fact of our gifted author recording this, in keeping with his extensive knowledge of the organs of vision, point clearly to the cause proceeding from the peculiar formation of the human eye. I am afraid I may have done wrong in alluding to Dr. Usher's admirable paper in support of my position, but I, at the same time, hope Mr. Proctor will not sharpen his ironical sword for use upon him. I cannot resist a smile when I ask Mr. Proctor if the man, when he announced the approach of these vessels (when no other eye could see them), *saw through the ocean*, which he must do if the surface is really convex.

It is not necessary that I should enter at length into "the shape of the earth's shadow as seen during a lunar eclipse." Enough has been acknowledged by Mr. Proctor on page 242, Vol. X., of the ENGLISH MECHANIC to cast a doubt on the minds of most men as to the correctness of the present theories, especially when we find it acknowledged by our author that "nothing but the complete survey" (described in Chapter IV. of his papers) "can be held to be a satisfactory proof." When that shall be shown to fail, what is to become of our boasted system of modern astronomy?

The "peculiarity noticed by balloonists" is accounted for by natural laws. When he ascends from the ground the earth gradually assumes more of a concave shape, until it has the appearance of a huge basin. If he looks down upon the earth below him, the rays of vision pass perpendicularly through the atmosphere; but if he casts a look at the distant horizon, at C or D, the rays of vision are bent *towards* the perpendicular; while if he looks upwards into a rarer atmosphere, the sky assumes a *convex* appearance, as the rays are bent (looking towards C or D) *from* the perpendicular, A B. In short, many of our theories are based upon wrong conclusions, which the plainest principles of vision will illustrate and explain.

I have now brought my remarks on the Earth's Rotation to a close. I might have adduced other arguments in favour of my position, but I think I have produced sufficient to induce serious thought on a matter too much confined within the sphere of dogmatic teaching. JOHN BEARDSLEY.

[At the foot of Mr. Beardsley's last letter we offered an apology for inserting it; now we must say a word or two in explanation. Almost immediately after the appearance of Mr. Proctor's admirable series of articles on the Earth, we received a letter from Mr. Beardsley, saying that he was preparing, in a series of letters, an answer to Mr. Proctor, and asking us whether we would insert it. Believing in free discussion, and believing also, from the tone of Mr. Beardsley's letter, that he had something worth saying, we said "Yes." Having given a promise, we felt bound to redeem it; but we must say that had we any notion at the time of the probable character and quality of Mr. Beardsley's reply, we should not have consented to allow him space. Possibly, however, the insertion of the letters will do good, as they show on what a narrow and shaky basis the theory of the earth being a plane rests upon.—ED. E.M.]

THE MOTIONS OF THE MOON AND EARTH.

SIR,—Will you allow me a small space to give my views respecting the motions of the earth and moon, as they differ in one or two particulars from the generally-received system of astronomy? About the year 1854 I felt a wish to construct a machine which should truthfully represent the motions of the earth, more particularly with reference to the changes of the seasons. In considering the subject with this view, the conviction forced itself upon me that the earth has a third motion not taken into account by astronomers—namely, an annual rotatory motion on an axis perpendicular to the plane of its orbit, and on the same principle that the moon has no axial motion. I am aware that a controversy on this question was carried on in the public papers some short time after I first propounded my theory, but I never got a sight of any of the correspondence; therefore, I am entirely ignorant of the nature of the arguments employed either *pro* or *con.*; so that my ideas are entirely original, so far as I am aware. The new theory, as discussed at that time, I believe, had reference only to the case of the moon. The principle of my theory involves some very interesting and important results as regards the earth, and which are well worthy a thorough investigation. But to the point. Astronomers tell us that the fact of the moon always presenting the same face to the earth proves that she turns on her axis in the same period of time that she performs her revolution round the earth. I maintain that this fact proves the contrary; for if the moon turned on its axis as described, each hemisphere would be successively presented to the earth. The phenomena presented by the moon are entirely the results of its orbital motion in conjunction with its annual journey round the sun. I will give one illustration of my view. Suppose a ball fixed to one extremity of a rod, the other being held in a person's hand, the arm and rod being maintained in a horizontal direction, the person turns round, carrying the rod and ball with him. The ball makes a revolution round the person, and while the same hemisphere is constantly turned towards the person, it is successively presented to each point of the compass. The ball has a motion about *a* centre; but where is that centre? Not within itself; it cannot turn about its own axis in the way supposed without being detached from the rod. The centre of motion is the person holding the rod, about which the rod and ball turn as a common centre, and producing precisely similar results to those produced by the moon's revolution round the earth.

I will now endeavour to state my views respecting the motion of the earth. In order to produce the changes of the seasons, I maintain that it is necessary to suppose a third motion, such as I have described in connection with the annual journey of the earth round the sun. And here a most interesting fact presents itself. By supposing a slight discrepancy in the periods of the orbital and the axial motion that I contend for, the precession of the equinoxes is produced. Another most interesting fact in connection with my theory is this:—This axial motion taking place in a direction contrary to that of the orbital motion, not only produces the changes of the seasons, but also maintains the parallelism of the axis of diurnal rotation, the poles of which always point in a particular direction. Now, supposing it had pleased the Great Architect of the Universe that this motion should have been in the same direction as the orbital one, we should still have had the change of the seasons; but would the axis have maintained its parallelism? No. Instead of our pole being constantly directed towards Polaris, it would during the year make two complete circuits of the heavens. This proposition I believe I am in a position to demonstrate to be a fact, and I shall be most happy to discuss the question with some of your able astronomical correspondents, so that it may receive a thorough investigation. F. F. HENBEST.

ON VELOCIPEDE CONSTRUCTION.

SIR,—From the number of queries contained in your journal, it is evident that subscribers are continually making their own machines—some from one idea and some from another. In many instances these new designs prove a failure because of the puff which announced their birth. The "Edinburgh" velocipede was advertised as having run four miles in 15 minutes. It might do that down-hill. On the road from Macclesfield to Buxton there is a gradual ascent of nearly six miles, and then it is a rapid five miles down-hill. The latter part of the journey might be accomplished in 18 minutes; but suppose you were only going seven miles an hour, and ran against a brick end left in the road which had been used by some carter to rest his horse with, why there would be a shock, and at the more rapid rate there might be a tipple. The inventor of the velocifere had better have one made (at his own expense) before coaxing any subscribers to your paper to make one themselves, and no doubt many gentlemen would be glad to witness the 15 miles an hour run so easily. I am not at all surprised at Query No. 2660 being in a fix with his ratchet, pawl, pulley, spring, &c. Depend upon it, the more simple these machines are constructed, the better they will go.

In answer to Query 2678, the "High Peak" velocipede is a moderately good travelling machine on the level and down hill. So are all three-wheelers where you drive from the crank under the seat, and steer from the front wheel, on condition that the machine is not over 76lb.; but, mind you, it is work going up hill. I have ridden the three-wheeler with the movement reversed—that is, I steered from behind, like a boat. This machine went splendidly up hill and on the level, but was dangerous down hill, because it tippled you out like a load of bricks. I have also gone out on the "Macclesfield" velocipede and the "English" velocipede, both of which are very useful and agreeable; easy to work up hill as well as down—in fact, I and a friend ran a mile-and-three-quarters, all up hill, the other day, in 10 minutes; but I prefer taking my time.

I don't believe in the bicycle movement, because the knee has to describe a circle, whereas the legs simply rock to and fro in the velocipede, which is less fatiguing. Watch a child seated on a form at school rocking its legs all day without any apparent trouble. I hope that all the subscribers now making their machines will look to simplicity of mechanism, and try to save weight and friction, which they will find to their advantage. A STRINGER.

HYGIENE OF VENTILATION.

SIR,—Many plans for effecting this desirable object have been carried out, both in public as well as in private buildings, and many more proposed, but all have, more or less, met with objections on various accounts, with the sole exception, I believe, of the Silvester system, adopted in the infirmary at Derby. The method proposed and published by me some years since, for the ventilation of phosphorus match manufactories, is simple in its character, and if properly carried out, would scarcely meet with objectors, and is quite independent of doors and windows. The principle is to cause the vitiated air to pass out through the floor, and the fresh to enter through a fine pierced ceiling in the following manner, namely. From the space between the floor and the ceiling below, lead off a tube or trunk into a chimney or air shaft, rising above the roof, capped with a direct-acting cowl, that is to say, *mouth from the wind*. In a similar manner lead off a flue from the space between the ceiling and the floor above, into another chimney or air shaft, capped with a reverse acting cowl, *mouth to the wind*.

In order to obtain a fine pierced ceiling, all we have to do is to leave out all the plastering on the laths, which in this case should be sawn, not split, and set close. Sawn laths would present an even surface for colouring in distemper, or other ornamentation. The pierced floor is produced by laying down a border of fine pierced thin metal, of sufficient breadth for the size of the room. If the automatic action of the atmosphere should be deemed inadequate to perform the office of perfect ventilation, a small stove may be placed somewhere in the upcast shaft, as is usual in our collieries. In more important cases, it may be advisable to adopt exhausting apparatus, set in motion by steam, gas, or water pressure, as in the present mode of blowing large organs; and it may be observed at the same time, that the friction of rarefied air in the exhausting process, is greatly less than that of compressed air in the blowing tubes, as proved by the fact that after a certain length, the most powerful blast will fail to put out a candle at the farther end, but by exhaustion it is immediately extinguished at the same distance.

There is an obstacle to the introduction of this mode of ventilation, that it cannot be the subject of a patent right, and therefore it is not very likely that it will ever be brought to bear. The products of the combustion of gas, or other lights, should always be carried off independently of ventilation by any mode by the arrangement perfected by the late Professor Faraday.

HENRY W. REVELEY, Reading.

CHOOSING ONE'S BELIEF.

SIR,—In the current number of our journal is a letter from "Saul Rymea" on the rotation of the earth &c., which, though an admirable letter in most respects, contains one statement which is decidedly wrong; he talks about people choosing their belief, now it is impossible for any man to choose his belief; for instance, just let "Saul Rymea" try to believe, say for half-an-hour, in the theories of "Parallax," John Hampden, or any of that fraternity, and he will see the impossibility of any one choosing his belief. There are many things which I should like to believe, but I cannot do so, the evidence is too strong the other way. I do not believe the earth to be flat like a pancake, but it is not from a wish to believe it globular, or rather spheroidal. I can no more doubt the form of the earth than I can doubt that the sun will rise to-morrow morning, and this is the case with everything else, from the greatest to the smallest. We must believe according to the evidence presented to our senses, and not according to our own wishes or choice.

T. COOKE.

ASTRONOMICAL.

SIR,—I thank "Omicron" for the explanation given as to the formula respecting the brilliancy of Venus. If he had time I could wish him to insert anew the formula given at page 614, Vol. X. for finding the longitude and latitude of a heavenly body from its right ascension and declination, it being impossible for young astronomers to make anything of it as there printed. Of course I am a little versed in these things or I should have been puzzled with it too.

G. FIRTH.

QUADRATICS REDUCIBLE TO QUADRATICS

(*Continued from page* 131.)

SIR,—"Bernardin" is correct in his supposition, but I intend simply going the shortest way to work in order to get the answers given by Mr. Todhunter. I think without egotism that I may say the solution given by me is similar to that which would be given by Mr. Todhunter himself, or I greatly mistake his letterpress upon the subject. But

(7.) $x + 2\sqrt{(ax)} + c = 0$

$$x + 2\sqrt{a}\sqrt{x} + (\sqrt{a})^2 = a - c$$

$$\sqrt{x} + \sqrt{a} = \pm (a - c)^{\frac{1}{2}}$$

$$\sqrt{x} = -\sqrt{a} \pm \sqrt{a - c}$$

$$x = \left\{-\sqrt{a} \pm \sqrt{a -}\right\}^2$$

(8.) $3x^4 - 7x^2 = 43076$

$$x^4 - \frac{7}{8}x^2 = \frac{43076}{8}$$

$$x^4 - \frac{7}{3}x^2 + \left(\frac{7}{6}\right)^2 = \frac{43076}{3} + \frac{49}{36} = \frac{516961}{36}$$

$$x^2 - \frac{7}{6} = \pm\sqrt{\frac{516961}{36}} = \pm\frac{719}{6}$$

$$x^2 = \pm\frac{719}{6} + \frac{7}{6} = \frac{726}{6}, \text{ or } 121$$

$$x = 11$$

(9.) $8x^n \sqrt[3]{x^n} + \dfrac{2x^n}{\sqrt[3]{x^n}} = 16.$

I should be glad if "Bernardin" would explain why such examples as the above are inserted. Like "Gimel," I do not for the life of me see their utility. As a tutor I know pupils hate and detest the sight of abstract questions containing the *nth* or any powers not expressed by arithmetical numbers. I scarcely see the use, therefore, of giving solutions to such questions, but to such as wish it the above may be solved by multiplying by $3\sqrt{x^n}$, then dividing by 3 and working as a quadratic. Unlike "Gimel," I believe algebra is extremely useful, as, in some future numbers, I will endeavour to show.

(10.) $x^{\frac{1}{3}} + \dfrac{5}{2x^{\frac{1}{3}}} = 3\frac{1}{4}$ (multiplying by $2x^{\frac{1}{3}}$)

$2x^{\frac{2}{3}} + 5 = \dfrac{13}{4}x^{\frac{1}{3}}$ (dividing by 2 and taking across).

$$x^{\frac{2}{3}} - \frac{13}{8}x^{\frac{1}{3}} = -5$$

$$x^{\frac{2}{3}} - \frac{13}{8}x^{\frac{1}{3}} + \left\{\frac{13}{8}\right\}^2 = -\frac{5}{2} + \frac{169}{4} = \frac{9}{64}$$

$$x^{\frac{1}{3}} - \frac{13}{8} = \pm\frac{3}{8},\ x^{\frac{1}{3}} = \pm\frac{3}{8} + \frac{13}{13} = 2, \text{ or } \frac{5}{4}$$

$$x = 8, \text{ or } \frac{125}{64}$$

C. H. W. B.

(*To be continued.*)

NEW PLANISPHERE.

SIR,—Having seen in this week's (May 6) MECH[illegible] and a
p. 167, an account of a new planisphere by [illegible] in a sepa-
of Greenock, I beg to say I have [illegible] quire some time
on the way for years, upon the [illegible] der it intelligible and
two discs, one opaque, and t[illegible]; these conditions [illegible]
which, when it is complete, will [illegible] ere ended the matt[illegible]
number of interesting problem[illegible] from Mr. Evans [illegible]
altitude and azimuth of any [illegible] hat the lathe belo[illegible]
luminary. When the British A[illegible] ely made at *his* fa[illegible]
wich, August, 1868, I applied [illegible] ving been prepar[illegible]
secretaries, the Rev. J. Cramp[illegible] beg to state, the [illegible]

much business having to be brought on, I did not get an introduction. Had I been able to have finished it in time I should have put it into the Exhibition of July next. **JOHN L. HAWKINS.**

SILVERING GLASS SPECULA.

SIR,—In reply to letter by Mr. James Gray, at p. 163, I beg to inform him that in silvering by the Rochelle salt plan, I found a marked improvement by *suspending* the glass in the liquor instead of covering the glass with it. I found in the latter way that a thick film formed on the upper surface of the pool of liquor, and this seemed to keep the light from the surface of the glass, and stop the action there, but when the speculum was reversed and hung as in Browning's method, the sun shone strongly through the glass; and by this means several very decent films have been obtained.

With respect to his query about the size of small mirror, if the question is not undeserving of a formula, I beg to send the following:—

Let A = the aperture of speculum
f = its focal length
a = aperture of field lens (lowest power)
d = the distance the image is thrown out from the axis of telescope
x = minor axis of small mirror

Then

$$x = \frac{d\,(A - a)}{f} + a$$

And if in his case we suppose the diameter of the field lens ¾in., and the image thrown out 7in., we have

$$x = \frac{7\,(6\frac{3}{4} - \frac{3}{4})}{64} + \frac{3}{4} = 1\tfrac{3}{8}\text{in. nearly.}$$

His mirror must not be less than this; he had better use one 1½in. **A. J. THOMAS.**

TO R. A. PROCTOR, ESQ.

SIR,—I am only a most unfortunate lover of science, and, as such, I most earnestly endeavour to keep myself apace with what appears in the scientific world, as much as I possibly can. Of course, I read your very able productions, both in English and French periodicals, and mainly in the ENGLISH MECHANIC. Not knowing your personal address, I venture to write to you through the medium of the latter most valuable paper, in the hope that these, my lines, will reach you. Being French, I beg you make allowance for my incorrect language.

Some time since I was struck in reading in a French review a few words on your new theory of the milky way. As it was but an abstract, I could not make much of it, and could guess nothing as to the principle and law upon which it stands; but I remained convinced that you are not acquainted with the physical law applicable to this great sidereal circle and its mode of formation, as when the law of a phenomenon is known all theories respecting it are at an end. I hope it will not be trespassing on politeness and personal respect and consideration to humbly tell you that such a law, such a mode of formation, are known, have been printed and published now for several years, and that, for me, at least, they do away with all uncertainty respecting the real nature of the galaxy, its form, composition, rules, &c., and its absolute mathematical connection with the universal sidereal system. The publication of the great work in which the details are contained was begun in 1858—12 years ago—but the part of it specially relating to celestial bodies and the galaxy, appeared in 1866, under the title "Physique Céleste;" it consists of about 3000 pp. 8vo., forming 3 volumes. When at Exeter, at the meeting of the British Association, in August last, I had the pleasure to present a copy of it to Mr. N. Lockyer. Since this I sent one to Mr. Warren-Delarue, and I should very much like to know the opinion of these savants upon works affecting so high a pretension.

In another number of the same French periodical I found, as translated from you, a "Mémoire préliminaire sur certains mouvements de translation des étoiles." This being more extensive, can fix one's mind upon its purport. After having read it, I feel convinced that you are yet seeking after a centre round which all the other sidereal bodies gravitate—a thing, again, that, unknown to you, no doubt, has been determined, printed, and published, long ago. In 1867 I took the liberty of sending to Mr. Glaisher, with a letter, a copy of a pamphlet entitled "Le Grand Soleil visible au centre du Système du Monde," with a celestial map representing the galaxy, with all the constellations, &c., and showing the universe in different aspects, according to physical laws. I of course expected from Mr. Glaisher what I never failed to obtain from English gentlemen—that is, at least an acknowledgment of the compliment paid him in my letter, and also of the receipt of the pamphlet. I was deceived in my expectation. Mr. Glaisher remained silent—which was very easy. I send with this letter one of these pamphlets, with a rough sketch (I cannot draw) of the celestial map, for your perusal.

Now will you allow me to present a few remarks upon your "Mémoires," from which I will make some quotations in French, as I do not possess the English text? You are made to say:—"J'ai trouvé que dans certaines parties du ciel, les étoiles manifestent une tendance bien marquée à si mouvais suivant une direction déterminée." May I be allowed to say, that many years ago, the very celebrated W. Herschel had observed it, not as a tendency, but as a fact; and that this great man for a long time sought for a central sun, which he considered as existing, our own sun having an orbituary motion round it? Later, Argelander made researches, but at a distance so far as 90° from its real place. He could not find it, and was then contradicted by J. Herschel, who was in the right; but as his father had attributed the movement of the bright stars to that of the sun, he dared not go farther.

"On ne peut que regarder comme trés significatif le fait que dans une grande partie du ciel il doit y avoir un mouvement commun, tel que je l'ai indiqué. Il me semble qu'on est force de considérer les étoiles qui présentent un mouvement commun de cette nature comme formant un système distinct dont les membres sont, il est vrai, associés au système de la voie lactée, mais qui sont plus liés entree eux."

What you say you have indicated is precisely what was first suggested years ago by Sir W. Herschel, and, as I said before, was actually discovered and published in France several years ago; therefore it is not a novelty.

"J'ai été amené à remarquer que le groupe nombreux d'étoiles autour di χ de Persée aitrouve presque exactement à l'intersection de la voie lactée et du grand cercle qu'on peut appeler l'équateur du mouvement solaire, cest-à-dire, du grand cercle qui a pour pôle le point vers lequel se dirige le soleil. Cette circonstance pourrait faire regarder ce groupe, plus qui celui des pleiades, comme le centre du système sideral, si ce système avait un centre que nous puissons reconnoitre." Certainly the sidereal system has a centre, and not only we *can*, but we *do* know it, and *we can see it* with naked eyes; but it is not in the direction of χ of Persee, which, relatively to our sun, is almost in the same direction as the Pleiades. The Hyades would be nearer still, as the real place is in the direction of the neck of the unicorn.

I do not think it necessary to enter into any more details on the subject, and beg respectfully to refer you to the annexed vouchers.

How fortunate you are in England! Whoever has a new idea or conception upon any hitherto unexplained subject is sure to find a press ready to make it public—nay, to take up matters so as to set forth any parcel of truth it may contain, and discussion never fails to anyone. Not so in France, I am sorry to say. Money is the only god now worshipped. No Editor will publish anything, however valuable, unless he is largely paid for it; and even under such conditions, if the new idea is likely to disagree with M.A.'s or M.B.'s theories, as these autorités savantes ordinarily bring water to the mill, there is no hope of our obtaining anything like publicity, were it for a Newtonian discovery. No one can form an idea of the check that science receives in France from the extinguishing power of *esprit de corps* and *journalism*. If we are now so far behind other nations, this is one of the principal causes. I tried to contend against such a regrettable state of things in creating the Réforme Scientifique, of which I here send a few numbers for your inspection, but I was not sufficiently supported. A thing worth mentioning, and for which I am grateful, is that English subscribers were my best supporters; some of them went so far as to offer me to double the price of subscription to enable me to go on, which, however, I did not do, being alone.

Should you think proper to answer this letter, and to make any remarks upon its contents, I should be very glad to see it in the ENGLISH MECHANIC.

CH. RABACHE, Morchain, Somme, France.

[M. Rabache complains of the want of freedom of discussion in France, and attributes to the Editors of French scientific journals the most mercenary motives. We believe the charge is untrue. If M. Rabache cannot get his communications inserted, let him seek for the solution of his non-success in *himself*. With the above letter he has sent us other contributions which would fill seven or eight of our columns, which we would not insert even if he paid us, unless the said contributions appeared amongst our advertisements. Our opinion is that M. Rabache's wordy, rambling, conjectural communications are not worth inserting, and in all probability Editors of French scientific papers are of the same opinion. In fact, M. Rabache is a scientific bore. Ordinarily, we should be more tender towards a foreigner, but as this one has not scrupled, as we think, to malign the motives of honourable men—some of whom we know to be zealous searchers after truth—it is requisite that things should be called by their right names. M. Rabache has mistaken his mission. We respectfully submit to his attentive consideration the papers on "Science for the Young," now appearing in our columns. Let him cultivate the spirit of a learner before he assumes the attitude of a teacher.—ED. E. M.]

PLATINISED GAUZE BATTERY.

SIR,—The platinized gauze battery, recommended by "Sigma," can be made with two pieces of gauze and a plate of thick amalgamated zinc, about the same size. Two thin strips of wood, or ebonite, should be put between the gauze and zinc, secured by a Smee's clamp. In making this form of battery, the gauze should be "dipped" in aqua fortis, *not dilute nitric acid*, and electrotyped by the single cell process, or by a Daniell's battery, it is then to be well plated with about 1oz. of silver to the square foot and platinised. Daniell's battery is the most suitable form that can be used for electro-plating on a small scale, but I have found nothing better than platinised carbon for gilding. **J. ROUND.**

THE TELESCOPE.—MR. BUCKINGHAM'S GIGANTIC REFRACTOR.

SIR,—Your able correspondent, "F.R.A.S.," p. 158, says, concerning this instrument, that "regarding its optical performance, we have as yet no definite report" published. Allow me to remind him, that at the meeting of the Society, January 14, 1870, and published, Mr. Buckingham said, he had been observing Jupiter before coming to the meeting, with the telescope referred to, which was 21¼in. aperture, and he found the reddish equatorial belt resolved itself into markings, apparently like marbles, with a whitish basis between them, suggesting the idea of clouds, and a photosphere visible below them. He had also noticed a new belt since yesterday, and mentioned some observations with the spectroscope. **T. V. B.**

SEWING MACHINES.

SIR,—I hail with delight the articles now appearing upon the sewing machine, considering as I do that the information contained therein will be productive of great good. It is in no fault-finding mood that I beg to draw your attention to one or two slight errors which occur in a letter, pp. 157 and 158. First, the Howe and Thomas shuttles are exactly the same in size as regards thickness. I measured a B Howe and a No. 2 7-16 Thomas, those being the corresponding machines. Thus, in this particular their virtues are equal. Then, as regards the quantity of thread the different shuttles hold, I find Singer holds most, Thomas next, and Howe the least, the Thomas shuttle reel being ⅛in. longer between brass ends, and also larger in diameter than Howe's. I quite agree with all that is said respecting the Singer shuttle, or crank action, it being far from correct. At the same time, the cams of the machines he mentions, in my opinion are far from being up to the mark. Let me begin with the Thomas cam. This moves the shuttle to its furthest extremity before the needle moves upwards; hence the needle thread is pulled up between end of shuttle carrier and shuttle, when the shuttle thread is at its tightest. This must injure the upper thread to a certain extent, and forces the operator to keep a loose tension in shuttle. Again, in the Howe the upper thread is pulled from between driver and shuttle at an angle, which also has the effect of injuring the upper thread, and causes irregularity in the stitching if the needle thread should be uneven.

Now, I have a machine on Howe's principle made by Messrs. Jones and Co., in which all this is obviated. The action of the cam forces the shuttle forward directly opposite the needle, then pauses while the needle in its upward movement, disengages the upper thread from between the shuttle and carrier, then, simultaneously with the needle, draws its thread tight. This, in my opinion, is the correct theory, and practice confirms it, as I find I can do tighter and better work on a machine of this description than on any of the others.

I have been a user for 12 years, during which time I have used the Thomas, the Singer, Howe (American), Bradbury (Howe principle), and Jones and Co.'s (Howe principle), all of which will do good work.

I should like to see "Practical Man's" opinion respecting the pause spoken of above. **STUDY.**

JUMPING FROM A TRAIN.

SIR,—The view expressed by "O. W. W. G." is undoubtedly the true one. I had not touched on the way in which the backward jump should be effected; only of *this* I was and am certain, from experiments of my own, that by jumping energetically backwards (really backwards as regards attitude, as well as regards motion of train or carriage) an important aliquot part of the forward motion may be neutralised. In the case of a runaway *open* carriage, I am certain, from experiments I made some years since from trucks moving at different rates, that a very sharp spring over the back of the carriage, all the energy of the body being employed to give motion horizontally from the carriage, would result in a very safe and easy fall, because one can neutralise the forward motion almost wholly. I am sure that in some instances where I tried the experiment, the velocity of the truck must have been very nearly equal to that of a runaway carriage; but the truck had no back, so that it was easy to give an energetic spring.

R. A. PROCTOR.

DARK LINES IN SOLAR SPECTRUM.

SIR,—Your comments on "T. A.'s" letter leave nothing to be said by me on the point you deal with.

As regards "T. A.'s" doubts, I could have resolved them at once, had he, in his first letter, simply asked on what evidence physicists grounded their belief that the dark lines in the solar spectrum are not due to our own atmosphere.

Long before Kirchhoff's great discovery (admirably described by "F.R.A.S." in the last number of the MECHANIC), Brewster had noticed that certain dark lines make their appearance when the sun is low. These are doubtless atmospheric. On the other hand, there are certain lines and nebulous bands (doubtless resolvable into lines) which are only seen, at least with ordinary spectroscopic power, when the sun is high. These are doubtless true solar lines, so faint as to be very readily obliterated. The remaining lines continue visible whether the sun is high or low. Nor do they grow *narrow*, as "T. A." supposes they should when the sun sinks low. It is contrary to the very essence and principles of spectroscopic science that they should do so, or, conversely, that the atmospheric lines should grow *wider* as the sun sinks low. What really happens is, that the latter lines grow *darker*, because as the sun sinks he shines through a greater and greater depth of our atmosphere, and so the atmosphere more completely absorbs those rays which its vapours have power to affect. Rays of greater or less refrangibility (that is, rays falling on either side of any atmospheric dark lines) our atmosphere cannot affect, let its density be increased ever so.

Now, it might seem that, by parity of reasoning, the *solar* dark lines should grow fainter as the sun sinks, but on consideration "T. A." will see that they will continue relatively as strong, whether the sun is high or low; for our atmosphere neither adds to nor subtracts from the quantity of solar vapour through which these rays have passed. The spectrum grows fainter, however, as the sun sinks, and so the solar lines do undoubtedly, *pro tanto*, diminish in distinctness.

I cannot close this letter without gently reminding "T. A." that our physicists are too earnestly engaged in seeking after truth to overlook such very obvious considerations as are sometimes urged against their theories. Let me quote one passage, in which Kirchhoff presents a portion of his results, in order that the spirit of the true man of science may be recognised by "T. A." and others:—

"The observed phenomenon may be explained by the supposition that the rays of light which form the solar spectrum have passed through the vapour of iron, and have thus suffered the absorption which the vapour of iron must exert. As this is the only assignable cause of this coincidence, the supposition appears to be a necessary one. These iron vapours might be contained either in the atmosphere of the sun or in that of the earth. But it is not easy to understand how our atmosphere can contain such a quantity of iron vapour as would produce the very distinct absorption lines, which we see in the solar spectrum. And this supposition is rendered still less probable by the fact that these lines do not appreciably alter when the sun approaches the horizon. It does not, on the other hand, seem at all unlikely, owing to the high temperature which we must suppose the sun's atmosphere to possess, that such vapours should be present in it. Hence my observations of the solar spectrum appear to me to prove the presence of iron vapour in the solar atmosphere with as great a degree of certainty as we can attain in any question of natural science."

This patient labourer in the field of arduous research, this cautious and clear-sighted reasoner, this modest and unpretending philosopher, is one of the "tricky knaves," the "shifty, dodgy liars" of Mr. Hampden; is "one of the class of men who, next to horse-dealers and jockeys, bear the unenviable reputation of being the most tricky and unscrupulous in their assertions." And of Mr. Hampden let me say this, in passing:—I think nothing he might write, or say, or do, could by any possibility cause scientific men even a passing annoyance; but I do hope that he will never so far try their patience as to endeavour to fix on them the stigma and deep disgrace of his approval.

R. A. Proctor.

COILS.

Sir,—Seeing D. Forbes's description of his coil (3715, p. 160), I think it a wise decision on his part to let his coil alone, for it is a very disproportionate-sized one, and I doubt if he could lengthen the spark either by winding over again, or adding more wire. The size core generally used for a coil 12in. long is about 1in. diameter (8 times the size of his wire. The variety known as "soft charcoal," is the best for cores. He seems to have rather a queer notion with respect to the secondary. He says "he made his coil . . . with a disc in the centre dividing the secondary in two, joined by *a piece of copper* at the bottom of the centre disc going through the disc." The usual way to divide the secondary is to wind a layer the whole length of the reel, insulate it all along with about 6 layers of tissue, then slip the disc over it and fix it there with paraffin wax, and wind away back to ¼in. or ⅜in. of the disc. This is rather different to joining the sec. by a "piece of copper," which, I presume, means a slip of copper. I make it a practise to seal up the edges of the tissue which are left against the sides of the ends and disc with paraffin. The spark, which might otherwise travel along the tissue down to the next layer by the absence of insulation (being prevented by the thickness from going through it) would (by sealing the tissue up against the sides) be prevented from passing. I should recommend him to use a glass or vulcanite tube ¼in. thick to enclose the core, and wind the primary directly on to it, covering the wire when wound well with insulation, and then wind the sec. on this, dispensing with lignum vitæ reels altogether. He ought to put 8lb. instead of 4lb. of sec. on a coil 12in. long, and get a 7in. spark from it. He could not use a better wire than No. 36; if he used thinner the spark would certainly be longer, but it would be thin and wiry—of no use in some experiments. The best wire for primary would be No. 12 cotton. Two layers of this would be sufficient, taking nearly 5lb. for the two. If he used a thinner wire, he would have to use more layers to magnetise the core to the same extent with a given battery power.

In addition to G. P. tissue, I find paper soaked in melted paraffin an excellent insulating material. Unsized newspaper is the most preferable for this.

I hope these will be the suggestions he asks for; being based on experience, I am sure of their correctness.

A. E. Tucker.

THE EARTH'S FIGURE AND ROTATION.

Sir,—Now that Mr. Beardsley has so kindly come forward to put us right upon the above subjects, I think we must not let him go without getting an explanation of all the appearances, celestial and otherwise, which are commonly said to result from the facts that the earth does rotate, and is of a round shape. For example, the shadow thrown on the moon in an eclipse, the fact of circumnavigation having been effected, coupled with the circumstance that ships are a day out in their reckoning of the time, one way or another, according to the direction in which the voyage is performed, and several other little circumstances which we must not fail to put him in mind of. It is rather too bad to expect such men as Mr. Proctor to waste time and trouble about such matters; it is like getting a professor of six or seven languages to argue with a precocious juvenile who insists that the alphabet is all wrong because the letter O is made round instead of square. I admire Mr. Beardsley's diagram of the sun's apparent diurnal motion, but can't make out how he brings the sun back so as to start all right in the morning. But this is an "error of vision" on my part, no doubt. You see I do not argue on the subjects I mention above, because they are in every book on Natural Philosophy, and do not therefore require repetition. I will undertake to find Mr. Beardsley in things to explain—and some uncomfortable things, too—which he will find not so easy as he thinks, judging by the style of his letters. To my eye the roundness of a dew-drop is quite sufficient proof of the shape of the earth, considering who was the Architect of both. Mr. Beardsley says he does not hold that the earth is a vast plane. If not a plane, and not a sphere, what shape is she? Sack-bag shape, perhaps, which is neither round, square, nor oval, as I once heard. He ought at least to let us know what shape she really is, as otherwise some nervous individuals may fear to go out after dark, as they will fancy every bank to be an edge over which they may tumble into space.

H. G, Salop.

THE MOA OR DINORNIS.

Sir,—I am glad to see "Urban" has returned to the ranks of "our" correspondents, and note his reminder of an old discussion, as to his last remarks on which some time since I intended to have said something. He refers to a letter in *Nature* arguing the probability that the Moa existed during comparatively very recent periods, and was known to the present aboriginal races. It is, of course, impossible to come to any certainty on such a subject, and I do not pretend to any actual knowledge. The discussion, if it can be called such, arose from a joke of mine as to the cause of cannibalism being the want of animal food; "Urban" suggested that the cannibal New Zealanders had the Moa in abundance. The letter now referred to was called forth by a report of a German *savan* who has been exploring New Zealand, and come to the conclusion that the Moa had been extinct many hundreds of years, which is my view of the matter, and, further, he says that he had examined the remains of ancient encampments, analagous to those our savage ancestors have left in old caves, and found many bones of the Moa, but mostly of the small species, and with them those of dogs, gulls, and whales, but found no human bones, indicating the probability that the race which had these sources of food *were not cannibals.*

I was much interested by "Urban's" last letter on the subject referring to Arabic records, but I must say that, in my present state of information as to these, I feel a strong conviction these are misunderstood. My acquaintance with Arab seamen, and especially Arab vessels, even of the present day, does not induce me to think it likely that they had explored the southern seas in the 13th century.

These early Arab navigators were but wandering merchants seeking markets, or else pirates looking for goods and people to steal as they do to this day; but they were miserably equipped, provided only for short coasting trips, and without incentive to urge, or knowledge to give them courage to traverse unknown seas out of sight of land: and, further, they were unmitigated liars, as also they remain, and their tales have little more value than those of the celebrated *voyageur* Sindbad, whose "roc," by-the-bye, was no doubt based upon some accounts of these very birds, and others of similar magnitude, natives not of New Zealand, however, but of Madagascar.

At the same time it is just possible that creeping about among the eastern islands, some stragglers might have found their way through Torres Straits or round New Guinea, and then blundering on the north of Australia, been blown out to sea and struck New Zealand. The difficulty would be, in such a case (and by such means these islands were probably peopled), how they got back again, with the then existing knowledge of navigation, and unaided by the compass, unless they picked that up from some far travelling Chinese junk, as that now stagnant race of early inventors claim to have known this instrument from very early times.

However, if the Arabs spoke truly, all they prove is that the Moa existed while New Zealand was *uninhabited.* That by no means prevents the conclusion that they were soon killed off by the early settlers, most likely shipwrecked and starving, and that cannabalism arose after the supply was exhausted.

Sigma.

TURNER'S ENGINE LUBRICATOR.

Sir,—I intended writing last week about the description given by Messrs. Turner of their lubricator; however, I find another correspondent ("B. W. R.") has in this week's number noticed it. I, like "B. W. R.," would like to know in what part consists the patent, because some few years ago a lubricator of the very same principle was made near Manchester, and I am informed that the maker ceased making them. I went, about two years ago, to Rochdale, to see one of these lubricators at work, but I did not like the principle of it, as it appeared very clumsy, and too much complicated; and furthermore, I thought there would be great difficulty in preventing the tallow passing the piston or plunger of the lubricator from the underside of plunger to the top side. Again, there was also a disadvantage in having to reverse the piston or plunger by hand labour to refill. However, I was at that time looking out for the best self-acting lubricator that would lubricate the valves and pistons efficiently (working 70lb. pressure per square inch), and a few months afterwards I was informed that a Mr. Butterworth, of Oldham, had taken out a patent for a lubricator that would suit me. Of course, I first saw the principle, and approved of it. It is now about eighteen months since we had the first one applied; we have now four of them working. I can assure my brother engineers that they have been a great assistance to me; they require no attention, only keeping clean.

For the information of my brother engineers, I can only say that I have not as yet seen any to surpass them, as they supply the valves and pistons constantly with the lubricant when the engines are at work, and the supply can be regulated at will. They work so easy, that they require not to be screwed down. The tallow can be put in the box while working; it starts and stops with the engine.

I have been looking over my back numbers, and I find it was illustrated in our English Mechanic of January 29, 1869.

Engineer.

EXTRACTS FROM CORRESPONDENCE.

COMMERCE AND TRADE.—"Herbert" says:—"In answer to the query of 'Saul Rymes,' who quotes the sum of the imports into the United Kingdom for 1868 as £294,693,608, and the exports as £179,677,812, I say that those figures indicate a very lucrative trade. If I freight a ship with a cargo which costs me £18,000, and she brings me back a cargo in lieu of it, of the value of £29,000, I think my trade would be very 'prosperous.' Now, if I individually should prosper doing a trade giving such returns, so does the nation of which I form an unit."

STAINING OAK.—"Faber" writes:—"Some time ago one of your correspondents asked the above question. I was anxious to see a reply, but looked in vain. I have since tried several experiments with acids, and find the best stain to be equal parts of American potash and pearl ash—2d. worth of each to about a quart of water. This will give a strong stain, it requires careful application, as the American potash is a strong solvent and will blister the hands; it softens a good paint brush once using, so I get a very common brush, and apply the staining with it. I keep it corked up in a bottle, and it is always ready for use; if it strikes too deep a colour add more water."

THE "HARMONIOUS BLACKSMITH."—"P. A. F., Rugby" writes:—"Thanks to our harmonious friend for his extract from 'non-historic times' on 'ancient architectural remains in India,' but why did he not give us the source from whence he drew his ideas? unless the "H. B." is in reality either Sir John Lubbock or the 'Quarterly Reviewer' in disguise."

[Possibly the "H. B." is the latter.]

THE PEDESPEDE.—S. F. Shakespeare, of Thrapstone, says:—"I see your remarks in the Mechanic of May 6th, inst., about the pedespede invention. I regret you seem doubtful, and appear to think it must be hurtful to any one using them. I, however, beg to assure you this is not the case. By the appliances I make use of in those I constructed, no danger would arise, whilst every comfort is allowed for the person using them, as he is able to use his feet and ankles easily, the same as during skating on the ice."

ALGEBRA.—"T. J. O'C." observes:—"Since almost every arithmetical solution which appears in the pages of our valuable journal is solved by means of algebra, and knowing that there are several brother readers complete masters of this beautiful science, I hope that some of them will lend his helping-hand during his leisure moments, and confer on his brother readers a short discourse on this valuable science."

THE "PHANTOM" VELOCE.—The following are extracts from letters just received:—"I wish Mr. E. M. T. Tydeman lived in my neighbourhood (Marlborough), to mount my 'Phantom' just once. He would then be convinced that he has made a great mistake in speaking against the 'Phantom' with rubber tires, as certainly there is no comparison with ordinary wheels. The nearest I can compare is riding in a broad-wheeled waggon full trot and the riding in a carriage."—G. Jones.—Mr. St. John T. Gore, of Eaton Place, Guernsey, says:—"Having noticed a letter from Mr. G. Sykes, of Huddersfield, relative to the 'Phantom' wheel, as made by the 'Phantom' Wheel Company, I think it only fair (especially after a letter from a Mr. Tydeman that appeared in your paper some little time since) to state that having tried a pair of the above wheels, with india-rubber tires, in my bicycle, for the last three weeks, I can fully endorse Mr. Sykes' statements concerning them in every particular, with the exception, perhaps of the weight, although they are undoubtedly lighter than many bicycle wheels."—G. S. Cole, Sea Side, Llanelly, says:—"Having the front wheel of my bicycle broken, I sent for one of the rubber-tiered 'Phantom' wheels, with axle, cranks and pedals complete; and I am of the same opinion as Mr. Sturges, of Huddersfield, respecting it; and I may add that several from the town and neigbourhood have sent, and are about sending for the same. "C. H. Maxsted, of Castle Park, Lancaster," says:—"I have tried the 'Phantom' veloce wheel, and find it much superior *to the* ordinary wheel, and fully endorse Mr. Sykes's sentiments."

REPLIES TO QUERIES.

[2007.]—TEMPERING DRILLS.—Once more! 'Tis a pity "S. T." should pass unanswered, since he took so much pains to get off the printer's shoulders, where he was so considerately placed by "J. B." Steel is hardened by being heated to redness and then quenched suddenly in some cold fluid. Tempering is not hardening, as "S. T." affirms in the sentence led off by that word, page 189, but a means of reducing the brittleness of hardened steel, which unhappily cannot be performed without reducing also the degree of hardness. Annealing either hardened or soft steel consists in heating to redness and allowing it slowly to cool; the effect of which in the case of soft steel is rather doubtful, unless performed in charcoal dust. If "S. T." can either harden or temper by the process bearing his signature, which we have in good set terms and black and white at page 19—namely, "Heat your drill to a dull red, allow it slowly to cool," &c., we can also give him credit for being able to shut his eyes by holding his breath. At any rate, if he will not see now that he is, to say the least, confounding two different things, he is shutting his eyes with a vengeance somehow or other. The whole of his "reply to the criticisms of 'J. B.'" is nothing in the world but making a rope of sand. It is curious to notice how correspondents, when set right, show at once if they feel themselves equivocally placed, by assuming the circumlocutive style.—Nobody.

[2374.]—BREWING.—"New Subscriber" begs to thank "A Reader of Old Books" and "W. L." for their information. He has just received a very elaborate work, but shall bear "W. L." in mind.

[2402.]—ELECTRIC BELLS AND BATTERIES.—If A. Spencer winds his coils with about 3oz. of No. 28 silk-covered wire, and uses 2 cells of manganese, or 3 cells of sulphate of lead battery, as described by me in the same number of our Mechanic as that in which his query appears he will find his bell will ring furiously.—A Good Boy.

[2522.]—SHEET IRON RUDDER.—Some people are not content with having a canoe with as few appurtenances as possible, but invariably endeavour to convert it into a floating lumber shop, carrying two masts instead of one, which is quite sufficient if there is anything fit to be called a sail for it; a jib which is no use, a boat-hook, or shoving pole, creep, cable, cook-trap, mats, portmanteau, and other appliances necessary for a larger craft, but no use in this case; also a rudder, which a canoe has no business with, as the paddle answers the purpose much better.—MATY.

[2531]—BRAZING CAST-IRON.—Cast-iron will not braze, if well tinned it can be burnt with brass in the manner described by "Blue Ruin," if "Reciprocity" will inquire he will find it was done so.—N. L.

[2563.]—VENEERS FOR HARMONIUM PANS.—In response to the hint conveyed in "Eleve's" most welcome letter. I beg to inform "Valve," that he will find great difficulty in obtaining beech veneers, such as he requires. I have myself used sycamore instead of beech, and find it answers admirably; it can be readily procured at any good timber yard. The use of sycamore was first suggested to me by "Eleve"; and like all his suggestions, it proved a really good one, as it is a wood which is most easily worked, and therefore well suited for an amateur's use.—TREMOLO.

[2582.]—WEIGHT OF FRUSTUM.—To "BERNARDIN."—Upon second working out of this problem, I find the weight of the whole frustum as sent in by myself a fortnight ago to be wrong. As it appears we have worked it out by the same formula:—

$$\checkmark = \frac{H\pi}{3}(R^2 + r^2 + Rr)$$

the same result ought to be obtained, when correctly calculated. Nevertheless if the values as given are substituted in the same, we receive:—

$$\checkmark = 4 \times 3\cdot1416\ (4 + 1 + 2 \times 1) = 12\cdot5664 \times 10 = \\ = 125\cdot664 \text{ cub. ft.,}$$

therefore its weight

$$= 125\cdot664 \times 440\text{lb.} = 55292\cdot160\text{lb.}$$

Or, reduced to tons

$$= \frac{55292\cdot160}{2240} = 24\cdot68 \text{ tons,}$$

whereas your result appears (agreeing very nearly with Mr. Wilson's to be 17·28 tons. I should feel obliged if you can tell me what causes the difference?—A. TOLHAUSEN.

[2582.]—WEIGHT OF FRUSTUM.—My diagram was stuck up at the top of centre column, p. 188, and the solution at bottom of third ditto. I think mine is correct, except two printer's errors, and simpler than others. Tolhausen puts letters for *known* quantities.—J. K. P.

[2600.]—CLEANING OF DIATOMS.—The filamentous matter that has tried "Beaton's" patience so much in attempting to remove it from his diatoms, is probably the remains of some confervoid growth gathered with the diatoms, and which acid will not entirely remove. The best plan that I have yet met with to get rid of it is to put the boiling of diatoms into a stoppered bottle holding about 6 or 8 ounces, adding clear filtered water until the bottle is about half full; insert the stopper and shake the bottle vigorously for several minutes. This proceeding will break up the flocculent matter into small particles, which, when the bottle is left to stand, will not subside so rapidly as the diatoms; and much of it may be poured off with the water after about an hour's subsidence, taking care not to pour off too closely. Repeat the process a few times, observing to shake well after each addition of fresh water.—W. W.

[2630.]—CANOE STRAKES.—The strakes are put together with copper nails and washers (otherwise known as burrs or rooves), the edges of the planks must be champered off sufficiently to fit them (no one can fit a sharp edge to a flat surface); the allowance for overlap to seams is ⅛th of an inch, which is sufficient. No caulking is necessary to seams when planks are properly put together.—MATY.

[2638.]—MAKING BUTTER.—In France they bury the cream in thick sacks under ground about 6ft for 24 hours, and when they take it up it is sweet butter and butter milk, which is then washed well in salted water.—SCORPIO.

[2640.]—GIRDER PATTERNS.—To bend the pattern will not do much good, for the moulder would ram it out of shape. Patterns are commonly made straight. When the moulder rams it up in the sand he applies a straight edge along the pattern, then knocks it down at the ends to suit his requirements. In well regulated foundries the foreman sees it is done right, it is one of those things where one ounce of practice is worth more than a pound of theory.—N. L.

[2645.]—IMPERFECT TWO MANUAL ORGAN.—Reed stops are usually troublesome, especially the upper notes, which in some measure accounts for the extra tuning the clarion requires. Reed stops will have a settling point in spite of the tuner. If "Antidiscord" will first tune the reeds with the wire, and use the organ a few hours, until the reeds are thoroughly settled; tune again (say next day) with shades, which must be soldered on the pipe tops for the purpose, a satisfactory result will be had.—T. TAYLOR, Leicester.

[2646.]—GILDING PLATE-GLASS.—I would advise "Blackburn" to prepare size from some of the cleanest filtered water boiled in a small pan, and a few shreds of best isinglass dropped in and kept boiling until the same is dissolved, Remove any scum from the top of size, and it is then ready for use. See that the glass, brush, and size is clean—perfectly so. When this is done apply the size with camel-hair tool, and gold-leaf to follow at once. Put aside till dry, and piece up imperfections, as stated above.—PAINTER.

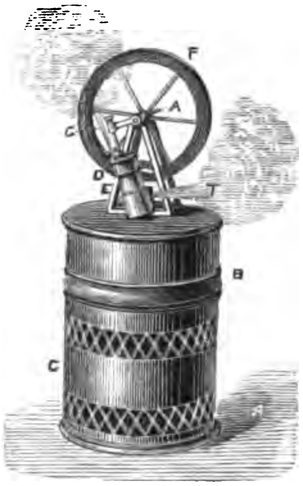
[2648.]—CARDING ENGINE.—I presume your correspondent wishes to know which is preferable, the hand strickle or the roller. For my own part, I think that both claim a share of our patronage. The hand strickle is a very easy, cheap, and (with care) an efficient way of grinding; yet however careful the person may be, he cannot avoid putting it on heavier in some places than others, therefore the roller is a useful—I may say indispensable—commodity for keeping the wires perfectly true—the one great desideratum in grinding. The system I adopt, is to have the cards ground every morning with the hand strickle, and the roller put on once a week, and I find it to act better than anything I have yet tried.—THE HARMONIOUS COTTON SPINNER.

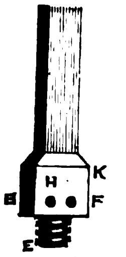
[2650.]—MAP PROJECTION.—There is a small atlas, published by E. Standford, 6, Charing-cross, called, "An Elementary Atlas," chiefly for map drawing, &c., by the Rev. J. P. Faunthorpe, B.A., F.R.G.S., which contains a concise dissertation upon map drawing. The price of this book I do not know exactly, but should say it is about 2s. 6d.—F.R.G.S.

[2651.]—LECLANCHE BATTERY.—"Telos" will find several communications by W. H. Stone, and one from A. J. Jarman, page 38, present volume, which fully answer what he requires, but is he sure his porous cells require recharging? Unless they have been in use some years they should not do so. Let him take the porous cells and put them into clean water a few hours, and then try them, as the sal-ammoniac fills up the pores of the porous pots by crystallising upon them, which only requires to be dissolved to be as good as new. Would "Telos" say in what respect the patent cells in his possession differ from those of ordinary make? I would draw his attention to a communication by "Sigma" in the number for April 15th, page 93, upon whose opinion I place the highest value, as I have proved it over and over again.—A GOOD BOY.

[2671.]—CANOE BUILDING.—The planks composing the skin of the boat, are first built up from the keel, after which the ribs are put in to strengthen and keep the skin in shape; the strakes, while building, are kept to curve by means of sticks, termed shores, to shore the plank up or down, whichever is necessary; the planks are gummed together with copper nails and burrs.—MATY.

[2676.]—MODEL STEAM ENGINE.—In reply to "C. R." I enclose the following sketch of a model vertical engine. On referring to the figure, B is the boiler, C the furnace, E the cylinder, D the feed plug (out of sight), G the crosshead, F flywheel, A the axle and crank, T the exhaust steam from cylinder. On filling the lamp with methylated spirit the steam will soon be raised, which will be indicated by a slight escape of steam at the safety valve. (Never use an engine without a safety valve, as the consequences may be serious.) The action of working is as follows:—The steam enters the steam block K at E, and up a hole drilled through and out at the hole F into a corresponding one in the cylinder, which oscillates on an axis just above the steam block. On the down stroke of the cylinder, the cylinder being at a reverse angle to that on the steam entering it, the steam rushes out of the cylinder at H, and escapes into the air at B. I hope "C. R." will understand my explanation and my drawing.—ANON.





[2679.]—CURLING HORSE HAIR.—The hair must first be washed in lime and water to cleanse it from the filth and impurities that adhere to it, then dried, afterwards it is spun into a rope of one fold ⅜" dia., when that is done the rope must be twisted very hard till it is kinked from end to end, so that it appears 1⅛" dia., (it is the kinking that makes the curl), it is then put in an oven on a wooden frame and roasted or dried for 24 hours at a heat about 212°, but experience is the best guide. Feathers are washed in lime and water, then soda and water; after being drained and dried they are smoked with sulphur fumes, and well beat with canes.—W. W.

[2682.]—TO "OMICRON."—I have never been a double star measurer, and my micrometer would be quite unequal, for want of power, to cope with so minute an object; all I can say is, that with a power of 450, I caught occasionally a momentary black separation between A and B ζ Cancri, on March 29 and 33, which in the better air of March 31 and April 4, was quite evident. I believe B lay in the *s p* quadrant: the distance I estimated about 0″·7, but this would be worthy of very little confidence, probably it might be less. I have never looked at ζ Herculis, since the re-appearance of the companion, in weather fine enough to show it with any certainty.—T. W. WEBB.

[2687.]—DUSTING BRASS MOULDS.—Charcoal will do if you use facing sand, but it makes the castings look black, like iron, different places use different stuffs. The commonest are common flour, potato flour, and peameal, if the castings are heavy it is a good thing to use weak facing sand to face them, say about the half of the coaldust that is used for iron; for cores, dry sand, and loam work, use charcoal blackwash the same as for iron, only thinner, just black water merely.—N. L.

[2689.]—TURBINE.—In answer to "Simpleton," I would advise him to write to Messrs. Williamson, Bros., Canal Iron Works, Kendal.—PRACTICAL.

[2695.]—GEOGRAPHICAL.—The most likely place to obtain the information desired, will be in some "local history." I have consulted "Words and Places," by the Rev. J. Taylor, which is a standard work upon this subject, but have not as yet found any mention of these names.—F.R.G.S.

[2696.]—CLEANING FLAGS.—Rub the flags with turpentine, and it will dissolve the tar.—SCORPIO.

[2697.]—CANARY.—I hope "Minnehaha" has not joined the Society for the Expression of Cruelty, and placed the bird in a draughty situation—always productive in delicate lungs, of asthma, &c. Remedy—warmth, and a cover to all cages, invalid or not, at night. By care, my birds live long, one 24 years. Give plenty of groundsel, called poison by some new beginners.—HENRY ALLEN.

[3708.]—CARBONIC OXIDE.—Carbon should be put into a retort, or glass flask, fitted with a bent tube, some crystallised oxalic acid, and pour upon it five times its weight of oil of vitriol. On applying heat the mixture is resolved into water, carbonic acid, and carbonic oxide; pass the gas through a strong solution of caustic potash, the carbonic acid will be entirely absorbed, the carbonic oxide remaining unchanged. Another method is to heat finely-powdered prussiate of potash with nine times its weight of concentrated oil of vitriol; carbonic oxide is given off, which may be collected over water. I presume "Carbon" has some knowledge of chemical experiments, if not he can hardly ensure success.—R. HODDER.

[3708.]—CARBONIC MONOXIDE.—I beg to inform "Carbon" that carbonic monoxide can be prepared in 4 other ways besides the two he names.

(1.) By heating oxalic acid with hydric sulphate.

$$\left\{\begin{matrix}COHo\\COHo\end{matrix}\right. + S^{iv}O_2Ho_2 = CO_2 + C''O + OH_2 + \\ S^{vi}O_2HO_2$$

The oxalic acid is resolved, by means of the hydric sulphate into its constituent, carbonic dioxide, carbonic monoxide and hydric oxide. The dioxide may be separated from the monoxide by passing the mixed gases through a solution of potassic hydrate, which absorbs the former.

(2.) By heating potassic ferrocyanide (yellow prussiate of potash) with hydric sulphate

$$Fe''(Cu''')_2 4KCn + 6S^{vi}O_2Ho_2 + 7OH_2 = 2S^{vi}O_2KO_2 \\ + 3S^{vi}O_2(N^vH_4O)_2 + S^{vi}OHo_2Feo'' + 6C''O$$

That is, potassic ferrocyanide, hydric sulphate and water give potassic sulphate, ammonic sulphate, ferrous sulphate and carbonic monoxide.

(3.) Heat iron or zinc with any carbonate.

Take zinc and potassic carbonic

$$COKo_2 + Zn = OK_2 + ZnO + C''O$$

Which give potassic oxide, zincic oxide (which two substances form, when amalgamated, potassic zinc K_2ZnO_2) and carbonic monoxide.

(4.) By taking the elements of water from hydric formiat. This is done by adding hydric sulphate (which has a very great attraction for water) and applying heat

$$C\begin{matrix}Ho\\Ho\end{matrix} + S^{vi}O_2Ho_2 = C''O + S^{vi}O_2Ho_2 + OH_2$$

In this reaction, as also in the reaction of the first method, the hydric sulphate remains unaltered. Chloride of tin can obtained from Jackson and Townson's 89, Bishopsgate Within, for 4d. an ounce.—EDWARD HEARD, A.A.

[3709.]—TURNING.—An amateur never will find a coarse sharp new file remove the scale from his castings, which ought to have been first pickled, but from his description, I fancy that the castings are not good, and that the interior of the metal is full of the oxide of zinc, which has a much worse action on the tools than any sandy surface. The rest of his question is obscure.—Q. YORKE.

[3710.]—ARITHMETICAL QUESTIONS.—Every circle is equal to a parallelogram whose length is equal to half the circumference, and the breadth equal to half the diameter; and as the area of a parallelogram is found by multiplying the length by the breadth, it is evident that the area of a circle will be found by multiplying half the circumference by half the diameter, and as 3·1416 is the circumference when the diameter is 1·, therefore if half 3·1416, which is 1·5708, be multiplied by ·5 (half of 1·, the diameter), the product will be ·7854, the area of circle whose diameter is 1·.—J. SHARP.

[3711.]—CUSTOMS EXAMINATION PAPER.—"R. P." should obtain the Report of the Civil Service Commissioners, or obtain the information from some friend who has passed the examination. Further information will be gladly given.—R. HODDER.

[3717.]—COPPER AND SILVER COINS.—In answer to my friend Mr. Samuel Smith, I beg to inform him that his large silver coin is very similar to an Indian rupee, though, not having studied foreign coins very much, I cannot speak possibly on the subject. Mr. Batty, whose speciality is the knowledge of tokens, will no doubt be able to give some information concerning the copper one.—HENRY W. HENFREY, M.N.S., &c., &c.

[3718.] — TALL CHIMNEYS. — ST. ROLLOX'S CHEMICAL WORKS, GLASGOW.—Heigt (total) 447ft. 6in; height (above surface), 432ft. 6in.; diameter at base, 45ft.; diameter at surface, 40ft.; diameter at top, 13ft. 6in.: thickness at bottom, 3½ bricks; thickness at top, 1½ bricks; internal flue 260ft. high; perfectly vertical.—"Engineer and Contractor's Pocket Book for 1858." I have a working drawing of a chimney about 120ft. high above surface which I can lend "Gainsboro," if he will promise to be very careful of it, and return it soon.—J. K. P.

[3718.]—TALL CHIMNEYS.—The dimensions of the tallest chimney in the world, that at Townsend's Chemical Works, Glasgow, are as follows:—Height 468ft., outside diam., at bottom 32ft., and at top 12ft. 8in; thickness at bottom 7 bricks, and at top 1½ bricks. The St. Rollox Chemical Works stalk is 435ft. high.

and 30ft. outside diam. at base; the rest of the sizes I do not know.—R. H. M.

[3720.]—BONE BLEACHING.—"O. S." will find frying his bones in turpentine bleach them entirely, but make them more brittle by so dissolving the albumen. For small pieces, take a common frying-pan and provide a lid to it, say a piece of sheet iron or tin plate, which have handy to apply instantly in case the turpentine takes fire, which would be bad to allow to proceed for many reasons. The time for keeping the bones in the turpentine depends much on their condition, and experience alone would teach.—Q. YORKE.

[3728.]—CURIOUS CHUCKS, BY "W. J."—I have never seen one of these chucks, but I have no doubt but that the three pins or catches in the centre are forced out by a spring on the unscrewing of the half of the chuck (a cut for which I perceive in the engraving), and thus admitting the piece of iron, &c., which on being rescrewed forces the said catches by the hollow in the centre of the said half being formed in the shape of a cone, and thus rendering it a true centre chuck.—A GUERNSEY AMATEUR.

[3736.] — GENEVA CYLINDER. — In reply to "Cyl," the callipers used are similar to the smaller pair of compasses that have a tail or handle, usually contained in a superior case of drawing instruments; only where the points draw out to be replaced by the pen or pencil, a screw with a nut on one end of it passes through holes in both the legs. The legs are flat instead of triangular, and spring like a pair of sugar-tongs where the compass opens and shuts with a joint. I do not know how any other tool could be made on take these heights, or how it could be used supposing one made. "Cyl" could take his height on a slip of paper, or wood, or wire, and send it through the post to the tool shop, stating at the same time it was the height from the 'scape wheel to the end of the pivot.—NOBODY.

[3739.]—CHLORIDE OF TIN.—"Amator Scientiæ" may succeed by asking for muriate of tin, salts of tin, or butter of tin. He can easily make it by dissolving tin in hydrochloric acid. (best in a copper vessel), having the tin in excess. On evaporating the liquid the salt crystallises out in prismatic needles.—R. HODDER.

[3741.]—TURBINE.—A turbine was a few years since at work at the paper mills, Chafford, near Tunbridge Wells. A letter addressed to the proprietor, Turner, Esq., will no doubt enable "M. R. C. S." to have a view of the same.—R. HODDER.

[3744.]—SILVER COIN.—In reply to Mr. Nash, his coin is an English silver half-groat, or twopence of James I.'s 2nd coinage. The observe legend is I. D. G. ROSA. SINE SPINA (James, by the grace of God, or a rose without a thorn). The reverse inscription is TVEATVR VNITA DEVS (may God uphold them in union). A common coin, worth about 1s. It is described in my "Guide to English Coins," part II., page 76. Some half-groats of Charles I. are exactly like it, differing only in having "C." instead of "I." in the obverse legend. See page 89 of the same work.—HENRY W. HENFREY. M.N.S.. &c., &c.

[3746.].—PROVING STEAM BOILERS.—There are two methods of proving steam boilers without unseating them, each of which is effectual, and at the same time safe to the operator. In the first case, by cold pressure having drawn the fire and allowed everything to cool down, run the boiler full of water and put extra weights on the safety valve in order to prevent all escape: then disconnect the feed pump from the pipe, and attach an ordinary boiler-maker's force pump, and pump up the pressure until you find your steam gauge indicates at least 2 or 3 times the pressure you are likely to require under steam. Of course I am here taking your own figures—10lb. on the inch—and unless your boilers are very old indeed, you ought to pump them up to, say 50lb., good new boilers being generally proved up to 120lb. Having got the required pressure, let some one go into the flues and see if there is any leakage; if not, your boiler may be worked with safety, but if there is, have in a boiler-maker to set you right. The other way is to fill your boiler *quite full*, fasten down the safety valve, attach a pressure gauge, and then light a fire underneath. As the water expands by the warmth you will find the gauge will indicate the pressure, and when it is high enough examine the boiler carefully in the same manner as before directed while the pressure is on. I need scarcely say that the heat must not be carried far enough to generate steam, or the result may be very serious. In the latter plan the boiler must be, as I have before said, quite full, or the experiment will not succeed.—T. S. CONISBEE.

[3751.]—ASCARIDES.—Worms are mainly occasioned by poor living, too much fruit and sugar, eating under-done meat, &c. Certain unhealthy states of the constitution favour worms, as indigestion, &c. Cure: —The best is an injection consisting of tincture of perchloride of iron ½ dr. infusion of quassia 8oz.; inject a sixth part every night, or take a dose of cammony powdered 6gr., rhubarb 6gr., jalap 6gr., calomel 4gr. Better still, and more simple, a dose of rhubarb and magnesia, about 30 gr. of the former to 20 of the latter. To prevent their re-appearance, eat good wholesome food, and live in a healthy, well-ventilated house; take plenty of exercise. The cause of their being felt more at the close of the day is no doubt due to their being carried down with the contents of the intestines.—R. HODDER.

[3751.] — ASCARIDES.—Get a bottle of *Cina Anthelmintica* from any homœopathic chemist. Take 2 pilules 4 times a day, (not within 1 hour of meals), till realieved, then less frequently.—J. NASH.

[3751.]—ASCARIDES.—"A Great Sufferer" has my sincere sympathy. Many years ago I was nearly frantic with those tormenting pests. Having a "Graham's Domestic Medicine" to bind, I consulted its pages, and followed the advice there given—viz., to use an abundance of salt, and to take a teaspoonful of salt every day in water. It is a nauseous remedy, but I strongly recommend "A Great Sufferer" to persevere in taking it, and I am certain that the Ascarides will soon cease to trouble him, as they do not relish the salt at all. I hope to hear that he is relieved.—AB INITIO.

[3755.]—TURBINE WHEEL.—"A. B." must give some data to start upon—say height of fall or quantity of water available—as the speed and size of the wheel depend upon these entirely; for the greater the fall, the less quantity of water required, the smaller the wheel, and the greater number of revolutions; and inversely, viz., the lower the fall, the greater the body of water, the larger the wheel, and the lesser speed obtained.—SENEX.

[3761.]—EMIGRANTS' INQUIRIES.—"Emigrant" couches his query in such peculiar language that "the learned F.R.G.S." has nearly determined to let him gain the information he seeks from some other source. "F.R.G.S." has a "doubt" whether the use of such an unsought-for expression was really meant as a sarcastic rally on the part of the writer or not, and therefore "Emigrant" gets the benefit of the doubt. To his question I answer, the noxious animals, &c., he mentions are to be met with in Natal—*vide* "African Hunting from Natal to the Zambesi," by W. C. Baldwin; Bentley.—F.R.G.S.

[3763.]—THEINE.—A. A. Attwood should try again. He may next time succeed, or he may, after evaporating, add alcohol, and crystallise from the alcoholic solution. I have obtained them many times by the above process.—R. HODDER.

[3767.]—FLY WHEEL ARMS.—They are properly made so, as the thick part is where the strain comes. The arms are merely so many levers for transmitting to the heavy rim and back again the balance of work that the engine does at one part of the stroke over and above the resistances, and at another part of the stroke—viz., the dead points, work accumulated in the rim of the wheel, ready to be given back again when the engine power falls short of those resistances.—J. K. P.

[3768.]—POISONING BY CANTHARIDES.—Camphor is the antidote.—J. NASH.

[3769.]—STREET TELESCOPE.—He may see a "street telescope" of 5in. aperture in the Marylebone-road, near the Portland-road Railway Station, on any fine night when either the Moon, Venus, Jupiter, or Saturn are conspicuous objects, and (also occasionally pick up some astounding bits of astronomical information. The old gentleman who exhibits the instrument informs me that the moon is the best paying object (excepting a good comet). Double stars and clusters do not "take." Nor the spots on the sun; they are not big enough to satisfy his customers. I have also seen "street telescopes" in Hampstead-road, near Ampthill-square, also near the Elephant and Castle, and in the Whitechapel-road, but do not know if they are to be seen regularly.—G. F.

NOTES AND QUERIES.

[3774.]—LOOSE PULLEYS, &c. — What is the best way to bush cast-iron loose pulleys or other cast wheels that have got worn in the holes on the shaft; would it do to bore the hole larger and fill round the shaft with some composition? If so, what is the best composition, and how prepared?—WM. CORLETT.

[3775.]—EMERY GRINDSTONES.—A few replies have appeared, but none satisfactory to me. Will some one who knows give the best for sharpening reaping machine knives, &c., how prepared, and where the emery may be purchased, and whether fine or coarse? —WM. CORLETT.

[3776.]—CASE FOR FERNS AND MOSS.—I wish to make a Wardian case for ferns and moss, about 3ft. long by 18in. broad, would some brother reader give me a handsome design, with instructions how to stock it, and what sort of soil to use; also treatment for the plants?—SCOLOPENDRIUM.

[3777.]—EAR BORING.—When a boy I was induced to have my ears pierced, and for some time wore earrings, I have now abandoned such a foolish practice, but the holes in my ears are plainly visible; can any one advise me how to make them less conspicuous?—REPENTANT.

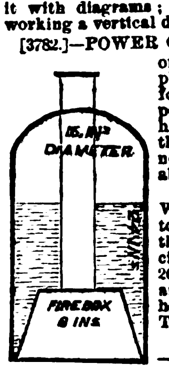
[3778.]—LIGHTHOUSES.—Where can I obtain information on the subject of lighthouses, their history, construction, and management, as I am about to prepare a little lecture with diagrams?—RYD.

[3779.]—BOILER.—Having a boiler with safety valve 3in. diameter, distance from fulcrum to centre of valve 8½in., length of levers from centre of valve, 20in., weight of valve and lever 7lb. 14oz., what will be the weight required at the end of lever for 60lb. per square inch?—ONE IN NEED.

[3780.]—FOG HORN.—Would the "Harmonious Blacksmith" have the kindness to inform me how the fog horn is made, and if it would do to be blown by steam? A sketch with dimensions would greatly oblige, and no doubt would confer a favour upon more than one brother reader.—E. A.

[3781.]—PHOTOGRAPHY.—I should be glad if a brother photographer could inform me how to construct an exchange box for the dry process, explaining it with diagrams; and also give his experience in working a vertical developing bath?—P. MAKIN.

[3782.]—POWER OF BOILER.—Will "J. K. P.," or any other kind brother reader, please favour me by giving me the following explanation:—1st. What power could I obtain from a boiler, having the same dimensions as in the drawing? 2nd. Also what thickness plates should I require for the above?—HYDRAULICAN.

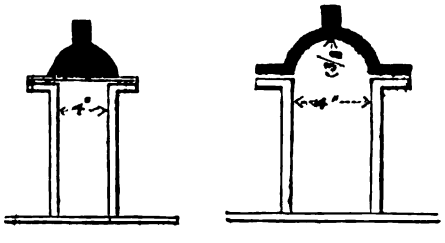


[3783.]—TO "FORTUNATUS."—Will "Fortunatus" be kind enough to say if the mixture as well as the ointment for which he gave recipe in Reply 1871, p. 66, of No. 263, is for external application only; and if not, in what quantity, and how often should it be taken?—T. B.

[3784.]—TO WATCHMAKERS.—When a pivot is broken off, could some kind brother inform me the best mode of catching the centre of pinion to replace the pivot?—J. A. E.

[3785.]—PRICES FOR SAWING TIMBER.—Can any brother reader inform me what is the price of sawing beech wood by machinery in England; also the appoximate price of turning the same into 2in" cylinders, 6ft. long?—WIFITIN.

[3786.]—AREA OF SAFETY VALVES.—What is the difference of the area of two safety valves, the one having a flat surface, and the other having a concave surface, the concave valve being concaved ⅜in.



deep, and both being 4in. diameter, according to a rough sketch which I have enclosed?—FLAT AND CONCAVE VALVES.

[3787.]—TEMPERING BUFFER SPRINGS.—I should be glad if you, or any of your correspondents, could inform me of a method to temper worm or buffer springs, those that are tapered at the ends?—C. Y.

[3788.]—BONE BREAKING.—May I ask one or more of your medical correspondents how it is that men employed daily breaking and reducing to powder with a hammer, large quantities of bones for manure, with flesh and blood adhering to them in a state of decomposition, do not suffer in health; surely they cannot derive any benefit from the minute particles they inhale. To one unaccustomed to the work, the smell is most offensive, but those employed do not, apparently suffer any inconvenience, but the real stingo is when the vitriol is poured over the bones?—C. T.

[3789.]—AVIARY.—I wish to make an aviary about 3ft. high, and would feel obliged if some kind reader will inform me how to set about it, and the approximate cost?—A LOVER OF BIRDS.

[3790.]—THE VELOCIPEDE ROUNDABOUT.—Can anyone inform me whether the velocipede roundabout is patented, and what it would cost to make one, say for 24 riders?—AN OLD SUBSCRIBER.

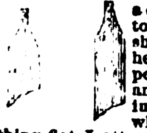
[The description given in our pages about twelve months since, was that of an American arrangement. An "Old Subscriber" may obtain a number if he likes.

[3791.]—CLIMATE, &c., OF OUR AFRICAN AND AUSTRALIAN COLONIES.—I observe with much pleasure "ours" is to be enriched with geographical notes by "F.R.G.S.," and have no doubt but that many, like myself, will feel greatly interested in this feature of our valuable paper. I fear I must seek out a milder climate before the return of another winter. What I want from "F.R.G.S." is some information on the climate of our different Australian and African colonies, with the advantages offered by each to a person of delicate constitution, but I hope as yet without disease. At same time a few facts as to the social and commercial state of the colonies brought under notice will be highly esteemed? I may mention I can carry with me a moderate amount of capital.—NAGNATA.

[3792.]—SEPARATING CHALK FROM WATER.—Can any reader of the ENGLISH MECHANIC give me the construction of Dr. Cask's apparatus for separating chalk from ordinary pump water; and whether such apparatus can be adapted for private houses? The water filtered through the chalk hills of Kent give a proportion of 16oz. 17gr. of carbonate of lime in solution to the gallon, thus impairing the quality of the water both for cleansing and infusing purposes.—J. GRAYLING, M.D.

[3793.]—COOKING BY GAS.—Will any of your numerous readers inform me whether the meat cooked in a gas stove (say roasted) is considered as wholesome and good as if roasted before a fire or baked in the ordinary oven; also the best shape for usefulness, and whether gas at 3s. 2d. per 1000ft., or coals at 23s. per ton, is the most economical?—J. M. D.

[3794.]—TO "NOBODY."—POLISHING STEEL.—I return my sincere thanks to "Nobody" for his great kindness in replying so minutely and clearly to my query respecting a Geneva cylinder, and also for the excellent diagram accompanying it; I shall now be able to proceed without difficulty. I should feel greatly obliged if he would help me out of another dilemma—polishing steel. I use oilstone dust and red stuff, but cannot succeed in imparting that beautiful black polish which is seen in a good watch. Anything flat I attempt is of a light grey colour, and covered with minute scratches. Again, in trying to polish pivots, I cannot prevent rings from forming. I use a brass centre, is there anything better than that; I notice in balance staffs, two different shapes for the pivots A and B, as per sketch. Will "Nobody" give me his opinion which he thinks the best shape, and how they are made?—CYLINDER.



[3795.]—VULCANISING RUBBER.—I see in your issue of the 29th inst., information respecting the system of vulcanising rubber, for which I was just about to write, The above not being sufficient, I beg to ask a few more questions. 1st. In what state shall I purchase the rubber, and where can it be obtained; also the very lowest price per pound, taking a quantity of the rubber, to be of the A 1 quality? 2nd. I want to put the rubber into an iron mould previous to vulcanising it, would a cast iron steam chest with loose top do to put the mould and rubber in and close the same up; if so, please say how many pounds' pressure of steam should be put in and for what length of time, as I want the rubber stiff, and at the same time to stretch freely? Information will be thankfully received from "Dentist," or any other experienced friend.—X. Y.

[3796.]—PROBLEMS.— I. N T is the diameter of a circle, the centre of which is M. Through R, a fixed point on this diameter, a straight line is drawn cutting the circle in O and S. It is required to prove that

$$\tan. \tfrac{1}{2}\, T\,M\,O,\ \tan. \tfrac{1}{2}\, T\,M\,S = \text{constant.}$$

II. In a spherical triangle prove that

$$\tan._2 \frac{a}{2}\,\frac{\sin. (B - C)}{\sin. B, \sin. C} + \tan.^2 \frac{b}{2}\,\frac{\sin. (C - A)}{\sin. C, \sin. A} + \tan._2 \frac{c}{2}\,\frac{\sin. (A - B)}{\sin. A \sin B} = 0.$$

III. Solve $n^3 - \frac{1}{3}\, m\, x + \frac{n}{108}$ O

where

$$m = a_4 + c^4 - a^2 b^2 - a^2 c^2 - b^2 c_2,$$

and

$$n = 4 \left\{ (2a^2 - b^2 - c^2)\,(2b^2 - a^2 - c^2)\,(2c^2 - a_2 - b_2) \right\}$$

IV. Find the equation whose roots are the differences of the roots of

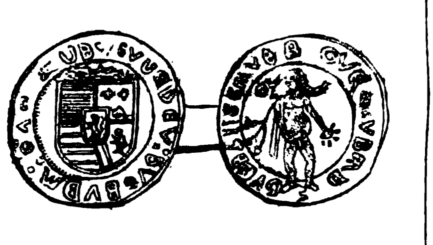
$$p\,x_4 + q\,x^2 + r\,x + s = 0.$$

V. If two diagonals of a spherical quadrilateral be quadrants, prove that the third is also; and state the well-known theorem of which this is the reciprocal.—READER.

[3797.]—TELESCOPE STAND.—I am under great obligation to "F.R.A.S." for his admirable letters on the telescope, also to "Hipparchus" (p. 505. Vol. X.), and to Mr. Purkiss (p. 604, Vol. X), for their letters; but I want a little more detailed information about the construction of a good stand for a refractor. Will one of the gentlemen above referred to oblige me. "Hipparchus" refers to the Varley stand—what is it like? He also mentions "the simple apparatus for moving the telescope in right ascension," recommended by Lord Rosse—where can I find a description or illustrations of this? I have a stand of the ordinary construction, but want some means of getting a slow, steady motion, both for finding and following stars?—TURTON.

[3798.]—TUBE FOR 9IN. TELESCOPE.—Will any of your correspondents who have mounted specula, inform me what thickness of sheet iron it is necessary to use for the tube of a 9in. telescope of 6 or 7ft. focus?—C. S. G.

[3799.]—BRASS COINS.—Can any of my brother readers inform me what coin this is, of which I send a drawing half size? It was found by me at Dalkey, co. Dublin, near a Danish castle. I observed one nearly the same in one of the recent numbers of the ENGLISH MECHANIC. Made of brass and very thin.—F. B. K.



[3800.]—PHOTOGRAPHY.—Can any of your subscribers inform me if a good vignette carte-de-visites can be taken in a room with an ordinary window, about 4ft. wide, and facing the north; if so, what apparatus would be best for the purpose?—WOULD-BE AN ARTIST.

[3801.]—LEVER ESCAPEMENT.—Allow me to thank "Nobody" for his instruction for Geneva cylinder; would he now kindly give me plain instructions to plant a lever escapement, in converting or new work, proper dimensions, &c.?—GRACCHUS.

[3802.]—TO "SIGMA."—I beg to thank "Sigma" for his kind answer to my query (gilding battery), but would he give me plain instructions, quantities, &c., how to work my battery successfully, how to suspend the sulphate, &c.? I don't think he understood quite the kind of battery I have. First is a copper call, inside that stands a porous Wedgewood pot, then suspended by a cross piece of wood in that, the zinc pole, set screw, &c., fastened in the pole.—ONE IN A FOG STILL.

[3803.]—PRIMROSES.—Can any of your gardening correspondents tell me how to change the colour of primroses?—J. D. MORGAN.

[3804.]—WATCH CLEANING.—Would any correspondent oblige by telling on who does not know, how to take to pieces, clean, and put together again, one of those old watches; also a list of the tools required? This query appeared about a month ago, but I have seen no answer to it. A paper how to doctor disabled watches, like the one we had on clocks, would be very useful.—J. D. MORGAN.

[3805.]—REDNESS.—I am troubled with a very red face, especially while in a hot room, and it burns very much, if any kind reader of our journal would name the cause, or if there is any remedy for it, would greatly oblige? I take scarcely any malt liquors or spirits.—ROUGE.

[3806.]—POLISHING FACETED GOLD CHAINS.—Would any of our Birmingham or London readers say how the polishing is done, such as the secret link pattern chain; the squares are so equal, like the squares of the diamond; I think it is done with a revolving stone, but what kind of a stone I am unable to say?—T. G.

[3807.]—PAINTING STONES IN JEWELLERY. What method is used in giving that brilliant colour to pale stones to make them a deep colour; there is some kind of paint used besides tin foil?—T. G.

[3808.]—TO "SENEX."—Has "Senex" seen my suggestions for attaining an increased amount of power from an ordinary four-armed turbine, suited to low water falls, illustrated in the latter part of the late *Penny Mechanic?* Will he be kind enough to give a calculation of the power attainable by it, as described; and what power he finds attainable from a current of 200 cubic feet per minute by it, fall 7ft., diameter of table 14ft.? What I mean by no pressure, is no pend head of water required, but a sufficient amount that may flow from a conduit or rivulet.—J C. SHEWAN.

[3809.]—MODERATOR LAMPS.—ADDLEPATED NONSENSE.—Can you or any of your correspondents give me the address of a manufacturer of moderator lamps? I congratulate you and my fellow subscribers on the sterling merits of your magazine. If I might suggest one improvement, it would be the consignment to the waste paper basket of the letters of those gentlemen who, too lazy or too conceited to study what they talk about, have the assurance to ask us to join with them in dissent from Newton, Herschel, and a few others of similar calibre, and in pronouncing them cheats and swindlers. It is not fair to call upon us to expose their addlepated nonsense. In order to discuss the matter with such smatterers, one must first teach them the sciences on which the subject depends, of which they are sublimely ignorant, and next a little modesty, a quality with which they are less acquainted still.—F. H. N.

[3810.]—PATTERN OF CYLINDER, &c.—I should be very much obliged if any pattern-maker would oblige me with a sketch and how to make a pattern for a steam engine cylinder, which, no doubt, would be serviceable to many readers, and how the piece of girder is made mentioned in the Whitworth scholarship.—AMATEUR.

[3811.]—GUIACUM.—Can any brother reader tell me what the medicinal properties are of the guiacum plant, and whether infusing or distilling is the best way to obtain all the medicinal properties of herbs; and how much water is used per oz. of herbs, so that a wineglass full can be taken three times a day.—FOX.

[3812.]—CONDENSING ENGINE.—Can any reader inform me why all condensing engines make such an unpleasant noise upon finish of up-stroke of air-pump, and a remedy for it.—A VERY OLD SUBSCRIBER.

[3813.]—CLEAN CASTINGS.—Will any reader suggest a plan to get clean castings, free from sullage and airholes, which look very bad after being cleaned up and polished, and which is a great annoyance to one who wants his work to look well.—A VERY OLD SUBSCRIBER.

[3814.]—MENDOZA PULLEY.—I would feel very much obliged if any of your readers could give a sketch and particulars of the manner of constructing and working a kind of pulley used in the jenny mule in spinning. It is for driving the spindles as they wind on the thread, and has a double or rather a continuous groove for a band, the object being probably to give more bite on a small diameter. It was called (if not still in use) a Mendoza pulley.—J. B., Bath.

[3815.]—FASTENING EMERY TO LEATHER.—Could any reader inform me how to make emery stick into leather to go round two pulleys at a good speed? I have tried glue and white lead paint, but both wear off very soon.—A. T.

[3816.]—PRESSING LADLES OR SHOVELS INTO SHAPE.—Could any of your numerous readers inform me if there is any machine in use for pressing ladles or shovel plates into shape. If he could favour me with a sketch, I shall feel greatly obliged.—SHOVEL PLATER.

[3817.]—STEAMING WOOD.—Will any reader of the ENGLISH MECHANIC give me the practical way to steam wood for bending; how long to be cut down before it is steamed; and how long after before it is fit to use? The wood will be ash, elm, and oak.—W. B.

[3818.]—TO "SIGMA."—Will "Sigma" please say if he considers a quart cell of his battery to be equal in power, quantity, and constancy to a bichromate or Bunsen's of the same size, and also if he thinks such a battery capable of exciting an intensity coil?—W. BARBER.

[3819.]—CHEAP GAS.—Can any reader tell me of a plan for lightening my gas bills (which often come very heavy to myself and a widowed mother) by (for instance) causing the gas to pass through a reservoir filled with some hydrocarbon on its way from the meter, and thus causing an increase of light with less gas? Any information given in this journal relative to increasing the light of our London gas, at the same time (if possible) reducing the cost, would, I am sure, prove acceptable to hundreds of its readers.—CHEAP GAS.

[3820.]—AQUATIC BOTANY.—What aquatic plants of an interesting character are suitable for a glass basin 16in. diameter, to be placed in centre of room?—OCEOLA.

[3821.]—WHEEL-CUTTING.—TO "J. K. P."—Our kind and practical correspondent, "J. K. P.," Vol. XI., page 114, informs us that he has been cutting some steel wheels ⅜in. pitch, ⅜in. deep, and through cast steel ⅜in. thick. Will he have the kindness to give us a sketch of the teeth, for I have not seen any that would work well whose depth was above $\frac{12}{15}$ of the pitch—viz., $\frac{5\frac{1}{2}}{15}$ outside the pitch line, and 6½ within the pitch line (that would be), the working depth $\frac{11}{15}$ of ⅜in. I think he would not clear well at the points of the tooth, being so very deep.—J. K. ENGLAND.

[3822.]—FORCE PUMP FOR BOILER.—What would be the size of a force pump to supply the boiler of an engine with a cylinder 2⅜in. diameter and 5in. stroke, the water to come from above? I should like to see a print of one as simple as possible, the print in No. 267 being too complicated and not sufficiently explained to my unprofessional eyes.—A GUERNSEY AMATEUR.

[3823.]—SLOT CUTTING.—To "J. K. P."—Two weeks ago a slot-cutting tool was shown in "our journal." Several amateurs, including myself, could not understand the shape of the tool and cutting edges, and we should esteem it a favour if "J. K. P." would give another illustration if it is for the lathe. I give the result of my attempt at slot-cutting in the lathe. Having a ¼in. American twist drill, with 1in. of the fluted part only left. I eased off the back along the two flutes, and sharpened edges to cut, drilled a ¼in. hole through strap iron ¼in. thick, entered the altered drill, fixed iron in tool holder of slide rest (lathe 5in. centre), and with a speed ordinarily used for cutting wrought iron, cut a slot by feeding up to the cutter at the rate of 1in. in 5 minutes. There may be nothing new in this to "J. K. P.," but numerous amtaeurs will doubtless gladly avail themselves of this plan unless a better can be shown. The drill I think originally cost 1s., and the alteration may be made in 10 minutes.—J. F.

[3824.]—GOVERNORS.—Will any reader say what is the greatest variation of speed allowed by the best steam engine governor, and give description of governor. I presume there must be an increase of speed before the governor can act, and speed then rise in proportion to the work thrown off the engine. If, when the engine carries its full complement, a shaft runs at the rate of 60 revolutions per minute, how many revolutions per minute will the said shaft be allowed to make if more than half the complement be thrown off? also can the principle be applied to govern water wheels.—EXPECTANT.

[3825.]—FROM "ROTHERWOOD" TO "JOHANNES"—I am very sorry that the reply to Johannes should have been lost on its way to your office; but if he will have the kindnes to inform me how he is proceeding with his gas works, and what information he now requires respecting the, I will endeavour to set him right.—ROTHERWOOD.

[Rotherwood's reply referred to above, did not reach us, which we regret for the sake of Johannes.—ED. E.M.]

[3826.]—THE TELESCOPE.—Will "F.R.A.S." kindly give me a description of a pancratic eyepiece and tube, and how it is fitted to a Newtonian reflector. Also, if the lenses of the Ramsden eyepiece are the same diameter?—E. M. B.

[3827.]—NITRATE OF SILVER STAINS.—How can I effectually remove nitrate of silver, and stains of developers from deal floors, &c.? I have tried cyanide of potassium, but it only takes up the newest spots.—OLD SCRUB.

[3828.]—KID BOOTS.—Could any kind reader give me a good receipt for preserving the new and soft appearance of ladies' kid boots, as most of the recipes have the effect of making the kid hard.—OLD SCRUB.

[3829.]—SOLDERING.—How can I solder metal feet to cylinder bottom, which are of cast iron, so as they will hold firm; and what must I use for it when the cylinder gets heated by working; will it effect the soldering?—THOS. STRINGER, JUN.

[3830.]—WIRE COVERING.—The wire covering machines hitherto illustrated do not suit my purpose. Will any reader give a design for one for covering fine copper wire with cotton. The machines given in back numbers do not, moreover, provide for drawing off the wire when covered in a regular and even manner.—POMPEY,

[3831.]—PLANT FOR STARCH AND CORN FLOUR MANUFACTURE.—Can any of your readers give me particulars of the machinery or plant used in the manufacture of the best quality of starch, corn flour, arabica, and maizena foods, with description of the processes, or refer me to any work treating on the subject.—HOTSPUR.

[3832.]—BURNISHING PLATE.—Can any correspondent give me instructions for burnishing silver spoons and forks that are badly scratched, and describe the tool to be used?—G. H.

[3833.]—TO "BOATBUILDER."—I should be greatly obliged to "Boatbuilder" if he would send me a drawing, say about 1in. to the foot scale, as I am one who contemplates "attempting this pretty art?"—J. F. O'BRIEN.

[3834.]—DUMB BELLS.—Will some reader kindly tell me of a good reliable book on dumb bells and Indian clubs. State publisher's name and price? An answer will oblige—AN APPRENTICE.

[3835.]—CLEANING COINS.—Can any fellow-subscriber inform me how to clean old coins so as to discover their inscriptions, &c.—J. NASH.

[3836.]—SCREW PROPELLER.—Will some brother reader kindly tell me the shortest and best method for calculating the pitch of a screw propeller? Perhaps Mr. T. Brown will kindly assist.—T. J. O'C.

[3837.]—TO "ADEPT."—I am much obliged to "Adept" for his answer to my query. I am just finishing my sound-board and wind-chest, so could not make the change he advocates. I shall therefore have to rely upon my pedal organ for bass. Perhaps he would give me an idea as to what pipes I should use, what scale, and whether metal or wood? Would it be an improvement if I inserted a viola di gamba or hautboy in place of the 12th and 15th?—GEO. M. LITTLE.

NUMISMATISTS are reminded by the *Athenæum*, to be quick in securing specimens of the Roumain coinage, because the Porte has protested against it as being in defiance of the firman of investiture, bearing, as it does, only the effigy of the Prince without any recognition of the suzerainty of the Porte.

A SUM of money subscribed in Germany for presentation to Baron Liebig has, by his request, been devoted to the foundation of a prize, to be called the Liebig Medal, and to be given from time to time for scientific investigations in subjects connected with agriculture.

ANSWERS TO CORRESPONDENTS.

\. All communications should be addressed to the EDITOR of the ENGLISH MECHANIC, 31, Tavistock-street, Covent Garden, W.C.

ADVERTISERS' TESTIMONIES.

SIR.—In answer to my advertisement in last week's MECHANIC, I received replies from London, Stockton-on-Tees Ireland, and Scotland, and in less than a week obtained what I required. GEORGE BAZLEY.

Clinton-cottage, Church-terrace, Leamington.

WE wish our advertisement enlarged, as we are encouraged by the success we have met with through your columns.

ORME BROS., Elgin Works, Wolverhampton.

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THE following are initials, &c., of letters to hand up to Friday morning, May 13, unacknowledged elsewhere:—

H. Stephenson, M. A. H., W. B., Ignoramus, Veritas, Patermilias, J. D. Fresenius, Tim Bobbin, Jaundice, W. R. C., Capt. Selwyn, Letts, Son & Co., Orme Bros., J. H., E. W. T., T. M. D., Ashworth Bros., E. S. (Burnley), G. W. A., Steersman, C. H. W. B., Scorpio, Anti-Egyptian, A. Tolhausen, Cotton Clerk, J. M——o, R. F. C. W. B., H. F., J. M., Old Subscriber, W. H, Thorpe, B. H. R., J. Bloomfield, O. P. Q., J. H. D., Painter, T. J. O'C., F. W., G. S., J. E. P., Rev. C. H., Edwin Baker, Rev. J. F., Henry Pecher, R. K. P., W. T. D., J. E. F., J. H. and Son, S. T., P. C. V., B. S., J. E. L. B., A. S., R. A. Proctor, J. Jebb, J. and G., R. Burnside, J. T. W., W. Nicholas, Dr. Z., T. R., S., J. B. D. W. K., W. N., J. E. Phillips, A. Gray, T. W. W., John Dutton, H. W. Henfrey, E. J. Jones, John Taylor, (letter forwarded), T. A., T. N., L. and Co., G. S. and G., John Heywood, D. Hermann, S. C. and Sons, N. S. Heineken.

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HERMANN.—Refer to the page quoted.

SAM MUNDY.—A postage stamp will not do.

SNAKESTONE.—We know of none. Some good information was given by a practical man in our last Volume; see Index.

T. H. S.—See recent back numbers.

A. SOLOMON.—Directions have appeared in back numbers for making inks of all colours.

WM. BATEY.—We do not favour private communications. Can you not make your directions plain to "Little Charley" by means of a sketch? Then all will benefit, and not he alone.

J. P. SMITH.—Consult the first elementary engineering book you can pick up.

AQUAMBULATOR says he has invented an arrangement whereby he can walk on the water without the use of balancing poles, inflated bags, &c., and he wants an enterprising person with money to insure its immediate introduction. He must advertise.

J. L.—Your letter, in fact, was so badly written that we could not make head or tail of it, and hence its non-appearance.

EQUATOREAL.—Your letter contains nothing new. We have given enough space to the subject by inserting Mr. Beardsley's letters.

J. R. JAMES.—In due time.

O. H. S.—We have a partiality for the arts of peace, hence the delay in publishing articles on war vessels. Besides, as a rule, we have more respect for facts than notions, and particularly in matters relating to vessels of war. We edited for some years the *Mechanic's Magazine*, which at the time devoted much of its space to gunnery and war vessels. In fact, we took the management of that publication, when Mr. E. J. Reed left it to become Chief Constructor of the Navy. The number of projects suggested for building and improving iron and iron-clad ships was amazing—projects which are now sleeping in oblivion. Let it not be supposed we eschew notions when they may relate to war. But as our space is limited, and the demands on it are numerous, we prefer verification to speculation.

W. MORRIS says he can endorse the statement of "F.R.A.S.," on page 159, that "there appears to be a recent fashion with people who have nothing else to give to offer prizes." He says he was sufficiently lucky on a recent occasion, to win a prize, but by some means or other it never came to hand, though he has written several letters about it. He, however, consoles himself with the thought that if it came to hand, it would not, in all probability, be worth the carriage or houseroom.

EDWARD MALBON.—Our former decision must be adhered to with regard to your letter, simply because it is best for all parties. We cannot reply to your first query. With regard to the stone-breaker, you would have to be careful that you did not add anything contained in his specification.

G. EDWARDS.—The drawings and description not good enough.

J. R. T.—As you expected. "The Editor's capacious waste basket has swallowed up your letter." One Beardsley at a time is enough.

R. B. SAUL.—The reason was that we could not even read your signature. Names and addresses should at all events be readable. But some of us are so familiar with our writing, and particularly with our own signatures, that we fancy others must be also. This is a mistake.

L. Y. in a letter suggests that "a mode of propulsion for the velocipede might be applied after the principle of the oar, but with the fulcrum differently situated, the free end having a purchase on the ground. A method of guidance may be made by the feet, and other means." Suppose it would act, what on earth would be gained?

W. T., DELTA, AND T. SAVAGE.—No stamps enclosed.

R. T. S.—A good suggestion. Thanks.

TRUST.—It is somewhat beyond our province to point out or to recommend any particular manufacturer's goods.

J. R. T.—The insertion of your letter would only advertise the journal, which has for months been trying in vain to get a circulation. It is well known to be a signal failure, and we are not going to assist it by holding a controversy which it is so desirous to provoke; besides, we believe "J. R. T." is too magnanimous to strike a man when he is down.

Q. YORKE.—Your writing on one side of the paper is sufficient. It is well to put the number and the title of the query answered. Thanks.

J. H. TWITCHELL.—We cannot give more space to the subject.

THE "Sixpenny Sale Column" is the only place in which can appear queries sent by Joseph Taylor, Photo, M.A., Oxford, J. Brow, H. H. Fry, A Brass Moulder, Amateur (Welsh books), J. Nash (second query), Colour.

JUVENILE had better consult a good optician. We can hardly trouble "F.R.A.S." with many of such queries; they take up time which is valuable to him and our readers.

JAMES LINTON.—We have no space for problems of the kind you send.

MECHANIC.—See back numbers.

E. G. F.—We very much fear no such scheme will ever be found practicable. Looking at the size and power required to move the spring of an ordinary barrel organ, we cannot but remain incredulous.

DANIEL KEAT.—See pp. 210, 460, 475, Vol. X.

A NEW SUBSCRIBER.—Buy the indexes.

POMPEY.—Your second letter warrants the appearance of the query; inserted accordingly.

STITCHER.—"Practical Man" will doubtless deal with the subject in due course.

T. DIGNEY.—See reply to "E G.F."

CHARLES NOYES.—"Feu Follet" is either unable or unwilling to reply, or he would not have neglected the query, which has now been asked three times.

ENGLISH MECHANIC.—We cannot ask for directions to enable you to manufacture a patented article.

UPSILON.—We have the numbers; they were sent to you last week addressed Mr. R. B. *Lane*, which appeared to be your name from your signature. Perhaps they may be lying at your post office.

FALSTAFF.—A good series of articles on painting and decoration is at present appearing in the BUILDING NEWS. Inquire of F. J. Cox, who advertises in our pages.

THANKFUL.—If you turn to page 143, you will see that another querist has anticipated you by asking "Fortunatus" the same question. His reply is not yet to hand, and you had better watch for it than write grumbling letters without cause.

VENTRILOQUISM (F, Manheerman).—A natural gift, only to be improved, and not acquired, by practice.

ARCH-DRUID.—We know of none, and surely with our back numbers you cannot want any.

A MORAYSHIRE MAN.—Thanks. Next week.

THOMAS J. O'CONNOR (Wexford).—Many thanks.

THE *ENGLISH MECHANIC* LIFE-BOAT FUND

Subscriptions to be forwarded to the EDITOR, at the office, 31, Tavistock-street, Covent-garden, W.C.

	£	s.	d.
Amount previously acknowledged	£179	14	4
F. Weatherhogg..	0	1	0
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New Subscriber	0	0	6
English Mechanic	0	0	6
E. M. B...	0	1	0
	£180	1	4

THE INVENTOR.

IN obedience to the suggestions of a number of readers, we have decided on appropriating a portion of our space to a condensed list of patents as nearly as possible up to the date of our issue.

APPLICATIONS FOR LETTERS PATENT DURING THE WEEK ENDING MAY 9, 1870.

1260 A. Barlow, Albion-road, Dalston, and H. Browne textile fabrics for book covers

1261 F. J. Livsey, Manchester, machinery for printing upon spools used for holding thread and like materials.—A communication

1262 J. A. Emslie, Tarbert, Argyll, and J. T. Emslie, North shields, apparatus for lifting, forcing, or conducting liquids, gases, or air

1263 H. Belmont, Romford, apparatus for cultivating land

1264 T. Bradbury, Shrewsbury, and J. Bamford, Manchester, communicating between passengers, guard, and engine driver

1265 J. Ormerod, Whaley-bridge, Chester, looms

1266 S. Taylor, Birmingham, rack pulleys for the cords of window blinds

1267 E. P. North, Birmingham, supports for supporting and adjusting umbrellas

1268 W. H. Preece and W. E. Langdon, Southampton, working railway signals

1269 J. Tiranoff, S. Petersburgh, apparatus for preventing railway carriages running off the line

1270 A. M. Clark, 53, Chancery-lane, improvements in traction and locomotive engines.—A communication

1271 J. Guy, C. J. Guy, and F. S. Guy, South-street, Finsbury, copying letters

1272 G. Wright, Masborough, brick-making machines

1273 A. M. Clark, 53, Chancery-lane, steam carriages for common road locomotion.—A communication

1274 W. Woodward and A. Woodward, Manchester, apparatus to be used in connection with retorts for the manufacture of gas

1275 C. P. Matthews, Grantham, preparation to be applied to the insides of casks

1276 W. N. Hutchinson, Wellesbourne, Devon, improvements in the existing iron rails of railways and tramways, and in the construction of rails for future lines of railways and tramways

1277 W. O. Rawlins and A. Knowles, Liverpool, improvements in reversing gear for engines

1278 C. Exter, Munich, Bavaria, an improved brake applicable to the rolling stock of railways

1279 H. Kinsey, Nottingham, improvements in wheels for carriages

1280 B. Walker and J. F. A. Pflaum, Leeds, machinery for puddling

1281 J. Campbell, Belfast, improvements in drawing flax and other fibrous substances.

1282 F. M. Blyth, Norwich, harvesting machines

1283 B. Burton, 46, Leadenhall-street, breech-loading fire-arms and cartridges therefor

1284 G. Ingram, 37, Marylebone-road, regulating the lift of carriage windows

1285 J. B. Hickmott, Carlisle, manufacture of gas and coke

1286 W. R. Lake, Southampton-buildings, improvements in steam engines.—A communication

1287 A. V. Newton, 66, Chancery-lane, apparatus for cleaning grain and seeds.—A communication

1288 J. H. Johnson, 47, Lincoln's-inn-fields, treatment of maize.—A communication

1289 J. H. Johnson, 47, Lincoln's-inn-fields, improvements in safes, chests, bank vaults, and other like structures.—A communication

1290 T. Ellis, Coatbridge, improvements in furnaces and boilers

1291 F. Hart, Bourton, planes for chamfering and moulding

1292 J. May, New Wortley, apparatus for spinning wool and other fibres into yarn

1293 W. Thornton, Nottingham, manufacture of gaiters, cuffs, mitts, or other similar articles

1294 W. Brough, sen. and W. Brough, jun. Keele, construction of ovens and kilns

1295 A. Ripley, 34, West-square, Southwark, a new or improved pipe wrench

1296 S. Clark, 5, Westminster Chambers, constructing piers, breakwaters, wharfs, cofferdams, river and sea walls, and other works in water

1297 R. Leake, Manchester, improvements in machinery for etching or engraving rollers for calico printers

1298 J. Tester, Hurst Green, Sussex, machinery for cutting chaff and other vegetable substances

1299 D. Walker, Leith, apparatus for preventing or reducing the production of smoke in furnaces

1300 E. T. Kirkpatrick, Brussels, improved mode of producing oxygen gas

1301 W. Thompson, No. 8, Cloak-lane, London, apparatus for recording electric telegraph signals

1302 S. C. Lister, Bradford, and J. Robinson, improvements in double-pile fabrics

1303 A. H. Macnair, No. 2, Prince Consort-place, Leith, improvements in the permanent way of railways

1304 T. Don, Redhill, improvements in obtaining and applying heat

1305 W. T. Blake, 237, City-road, and M. Hyams, 55, Bath-street, tobacco pipes

1306 H. Brooke, Huddersfield, improved drain-pipe rest and subsoil drain

1307 F. K. A. Glover, Isle of Wight, steering or manœuvring ships and other vessels

1308 W. S. Lowe, Torr Vale Mills, Disley, improvements in tape-dressing or sizing machines

1309 J. Ninon and J. Winterbotham, Sheffield, improved machinery for piercing and drilling tangs and scales for table knives and forks

1310 J. Bullough, Accrington, improvements in sizing machines

1311 R. Weare, Newcastle-under-Lyme, apparatus for receiving and treating sewage

1312 L. Mond Farnworth-within-Widnes, and J. Hargreaves, Appleton-within-Widnes, improvements in the manufacture of chlorine

1313 W. R. Lake, Southampton-buildings, London, an improved stamping apparatus.—A communication

1314 A. P. Price, 47, Lincoln's-inn-fields, improvements in the treatment of sewage

1315 E. Guenin, Henrietta-street, Covent-garden, manufacture of mustard and other plasters

1316 B. Bert, No. 1, Place Richelieu, Bordeaux, a basin for the breeding of oysters.

1317 D. Brown, Belfast, machinery for dressing flax, hemp, and other analogous materials

1318 G. S. Penny, Cheltenham, improvements applicable to cabinet stereoscopes

1319 J. Speight, Bradford, improvements in machinery or apparatus for spinning, twisting, and roving worsted

1320 J. I. Evans, Merthyr Tydvil, improved brushing machine for cleaning tin plates

1321 E. Whitworth, Groombridge, in Sussex, improvements in rotary engines

1322 T. Banks, Redditch, an improved needle wrapper

1323 B. Hunt, 1, Serle-street, Lincoln's-inn, securing or locking screw bolts and nuts.—A communication

1324 J. Pepper, Lake Village, Belknap, New Hampshire, U.S.A., machinery for knitting looped fabrics

1325 H. M. Ward, Ballymaconaghy Co. Down, machinery for spinning or twisting flax, hemp, jute, and other fibrous substances

1326 C. Brook, Huddersfield, improvement in the manufacture of sewing thread

PATENTS SEALED.

3216 P. Walker and A. Walker, an improved gas meter

3217 T. Perkins, apparatus for ploughing or cultivating land

3223 R. Jones, a special and general paper, card, or form holder

3223 E. Thomas, miners' safety lamps

3233 W. Donbavand, improvements in balances for weighing

3241 L. Battinson G. Battinson, and T. Whitehead and H. W. Whitehead, machinery for combing wool, cotton, flax, and other fibrous substances

3252 G. Simpson, and L. Strauss, arrangements or apparatus for withdrawing beverages or other liquids from casks

3253 J. M. Rowan and T. R. Horton, improvements in steam engines and boilers

3257 P. Wilson, improvements in locks and latches

3258 H. Rochatte, improvements in breech-loading fire-arms with central percussion

3261 B. Shaw, improvements in machinery for cutting soap.

3266 T. Snow, an improved column for exhibiting notices at railway stations

3272 G. H. Hannaford, improvements in apparatus for working, locking, and controlling railway switches

3274 W. E. Gedge, composition to be used as a coating for preserving metal.—A communication

3275 W. E. Gedge, machine for cutting, drilling, and shaping wood and metals.—A communication

3280 F. Clarbour and W. E. Teale, improvements in mining lamps

3292 C. D. Abel, a new or improved process for refining and desilvering lead.—A communication

3310 C. Ching, improvements in the boilers of hot-water apparatus

3337 R. K. Miller and A. B. Herbert, improvements in pumps

3344 C. D. Abel, improvements in the means and apparatus for utilizing streams, motive power.—A communication

3419 J. Fletcher, sen., J. Fletcher, jun., and W. Fletcher, improvements in mortar mills and other machines of the like nature

3446 G. B. McFarland, a new and improved convertible double-centre rotary engine

3629 T. Parry, and J. McHardy, an improved drag or brake applicable to wheeled vehicles

3718 C. H. Roeckner, and W. H Northcott, improvements in the process and method of disintegrating wood

408 J. Thompson, an improved spindle for door-handles

711 J. Jeavons, improvements in the manufacture of armour plates

3263 C. Brakel, improvements in obtaining and applying motive power

3255 O. Rose, improvements in pistons for steam engines

3296 G. D. Edmeston, improvements in hammers to be worked by steam or other elastic fluid

3269 W. B. Dobson and F. Dobson, improvements in shawls made on lace machines

3271 H. R. Minns, improvements in letter pillar posts

3281 T. A. Dillon, an improved safety lamp

3282 W. Richardson, improvements applicable to valves of steam engine cylinders

3283 H. H. Grierson and J. M. Rigby, improvements in machinery for cutting or dressing stone

3290 F. Brampton, improvements in locks

3302 W. Srigley, a new or improved friction engine

3317 E. Basin, A. Ruiz, and E. Le Pelletier, improvements in spinning looms

3556 H. Byk, refining and bleaching paraffin

3612 W. McGee and W. McGee, doubling and winding fibrous materials

767 P. W. Spencer, improvements in limekilns

780 J. T. Walker, horseshoes

781 W. R. Lake, an improved machine for forming trenches or ditches.—A communication

808 J. H. Johnson, improvements in crimping machines

850 C. J. Eyre, apparatus for producing motive power

870 W. R. Lake, improvements in turbine water wheels.—A communication

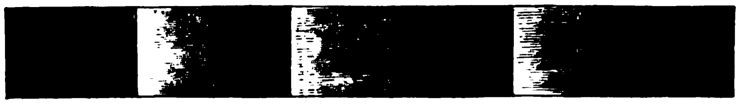
872 W. R. Lake, improvements in the preparation of ammoniated sulphuric acid for the manufacture of manure.—A communication

885 W. R. Lake, improvements in the valves of steam engines, and in the mechanism for operating the same.—A communication

899 R. Smith, improvements in machinery for doubling and winding cotton.

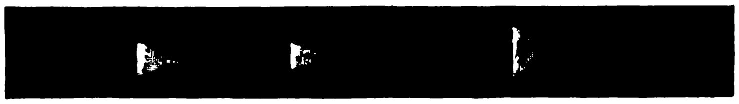
The English Mechanic
AND
MIRROR OF SCIENCE AND ART.
FRIDAY, MAY 27, 1870.

FIG. 9



CARBON. SPECTRUM in OLEFIANT GAS

FIG. 10



COMET II. 1868

WHAT STRIPES THE SUNBEAM.

BY A FELLOW OF THE ROYAL ASTRONOMICAL SOCIETY.

(Continued from page 194.)

As we have seen that it is to the joint research of the two German philosophers, Bünsen and Kirchhoff, that we owe our first knowledge of the chemical constitution of the Sun, so it is to the combined investigation of two eminent Englishmen, Mr. William Huggins, F.R.S., and Dr. W. A. Miller, F.R.S., that we are indebted for nearly all that we know about the chemistry of the stars, nebulæ, and comets.

Considering that our own moon and the planets merely reflect to us the light of the Sun, it might, at the first blush, be imagined that nothing as to their own chemical constitution could be learned by a spectroscopic examination of them; but, remembering what we have previously said about certain dark lines which are very conspicuous in the Solar spectrum when the Sun is near the horizon, and which certainly have their origin in the absorptive action of the Earth's atmosphere, a little reflection will suffice to show us that, if the Moon or any of the planets possessed a similar atmosphere to ours, this would intensify the absorption lines to an extent which would be very perceptible. As far as the Moon is concerned, the spectroscope only serves to add to the vast mass of negative evidence we possess, and to increase the moral probability almost to a certainty that she has no appreciable atmosphere of any sort or description whatever. An experimental observation of Mr. Huggins's, as beautiful and ingenious as it was conclusive, may be held to have set this matter at rest. It is well known that the Moon, in the course of a lunar month, describes what is, in effect, a great circle in the Heavens. In doing so, she must, of course, pass over and hide the infinitely distant stars which lie in her path, so that they will disappear at her advancing limb, and reappear at the opposite one as she travels on. These phenomena are called occultations, and are familar to all who take the smallest interest in the face of the night-sky. In fact we give a list every month, in our "Astronomical Notes," of all occultations up to stars of the sixth magnitude. Now, suppose that the Moon *had* an atmosphere, we should see the star by refraction after it was actually behind the Moon · and it would seem to reappear at the opposite limb, from the same cause, before it had in reality emerged; just as we see the Sun before it has really risen, and after it has really set. But the differently-coloured rays *are differently refrangible*—the violet the most, and the red the least; so that if the Moon had an atmosphere, the red end of the spectrum would die out first, and the spectrum would fade away up to the violet, which would be the last to disappear. On the 4th of January, 1865, then, Mr. Huggins observed the occultation of the star ε Piscium with the spectroscope, with the special purpose of detecting any gradual fading out of the spectrum, should such exist; but, says that gentleman, "The advance of darkness upon the spectrum, since it occurred precisely in the direction of its breadth, swallowed up the rays of different refrangibilities throughout the whole extent of the visible spectrum at the same instant."

Jupiter, however, shows lines in his spectrum indicative of an absorbing atmosphere, and one band, notably, does not correspond with any of the lines of absorption in the terrestrial atmosphere, and, therefore, is a sign of some gas or vapour which is foreign to our air. Saturn has, probably aqueous vapour in his atmosphere; and Mars seems to have a gaseous envelope exceedingly like our own. No intensification of the atmospheric lines is perceptible in Venus at all.

Leaving, however, our own system, let us see what the spectroscope has revealed to us of the constitution of those almost infinitely remote bodies which spangle the dim depths of space, the stars. And here we may say that no one can ever view a fixed star in this instrument without the greatest astonishment at, and admiration for, the labours of those (amongst whom Mr. Huggins is *facile princeps*) who have obtained such remarkable results as those of which we are now about to speak: the extreme relative faintness of the spectrum of a fixed star; the difficulty of maintaining its image accurately upon the slit of the spectroscope; the undulation and confusion of the lines from the twinkling of the object viewed, and other noticeable causes, combine to render the mere observation of the spectrum of a star an undertaking of the most laborious and difficult nature. What, then, must we think of the task of *measuring* accurately the position of lines in it?

In order that we may identify the substances to the absorptive action of whose vapour the dark lines in the spectrum of any given star are referable, it is necessary, as we have before explained, that we should possess the means of bringing the spectra of the suspected substances into juxtaposition with that of the star itself. The little prism D in Fig. 8 supplies us with the means of doing this, as it enables us to see at a glance whether the bright lines of the incandescent vapour which we are producing in our observatory, concide with, or appear to be prolongations of, the dark ones of the star spectrum.

When this is done, we shall be struck with the diversity which exists in the spectra of various stars. Huggins gives a description of the spectra of the two stars Aldebaran and α Orionis for the purpose of comparison, and has made a marvellously accurate drawing (too delicate and complicated for reproduction here) of the dark lines which they respectively exhibit. In one thing, however, they and other stars obviously agree, and that is in their light yielding a continuous spectrum striped by dark lines or bands; so that we can only infer that they are Suns, resembling our own in having brilliantly white-hot nuclei, the light from which passes through atmospheres containing absorbing elements. With regard to the two stars which we have just specially mentioned, we may say that the two hydrogen lines C and F (Fig. 7, p. 172) are present in the spectrum of Aldebaran, but absent from that of α Orionis; so that we see that the atmosphere of Aldebaran does (like that of our own Sun) contain hydrogen, while it has no existence in that of α Orionis. Four lines of calcium, also a solar metal, are present in both stars, as is our old friend sodium; in fact, Huggins and Miller have detected nine elements at least in Aldebaran alone. We have just said that hydrogen is absent from α Orionis. So far as we know, it is wanting in only one other star, β Pegasi. All the other stars which have been examined contain this element, which plays a part of such extraordinary importance in our own Sun's atmosphere. Sodium, magnesium, and iron also would seem to be present in a large proportion of the stars. We may well stand appalled at the grandeur of the conception thus realised, that the whole of the visible universe is knit together by the identity of the elements of which it is composed!

The next question which Huggins set himself to determine was, will the spectroscope throw any light on the cause of the diversity of colour in the fixed stars? and he had not long to wait for an answer. Commencing with that brilliantly white star, Sirius, he found that the dark lines of its spectrum were equally distributed all over it; so that rays of all refrangibilities or colours, being equably obscured, the light appeared to the eye to be colourless. Turning now to the larger component of that lovely double star, α Herculis, he found its spectrum crossed by numerous dark lines in the deep red, green, and blue, leaving the yellow and orange relatively free from shading; so that the light affected the eye as a bright orange. Carrying on this same system of research, Huggins ascertained that in those pairs of stars conspicuous for the beautiful contrasts of colour they present, the same explanation applies—that is to say, that a star whose spectrum was thickly ruled with dark lines in the red, yellow, and green, would appear of a vivid blue, while a corresponding shading at the more refrangible, or violet and blue, end of the spectrum of a star would cause it to appear to the eye as of a red hue. Father Secchi, of the Observatory of the College at Rome, in his "Catalogo delle Stella di cui si é Determinato lo Spettro Luminoso," published in 1867, divides all the stars into three groups: Firstly, the white stars, Sirius, Vega, β, γ, δ, ε, ζ, and η Ursæ Majoris, &c., having four well-marked black lines coinciding with the hydrogen ones. His next group comprises the yellow stars, such as Arcturus, Pollux, α Ceti, our own Sun, &c.; thirdly, the red and orange stars, α Herculis, α Orionis, Antares, &c., the spectra of which are cut up into a series of bright and dark bands, increasing in intensity towards the red. Since then, Secchi has added a fourth group, consisting of small red stars, whose spectra present three bright zones increasing in intensity towards the violet.

And here, before passing to the next division of our subject, we must, parenthetically, tell the story of the marvellous result of the application of the spectroscope to the examination of an otherwise unaccountable phenomenon observed in the Heavens in the year 1866. On the night of May the 12th in that year, an Irish gentleman, Mr. John Birmingham, of Tuam, saw a perfectly new star, which he described as "very brilliant, of about the second magnitude," next to ε in the constellation Corona Borealis (*vide* Vol. X., p. 65). This star was observed by Mr. Baxendell, of Manchester, on the 15th, and afterwards by numerous observers in various parts of the country. We have called it a perfectly new star, but in fact it was only so in the sense of its appearance as a large and brilliant object, where nothing but a star of the 9·5th magnitude had previously been known to exist. It had arrived at its greatest brilliancy *per saltum*, or by a jump, for there would appear to be abundant negative evidence that it was not visible to the naked eye prior to the night of Mr. Birmingham's discovery of it, when it vied with the brightest of its neighbours in lustre. From the time that it was first seen it began steadily to decline in brightness until about the middle of August, when it had diminished nearly to the 10th magnitude. Four nights after it was first detected by Mr. Birmingham, Mr. Huggins and Dr. Miller examined it with the spectroscope. The results they obtained are so extremely remarkable, that we shall give them, to a great extent, in Mr. Huggins's own words. He says: "The light of the star is compound, and has emanated from two different sources; each light forms its own spectrum. The principal spectrum is analogous to the light of the Sun. The portion of the star's light represented by this spectrum was emitted by an incandescent solid or liquid photosphere, and suffered partial absorption by passing through an atmosphere of vapours existing at a temperature lower than that of the photosphere." Omitting the description of this absorptive spectrum, which does not here concern us, we proceed to quote Mr. H.'s account of the other: "The second spectrum, which in the instrument appears to be superposed upon the one already described, consists of five *bright lines*. This order of spectrum shows that the light by which it was formed was emitted in the shape of *gas*." It only remains now to say that these bright lines coincided with those of the spectrum of hydrogen; and the reader, if he have thoroughly comprehended what we have said on pp. 146 and 127, will be able to draw for himself the true inference from these appearances. It is simple this, that we were looking at some sudden and stupendous conflagration of hydrogen gas—in plain English, that *the star was on fire!* A spectacle such as this suggests the reflection that an analogous catastrophe, albeit very improbable, is by no means impossible with our own Sun. We have previously seen how abundant hydrogen is on his surface, and how the marvellous red prominences, always visible during a solar eclipse, are composed of it, so that the material for combustion is present in enormous quantities. Of the nature of the agency requisite to set up sufficiently energetic action we know literally nothing, and it would be merely idle to speculate upon it; but of the result of such a convulsion there can be no doubt whatever. The intensity of the Sun's rays would be increased some eight hundredfold, and our own globe, and everything on it, would be instantly dissipated in the form of vapour. It may be worth while to add, that Secchi has observed bright bands in the spectra of more than one minute star, though without determining their position; so that we are unable to say whether they indicate a similar condition of things to that which obtained in the star in Corona or not, but that the spectrum of γ Cassopeiæ (Vol. X., Map, p. 25) certainly resembles that of T Coronæ, the star of which we have been speaking, to a very considerable extent.

(To be concluded.)

ELECTRICITY—ITS THEORY, SOURCES, AND APPLICATION.

BY J. T. SPRAGUE.[*]

(Continued from page 196.)

124. The fluid surrounding the zinc may be the usual acid, or where great action is not needed, common salt, or sal ammoniac, and other substances are used, or for telegraphic purposes, pure water; in these cases the zinc need not be amalgamated, which has this advantage, that any copper reduced on it does not combine, but causes less local action, and is more easily removed. For purposes of comparison, I made a cell of this kind fitted with plates 2in. by 1, and ½in. apart, as before. Charged with acid this gave 32°, with sal ammoniac 30°, with common salt 27°, and other salts, such as sulphate of soda and nitrate of soda, were still still less effective. It will be noticed that these figures are much lower than some of the previous forms, but it would be erroneous to suppose that this signifies less force; the Daniell's cell has a higher force than the Smee at its best, but it has a much higher internal resistance of one kind to overcome—viz., the porous division; this, with the Smee form, with the plates on opposite sides of the division, reduced it from 50° to 35°. But when different batteries are doing actual work, the result is that the power of the Smee is reduced in much greater degree than that of the Daniell, while the latter continues to act steadily. This is exemplified by the following comparison of a good working Daniell's cell, which, at its utmost work, only gave 50°, with my powerful cell giving 81°, with different resistances interposed :—

Units	1	2	3	4
Daniell	50	27	20	13	11
Mine	81	33	21	14	11

It must be understood that the actual variation is much greater than these figures, as it is in the ratio of their tangents. I have prepared, at great cost of time and labour, a complete table, which will be appended to the paper on Galvanometers, and will give the readers of the ENGLISH MECHANIC a more complete conception of this and of the teachings of galvanometers than has been furnished in any work hitherto published; at present I need only say that 50 has a value of 68, while 27 is 29, a difference of 39, or 55 per cent, while 81 and 33 represent 362, and 37 a difference of 325, or 89 per cent., caused by the first unit of resistance.

125. I believe the flat form to be the most convenient, but when cylinders are used, it is doubtful which way is best to arrange them—as described and usually made, or with the copper inside. The latter has the advantage of giving a larger area of diffusion to the leakage of copper salt, while it is not necessary to use a cylinder of zinc, for 1 or 2 rods or slips will furnish all the necessary force, as the copper surface is so much diminished; thus one cell will not give off so much current on short circuit as in the usual form, but this is not of much consequence. Fig. 39 shows a cell arranged in this manner with a reservoir of crystals in a flask, as there is no capacity for it in the cell. The flask is closed with a perforated cork, fitted with a glass tube, which dips below the surface of liquid in the cell, and keeps up the supply on the principle of the bird fountain. Such a cell, provided with two or three wire gauze cylinders, between the zinc and the porous jar, would probably furnish a constant current for a prolonged period; this is called the Meidinger cell. There are many other modifications of the Daniell, vaunted by their makers, but there are only two calling for any remarks, because they are frequently mentioned.

126. THE MINOTTO has been much lauded; it consists of a jar, at the bottom of which is a copper plate, fitted with a wire, this is covered with an inch of crushed sulphate of copper, and this again with a layer of silver sand, which is to act as the porous division. My own experience with it is that it has all the evils of the ordinary form, and few of its advantages; the copper finds its way to the zinc very soon, while the resistance is so great that there is little power to spare; a full-sized one, with a plate 4½in. diameter, only gave 15° and 13° after two days, during which it had done no work, but by which time there was a great deal of copper on the zinc. I have tried several modifications, but all with the same result.

127. BOULAY'S cell, is another attempt to overcome the evils of the Daniell. It is very peculiarly constructed, the porous jar being double, and containing both metals as cylinders, separated by paper and by crystals of common salt ground up with equal bulk of flour of sulphur surrounding the zinc, and equal bulks of sulphate of copper and nitrate of potash around the copper; the cell, thus tightly packed, is placed in a jar containing crystals of copper sulphate and water. The patentee claims great advantages for this cell, stating that the sulphur has a peculiar property by which, though itself unacted on, it prevents the passage of the copper salt to the zinc, and that the addition of the nitrate of potash greatly adds to the electro-motive force. It has, no doubt, good properties, and once set up gives no further trouble, and is, I understand, about to be largely employed by the Government in the telegraphic department.

I found its action much stronger than I expected at first, as one cell gave 37°, rising in two hours to 55. It was then set aside for a week, doing no work, after which it gave 25°, falling to 20, and I find that it remains with a power of about 20 to 16, so that it is very useful for experimental purposes, and would, no doubt, remain a long while in action with bells and alarms for domestic use, and require no attention. On the other hand when exhausted it would be troublesome to re-charge.

128. The theory of the action of the sulphate of copper cell is easily explained as an extension of that shown in Fig. 36, p. 75. If we imagine the porous partition in the middle and the two right hand molecules to be sulphate of copper,

We have—	Zinc	$\overbrace{H_2SO_4}$,	$\overbrace{H_2SO_4}$,	$\overbrace{CuSO_4}$,	$\overbrace{CuSO_4}$,	Copper.
polarised		$\overbrace{SO_4H_2}$,	$\overbrace{SO_4H}$	$\overbrace{SO_4Cu}$,	$\overbrace{SO_4Cu}$	
breaking up		$\overbrace{ZnSO_4}$,	$\overbrace{H_2SO_4}$,	$\overbrace{H_2SO_4}$,	$Cu\overbrace{SO_4Cu}$	

The last line shows us that what occurs is that an atom of zinc is taken up and one of copper displaced, that the source of the force is simply the difference of affinity of sulphuric radical for zinc and copper; the force yielded is equivalent to the heat zinc would give while precipitating copper from its sulphate, and is really the difference between the internal force necessary to the existence of sulphate of copper, and that bound or latent in sulphate of zinc. It is probable, however, that it is only at the last molecule that copper sulphate forms part of the circuit if there is free acid present, but that does not affect this principle, which sets the action before us far more comprehensibly than the idea that water, or even acid is decomposed, and completes the circuit, while the nascent hydrogen merely reduces the copper chemically.

129. I have dwelt thus fully on this form, because of its importance, both practical and theoretical, and it only remains now to show the cost of its working; this will be the same as the simple cell, with an addition for excess of local action varying in each case, and the extra cost belonging to each special form; in the Daniell, this is the sulphate of copper, worth about 5d. per pound, but as it yields one-fourth its weight of copper as a residue, the price may fairly be set at 3d. Using for convenience and intelligibility the pound in all cases, multiplied by the equivalent weight and dividing by 7000, the number of grains in a pound, we get the cost on the scale of grain equivalents, which is that I shall adopt, the unit of quantity or total current being one equivalent of any metal deposited or water decomposed :—

Sulphuric acid equivalent		49
,, local action, say 5 per cent.		2¼
,, left unconsumed one-fifth...		5¼
		57
57lb. at 1¼d. = 71d. ÷ 7000 =		·0101
Zinc equivalent...........	32·6	
,, impurities...........	2·4	
,, local action 5 p. cent	2·	
	37	
37lb. at 7d. = 259d. ÷ 7000 =		·0370
Cost of each single cell		·0471

The data I gave in last paper, based on the working of one pint of acid, brings the cost out, ·0427 of a penny, being under 1-20th of a penny per unit of work. The extra cost of the Daniell will be :—

Extra local action, at least 5 per c.—		·0024
Copper sulphate, equivalent	125	
Loss by leakage, &c.........	1	
	126.	
126lb. at 3d. = 378d. ÷ 7000 =		·0540
Extra cost of Daniell....................		·0564
Normal cost		·0471
Total cost per unit........................		·1085

The cost would, of course, be less if salt were used, both by its less cost, and by diminished local action, and it must be remembered also, that these figures only supply one element of the calculation in which the electro-motive force and the nature of the work to be done each contribute their elements before any accurate conclusion can be come to.

(To be continued.)

ANCIENT COINS.—III.

BY HENRY W. HENFREY.

(Continued from page 197.)

WE will now give a few particulars concerning the Imperial Roman series. They commence with Augustus, Emperor from 27 B.C. to A.D. 14.

The copper and brass imperial coins are extremely numerous, and of great interest. The usual divisions of them—which are purely arbitrary—are into large, middle, and small, or 1st, 2nd, and 3rd brass coins. The large brass is perhaps the *sestertius;* the second brass, when of *brass*, is the *dupondius*, and when of *copper*, the *as*. "In the reign of Philip we find a coin rather larger than the usual third brass, called the *Philippus æreus*, and in the time of Gallienus, although the *sestertii* and *dupondii* cease altogether as a regular series, there are small coins of brass, which we may suppose to represent the *as*. In the reign of Diocletian a new coin of copper appeared, termed the *follis*. This and a smaller coin (*the assarius*), both of which gradually decrease in size, continue till the reign of Honorius." (*Madden.*)

Copper or brass *medallions* were made of a larger size than the first brass coins. They were not struck for circulation as money, but probably served the same purpose as our modern medals.

A complete series of Roman large brass is very costly. The superior size of these pieces, and the beauty and interest of their reverses, combine to make them of great value. With Gallienus, A.D. 268, they terminate. Among the scarce and interesting types are the following :—One of Livia with her bust, and IVLIA AVGVSTA GENETRIX ORBIS. This latter title was conferred on her by the Senate. Coins of Drusus, commemorating his conquest of the Germans, hence called GERMANICVS. One of Claudius, with *reverse* a triumphal arch, and DE BRITANNIS, relating to his triumphs in Britain. Another of Vespasian, bearing a female figure of Judæa, seated weeping under a palm tree; inscription, IVDAEA CAPTA referring to the conquest of Judæa and destruction of Jerusalem, A.D. 70. Others of Titus, similar, and commemorating the same events. One of Trajan smiting a Dacian foe. Others with fine portraits of Antoninus Pius, Marcus Aurelius, the two Faustinas. The famous medallion of Commodus with BRITANIA. The VICT BRIT. of Geta, &c.

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[*] "Sigma."

No. 5.

The engraving No. 5 represents the reverse of a large brass coin of Antoninus Pius, bearing a seated figure of Britannia. The reader interested in these coins should procure Akerman's "Coins of the Romans relating to Britain."

The second or middle brass coins are also very numerous, and often have similar types to the large brass. The third or small brass, however, are those of the most frequent occurrence. Among the commonest are those of Probus—of which several thousand varieties have been found—Constantine, and his sons. With the small copper are classed plated coins, and pieces of mixed copper or tin, washed with silver, called *billon*.

The silver Imperial coins consist of denarii and quinarii, generally smaller than the Consular coins of the same denominations. The reduction from 84 to 96 to the pound is supposed to have been made by Nero. This latter standard would make the full weight about 52 grains troy. "In the reign of Caracalla (A.D. 211—217) a silver coin of a larger size appeared, called 'Argenteus Antoninianus,' having always the radiate head of an emperor, as Apollo, or that of an empress, as Diana. There were sixty struck to the pound: the coin was always of base silver; and, in the reign of Volusian (A.D. 251—254), the standard became extremely base, and the metal was either copper or tin, both covered with a wash of silver. In the reign of Diocletian (A.D. 284—305) good silver reappears, and is found to the end of the empire. The coins were still of two sizes, probably the 'argenteus' and the 'denarius.' The principal silver coin of Constantine the Great (A.D. 306—337) was the *cententionalis*, which is most likely the silver coin, which weighs a little less than fifty grains: when it was first issued is not certain." (*Madden.*)

The series of Imperial silver is by far the cheapest and most easily obtained, besides being extremely interesting from its great variety, curiosity, and beauty. The types are so numerous that we find it impossible to name the most interesting ones. In the words of Pinkerton, "They contain figures of deities, at whole length, with their attributes and symbols; public buildings and diversions; allegorical representations; ceremonies, civil and religious; historical and private events; figures of ancient statues; plants, animals, and other subjects of natural history; ancient magistracies, with their insignia; in short, almost every object of nature or art."

The one which we have selected for illustration is a silver denarius of Tiberius Cæsar, Emperor from A.D. 14 to A.D. 37. It is called the *tribute money*, being one of the identical coins spoken of in Matthew, chap. xxii. "But Jesus perceived their wickedness, and said, Why tempt ye me, ye hypocrites? Show me the tribute money. And they brought unto him a penny [literally, a denarius]. And he saith unto them, Whose is this image and superscription? They say unto him, Cæsar's." The coin has, *obverse*, the bust of Tiberius Cæsar. Inscription: TI. CÆSAR. DIVI. AVG. F. AVGVSTVS; showing the name Cæsar at full length. *Reverse*, a female figure seated. PONTIF. MAXIM. See the engraving, No. 4.

The gold Imperial coinage consists chiefly of the *aureus*, but there are apparently double-aurei and half-aurei, and other divisions, all of fluctuating weights. Augustus struck 40 aurei to the pound, Nero 45, Caracalla 50, and Gallienus still more. Diocletian made 60 out of a pound, and Constantine the Great issued a new coin, the *solidus*, instead of the aureus. The solidus was coined at the rate of 72 to the pound until the termination of the Empire. In size and type the aurei are very similar to the denarii, many types being the same in silver and gold.

We engrave (No. 6) an aureus of Titus, Emperor from A.D. 79 to A.D. 81. *Obverse*, laureated bust. IMP. TITVS. CAES. VESPASIAN. AVG. P.M. *Reverse*, a dolphin twined round an anchor. TR. P. IX. IMP. XV. COS. VIII. P. P. Weight 113 grains.

Gold and silver medallions of large size were struck, probably for the same purposes as the copper ones.

The abbreviations of some of the titles, etc., are as follow:—

AED. CVR., Ædilis Curulis.
AED. PL., Ædilis Plebis.
AVG., Augustus.
AVGG., Two Augusti.
AVGGG., Three Augusti.
C., CAE., or CAES., Cæsar.
CAESS., Cæsares.
CEN., Censor
COS., Consul; COSS., Consules.
D., Divus.
DAC., Dacicus.
DES. or DESIG.; Designatus.
D. F., Divi Filius.
DICT. PERP., Dictator Perpetuus.
DIV., Divus.
D. N., Dominus Noster.
F., Filius or Felix.
FEL., Felix.
FL., Flavius.
GERM., Germanicus.
IMP., Imperator; IMPP., Imperatores.
III. VIR., Triumvir.
OB. C. S., Ob Civis Servatos.
P. F., Pius Felix.
P.M. or PONT. MAX., Pontifex Maximus.
P. P., Pater Patriæ.
PROC., Proconsul.
PROP., Proprætor.
S. C., Senatus Consulto.
S. P. Q. R., Senatus Populusque Romanus.
TI., Tiberius.
TR. P. or TRIB. POT., Tribunitia Potestate; having Tribunitian power.
VOT., Votis., &c., &c.

(*To be continued.*)

THE SCENERY AND GEOLOGICAL STRUCTURE OF A COUNTRY. *

THE subject I have chosen is to some extent new to many, and I think it promises to bring with it a new source of intellectual pleasure to us, in that it may be made a source of agreeable mental exercise. I can say, from my own experience, that it has enabled me to pass many a long and tedious railway journey much more pleasantly than I could have passed it had I been ignorant of the simple truths I am about to place before you. We know that tastes and pursuits of this sort are powerful engines of enlightment and truth; and that they tend very much to keep us out of that mischief which, the prophet tells us, is always ready for idle hands into. The necessary knowledge for this recreation lies within the reach of every one. It is not like going into the full study of Geology—*that* takes a lifetime. This pleasant application of science requires little more than a good use of the eyes, and plain, homely, common sense.

The delight in natural scenery and the power of appreciating its beauty is one of gradual growth in the human mind; and I think it is a product of comparatively recent date. If we look at the great poets of antiquity, we find what appears to us a surprising deficiency on this head. I do not mean to say that these writers have not given us many accurate and exquisitely expressed description of what they saw around them; but I do think that we fail to find that feeling of joy, and that delight in pure, natural, beauty for its own sake which every modern writer of cultivated mind shows, whether he intends it or not. I must preface my lecture with some slight attempt to prove this point. I suppose, for instance, that Mount Etna is one of the loveliest objects in the world. Sir Charles Lyell, describing it from a purely scientific point of view, could not resist the impulse of paying a passing tribute to the charms of its scenery. Pindar, by a few well-chosen epithets, brings before us every feature of the scene the snowy cap, the belt of dark-leaved vegetation below, and the startling phenomena of volcanic action. All this he evidently saw, and he described it in a manner which cannot be surpassed; but I do not think that he experienced the same delight that a modern writer or traveller would have felt, had he been gazing on so beautiful a country. The contrast appears to be very curious. We have a scientific man going out of his way, as it were, to speak of it with enthusiasm, and we have a poet entirely omitting to give such expression to his description. The solution of this is that the one had, and the other had not, this sense of the beautiful. Then, again, there is another famous passage in which Virgil describes his own fatherland, Italy. There is a long and detailed list of all her material advantages expressed in elegant and graceful language, but I must confess that it rather reminds me of an auctioneer's catalogue; and I think it would have excited the admiration of the famous George Robins, if he could have read it. Italy, we all know, is looked upon as the home of loveliness, and it seems very strange to us that a poet writing in praise of his own country should have omitted this. If we come down to more modern times, I always fancy, when reading Pope, that he seems to love the forest for its shade, and not for its intrinsic beauty; and valued brooks and rivers, not as points in the landscape, but as possible bathing or drinking places for his nymphs. Then, again, there is a passage in Macaulay respecting a man who had been travelling in Scotland, and the only impression which seems to have been produced upon this man's mind was, that its mountains were "unsightly excrescences." Many of the pictures of the great masters of painting exemplify this want of appreciation of the beautiful in nature. They certainly did study one natural object with very great attention—viz., the human form, to the effect I am afraid, of sometimes making its anatomical details very conspicuous in the picture. But they were very indifferent to most natural things; in fact, if we confine ourselves to our own literature, I think it is not until the time of the Lake School, Scott, and Byron, that this love for natural scenery seems to have been fully developed. Since then it has been universally cultivated and enjoyed. Now I think that science is in a fair way to add to this lately-acquired source of pleasure, for it will, before very long, fully explain to us the way in which different features of landscape were produced; and this will necessarily add very much to our enjoyment when gazing at such a landscape.

The scenery of a country will depend in a great measure on the shape of the ground: whether it is hilly, mountainous, flat, or traversed by deep or broad valleys. When we wish to see the connection between scenery and geology, we must first see how it had its appearance given to it. Hills and mountains, valleys and deep gorges seem very striking to us, but if we look at them in comparison with the size of the whole earth, they appear as little bulges on its surface. Now, the earth is enveloped in a thin external shell, which is made up of a number of substances, such as limestones, sandstones, clays, gravels, &c., all of which are known geologically under the name of rocks; and a very large proportion of these rocks were originally formed of sand, mud, and soft sediment, which was carried down by rivers to the sea, and allowed to fall to the bottom. Thus the sea-bottom was gradually raised up until at last it was elevated into dry land. Now it was while this elevating process was going on that the land first began to assume its present shape. We need not for our present purpose concern ourselves with the way in which the sediment was brought, or where it came from; I ask you to believe me when I tell you that the sediment was carried into the sea, and that after it had remained there and increased in bulk by continual additions, it gradually got above the level of the water, and became dry land.

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* A lecture delivered at St. George's Hall, by A. H. Green, Esq., M.A., Cambridge, F.G.S. (of her Majesty's Geological Surveys), March 20, 1870.

As soon as any portion of the sea-bottom is raised above the level of the water, it is attacked by a number of forces which tend to wear it away, and carve out inequalities in it, and it is to these forces almost exclusively that the present shape of the land may be said to be owing. These denuding forces are divided into two classes. 1. The sea; which is called the marine denuding force. 2. The wind, frost, ice, and rain, which are called sub-aërial denuding forces. We will first take the action of the sea; and it is of the utmost importance to note that at great depths the sea exerts little—I think I may say *no* denuding power at all. It is only able to exert a wearing-away action in shallow water, and along coast lines. At these spots, the waves are constantly wearing and tearing away whatever rises above the water; and in this way they are aided very much by sub-aërial agents. They sweep clean away everything that rises against them, and plane the land down, as belt after belt comes within the range of their denuding action; so that, at last, the result is a tolerably level surface. When the land is removed beyond the reach of marine action, its surface will most probably be very nearly level, with a small slope seawards. Then rain will begin to fall upon it, and form brooks and rivers, which will cut their way into the ground, and make a branching system of trenches across the plateau. The channels thus cut will be of a steep-sided, trench-like form; but the action of rain, frost, and springs will tend gradually to round off these sharp edges, so that by degrees the trench will become widened more and more, and at last spread out into a broad valley. This is now pretty generally admitted to be the most probable manner in which the contours of the earth's surface have been formed. The sea first makes a plain; the different brooks and rivers carve out systems of boundaries; similarly as a man cuts a slab of marble out of the quarry and takes it to the sculptor, who carves out a group in relief on it. Valleys are not rents and cracks torn open in the earth's surface, but channels eaten out below the level of the ground by rivers.

Let us see if we cannot somewhere find traces of old marine denudation. If we post ourselves on a central commanding point of a group of mountains, we are at once struck with the fact that a large number of the hill tops appear to rise much to the same level; and if we take a raised map of this country, and lay over it a sheet of plate glass, we shall find that our first impression is correct; we should find that the sheet of glass would lie along in such a manner as to touch the tops of very nearly all the principal hills. That sheet of glass represents what was at one time the level of the whole country; wherever the surface sinks beneath it portions have been swept away by sub-aërial denudation, and the mountain tops and elevated plateaux are the only parts of the original surface that remain. I once saw a very striking instance of such traces remaining. I started one morning from the frontiers of Portugal to ride across Andalusia towards Seville, and I saw what seemed to be, as far as the eye could reach, an endless flat. I thought I should have an easy journey, and a speedy arrival at the end of it; but I had not travelled much more than half an hour before I found out I was mistaken. I found the country traversed in every direction by valleys, some of which were so steep-sided as to deserve the name of gorges. You might almost ride up to the edge of one before you had any idea of its existence. When I turned back and viewed the landscape I could scarcely believe but that I had passed the entirely unbroken, flat country which it seemed.

(*To be concluded*)

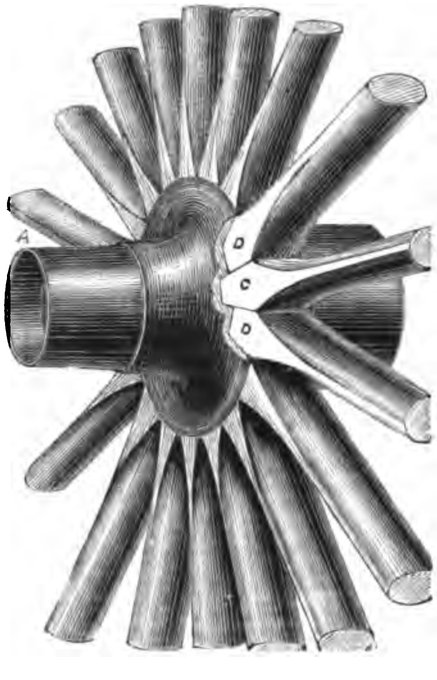
KEYES' IMPROVED WAGGON WHEEL.

FIG. 1 is a perspective view of the central portion of one of these improved wheels, with a portion of one of the iron flanges of the hub broken away to show the way in which the spokes are inserted; and Fig. 2 is a section of the same, revealing the entire construction of the hub, and the manner of inserting and fastening the spokes.

A, Figs. 1 and 2, is an external hub of malleable cast iron, lined with an internal hub of wood, B, Fig. 2. The inner and larger portion of the external hub A, is recessed, as shown, and a shoulder to correspond is made upon the internal wood hub, the inner end of the wood hub being made somewhat smaller than the recess in A, as shown.

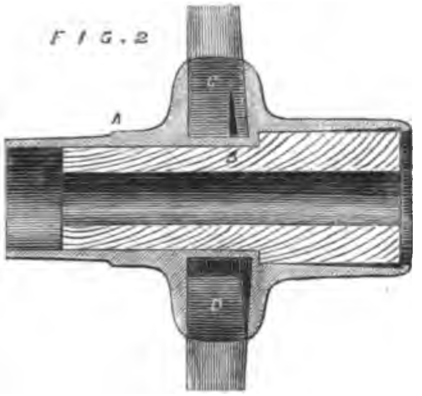
The internal wooden hub receives the axle box, which is first driven into the wood hub B as tightly as possible, and when the axle box is driven in and wedged, the wood hub is forced outward, so that it enters and fills every part of the recess, and the shoulders of the recess prevent its moving or working loose. Previous to driving in the axle box, the wooden hub B is also fastened to the iron at the bottom of the spokes subsequently to be inserted.

FIG. 1



The external iron hub has two very stout flanges which laterally support the tenons of the spokes when the latter are driven, as shown in both engravings; each alternate spoke C being wedged, as shown in Fig. 2, and the others D, Figs. 1 and 2, being shorter, and resting upon ledges of iron which rise between the extremities of the longer spokes, and serve to greatly strengthen the central part of the hub.

FIG. 2



The axle box may be driven and retained in the hub with much greater force than in a plain wooden hub, with iron bands, and the parts of the whole structure mutually sustain each other under strain. The hubs may be used for new wheels, when the other parts of the wheel are worn out.—*Scientific American.*

ENGLISH MECHANIC MUTUAL IMPROVEMENT SOCIETY.—MANCHESTER BRANCH.

A SECOND meeting was held on May 16, and the officers to the society elected, with a committee to draw the rules, which will be submitted to the society members next meeting. The business on this occasion will be the inaugural address from the President, and a paper on "A New Solution to the Parallelogram of Forces," by the Secretary. The meeting to be held at the Manchester Mechanics' Institution, David-street, on June 1, at 8 p.m., precisely

MECHANICAL MOVEMENTS.*

(*Continued from page 200.*)

106. THREE-LEGGED pendulum escapement. The pallets are formed in an opening in a plate attached to the pendulum, and the three teeth of the escape-wheel operate on the upper and lower pallets alternately. One tooth is shown in operation on the upper pallet.

107. A modification of the above with long stopping teeth D and E. A and B are the pallets.

108. A detached pendulum escapement, leaving the pendulum P free or detached from the escape-wheel, except at the time of receiving the impulse and unlocking the wheel. There is but one pallet, I, which receives impulse only during the vibrations of the pendulum to the left. The lever Q locks the escape-wheel until just before the time for giving the impulse, when it is unlocked by the click C, attached to the pendulum. As the pendulum returns to the right, the click, which oscillates on a pivot, will be pushed aside by the lever.

109. Mudge's gravity escapement. The pallets A B instead of being on one arbor are on two, as shown at C. The pendulum plays between the fork-pins P Q, and so raises one of the weighted pallets out of the wheel at each vibration. When the pendulum returns the pallet falls with it, and the weight of the pallet gives the impulse.

110. Three-legged gravity escapement. The lifting of the pallets A and B is done by the three pins near the centre of the escape-wheel, the pallets vibrating from two centres near the point of suspension of the pendulum. The escape-wheel is locked by means of stops D and E on the pallets.

111. Double three-legged gravity escapement. Two locking-wheels A B C and *a b c* are here used with one set of lifting-pins between them. The two wheels are set wide enough apart to allow the pallets to lie between them. The teeth of the first-mentioned locking-wheel are stopped by a stop-tooth D on one pallet, and those of the other one by a stop-tooth E on the other pallet.

112. Bloxam's gravity escapement. The pallets are lifted alternately by the small wheel, and the stopping is done by the action of the stops A and B on the larger wheel. E and F are the fork-pins which embrace the pendulum.

113. Chronometer escapement, the form now commonly constructed. As the balance rotates in the direction of the arrow, the tooth V on the verge, presses the passing-spring against the lever, pressing aside the lever and removing the detent from the tooth of the escape-wheel. As balance returns, tooth V presses aside and passes spring without moving lever, which then rests against the stop E. P is the only pallet upon which impulse is given.

114. Lever chronometer escapement. In this the pallets A B and lever look like those of the lever escapement 296: but these pallets only look the escape-wheel, having no impulse. Impulse is given by teeth of escape-wheel directly to a pallet C attached to balance.

115. Conical pendulum, hung by a thin piece of round wire. Lower end connected with and driven in a circle by an arm attached to a vertical rotating spindle. The pendulum-rod describes a cone in its revolution.

116. Mercurial compensation pendulum. A glass jar of mercury is used for the bob or weight. As the pendulum-rod is expanded lengthwise by increased temperature, the expansion of mercury in jar carries it to a greater height therein, and so raises its centre of gravity relatively to the rod sufficiently to compensate for downward expansion of the rod. As rod is contracted by a reduction of temperature, contraction of mercury lowers it relatively to rod. In this way the centre of oscillation is always kept in the same place, and the effective length of pendulum always the same.

117. Compound bar compensation pendulum. C is a compound bar of brass and iron or steel, brazed together with brass downwards. As brass expands more than iron, the bar will bend upward as it gets warmer, and carry the weights W W up with it, raising the centre of the aggregate weight M W to raise the centre of oscillation as much as elongation of the pendulum-rod would let it down.

118. Watch regulator. The balance-spring is attached at its outer end to a fixed stud R, and at its inner end to staff of balance. A neutral point is formed in the spring at P by inserting it between two curb-pins in the lever, which is fitted

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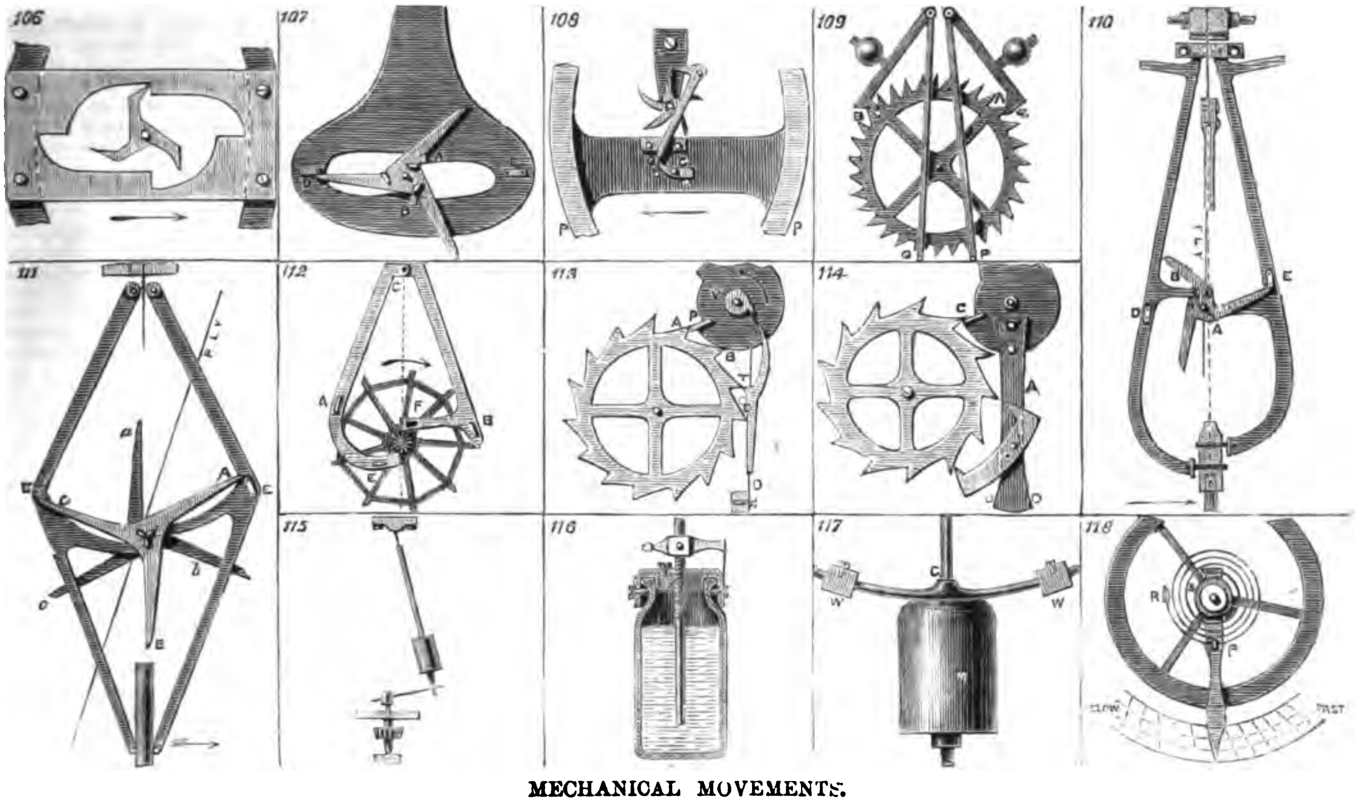
* Extracted from a compilation by Mr. H. T. Brown, Editor of the *American Artisan.*



MECHANICAL MOVEMENTS.

to turn on a fixed ring concentric with staff of balance, and the spring only vibrates between this neutral point and staff of balance. By moving lever to the right, the curb-pins are made to reduce the length of acting part of spring, and the vibrations of balance are made faster; and by moving it to the left an opposite effect is produced.

(To be continued.)

ON THE RELATIONS BETWEEN BODY AND MIND.*

LECTURE I.

(Continued from page 199.)

TAKE, for example, the so-called faculty of memory, of which metaphysicians have made so much, as affording us the knowledge of personal identity. From the way in which they usually treat of it, one would suppose that memory was peculiar to mind, and far beyond the reach of physical explanation. But a little reflection will prove that it is nothing of the kind. The acquired functions of the spinal cord, and of the sensory ganglia, obviously imply the existence of memory, which is indispensable to their formation and exercise. How else could these centres be educated? The impressions made upon them, and the answering movements, both leave their traces behind them, which are capable of being revived on the occasions of similar impressions. A ganglionic centre, whether of mind, sensation, or movement, which was without memory, would be an idiotic centre, incapable of being taught its functions. In every nerve-cell there is memory, and not only so, but there is memory in every organic element of the body. The virus of small-pox or of syphilis makes its mark on the constitution for the rest of life. We may forget it but it will not forget us, though, like the memory of an old man, it may fade and become faint with advancing age. The manner in which the scar of a cut in a child's finger is perpetuated, and grows as the body grows, evinces, as Mr. Paget has pointed out, that the organic element of the part remembers the change which it has suffered. Memory is the organic registration of the effects of impressions, the organisation of experience, and to recollect is to revive this experience—to call the organised residue into functional activity.

The fact that memory is accompanied by consciousness in the supreme centres does not alter the fundamental nature of the organic processes that are the condition of it. The more sure and perfect, indeed, memory becomes, the more unconscious it becomes; and when an idea or mental state has been completely organised, it is revived without consciousness, and takes its part automatically in our mental operations, just as a habitual movement does in our bodily activity. We perceive in operation here the same law of organisation of conscious acquisitions as unconscious power, which we observed in the functions of the lower nerve centres. A child, while learning to speak or read, has to remember the meaning of each word, must tediously exercise its memory; but which of us finds it necessary to remember the meanings of the common words which we are daily using, as we must do those of a foreign language with which we are not very familiar? We do remember them, of course, but it is by an unconscious memory. In like manner, a pupil, learning to play the pianoforte, is obliged to call to mind each note; but the skilful player goes through no such process of conscious remembrance; his ideas, like his movements, are automatic, and both so rapid as to surpass the rapidity of succession of conscious ideas and movements. To my mind, there are incontrovertible reasons to conclude that the organic conditions of memory are the same in the supreme centres of thought as they are in the lower centres of sensation and of reflex action. Accordingly, in a brain that is not disorganised the organic registrations are never actually forgotten, but endure while life lasts; no wave of oblivion can efface their characters. Consciousness, it is true, may be impotent to recall them; but a fever, a blow on the head, a poison in the blood, a dream, the agony of drowning, the hour of death, rending the veil between our present consciousness and these inscriptions, will sometimes call vividly back, in a momentary flash, much that seemed to have vanished from the mind for ever. In the deepest and most secret recesses of mind, there is nothing hidden from the individual self, or from others, which may not be thus sometimes accidentally revealed; so that it might well be that, as De Quincy, surmised, the opening of the book at the day of judgment shall be the unfolding of the everlasting scroll of memory.

As it is with memory, so it is with volition, which is a physiological function of the supreme centres, and which, like memory, becomes more unconscious and automatic the more completely it is organised by repeated practice. It is not man's function in life to think and feel only; his inner life he must express or utter in action of some kind—in word or deed. Receiving the impressions from nature, of which he is a part, he reacts upon nature intelligently, modifying it in a variety of ways; thus nature passes through human nature to a higher evolution. As the spinal cord reacts to its impressions in excito-motor action, and as the sensory centres react to their impressions in sensori-motor action, so, after the complex interworking and combination of ideas in the hemispherical ganglia, there is, in like manner, a reaction or desire of determination of energy outwards, in accordance with the fundamental property of organic structure to seek what is beneficial and shun what is hurtful to it. It is this property of tissue that gives the impulse which, when guided by intelligence, we call volition, and it is the abstraction from the particular volition which metaphysicians personify as *the will*, and regard as their determining agent. Physiologically, we cannot choose but reject *the* will; volition we know, and will we know, but *the will*, apart from particular acts of volition or will, we cannot know. To interpose such a metaphysical entity between reflection and action thereupon, would bring us logically to the necessity of interposing a similar entity between the stimulus to the spinal cord and its reaction. Thus, instead of unravelling the complex by help of the more simple, we should obscure the simple by speculations concerning the complex. As physiologists we have to deal with volition as a function of the supreme centres, following reflection, varying in quantity and quality as its cause varies, strengthened by education and exercise, enfeebled by disuse, decaying with decay of structure, and always needing for its outward expression the educated agency of the subordinate motor centres. We have to deal with will, not as a single undecomposable faculty unaffected by bodily conditions, but as a result of organic changes in the supreme centres, affected as certainly and seriously by disorder of them as our motor faculties are by disorder of their centres. Loss of power of will is one of the earliest and most characteristic symptoms of mental derangement; and, whatever may have been thought in times past, we know well now that the loss is not the work of some unclean spirit that has laid its hands upon the will, but the direct effect of physical disease.

But I must pass on now to other matters, without stopping to unfold at length the resemblances between the properties of the supreme centres and those of the lower nerve centres. We see that the supreme centres are educated, as the other centres are, and the better they are educated the better do they perform their functions of thinking and willing. The development of mind is a gradual process of organisation in them. Ideas, as they are successively acquired through the gateways of the senses, are blended and combined and grouped in a complexity that defies analysis, the organic combinations being the physiological conditions of our highest mental operations—reflection, reasoning, and judgment. Two leading ideas are ought to grasp and hold fast: first, that the complex and more recondite phenomena of mind we formed out of the more simple and elementary by progressive specialisation and integration; and, secondly, that the laws by means of which this formation takes place are not laws of association merely, but laws of organic combination and evolution. The growth of mental power means an actual addition of structure to the intimate constitution of the centres of mind—a *mental organisation* in them; and mental derangement means disorder of them, primary or secondary, functional or organic.

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* Two lectures delivered at the Royal College of Physicians in 1870. By HENRY MAUDSLEY, M.D., F.R.C.P., Professor of Medical Jurisprudence in University College, London.

Although I have declared the hemispherical ganglia to be pre-eminently the mind centres, and although it is in disorder of their functions—in disordered intelligence, in disordered emotion, and in disordered will—that insanity essentially consists, it is nevertheless impossible to limit the study of our mental operations to the study of them. They receive impressions from every part of the body, and, there is reason to believe, exert an influence on every element of it: there is not an organic motion, sensible or insensible, which does not, consciously or unconsciously, affect them, and which they in turn do not consciously or unconsciously affect. So intimate and essential is the sympathy between all the organic functions, of which mind is the crown and consummation, that we may justly say of it that it sums up and comprehends the bodily life—that everything which is displayed outwardly is contained secretly in the innermost. We cannot truly understand mind functions without embracing in our inquiry all the bodily functions and features.

I have already shown this in respect of motor functions, by exhibiting how entirely dependent for its expression will is upon the organised mechanism of the motor centres—how, in effecting voluntary movements, it presupposes the appropriate education of the motor centres. Few persons, perhaps, consider what a wonderful art speech is, or even remember that it is an art which we acquire. But it actually costs us a great deal of pains to learn to speak; all the language which the infant has is to cry; and it is only because we begin to learn to talk when we are very young, and are so constantly practising, that we forget how specially we have had to educate our motor centres of speech. Here, however, we come to another pregnant consideration: the acquired faculty of the educated motor centre is not only a necessary agency in the performance of a voluntary act, but I maintain that it positively enters as a mental element into the composition of the definite volition; that, in fact, the specific motor faculty not only acts downwards upon the motor nerves, thus effecting the movement, but also acts upwards upon the mind centres, thereby giving to consciousness the conception of the suitable movement—the appropriate motor intuition. It is certain that, in order to execute consciously a voluntary act, we must have in the mind a conception of the aim or purpose of the act. The will cannot act upon the separate muscles, it can only determine the result desired; and thereupon the combined contraction, in due force and rapidity, of the separate muscles takes place in a way that we have no consciousness of, and accomplishes the act. The infant directly it is born can suck certainly not consciously or voluntarily; on the first occasion, at any rate, it can have no notion of the purpose of its movements; but the effect of the action is to excite in the mind the special motor intuition, and to lay the foundation of the special volition of it. We cannot do an act voluntarily unless we know what we are going to do, and we cannot know exactly what we are going to do until we have taught ourselves to do it. This exact knowledge of the aim of the act, which we get by experience, the motor intuition gives us.

The essential intervention of the motor intuition, which is, as it were, the abstract of the movement, in our mental life, is best illustrated by the movements of speech, but is by no means peculiar to them. Each word represents a certain association and succession of muscular acts, and is itself nothing more than a conventional sign or symbol to mark the particular muscular expression of a particular idea. The word has not independent vitality; it differs in different languages; and those who are deprived of the power of articulate speech must make use of other muscular acts to express their ideas, speaking, as it were, in a dumb discourse. There is no reason on earth, indeed, why a person might not learn to express every thought which he can utter in speech by movements of his fingers, limbs, and body—by the silent language of gesture. The movements of articulation have not, then, a special *kind* of connexion with the mind, though their connection is a specially intimate one; they are simply the most convenient for the expression of our mental states, because they are so numerous, various, delicate, and complex, and because, in conjunction with the muscles of the larynx and the respiratory muscles, they modify sound, and thus make audible language. Having, on this account, been always used as the special instruments of utterance, their connection with thought is most intimate; the Greeks, in fact, used the word λογοσ to mean both reason and speech. But this does not make the relations of the movements of speech to mind different fundamentally from the relations of other voluntary movements to mind; and we should be quite as much warranted in speaking of a special faculty of writing, of walking, or of gesticulating in the mind, as in speaking of a special faculty of speech there.

What is true of the relations of articulate movements to mental states is true of the relations of other movements to mental states: they not only express the thought, but, when otherwise put in action, they can excite the appropriate thought. Speak the word, and the idea of which it is the expression is aroused, though it was not in the mind previously; or put other muscles than those of speech into an attitude which is the normal expression of a certain mental state, and the latter is excited. Most if not all men, when thinking, repeat internally, whisper to themselves, as it were, what they are thinking about; and persons of dull and feeble intelligence cannot comprehend what they read, or what is said to them sometimes, without calling the actual movement to their aid, and repeating the words in a whisper or aloud. As speech has become the almost exclusive mode of expressing our thoughts, there not being many gestures of the body which are the habitual expressions of simple ideas, we cannot present striking examples of the powers of other movements to call up the appropriate ideas; yet the delicate movements of the accommodation of the eye to vision at different distances seem really to give to the mind its ideas of distance and magnitude. No one actually sees distance and magnitude; he sees only certain signs from which he has learned to judge intuitively of them—the muscular adaptations, though he is unconscious of them, imparting the suitable intuitions.

The case is stronger, however, in regard to our emotions. Visible muscular expression is to passion what language (or audible muscular expression) is to thought. Bacon rightly, therefore, pointed out the advantage of a study of the forms of expression. "For," he says, "the lineaments of the body to disclose the disposition and inclination of the mind in general; but the motions of the countenance and parts do not only so, but do further disclose the present humour and state of the mind or will." The muscles of the countenance are the chief exponents of human feeling, much of the variety of which is due to the action of the orbicular muscles with the system of elevating and depressing muscles. Animals cannot laugh, because, besides being incapable of ludicrous ideas, they do not possess in sufficient development the orbicular muscle of the lips and the straight muscles which act upon them. It is because of the superadded muscles and of their combined actions—not combined contraction merely, but consentaneous action, the relaxation of some accompanying the contraction of others—that the human countenance is capable of expressing a variety of more complex emotions than animals can. Those who would degrade the body, in order, as they image, to exalt the mind, should consider more deeply than they do the importance of our muscular expressions of feeling. The manifold shades and kinds of expression which the lips present—their gibes, gambols, and flashes of merriment; the quick language of a quivering nostril; the varied waves and ripples of beautiful emotion which play on the human countenance, with the spasms of passion that disfigure it—all which we take such pains to embody in art—are simply effects of muscular action, and might be produced by electricity or any other stimulus, if we could only apply it in suitable force to the proper muscles. When the eye is turned upwards in rapt devotion, in the ecstacy of supplication it is for the same reason as it is rolled upwards in fainting, in sleep, in the agony of death; it is an involuntary act of the oblique muscles, when the straight muscles cease to act upon it. We perceive, then, in the study of muscular action the reason why man looks up to heaven in prayer, and why he has placed there the power "whence cometh his help." A simple property of the body, as Sir C. Bell observes—the fact that the eye in supplication takes what is its natural position when not acted upon by the will—has influenced our conceptions of heaven, our religious observances, and the habitul expressions of our highest feelings.

(*To be continued.*)

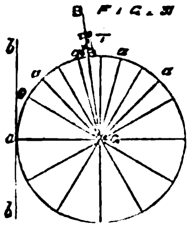
SCIENCE FOR THE YOUNG.*

BY THE REV. E. KERNAN, CLONGOWES COLLEGE.

(*Continued from page* 197.)

APP. XII. "Horizontal."—A body is said to be horizontal when its axis or base forms a right angle with the earth's radius. In Fig. 31 the line *b a b* is horizontal in the true sense of the word.

FIG. 31



App. XIII. The Plummet.—A weight hung freely, would fall, if allowed, along one of the radii, hence the line which holds it must have the same direction. If, then, any slide &c., of a body be parallel to that line, it must be perpendicular." A plummet or plumb line supplies a means of proving such parallelisms. This, so very common an instrument, scarcely requires description, Fig. 32. The bar A (of wood, iron, &c.), has a cut or slight groove down the middle, and parallel to its edge *a a*. A small weight hangs from the top of the bar. The edge being placed upright along a body, if it be perpendicular, the cord from which the weight hangs will lie along the groove; if not it will lie one side or the other. It was this instrument which the French philosophers found at fault in Peru. The plumb line may also serve to show that a body is horizontal or not. For this purpose the cord groove is made at a right angle to edge to be applied at A, Fig. 33. Any deviation of the cord from the groove, will show that the body (its side, or axis, &c.) does not form a right angle with the earth's radius—is not horizontal.

FIG. 32

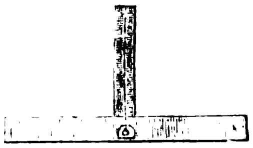
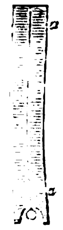


FIG. 32



App. XIV. "Sun's Heat."—The mechanical theory of the sun's heat by percussion, depends upon the great force exerted by its enormous mass on small bodies in heavenly space.

App. XV. Aërolites, Meteoric Stone.—The display of light and the fall of these upon the earth is caused by their coming within range of the earth's attraction. At different periods of each year the belt in which they move is more or less approached; hence the fixed dates of more or less action. Besides this yearly occurrence, certain periods of years, said to be 33, bring the earth much nearer for a short time, which produces, by increased attraction, those gorgeous phenomena witnessed some years ago.

App. XVI. Earth, Different Gravitations.—In consequence of the earth not being a perfect sphere, the gravitation varies slightly in one place from another. Some time ago, too, a decrease was observed, near a mountain. This was accounted for as being caused by a lesser quantity of matter under the mountain. The same was observed at an earlier period in an open country near Moscow.

PROBLEMS.

Prob. I. Why is the earth not seen to move to feathers falling? Show from formula.

II. Explain the great cause of the high and low tides, and what could have been the reason of the extra high tide predicted for last October (1869)?

III. To what causes should be attributed a decrease of attraction between the earth and moon?

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§ V.—POROSITY—DENSITY.

Porosity is the existence of some space between the particles of matter. A sponge is an excellent example. There is little more to be said of this property than that all bodies have it, varying in degree. Gold, the most compact, steel, &c., have pores. There is no solid the matter of which cannot be forced into a smaller space. There must have been room for the particles to move into.

Density is a very important property. By the name is signified the quantity of matter in a given space. It differs, therefore, essentially from "weight," which does not take the bulk, the size, the volume into account, or when these terms are used, it is only meant to convey the idea of a certain amount of matter without any comparison of volume. To make the notion of density clear, take an example. Let A and B, Fig. 34, represent two cubes of equal capacity. A is filled with water, B with mercury. Now mercury, in round numbers, is thirteen times more dense than water—*i.e.*, that in the same volume there is thirteen times more matter in the mercury than in the water. Weight has no reference to volume. It says, "There are 2, 3, 4lb. of mercury." Density, on the contrary, is the *weight of a given volume*. It says, "in *that volume* there are 2, 3, 4lb. of mercury."

Weight refers to some understood quantity of matter—an ounce, a pound, &c., taken as a standard, no matter what the body be; an exact ounce of wood will do as well as an ounce of brass.

Density refers to no fixed quantity, but to some determined body as the standard of comparison, no matter what the volume, provided equal volumes be taken of the standard and body to be compared. The relative weight of these equal volumes gives the density. Of this density much in chemistry, just now enough to understand what it is, and to see briefly its chief laws. The definition of density is contained in the formula $D = \frac{M}{V}$, M quantity of matter, V volume containing it.

No. 1. Laws.—These are important, yet simple, and easily remembered.

Law 1. All bodies have density. Solids, liquids, gases, have their own density.

Law 2. The density increases with the quantity of matter in the same volume. As there is more matter within the same bulk the body is more and more dense.

Law 3. The density decreases with the increase of volume, for the same quantity of matter. The *greater* the volume, the quantity not changing, *the less* is the density of the body.

Law 4. When the densities of two bodies are equal, the masses are directly proportional to the volumes.

Law 5. The masses being equal, the densities are inversely proportional to their volume.

Law 6. The volumes being equal, the densities are proportional to the masses.

No. 2 Proofs. These are a remarkable evidence to the student of the utility of even simple formula. The laws may be all remembered by means of the formula $D = \frac{M}{V}$, which contains all e laws.

Law I. Every body has a certain quantity of matter, and occupies some space. Therefore D has always some value. In the gases the volume is evident, and that they have M is proved by their weight and action (mechanical) on solids and liquids.

Laws II., III. Looking at the formula it is clear that as M grows larger, V remaining the same, the quotient of the division most *increase*, therefore the density. Again, while M remains the same, if V increase, the quotient must *decrease*.

Law IV. Comparing the densities of two bodies in proportional formula $\frac{D}{D'} = \frac{\frac{M}{V}}{\frac{M'}{V'}}$ (1).

Now if $D = D'$, $\frac{M}{M'} = \frac{V}{V'}$. For the densities being equal, the expressions of these densities must be equal.

Law V. Here $M = M$. Therefore $\frac{D}{D'} = \frac{V'}{V}$

For effecting the division in the general equation

(1) $\frac{D}{D'} = \frac{MV'}{M'V} = \frac{V'}{V}$ (reducing $M = M'$).

Law VI. This law has $V = V'$. Therefore $\frac{D}{D'} = \frac{M}{M'}$ (reducing $V = V'$).

The application of the density laws cannot be given here. They belong in great part to the mechanics of liquids. It may be noted, however, that the chief object of the Cavendish apparatus twas the determination of the mean density of the rea h. This had been already established by the Sheballien experiment.

The subject of density gives a remarkable example of the fact that scientific views not unfrequently are contained in ordinary language; that they are familiar to man without his adverting to their existence within his mind. Nothing is more common than to say such a body is "heavier," than an other—that material is "too heavy," and the like. Now in such expressions, it is never meant that, for example, a pound of feathers is heavier than a pound of lead. In many cases it signifies, and is the simplest, expression of density; that, in a given volume there is more matter in one body than in another.

FIG. 35

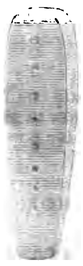


FIG. 36

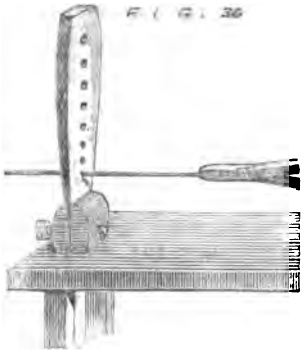


FIG. 33

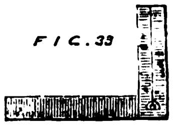
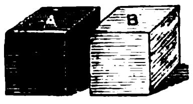


FIG. 34



The student may profit much, by turning the expression of density $\left(D = \frac{M}{V}\right)$ round and round, up and down, seeking now one, now another unknown quantity. He will thus learn by a simple example how formulæ contain what it would require pages on pages to express, and great efforts of the memory to recollect. If the formula be retained in the safe keeping of the *intellect*, is all its development.

The expression $D = \frac{M}{V}$ in the present matter will be a sure guide to a correct, or at least a safe answer, to a suddenly put complicated question of density.

SECTION II.

ACCIDENTAL PROPERTIES OF MATTER.

As before, of these in groups or singly, according to importance.

§ I.—COMPRESSIBILITY, DILATABILITY, HARDNESS, &C.

Compressibility, is the permitting reduction into a smaller volume. Some bodies have this property very evident; examples well known; others have but little sign of it—thus iron, stone, water. It exists in all, in a greater or less degree, and is the cause of the apparent penetrability observed in bodies.

Dilatability is the power of occupying a greater volume. It is the reverse of compressibility, and, like it, very evident in some bodies; not almost perceived in others. The gaseous state is the great example.

Hardness.—Better understood than expressed. It is the power of resisting disintegration—division. A knife separates easily the particles of a bit of wood: not so those of a bit of glass. This property depends somewhat upon density; it exists only in solids, and in these it is relative; hardness in timber would be called softness in stone, iron. There is no body absolutely hard, at least, as yet, none discovered which can *not* be deprived of some matter.

Brittleness.—Easily divided by a shock. Belongs to solids only.

Malleability.—Easily changing form or volume, without injury to texture, by compression or percussion. The name is taken from the hammer. (Latin, *malleus.*) An important property possessed by some bodies, especially amongst the metals—lead, tin, gold, platinum, &c. The well-known gold leaf is a familiar example. Its very thin sheets have a thickness not greater than $\frac{1}{200000}$ of an inch. Recently iron has been "laminated," as the term used is, to the thickness of paper, and employed for writing a letter upon.

Ductibility.—Easily changing form or volume by being drawn through openings finer and finer. (The name from the Latin, *duco*, I lead.) This property it is which permits the making of metallic wires. Only some amongst the metals possess ductility, and it is a remarkable fact that some malleable metals are not ductile, and *vice versa*. Wire drawing, as the process is called, is effected by drawing metals through conical-shaped holes in a plate of steel. Each hole, Fig. 35, is a little smaller than the hole which preceded. The wire is drawn through one hole after another, until the required diameter is reached, Fig. 36. Some metals, not ductile, are made into wires by being *forced* through holes—for instance, the new metals, magnesium and thallium. Ductility would seem to depend, at least in part, on the next property.

Tenacity.—The power of resisting an effort of drawing asunder the particles of a body. Attraction of cohesion, the cause of this property's varying so much, tenacity must differ much in various bodies, and shows but little beyond the solid state. It does not seem to have any dependence on density; steel wire $\frac{1}{100}$in. will bear 134lb. Platinum, same diameter only 16lb., although platinum is almost three times as dense as steel.

(To be continued.)

MESSRS. CUNNINGHAM AND McCARTHY'S IMPROVEMENTS IN OBTAINING MOTIVE POWER.

THIS invention, patented by W. J. Cunningham, of 480, New Oxford-street, and Alfred Patrick McCarthy, of Bloomsbury, consists in the application of springs of any description or any equivalent power so combined with wheels, levers, and other apparatus as to act alternately or simultaneously the one on the other, and by this means aid or cause the propulsion of any wheeled vehicle. Fig. 1 is a longitudinal section of the apparatus, Fig. 2 combining sections through A B and C D, Fig. 1. The said springs are contained in boxes or cases *a* a^1, free to revolve on a shaft *b*, and have attached to them gear wheels *c d* in gear with pinions *e f* on the shafts *g h* of the winding-up wheels *i j*, which are alternately placed in and out of contact with the ground. On the same shaft *b* as the spring boxes is a gear wheel *k* taking into a pinion *l* on the driving shaft *m* of the machine, on which are the two carrying wheels *n*, so that the action of the springs being communicated to the shaft *b* causes the gear wheel *k* to revolve, thereby imparting its motion through the pinion *l* to the carrying wheels, and thus propelling the machine. But so that the action of the springs shall be continuous they are alternately acted upon and kept up to their working power by the wheels *i j* in the following manner:—On the spring shaft *b* are small fast and loose pulleys *o p*, from which a band or strap passes to a corresponding pulley *q* on an auxiliary shaft *r*, on which is a conical pulley *s* corresponding to another conical pulley *t* placed in the reverse direction on the shaft *u*, and a strap connects these said conical pulleys *s* and *t*, so that by shifting the said strap from right to left, or *vice versa*, a slower or faster action may be imparted to the cams *v w*, on the shaft *u*. These said cams act upon the upper ends of sliding blocks *x y*, carrying the bearings *z* b^1, of the winding up wheels *i j*, and alternately depress the said wheels, which by their contact with the ground during the progress of the machine as

FIG. 1

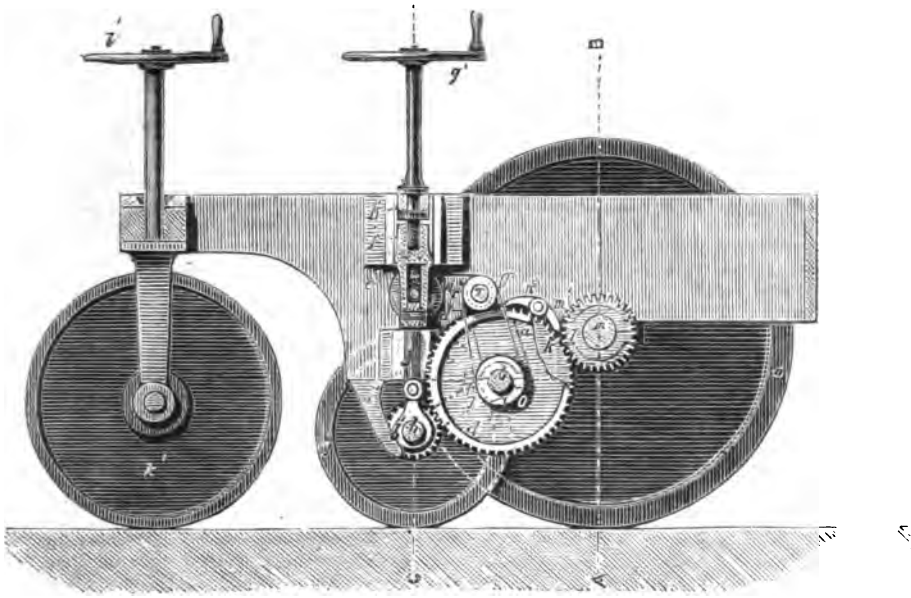
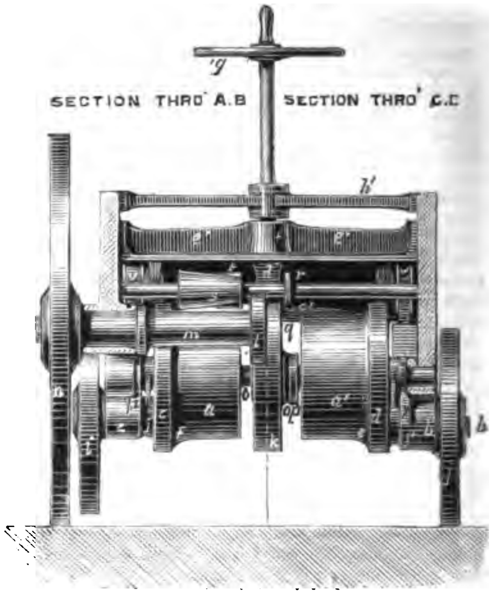


FIG. 2



caused to revolve, thereby rotating the pinions *e f*, from which motion is communicated to the gear wheels *c d*, attached to the spring boxes *a* a^1, and thus wind up the springs in advance of the speed of rotation of the gear wheel *k*, thus ensuring their constant action. The said sliding blocks *x y*, act alternately upon the ends of a lever c^1 oscillating on a fulcrum d_1 suspended from the cross frame e^1 carrying the bearings of the cam shaft, by which means the cams have little or no work to do in rising the wheels, as they exactly balance one another, thus preventing a great strain being thrown on the working mechanism of the machine. If a greater amount of adhesion is required on the winding wheels, the cross frame e^1 may be lowered by the screw f_1 worked by the hand wheel g^1. and having its bearing in the cross bar h^1. The bosses on the winding shafts *g h* at all times bear against a guide i^1, and are connected to the shaft *b* by radial arms j^1, thus ensuring the wheels *c e* and *d f* being always in gear with one another. One or more guide wheels k^1 is or are adapted to the fore end of the machine, and actuated by a hand wheel l^1, by which means the course of the vehicle to which this apparatus is applied is directed. When the machine is going forwards the pawls m^1 acting on the gear wheels *c d*, attached to the spring boxes are placed in contact therewith to prevent their springing back in a contrary direction when not acted upon by the winding wheels, and when the machine is required to go backwards these pawls m^1 are lifted out of gear with the wheels *c d*, the pawl n^1 having been previously thrown into gear with the wheel *k* to prevent its forward driving action. It is evident that the action of the spring boxes and spring shaft may be reversed so that the machine may be driven either by one or the other. When it is desired to stop the vehicle all the pawls are placed in gear, by which means the whole power of the springs is stored up for a new start, and the course of the machine gradually arrested. The springs may be additionally wound up by hand if required, and the self-acting winding wheels may be placed in and out of contact with the ground by hand instead of by the means described, and several springs may be placed on one shaft so as to have a continuous action, by which arrangement much power will be gained. The carrying wheels may have clutches applied to their axles, so that they may be disconnected therefrom when turning, or at other convenient periods, and the two or more springs may be arranged to act simultaneously if desired.

A whistle acted upon by compressed air or otherwise may be placed on any convenient part of the machine so as to signal its approach in the same manner as obtains at present with steam whistles; and the pawls may be made to act upon spring balances to indicate the amount of power given off by each spring.

This machine or apparatus may be employed either for railways, road vehicles, stationary engines, clocks, or any other purpose for which motive power of any description is required, and will form a valuable addition to steam engines by enabling a comparatively small power to perform the same amount of work as a greater power.

NOTES FROM THE PROCEEDINGS OF THE ROYAL ASTRONOMICAL SOCIETY.

W. LASSEL, ESQ., F.R.S., PRESIDENT, IN THE CHAIR.

THE President expressed the deep grief that the Society experienced on hearing of the death of the late able President, Admiral R. H. Manners, and remarked on his many amiable qualities, and the interest he took in promoting astronomical science.

Professor Selwyn exhibited to the Society a chart that he had received from Sir John Herschel, in which were roughly mapped all the solar spots observed by Mr. Carrington. Sir John stated that his object was to discover whether any particular region of the sun showed any decided tendency to macularity. Had he been successful in detecting any locality where spots appeared more frequently on the solar disc the chart would have been made more accurately, but not having been successful, the chart was submitted to the attention of the Society in its rough state.

Several observers presented their observations of the occultation of Saturn, on April 19th, with their remarks upon the phenomenon. Three distinct observations had been made at the Royal Observatory; Mr. Joynson, Captain Noble, and Mr. Talmage, had also observed the occultation. Mr. Talmage also observed the occultation of Titan, and remarked that had he taken the trouble to compute the place of some of the brighter satellites, he might equally well have observed their occultation also.

Mr. Penrose submitted to the attention of the Society, some observations of occultations, solar spots, and of the variable Algol: concerning the latter, Mr. Penrose stated that the period required some slight correction, as the observed time of the minimum brightness was three hours in advance of the computed time. The observations of solar spots (a diagram of which was presented to the Society) did not appear to indicate that cuplike depression which these phenomena usually present. Mr. Browning remarked that in his observations of solar spots the same peculiarity had often presented itself when the penumbra had appeared nearer the centre of the sun than the limb.

Mr Lockyer said that he believed that during the last year a great change had taken place in the appearance of sun spots, and submitted as a working hypothesis that possibly the photosphere at the time of maximum macularity was thinner than at the time of the least frequent appearance of spots.

Lieutenant Brown offered some meteorological observations made at Gibraltar from 1860-9, towards the end of December in each year, with a view of determining the probability of the Solar Eclipse of 1870 being visible. The general tenor of these observations was to show that the sky at that period of the year was generally free from cloud, and that the chances were greatly in favour of complete observation.

The President remarked that a great number of letters had been received from gentlemen volunteering their assistance in the expected forthcoming expedition, and that in the course of a week, the Council of the Society would meet to discuss the most likely method of procuring the co-operation of the Government.

Mr. Airy repeated the remarks that he had made at the previous meeting of the Society. From the experience gained by English and American observers in former eclipses, it appeared that the three great subjects of observation which required especial attention and especial training were photography, spectroscopy, and polarisation, and this division was so necessary that he had no fear of its being disputed. The number of persons who will be required at one station to carry on the observations by photography with good effect, is three well-skilled observers, thoroughly versed in the use of photographic apparatus, and able to adapt themselves to the singular circumstances of the phenomenon. These three observers will require two assistants, who need not be so well acquainted with photography, one of whom, if possible, should be a *carpenter*, who may be valuable for other purposes. The particular wants of spectroscopy require five skilled observers, to be assisted by three others, who understand a little of the nature of spectrum analysis. For the observations with the polariscope it seems impossible to dispense with fewer than three skilful observers, who would require, probably, three assistants. The number of skilled observers is, therefore eleven, and with their assistants and other general observers, would make a total of twenty-six persons required for each station. About sixty gentlemen have expressed a wish to take part in this expedition, so that two stations can be completely furnished, one at Cadiz, and the other at Gibraltar. It is necessary that the directors of the expedition should know what observation each volunteer is competent to make, and whether he is willing that his services shall be transferred to any other department that necessity may render desirable. Mr. Airy concluded by expressing his opinion that the observers who had taken the observations with the polariscope in former eclipses knew nothing of the use of that instrument, and that it was indispensable that every observer should satisfy some competent person that he knew what polarisation is, what the plane of polarisation is, and what the plane of polarisation is when he sees it.

Mr. De la Rue said that he believed an expedition had never been organised which was so likely to have a successful issue as the one under discussion. Gentlemen the most competent to bring about a success had expressed their intention of taking part in the expedition, there was required only a master mind to direct the proceedings, which he hoped would be found in the person of the the Astronomer Royal.

The Astromoner Royal could not undertake to reply to the invitation of Mr. De la Rue, and left the matter doubtful; at a subsequent period of the evening Mr. Airy said that, considering all the contingencies and requirements of the observers, it would be desirable that the steamer should be ready to start on Saturday, the 3rd of December; and that, in case the number of volunteers increased, in a manner totally unexpected, it might be desirable to detach a party to the East Coast of Sicily, which would require the expedition to start still earlier.

Prof. Grant hoped that a certain number of artists and draughtsmen might accompany the astronomers, as their services would probably be very useful. It was announced by the committee that the names of several had been received.

Mr. W. T. Lynn communicated a paper on the "Proper Motion of the Star Groombridge, 1830," derived from a discussion of the Greenwich observations for 20 years, and which tended to establish the hitherto received value of its proper motion.

Mr. Proctor addressed the Society on the subject of the resolvability of star clusters being regarded as a proof of distance, and in the course of the discussion which followed, Mr. Stone expressed his opinion on the cause of the increased proportion of small stars that become visible as the aperture of the instrument is increased. For the purpose of explanation, Mr. Stone considered the stars as being collected in concentric rings around the solar system, at increasing distances, and supposed stars of all magnitudes equally distributed in these rings. Then the stars of the first magnitude in the first ring are our first magnitude stars. The second magnitude stars may be supposed to embrace not only the stars of the second magnitude in the first ring, but the stars of the first magnitude in the second ring. For third magnitude stars the first of the third ring will be excluded, and so on down to the eleventh or twelfth, or any magnitude.

Mr. Williams, Assistant Secretary of the Society, exhibited and described an ancient astronomical instrument of the 17th century, the work of Campani, and late the property of Dr. Lee. The diameter of the object glass was about 2in., but the diameter of the eyepiece, which consisted of three lenses, was about 5in. The field of view was said to be very flat, and the definition good, though the tube being made of vellum, the flexure of the instrument interfered considerably with its performance. The focal length was about 9ft., and the weight about 2¼lb.

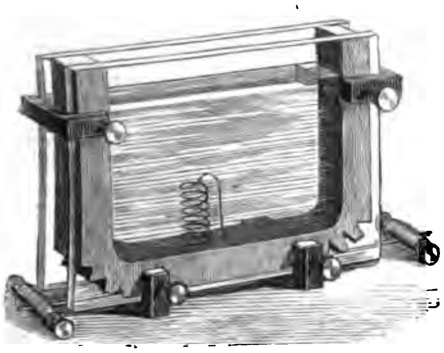
THE ELECTRIC FULGURATOR.

AT the recent annual conversazione of the Plymouth Institution and Devon and Cornwall Natural History Society, held a Plymouth, Mr. J. N. Hearder, F.C.S., exhibited a new and extraordinary apparatus, to which he has given the name of

Electric Fulgurator, having for its objects the production of electric sparks or discharges of statical or frictional electricity of immense length precisely resembling lightning flashes. The effect is produced by a peculiar arrangement of large Leyden jars, which are all insulated on separate glass pillars, 3ft. high, fixed in a frame and connected by levers, which permit them to be joined together, either as an ordinary battery, or turned into a position which connects the inner coating of each with the outer coating of the next. The jars are first charged as an electric battery from a powerful glass electrical machine, and when sufficiently charged are suddenly dissevered from battery connection with each other, and are thrown into the intensity, or, as it is sometimes called, cascade position. The discharge takes place between the balls of a suitable discharger connected with each terminal. By this arrangement prodigious sparks of great length are obtained, resembling zig-zag flashes of lightning, accompanied by a loud report. The apparatus, consisting of thirteen Leyden jars, gave sparks in free air of 3ft. 6in. in length, very thick and crooked, and of a brilliant bluish-white colour. The deflagrating power of the apparatus, as exhibited in the combustion of metal leaves and wires, appears to be greater in the intensity than in the quantity arrangement. When this discharge is made to pass through heated air its length is amazingly increased. Sixty-three small spirit lamps, each having two wicks, were arranged in a long ebonite trough, so as to form a line of 126 spirit flames, extending to the length of 9ft. Over these flames a brilliant spark passed with such facility from a moderate charge that Mr. Hearder calculated that a full charge would be able to pass more than double the distance. When the charge was a little reduced the sparks still passed through the flames in a less brilliant form, but producing a bright spot immediately over the top of each wick, giving to the whole the appearance of a long string of brilliant beads. Mr. Hearder stated that, although this apparatus originated with him, it was not now, as regards date, for he had shown the society a similar arrangement, though on a very much smaller scale, more than 40 years ago. Its present more imposing form was entirely due to the zeal and liberality of the gentleman before-mentioned, who, being desirous of ascertaining to what extent the principle admitted of development, had given him an order to construct the apparatus now before the society. The conclusions arrived at were, that with suitable apparatus and accommodation, and electrical machines of adequate power, the arrangement might be almost indefinitely extended, and that sparks of 15 or 20ft. in length in free air would be by no means difficult of attainment. The present apparatus originally consisted of 15 jars, which gave sparks of 5ft. in free air. In conclusion, Mr. Hearder remarked that this apparatus opened a new field for electrical investigation in connection with the effects of quantity and intensity in relation to statical electricity, a subject never yet attempted for want of suitable apparatus, and he was bound to say that the results of the few experiments he had been able to make are such as could hardly have been predicated with our present notions of the action of the Leyden jar.

SOLAR ECLIPSES.

THROUGH the kindness of Prof. Henry Morton we are enabled to give a brief account of a lecture on the above subject given by him for the benefit of the Franklin Institute. We have before had occasion to refer to the popularity of this eminent lecturer, as well as to the enormous scale on which he conducts the most successful experiments; and the lecture on solar eclipses, which was demanded a second time, illustrated as it was with the most brilliant experiments, fully sustains the high reputation he has gained both in the old and new world. After describing experimentally the causes of an eclipse, the umbra and penumbra, the law of direction, the total eclipse, and the prominences, the lecturer proceeded to illustrate the formation of solar prominences, by means of a tank and a coil of wire (see woodcut).



The tank is filled with water, and then a solution of cochineal is run in on the bottom with a pipette. A single flask cell excited with bichromate of potash and sulphuric acid is enough to determine the ascending currant, which carries up the crimson solution in a very beautiful manner. By interrupting the circuit, the red prominence can be made to settle back, or topple over, so as to assume many of the forms actually observed. To erect the image on the screen Professor Morton used one of Zentmayer's erecting prisms Mr. J. N. Lockyer's drawings of solar prominences, pictures of the corona, and its coruscation, illustrated by a new piece of apparatus for the lantern, and producing on an immense scale the beautiful effects shown by the chameleon top, were very clearly shown.—*Chemical News.*

THE INFLUENCE OF THE SUN UPON GLASS.—M. Bontemps, managing director of the famous glass works at Choisey-le-Roi, states that the best and whitest glass made at St. Gobaix turns to a distinct yellow after three months' exposure to the sun. Extra white glass (peculiarly manufactured) has become even more yellow, and gradually assumes a colour known as *pelure d' oignon*; glass containing five per cent. of litharge was also affected, though far less perceptibly; crystal glass, made with carbonate of potassa, litharge, and silica was not at all affected (the other varieties referred to contain carbonate of soda); English plate-glass, from the British Plate Glass Company, of a distinctly azure blue tinge, also remained unaffected.

LETTERS TO THE EDITOR.

[We do not hold ourselves responsible for the opinions of our correspondents. The EDITOR respectfully requests that all communications should be drawn up as briefly as possible.]

*** All communications should be addressed to the EDITOR of the ENGLISH MECHANIC, 31, Tavistock-street, Covent Garden, W.C.

All cheques and Post Office Orders to be made payable to J. PASSMORE EDWARDS.

I would have every one write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that, as to other things, knows no more than what everybody does, and yet to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks: a vice from whence great inconveniences derive their original.—*Montaigne's Essays.*

THE FUEL OF THE SUN.—MR. BEARDSLEY'S DYNAMICS.

SIR,—"F.R.A.S.," p. 203, has replied so fully to the "Harmonious Blacksmith's" request for an opinion as to Mr. Williams's book "The Fuel of the Sun," that I should not feel any call to give a reply myself, except for a remark or two of "F.R.A.S."

I know more of the book itself, and should sum it up in the well-known *jeu de mot*, "what's new is not true, and what's true is not new." The author appears to fancy he is giving out a new and defined theory when he is simply muddling up ideas common to most men who have thought on the subject seriously, and with the means of thought. It is pretty generally believed now that all space contains matter in various forms, as ether, aërolites, and cosmical dust; microscopic planets, in fact. The heat of the sun is commonly attributed to the impact of such bodies continually drawn in. What then becomes of the "exhausted Fuel?" Simply this, the same force of impact which results in heat by the arrest of motion, destroys the bonds which hold the substance together, it is resolved into its elements, and those elements into their ultimate state of division; to use a common illustration, the body is resolved into vapour just as would a drop of water falling on molten iron; this vapour or gas necessarily recedes from the sun by ordinary laws (not by any supposed *repulsion*), and forms the chromosphere and the absorbing atmosphere, and probably, for here we pass into conjecture, the ether, which carries away into space again both the heat and light produced by the concussion, and *also the matter*, which, again condensing in distant space after parting with the heat it carried away latent, is prepared again to commence its journey back to the sun, again to repeat that process.

Nature, in fact, exists on a system of perpetual motion, because there is no loss or friction *outside of her workings* as in our machines; she never loses her force, but its changes of form and operation are what we know as her works.

Mr. Beardsley has occupied two columns of small print, p. 209, in spreading an intellectual mist which three lines will dissipate. All his argument about the gyroscope and pendulum, which may seem "tall talk" to people as ignorant as himself, is based simply on that ignorance. Now let us at once admit that ignorance on a matter of science is no crime. A man may fairly be in error, and base a false argument on an erroneous observation; every scientific man does so at times, and needs not punishment, but correction. But when a man challenges the whole scientific world, and calls them idiots, on no better ground than his own very limited perception, the case is very different; such men are public pests, and deserve punishment, for correction they cannot receive.

Is it possible, after all this talk, to open the eyes of this man to the simple fact that *the whole* of the machinery he is arguing about is in motion, not only the supporting points, which are solidly connected to the earth; that consequently his argument on the effect that the motion of the earth *ought* to have on the ball of the pendulum is simple nonsense, because the only effect would be due to the difference in length of the two arcs described by the ball and its point of suspension, proportioned to the distances of each from the centre of the earth. Exactly the same argument applies to his former difficulties about the minds. The water and the air are as much attached to the earth as the soil itself, and revolve with it. If the earth suddenly stopped, then the results he supposes would come into effect. It is just so with a vessel of water set spinning, as any one may see. At first the vessel revolves *around the water*, which remains at rest; gradually the friction of the sides sets the water revolving, and after awhile, the whole turns just as though the water were solid and fixed to the vessel; stop the motion, and the water goes on revolving till its motion is exhausted by friction.

Of course if Mr. Beardsley merely wishes to cause mental confusion, and act as a sort of advertiser to that pretender Parallax, he is wise to do his fighting among hedges and ditches, that is, to argue about pendulums and gyroscopes, subjects so obscure to most minds that his assertions as to what they *must* teach may seem reasonable: but I have asked him to deal with two simple facts in every day experience; he says, p. 209, that the sailor can travel anywhere if he has a chart. Just so; will he have the goodness to tell us where a chart is to be found which is not based on the spherical form of the earth? I have seen a great many charts, but none except on this principle. A map of the world on Mr. Beardsley's plan would be so interesting, and such a novelty, that if he can by any possibility devise one, I will ask you, Mr. Editor, as a personal favour, to give him a whole page for its production.

SIGMA.

CLAIRVOYANCE.

SIR,—I am afraid that it is out of my power to give our friend "The Harmonious Blacksmith," the information he asks me for. In fact, I am no believer in clairvoyance, by which I do not mean that I am a disbeliever or absolute denier of the existence of such a faculty, but that I do not accept it, simply because no evidence beyond report has ever presented itself to me, though often sought for. My present opinion is that clairvoyance is a misconception of transfer of thought, and that when a clairvoyant gives true information it is because the questioner has the reply in his own mind. Two out of many cases will illustrate what I mean. My watch was once stolen from my room, so I went to a mesmeric friend who boasted the possession of a perfect clairvoyant. She described to me the thief and the circumstances, the going away with it, and pawning of it at a place she did not name, but described as though she saw it, and read the name from over the shop window. She was correct as to the thief: *all the rest was pure imagination*, the fact being that I had a very strong suspicion as to the first; all the rest I traced out in vain, though I found the place she named. But some time after I caught the thief and recovered my watch, and learnt all the real facts; yet the description was so vivid, that one could but believe facts were being seen by the clairvoyant as they passed before her eyes.

Another clairvoyant being tendered me as evidence, and as having the power of describing distant occurrences, I tested her by going to my brother's house, and requesting him to make some alteration in the ornaments, and to write me a note saying what was done. The young lady was next day duly thrown into a trance, when she described my brother's house and sitting-room, and told me how he and his wife were engaged, but, singularly enough, omitted to say that another brother was at that moment in their company, *I not knowing he was in London.* She decribed the room, pictures, &c., very clearly, till she came to the altered ornament, which she said was either a large figure or vase, but she could not clearly say which, evidently because I was myself uncertain what was there; the evening before it was a large alabaster vase. However, I admitted the truth of the description; but just as my friend asked me if I were now satisfied as to clairvoyance, I took out my brother's note, unopened till then, and found these words, "The vase is removed, and the parrot cage put in its place."

I have repeatedly tried to act upon my most sensitive subjects from a distance, but never succeeded. This may have been caused by my own doubting faith, however, because, on the other hand, I readily transfer the impression of my will to them from some distance, providing I have first entranced them, as in the case I referred to a while ago. When, to satisfy a very incredulous person, I left my patient in the house, and allowed him to take me where he pleased, leaving directions to open the door after a certain time, there was no possibility of anyone knowing where we were gone, and yet the observers declared that she did not hesitate an instant, but made as nearly as possible a straight line from where we stood, following the line of street when forced to, and turning corners at the shortest angles, till she came to us, her eyes closed, and in deep trance, and, standing before me, said, "You called me." I therefore recognise the possibility of mental actions at a distance, but never allowing myself to be led beyond what there is good evidence for, I cannot at present admit that clairvoyance is anything but a misconception, due to want of understanding the relations between two minds, and to the excitement of mind caused by the extraordinary things really witnessed by observers, and unconsciously exaggerated in the recitals.

SIGMA.

INDUCTION COIL.—GALVANIC BATTERIES.

SIR,—Mr. Cunningham, p. 207, is not correct in supposing that the current will escape as readily from adjoining coils as from successive layers. It is a question of relative tension, which may be compared to hydraulic pressure, and the tension increases as the number of coils or length of wire accumulates at the two ends. Now the length of wire in each turn is a mere nothing; the difference of tension is nothing; and there is no more tendency for electricity to escape than there would be for water to run from one barrel to another through a connecting pipe if the level were the same in both; but the layers resemble the same barrels raised one above the other, with a tendency to escape proportioned to the height. It is only in very powerful coils that there is any need for interposing anything except the covering and varnish. Even the partitions between the layers would be needless if we could begin the coil at one end, and, working inwards and outwards, instead of longitudinally, complete the whole at the other end. This is not easily done, but is approached to by dividing the secondary into several vertical sections, each complete in itself, and connected to the next. This is the process which Mr. Tucker, p. 212, refers to as tried by another correspondent, and the importance of which he does not seem to sufficiently appreciate.

"One in a Fog Still" (3802), p. 215, will, I hope, be relieved of his difficulty by reading the paper on the Daniell's cell, which (p. 159) deals with that subject, though I fear readers will get a little troubled by the displacement of the drawings, as Fig. 37 belongs where 39 is placed, and this latter belongs to a part of the paper not yet printed.

If W. Barber (3818) carefully studies the theoretical principles which I am endeavouring to make plain in my papers on electricity, he will see that the form of cell I described cannot possibly be equal to a bichromate or Bunsen's of the same size, or work an induction coil. It is a common mistake to regard a galvanic battery in the abstract, and compare various forms together, omitting from consideration the various works they are adapted for. A Bunsen's will work an induction coil far better than mine. Mine would do electrotyping far more cheaply and conveniently than a Bunsen. In mine, the internal resistance is reduced to a minimum; it is therefore adapted to work giving little resistance; but this resolves itself into a question of cost, as we can get the same force from any form by increasing the number of cells in series, This point will be examined shortly, only let readers try to follow out the reasons of things, not merely seek "practical" directions. These last fit only one case, and tend to narrow the mind. A clear conception of causes elevates the mind, and enables us to adapt our plans to all circumstances.

SIGMA.

EMPLOYMENT AND ADVERTISING.

SIR,—Your readers who want to *exchange* or *sell* have an advantage which I beg to suggest might be conferred on those who seek employment. To see by the side of "The Sixpenny Sale Column" a Sixpenny Employment Column, would be pleasing to the multitude of English mechanics, and others.

Some of us who know what it is to walk about for a job and receive the disheartening No! in a manner that adds insult to misfortune would be glad to pay 6d. for the chance of a job that we could not call for, including all parts of the country. Apprentices who want to improve, and young men with a mechanical turn, could then look out in time for suitable places. All trades and occupations in a mechanical way would use the column after a while. Only try it long enough to be well known, and employers would find it to their interest to employ a reading, thoughtful class of men, who would not demean themselves to offer beer and bribes to foremen for a job. I should like my brother mechanics to point out any defect in such a method, if there should be one, if not, and it is tried, let them support it.

In every working man's club and library in the Kingdom, the sheet should be hung up. It would soon grow to a large sheet, and, if convenient, might be posted to employers for a yearly subscription.

ARTISAN.

SIMULTANEOUS EQUATIONS.

(*Continued.*)

SIR,—To resume:—

(4.) (1) $2x - 3y + 2z = 13$

(2) $4y + 2z = 14$

(3) $4u - 2x = 30$

(4) $5y + 3u = 33$

Subtract (1) and (2)

$$\begin{array}{rr} & 2x - 3y + 2z = 13 \\ & 4y + 2z = 14 \\ \hline (5.) & 2x - 7y = -1 \end{array}$$

Multiply (3) and (4) by 3 and 4 respectively and subtract:—

$$\begin{array}{rr} & 12u - 6x = 90 \\ & 12w + 20y = 128 \\ \hline & -20y - 6x = -38 \\ (6.) & 20y + 6x = 38 \end{array}$$

Multiply (5) by 3, and subtract from (6)

$$\begin{array}{r} -21y + 6x = -3 \\ \hline 41y = 41 \\ y = \frac{41}{41} = 1 \end{array}$$

Having found the value of y, we can get the value of from (2)

$$4y + 2z = 14$$
$$4 + 2z = 14$$
$$2z = 14 - 4 = 10$$
$$z = \frac{10}{2} = 5$$

Also of u from (4)

$$5y + 3u = 32$$
$$5 + 3u = 32$$
$$3u = 32 - 5 = 27$$
$$w = \frac{27}{3} = 9$$

Having the value of u we get the value of x from (3)

$$4w - 2x = 30$$
$$36 - 2x = 30$$
$$-2x = 30 - 36 = -6$$
$$-x = -\frac{6}{2} = -3$$
$$x = 3$$

Thus

$$y = 1,\ z = 5,\ w = 9,\ x = 3$$

(5.) (1) $7x - 2z + 3u = 17$

(2) $4y - 2z + t = 11$

(3) $5y - 3x - 2w = 8$

(4) $4y - 3u + 2t = 9$

(5) $3z + 8w = 33$

Multiply (2) by 2, and subtract (4)

$$\begin{array}{rr} & 8y - 4z + 2t = 22 \\ & 4y - 3u + 2t = 9 \\ \hline (6.) & 4y - 4z + 3w = 13 \end{array}$$

Then multiply (1) and (3) by 3 and 7 respectively, adding products

$$\begin{array}{rr} & 21x - 6z + 9w = 51 \\ & -21x + 35y - 14w = 56 \\ \hline (7.) & 35y - 6z - 5w = 107 \end{array}$$

Now multiply (6) and (7) by 35 and 4 respectively, subtracting—

$$\begin{array}{rr} & 140y - 140z + 105w = 455 \\ & 140y - 24z - 20w = 428 \\ \hline (8.) & -116z + 125w = 27 \end{array}$$

Lastly, multiplying (5) and (8) by 116 and 3 respectively then adding we get u

$$\begin{array}{r} 348z + 928w = 3828 \\ -348z + 375w = 81 \\ \hline 1303w = 3909 \\ w = \frac{3909}{1303} = 3 \end{array}$$

(5.) $3z + 8w = 33$

$$3z + 24 = 33$$
$$3z = 33 - 24 = 9$$
$$z = \frac{9}{3} = 3$$

(1.) $7x - 2z + 3w = 17$

$$7x - 6 + 9 = 17$$
$$7x = 17 - 9 + 6 = 14$$
$$= \frac{14}{7} = 2$$

(3.) $5y - 3x - 2w = 8$

$$5y - 6 - 6 = 8$$
$$5y = 8 + 12 = 20$$
$$y = \frac{20}{5} = 4$$

(2.) $4y - 2z + t = 11$

$$16 - 6 + t = 11$$
$$t = 11 + 6 - 16 = 1$$

Thus

$$w = 3,\ z = 3,\ x = 2,\ y = 4,\ t = 1$$

(6.) (1) $4x - 3y + 2z = 40$

(2) $5x + 9y - 7z = 47$

(3) $9x + 8y - 3z = 97$

Multiply (1) and (2) by 7 and 2 respectively, adding the products.

$$\begin{array}{rr} & 28x - 21y + 14z = 280 \\ & 10x + 18y - 14z = 94 \\ \hline (4) & 38x - 3y = 374 \end{array}$$

Then multiply (3) and (2) by 7 and 3 respectively, subtracting the products

$$\begin{array}{rr} & 63x + 56y - 21z = 679 \\ & 15x + 27y - 21z = 141 \\ \hline (5) & 48x + 29y = 538 \end{array}$$

Now multiplying (4) and (5) by 29 and 3 respectively adding the products we get the value of x.

$$\begin{array}{r} 1102x - 87y = 10846 \\ 144x + 87y = 1614 \\ \hline 1246x = 12460 \\ x = \frac{12460}{1246} = 10 \end{array}$$

$$38x - 3y = 374$$
$$380 - 3y = 374$$
$$-3y = 374 - 380 = -6$$
$$3y = 6$$
$$y = \frac{6}{3} = 2$$
$$4x - 3y + 2z = 40$$
$$40 - 6 = 2z = 40$$
$$2z = 40 + 6 - 40 = 6$$
$$z = \frac{6}{2} = 3$$

Thus

$$x = 10,\ y = 2,\ z = 3,$$

(7.) (1) $x - 2y + 3z = 6$

(2) $2x + 3y - 4z = 20$

(3) $3x - 2y + 5z = 26$

Multiply (1) by 2, and subtract (2) from product.

$$\begin{array}{rr} & 2x - 4y + 6z = 12 \\ & 2x + 3y - 4z = 20 \\ \hline (4) & -7y + 10z = -8 \end{array}$$

Then multiply (1) by 3 subtracting (3) from product

$$\begin{array}{rr} & 3x - 6y + 9z = 18 \\ & 3x - 2y + 5z = 26 \\ \hline (5) & -4y + 4z = -8 \end{array}$$

Now multiply (4) and (5) by 4 and 7 respectively, subtracting products

$$\begin{array}{r} -28y + 40z = = 32 \\ -28y + 28z = -56 \\ \hline 12 = 24 \\ z = \frac{24}{12} = 2 \end{array}$$

$$-4y + 4z = -8$$
$$-4y + 8 = -8$$
$$-4y = -8 - 8 = -16$$
$$4y = 16$$
$$y = \frac{16}{4} = 4$$
$$x - 2y + 3z = 6$$
$$x - 8 + 6 = 6$$
$$x = 6 - 6 + 8 = 8$$

Thus

$$x = 8,\ y = 4,\ z = 2.$$

C. H. W. B.

(*To be continued.*)

DINORNIS GIGANTEUS.

SIR,—With reference to "Sigma's" letter, page 212, undoubtedly at present the weight of evidence is vastly in favour of Professor Owen's theory, that the *Dinornis Giganteus* and *Dinornis Elephanteus* co-existed with the present inhabitants. That they did so until a recent period is most likely, and in all probability as late as the latter end of the middle of the eighteenth century.

The German *savan* referred to by "Sigma" is Dr. Haast, and the presence of "*Split human bones in the ovens belonging to the Maories, together with the bones of the 'Moa' the Kakapo, seals, &c.*," as found by the Hon. Mr. Mantell, F.R.G.S., is proof positive of the existence of cannibalism. Dr. Haast bases his opinion on purely *negative* evidence, to some extent contradicted by the researches of Prof. Owen and Col. Wakefield, and chiefly on a point thoroughly established by Mr. Mantell, and confimed by Sir George Grey and Mr. Davison.

As Sir George Grey observes in his letter read before the Zoological Society, Thursday, March 3rd (and he is fully borne out by Mr. Mantell, and Mr. Davidson) "The natives all know the word 'Moa' as describing the extinct bird," also, "the natives invariably spoke to me of the 'Moa' as a bird well known to their immediate ancestors." "They spoke of the 'Moa' in exactly the same manner as they did of the kakapo, the kiva, the weka, &c., in districts were all these birds had disappeared," speaking of it in exactly the same manner as they did of other birds that had been exterminated since 1777, and that still exist in other districts.

In fact, all confirm the statement that the natives are acquainted with the bird, and uniformly assert its existence in a recent period, and are extremely accurate and uniform in describing its habits and appearance, even before its discovery. The name, and the ovens its remains were found in are all Polynesian, and differ from the Australians in every manner.

With reference to the Arabian records of travel, they in general are wonderfully accurate in their accounts of travels and descriptions of people, places, and events. The works of Ibn el Wardee, Ibn el Joassi, and others (Papers of the Royal Asiatic Society, *Jour. de Soc. Asi., &c.*), show that during the 13th and 14th centuries they were perfectly acquainted with (including the politics) the islands of Sumatra, Java, Borneo, Celebes, Gilolo, Mindiano, and the Phillipines, as well as the southern ports of China. Chinese, Hindoo, and native accounts and records confirm this, and furnish independent checks on their accounts. In fact, as early as the 14th century, they had regular and firmly established stations in the Malaccan Peninsula, the East Indian Islands, Borneo, the Spice and Phillipine Islands, and everywhere the early European travellers in the 15th and 16th centuries found them permanently and long-established inhabitants. It also must be remembered that Mahomedan, and Buddhist, and Brahman religious works establish that they carried—*vie et armis*, overturning after a desperate resistance the established faith—Mahomedanism into Java, Sumatra and Gilolo, although they failed in Borneo and the Phillipines during the 13th century.

URBAN.

HARMONIUMS.—TO "ELEVE."

SIR.—The advantage of having two keyboards over one is equivalent to that obtained in an organ where you set up two organs in one, actuated by separate keyboards, though capable of being coupled by means of an appropriate stop. One may be enclosed in a swell, and may contain stops voiced sweeter than the other, which may be called the great organ. It is the same in degree in an harmonium, and as I have described before in my *resumè* of the two-manual professional and connoisseur's harmonium that I had, you can obtain in the stops connected with the soft manual, a degree of delicacy of tone, and also, on account of its situation with regard to the bellows, a softness of wind that is something entirely different to the effect of tone and wind that you can get in any one manual instrument. More than that; the reeds connected with the soft manual may be enclosed in a swell, and thus become the equivalent of the swell of a pipe organ. Added to this, you have the increased power of combining your stops which two manuals give over one, which advantage in an harmonium is that which an amateur of taste seeks the most in order to display his executive powers.

It will be self-evident to "Eleve," that a musician seeks variety in an harmonium or an organ. If he does not, he might as well rest himself content with a pianoforte, and hammer away on his monotone without change. But even Handel had two keyboards to his harpsichord. What else did he want with two keyboards if not variety?

MARK ELLOR.

TO MILLERS.

SIR,—First, I beg to thank you for such a paper as our MECHANIC is; also to thank you for the introduction into its pages of things about "dusty millers." I have read with very great interest the correspondence that has appeared in your columns, and the different opinions of the trade. Being a miller of quiet, sedate habits, I did not intend to answer any of its many important facts that have occurred from time to time, but reading a letter from your correspondent "J. S.," in this week's issue, I cannot refrain from refuting some of his arguments. First, he cannot see what use the patent balance is. I feel inclined to ask him if he has ever used or tested its efficiency? I cannot believe a practical miller would condemn Clarke and Dunham's patent balances if he has tested them thoroughly and properly, no matter what sort of bearing irons he may have, or how driven. I have had 25 years' experience in various parts of England; have seen, I should imagine, every sort of irons for driving millstones; have worked in mills from two pairs to 30 pairs of stones, and have been with master millers who delighted in trying anything new, regardless of expense, for the sole purpose of securing the best way for having work in stones—driving stones; in fact, everything connected with millstone work—and I challenge any man to produce a better plan for balancing millstones than Clarke and Dunham's—I mean, of course, running balance, because no miller wishes to keep his stones standing still. Let us have stones running, and we cannot do without the running balance. As to the other part of "J. S.'s" letter, an experienced miller can afford to pass it by. With Thos. Evans's letter, also R. R. Smith's, I fully concur in all they say. I should think "J. S." has tried to balance his stones running, but has failed (as I have known many good millers do), and in consequence gives the patent a bad name. I advise him to try and try till he succeeds. He will be sure to conquer if he perseveres.

C. M.

SIR,—In answer to "J. S.," p. 182, who inquires about silk dressing machines, I beg to refer him to Vol. VIII, p. 222, of the ENGLISH MECHANIC, where he will see the judgment of one who has had 12 or 14 years' experience with their working on English wheats, and on p. 282 of the same volume he will see remarks on the same subject well worthy his careful study. I am now dressing my flour through "Blackmore's patent cloths," and am quite able to compete successfully with silk-dressed flour within two miles on each side of me; for they cannot change their cloths to suit the different seasons of the year as I can. In the winter, my neighbours' flour was deficient in strength, from being dressed too fine, and my flour was giving satisfaction, dressed through a No. 12 "Blackmore's cloth." In this month of May I find it necessary to use a No. 16. Now the wheat is dry, the silk-dressed flour is a trifle whiter than mine; but I can quite equal theirs in colour and quality by dressing the flour over a second time.

Blackmore's cloths are very frequently put on the reel too tightly to dress well. Ayton's net on the reel is a great advantage. Silk reels for foreign and Revitt's wheats are very much better than wire or "Bolter;" but I believe, from my experience of their use in a country mill on Suffolk wheats, that in less than ten years the proprietor would wish he had never put them up, on account of the great variation of the condition of the English wheat, and also of the different treatment that the English wheat requires in different seasons, as after a wet or a dry harvest.

I suppose I may apply to myself the old, old saying, "Experience keeps a dear school, but fools will learn in no other."

R. R. SMITH.

DRESSING MILLSTONES, &c.

SIR,—I have read with much pleasure in the ENGLISH MECHANIC the controversy on the question of standing and running balances in mill stones. I should now like to lay before your readers a little experience of my own on the subject. I have been using for upwards of 20 years a stone which has always had what we call a *swish* to it; several millwrights have attempted to get rid of it, but could not succeed. I have had three new sets of driving irons, but it made no difference. And all the millwrights I have employed have given it up in despair; such being the case, I thought I would try and carry out a notion I had as to the standing and running balance being the same. On looking between the faces of the stones when running I found the face of the stone run true at first starting, but when the stone attained its full speed it run very untrue. I then removed some of the shot from two of the balance boxes into the opposite ones, and by that means succeeded in making the stone ran true, but the standing balance was untrue to the extent of about 3lb. I then started the stone again, when the heavy side dragged on the bed stone, but as the speed was increased, the heavy side gradually raised itself, and when the full speed was obtained the stones run perfectly true. I then set them to work, and since then I have seen nor heard nothing more of the *swish*, and the stones' work is much improved. I had previously had everything done that was suggested (except using the patent balances), and all that was done had not the slightest effect on the *swish* of the stone; I had a new hurst, new spur wheel and stone, nuts and new driving irons, but all to no purpose. I therefore feel quite certain that in *this* case a standing and running balance *are not* the same. Some of your correspondents seem to think that if the stone will balance standing, you need not trouble yourself about the running balance; that seems to me very shallow reasoning, for what is the object millers wish to attain when trying to balance a stone? Is it not to get an equal pressure from all sides of the stones at once. For it must be evident to all, that unequal pressure cannot turn out good work. And if the running balance *is* untrue there *must* be unequal pressure.

JOHN BOTTING.

CURIOUS ARITHMETICAL PROBLEM.

SIR,—The power of numbers in geometrical progression is very well illustrated by W. Leybourn, a mathemetician of the seventeenth century, in his "Cursus Mathematicus," published in folio in London in the year 1690, in the following calculation:—

A Londoner sojourning in a country market town, in winter, made himself a new frieze suit and coat, on which were set six dozen of buttons, of silk and silver; a baker being in his company liked it so well that he would buy it of him; the citizen consented to let him have it, paying for the first button a single barley-corn; for the second, two; for the third, four; and so on, doubling to the last.

The bargain was liked on both parts for the present, but shortly after revoked; for it could not be performed, and no man can be holden to an impossibility. But why this could not be performed may be judged, first, by inquiring into the worth of so much barley in money; and secondly, the weight of it, and how it should be removed.

1. For the first, allowing 10,000 corns to a pint, which is more than enough; then 5,120,000 corns make a quarter; and yet, for shortening the division, we will allow 10,000,000 corns to a quarter, by which, dividing the whole number of corns, which is done by cutting off the first seven figures towards the right hand, the quotient will be 472,236,648,286,964, and so many whole quarters there are omitted the remainder, as in this case inconsiderable.

Now, allowing barley were to be sold at 15d. per bushel, which is cheap, it is so many angels (*i.e.* = half-sovereigns); and therefore dividing it by 2, it s £236,118,324,143,482 sterling; which is in words, Two hundred and thirty-six millions of millions, one hundred and eighteen thousand, three hundred and eighty-two pounds; which I take to be too much for any tradesman to get or keep.

And reckoning land for ever at twenty years purchase, if this sum of pounds be divided by 20, the quotient is the yearly rent of 11,805,916,207,174; and this divided again by 365, the number of days in a year, the quotient is 32,344,975,918; that is about thirty-two thousand of millions a day for ever. So great a vanity may be concluded on for want of a little premiditation.

2. Now, secondly, for the weight of it; if we put eight bushels to weigh two hundred pounds weight, for sure it doth weigh more, then the whole number of quarters multiplied by 2, gives the weight of all to be 944,473,296,573,928 hundred weight; and if this be divided by 20, the quotient 47,223,664,828,696 is so many tons; and therefore it will require 47,223,664,828 ships of 1000 tons apiece to carry it; and, consequently, if every nation in the world had above 10,000 such ships, yet there must be above four millions of such nations; which I suppose are not to be found in this world.

J. F.B., Chelmsford.

COMMERCE AND TRADE.

SIR,—I am rather disappointed that my short letter on this subject has produced so few replies, and those all on one side. The figures I quoted were from the "Statesman's Year-book," which goes on to draw a dreadful picture of the fate in store for England if her imports should go on increasing while her exports fall gradually lower and lower. As this conclusion was diametrically opposed to my own, I ventured to ask some of the clear-headed correspondents of "our" journal what was their answer to so important a question, and I am obliged to "Sigma," "Exchange," and "Herbert" for the notice they have taken of it; but our worthy "Harmonious Blacksmith" has wandered rather wide of the subject. It is not a question of whether the figures are accurate, or whether they represent the *real* values of imports and exports. Certain figures are given, and on these *figures* a theory is founded directly opposed to common sense. I believe these figures very clearly show the opposite fact, and your correspondent "Sigma" agrees with me. The "Harmonious Blacksmith" says we cannot long continue to import more than we export, because foreigners won't "trust" us too much. I hope and believe that the present state of what is called the "balance" of trade will long continue as these figures show. How often is it that "coin" is exported from this country to pay for our imports? Very rarely, I think. Merchants don't like risking that sort of thing, if they can possibly avoid it. Besides, the fact still remains that we actually "import" considerably more bullion than we export. Another fact, and one your correspondents do not mention, is that the value of the exports is calculated at the port of "loading;" the value of imports at the port of "unloading." So that when the cost of freightage has been adjusted, the "balance" is our *profit*. It must be remembered that 7-10ths of the cost of carriage come to our pocket.

One other fact, and I have done. The three most prosperous nations of Europe annually import more than they export. Here are the figures:—

EXPORTS AND IMPORTS PER HEAD OF POPULATION.

	Exports.	Imports.
Holland	£7 9 1	£8 13 5
United Kingdom	5 10 9	7 5 9
Belgium	4 16 7	6 1 5

Whether these figures are correct, and represent the *real* values or no, I do not know; but surely they do *not* prove both "profit" *and* "loss," according to the colour of the examiner's spectacles.

SAUL RYMEA.

CHOOSING ONE'S BELIEF.

SIR,—Surely it does not require a great amount of clear-sightedness to see that the phrase "choose to believe," in my letter on "The Rotation of the Earth," is merely a "figure of speech." To argue whether it is possible for a man to believe anything he chooses might open up the whole question of "free will;" and nothing was further from my thought than that. Mr. T. Cooke says we "must believe according to the evidence presented to our senses," but he fails to perceive that what we believe depends a great deal on the ability of our senses to properly examine and weigh the evidence presented to them. If everybody were capable of looking at a question "outside of himself," as it were, there would be fewer religious sects than there are, and the followers of "Mr. Hampden, &c.," could be numbered on the fingers of one hand.

As some persons believe in the theories of "Parallax, &c.," in opposition to the plain logical evidence of the astronomers—shutting their eyes to facts they do not wish to see—I cannot conceive that the expression "choose to believe" was so "decidedly wrong" as to call for a special letter from Mr. Cooke.

This question of what man believes—of belief founded on "evidence," as opposed to *faith*—is a very interesting one, and I shall hope to see something about it in the papers on "The Relations between Body and Mind." That the "body" exercises some influence on the mind I suppose no one will deny. Byron himself says:

> Who'd pique themselves on intellect, whose use
> Depends so much upon the gastric juice?

SAUL RYMEA.

VIOLIN VARNISH.

SIR,—In the earlier volumes of the MECHANIC there are a few contributions on violins, from myself and others, in which the "varnish" has been slightly alluded to. The subject seems on this point to again attract the attention of your readers. It seems impossible to furnish proof of the materials of "Cremona Varnish" without actual chemical analysis, and I can hardly suppose the existence of a varnish mania so ardent as to impel the owner of a "Joseph Guanerius" of the true breed to allow the "Ruby" varnish to be peeled off for the purpose of undergoing chemical scrutiny. Until such a devotee is found, one must be content with the most probable solution, and it is with a view to this point that I now write.

To find a varnish which when applied (as one of your correspondents proposes) to one of two equal toned pieces of wood shall make no difference in the pitch of that piece to which it is applied, seems to be a myth, as any addition to thickness will certainly make an alteration in the pitch. Neither does the varnish by its presence contribute materially to the tone. A Guanerius violin which belonged to Spagnoletti (a former leader at the Opera) was by constant use almost denuded of its Ruby covering, yet the tone was left.

There are three distinct species of varnish which may be taken into consideration:

1st. Varnish in which alcohol is the solvent.

2nd. That with turpentine with or without drying oil.

3rd. That where drying oil is the only solvent.

As to the first or spirit varnish, it has advantages of being more easily made, coloured, and dried; but the result of its application to a violin is a thin, meagre, dry tone. I speak from having tried it on a newly made violin, and having found that on removing it, and using instead a varnish of the second species, the tone was much improved; and must, from observation of genuine Cremona violins, conclude that they were not covered with spirit varnish.

There are many old as well as modern imitations, and one great proof of the spurious imitations is the use of spirit varnish.

Examples of the use of the third species, fat oil varnish, are to be seen in some of the violins by Albani (an old Cremona maker), exhibiting, like an old picture or carriage, the cracks and thick coat of material never seen in spirit varnish. But it is with the second species of varnish, made with turpentine and drying oil, that to all appearance the genuine violins of the Amati, Straduarius, and the Guanerii violins were originally covered; and there seems little difficulty in imitating this covering in all respects but one—viz., the colour; and to attain this, some proper colour must be found soluble in turpentine; and a query on this subject was inserted by me in one of your previous volumes, to which no answer has been given.

As far as my observation goes, genuine Cremonas appear to have had the pores of the wood filled up with some species of uncoloured size, and to have been rubbed down to a very smooth surface previously to the application of the colouring varnish; which in most of the old ones, comes off in small flakes. The same thing has happened to violins which I have varnished with the second species of varnish. But I must confess that the imitation of the clear, transparent colour is at present beyond my knowledge.

I may add that although the coat of varnish has something to do with the tone as well as appearance of a violin, yet to expect that the thick wooded, ill-shapen, cheap violin (call it rather fiddle) could have the tone of a Cremona, would be as reasonable as to expect a London dray horse to run round an Eclipse. One of the best makers of the day is Vuillame, of Paris. His varnish is said to be of the first species, but I much doubt the statement; whatever it may be, his models and work are firstrate.

SUFFOLK AMATEUR.

BOILER FEEDING.

SIR,—The plan of feeding a boiler without a pump, as illustrated this week, and supposed to be the invention of Mr. Shewan, and as patented by Capt. Shaw, was in use in 1853 at a colour works in Lady Lake's Grove, Mile End-road. The feeder was placed in precisely the same position as shown, and worked exceedingly well. It was in this case worked by hand. You will find a patent was taken by a Mr. Beaumont, of Clapham, in 1859 or 1860, for the same thing, only to be self-acting. This I can prove by my own books, being the maker of it. It was exhibited in 1862 at the International Exhibition, where I saw it working. It was placed on a stage erected for the purpose, and drew its water from the same tank as the large injector which fed the working boilers of the Exhibition. This was made at Manchester. It is now nearly five years since I made one very similar to that of Beaumont's, which would draw its water full 20 feet. My brother readers will see from this there is nothing new in the matter.

T. E, T.

MUSICAL NOTATION.

SIR,—In your number for April 8 there is a letter from "The Harmonious Blacksmith" on Hawkins's musical notation, in which he promises to send a familiar melody written in it. I expect he will soon fulfil said promise. All the new musical notations I have as yet had the pleasure of seeing are directed to one point—viz., the mystery or difficulty in the various keys; and very severe terms have been bestowed on them. These terms I consider altogether misapplied and unmerited; on the contrary, not only are they full of interest to the musical student, but truthful as truth itself, the evidence meeting you both ways as you proceed from the natural or centre key of C. But the subject, I humbly think, might be improved. In explanation it is common to explain them by making a round of the keys, by fifths, or to say so many sharps or flats are required to put the semitones in their proper places; but two things ought to be considered—viz., the internal transposed, and the number of that internal the scale contains. Let this be done, and the difficulty of the keys will at once disappear. In addition to describing the scale as a succession of seven sounds, consisting of five tones and two semitones, let the more extended internals—thirds, fifths, &c.—be examined and their number pointed out. Example—What can be more expressive than the one sharp in the key of G, or one flat in F, pointing as they do to the one imperfect fifth the scale contains. By all means let there be improved systems, and improvements in systems, but it is surely desirable to render as plain as possible the established system of musical notation, which is so universally diffused, and contains such stores of music written in it.

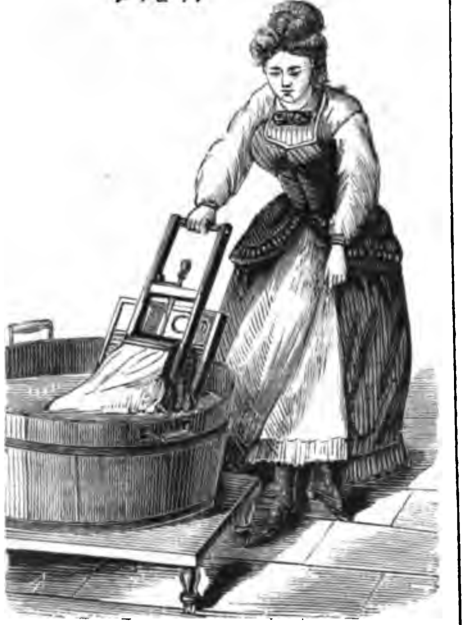
MUSIC.

DUGDALE'S UNIVERSAL CLOTHES' WASHER.

SIR,—The accompanying diagrams illustrate a device patented by Mr. J. Dugdale, of White Water, Indiana, U.S.A., whereby the hands are spared the discomfort and injury attendant on washing, and the temperature of the suds may be maintained as high as is possible in an open tub.

The device is shown in detail in Fig. 2. It will be seen it is simply a rubber, consisting of two parts in a suitable frame, which clasps the clothes when it is in use. The two parts when brought together present a rounded form, the exterior being fluted like a washboard, and the interior being made concave as shown, so that buttons, hooks, &c., may be clasped without damage

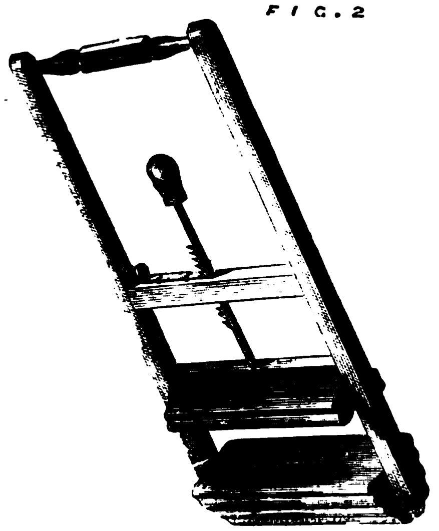
FIG. 1



The upper part of that portion of the device which clasps the clothes, slides in grooves made in the side pieces of the frame, and is raised or opened by pressing back the bolt which locks it to its place, and pulling it upward by a knob or handle provided for that purpose.

The clothes are fastened in by pushing the knob down. Common tubs and zinc washboards are used; the washboard is temporarily fastened in the tub, upon which the clothes are alternately drawn, and pressed down against the bottom of the tub; and they may be rubbed when required by applying one hand to the middle cross piece. This invention enables the operator to use suds hotter than the hand can bear, which dissolve the grease and dirt much more rapidly than suds at a lower temperature. J. B. T.

FIG. 2



A SUGGESTION.

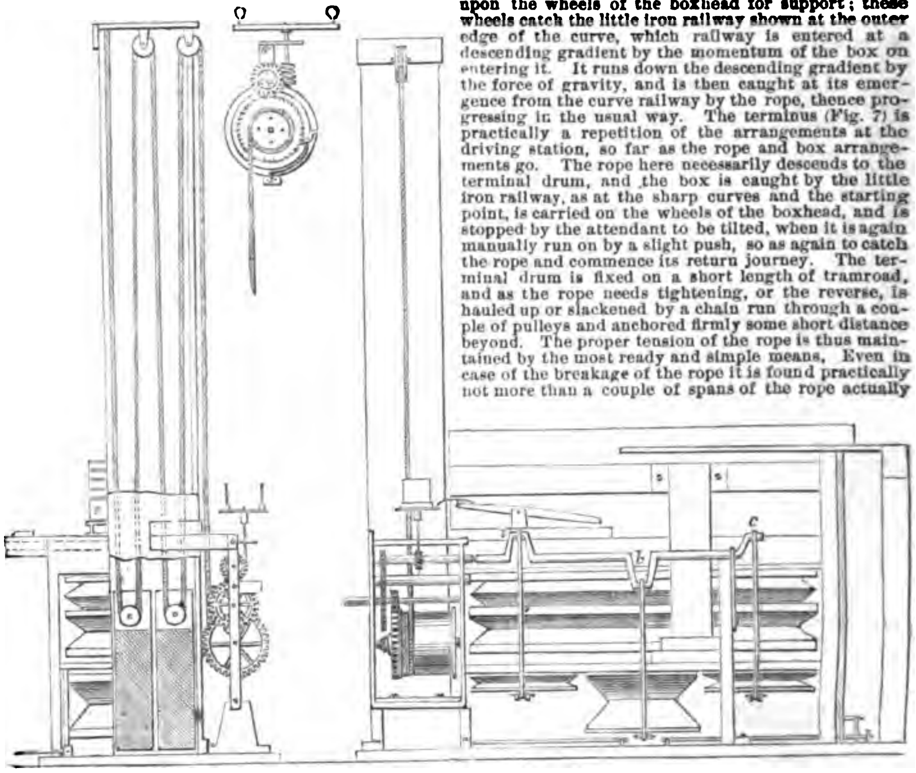
SIR,—As improvement and progress seem to be the watchwords of our paper, would you allow me to make a suggestion with regard to the index, viz., that it should extend to the "Notes and Queries" column. I am sure a large number of brother subscribers would agree with me in saying that it contains more valuable practical information than all the rest of the journal. I am aware that it would entail a good deal of trouble and expense to get up an index, but would suggest that it should be got up as an extra, and paid for accordingly, and, for my part, I should be perfectly willing to give half-a-crown or more for it. If you think the above worthy of publication, perhaps some other subscribers would give their opinions on it.

J. BROWN, Bedford-street, Belfast.

[Such an index would not cost half-a-crown, or more than twopence.]

BLOWING ORGANS.

SIR,—Several suggestions have of late been made in the ENGLISH MECHANIC for blowing organs. Perhaps the method by weights proposed in the "Manuel du Facteur d'Orgues" may interest some of your readers. Of this I forward photographs of the plates for your use. In the text it is merely said that the drawings sufficiently explain the plan. The scale is the metre, and is in tenths—one metre = 39·37in.; one-tenth = 3·93. From this scale I find the crank = about 4in.; feeder of bellows, about 14in. wide and 8in. deep; bellows, about 3ft. 4in. long; width not shown; rise, about 14in.; weights, about 14in. long and 5in, wide; height of room, about 7ft. 4in.; great wheel on barrel, 8in. diam.; winding and driving pinion, 2in. diam.; wheel driven by this, and carrying the stop ratchet, 5in. diam.; wheel on crank axle, 3¼in. diam.; width of fly, 5½in.; height of fans, 2¼in.; width of do., 2¾in. I guess the weights to be about 250lb. or 300lb, The barrel is about 6in. long and 6¾in, diam. Now as to the capability of the machine. The time of going will depend on size of barrel, &c., and height of fall; the velocity on weights. The bellows must have three feeders, and for ordinary purposes these might be so constructed as to act as one feeder. The machine is about 1ft. 8in. high and 11¼in. wide. The rope appears to be about ⅜in. diam.



I am not able to say how the machine will answer the end intended by it, but hope, if constructed by any of your readers, that they will make their experience known through the pages of the ENGLISH MECHANIC. N. S. HEINEKEN.

THE WIRE TRAMWAY AT BRIGHTON.

(For illustration, see next page.)

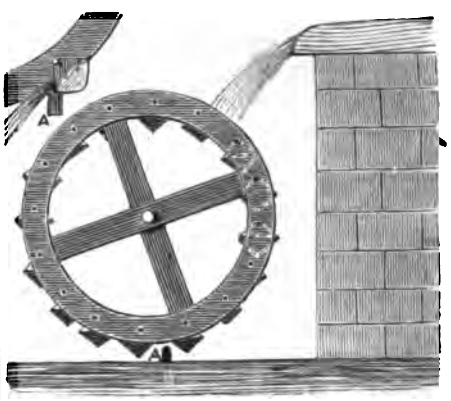
SIR,—The wire tramway system seems to be gaining favour. The *Engineer* recently stated that ten new lines in various countries have been constructed, and that many others are in course of formation. A description of the line now in operation at Brighton may be acceptable. This is one portion of a line sixty miles long Mr. Hodgson is about to erect in Ceylon. The plan (Fig. 1.) will give a good notion of the difficult angles the line embodies, and some idea of the irregularities of surface, an idea that will be fully realised by all who at all know the Brighton Downs in the most irregular and broken parts beyond and near to the racecourse. The line is twice turned at right angles, and every lesser angle is embodied, whilst the undulations are more trying to the system than the difficult country for which the plant was designed. There are 112 posts in the whole length, with varying spans up to 900ft. The posts (Fig. 2) are constructed of four perpendicular angle irons, with interlacing lattice work and the necessary crosshead, the whole of the parts made interchangeable, brought to the spot piecemeal, so as to suit the imperfect means of conveyance in wild countries, and riveted together on the spot by the use of a portable furnace. This form of post seems well adapted to meet the cross drag from sagging ropes and moving boxes, whilst it is much more than sufficiently strong for any downward pressure that can come on it, and in its material well suited to a tropical as well as any other climate. The rope is made of charcoal iron, is two inches in circumference, presents gradients in some parts as steep as 1 in 8, and the inventor calculates it capable of delivering 120 tons each way in a day of ten hours long. The boxheads (Figs. 3 and 3A) in the parts impinging on the rope are made of oak, which gives sufficient adhesion even in the steep gradients above. The power employed is one of Messrs. Robey and Co.'s 16-horse engines, driving, by a band and spur gearing, one of Messrs, Fowler's clip drums (Fig. 4). The boxes necessarily leave the rope at a turning, are carried by their momentum on a little circular iron railway, when the wheels shown in the boxhead come into use and easily carry the box round the curve, or allow it to be easily stopped for filling, and again started by hand, when the rope catches it and it proceeds in usual course.

The ingenuity of the inventor has, perhaps, been taxed as severely at the curves as anywhere. Curves up to 15 deg. are managed by simply inclining the carrying wheels at a slight angle (Fig. 5), and using them in a series. Sharper curves up to a right angle are managed as in Fig. 6, where it will be observed the box leaves the rope on entering the curve, is thrown upon the wheels of the boxhead for support; these wheels catch the little iron railway shown at the outer edge of the curve, which railway is entered at a descending gradient by the momentum of the box on entering it. It runs down the descending gradient by the force of gravity, and is then caught at its emergence from the curve railway by the rope, thence progressing in the usual way. The terminus (Fig. 7) is practically a repetition of the arrangements at the driving station, so far as the rope and box arrangements go. The rope here necessarily descends to the terminal drum, and the box is caught by the little iron railway, as at the sharp curves and the starting point, is carried on the wheels of the boxhead, and is stopped by the attendant to be tilted, when it is again manually run on by a slight push, so as again to catch the rope and commence its return journey. The terminal drum is fixed on a short length of tramroad, and as the rope needs tightening, or the reverse, is hauled up or slackened by a chain run through a couple of pulleys and anchored firmly some short distance beyond. The proper tension of the rope is thus maintained by the most ready and simple means. Even in case of the breakage of the rope it is found practically not more than a couple of spans of the rope actually reach the ground, the remainder only sagging, and in spans a little distance from the fracture only to a slight degree. The motion of the whole rope on the starting of the engine is all but instantaneous throughout, the terminal portions, five miles from the driving station, moving within two seconds of the start.

The *Engineer*, in an article from which I abstract the foregoing description, says that the experiment at Brighton clearly demonstrates the special applicability of the system to sparsely settled countries, the plant, &c., being so easy of transport. KAPPA.

WATER WHEEL.

SIR,—I enclose for insertion (if you think it worth it) a drawing of a water-wheel. The advantage I claim for it is that the buckets do not spill a drop from the time they are filled till they reach the lowest point, they being made to hang on rods, as shown in the sketch. They empty themselves by striking against the bar A. The sketch at the side shows a bucket being emptied, one side of the water-wheel being removed to show it better. W. H. THORPE, Reading.



MEAN DISTANCE OF THE SUN.

SIR,—By the application of Kepler's third law, as to the square of the periodical times being proportional to the cube of the mean distance of the sun, and in deducing by that law the mean distance of Venus from the Sun at 67,301,800 miles, that of the Sun being 93,044,100 miles, and the distance of Venus from the centre of the earth being the difference between these two distances, or 25,742,300 miles, the mean horizontal parallax of Venus being 31″·69854, which equals 3956·06 miles, divided by 25742300 miles.

Now, the mean distance of the Sun is to the mean distance of Venus from the earth, so is the mean horizontal parallax of Venus to the mean horizontal parallax of the Sun—viz., 93044100 miles : 25742300 miles : : 31″·69854 : 8″·77 very nearly.

By Logarithms—7·9686890 : 7·41064866 : : 1·50103934 : 0·9429990 = 8″·769068. VERITAS.

THE WIRE TRAMWAY AT BRIGHTON.

SPECIMEN OF A LINE 60 MILES LONG ABOUT TO BE ERECTED IN CEYLON.—(Described on page 228.)

FIG. 4

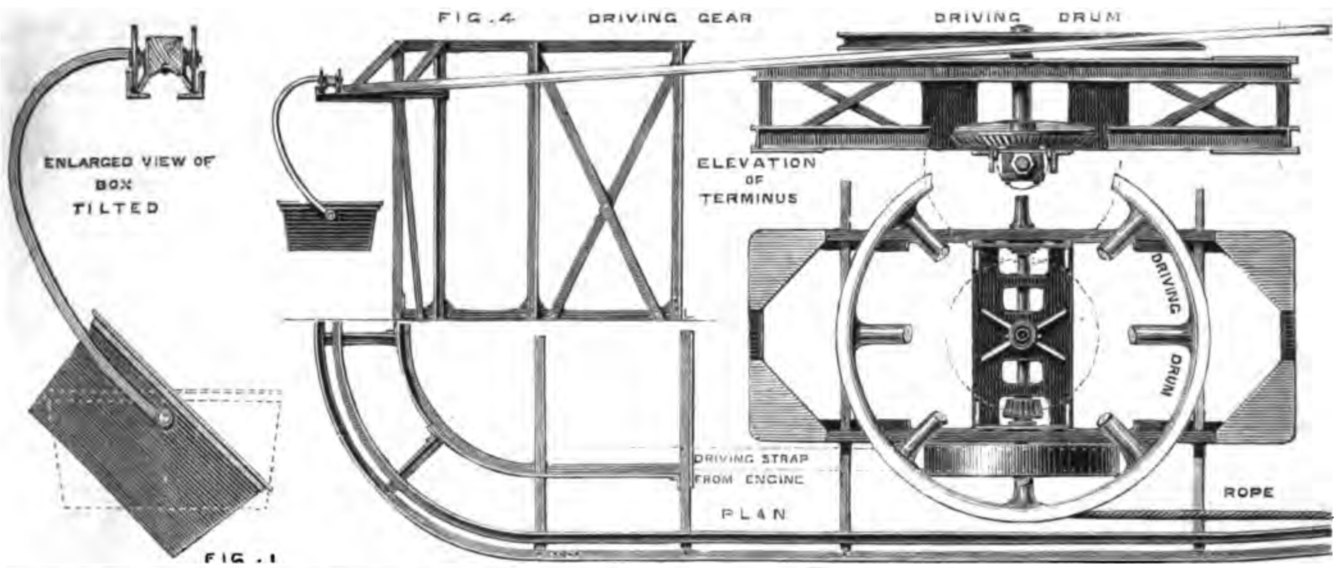


FIG. 1
GENERAL PLAN OF LINE

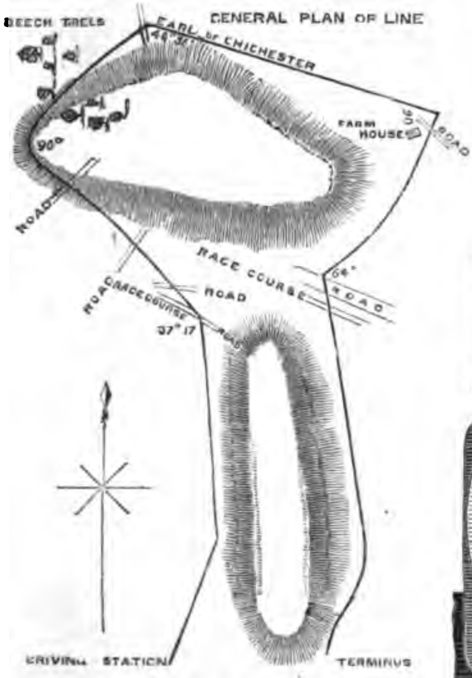


FIG. 3
END ELEVATION OF BOX HEAD

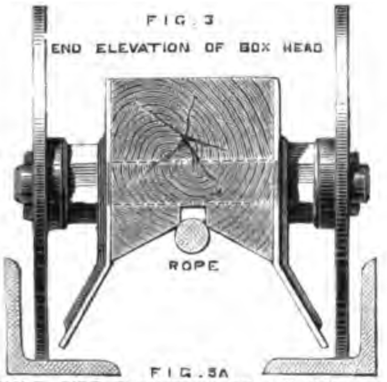


FIG. 3A
HALF SIDE ELEVATION OF BOX HEAD

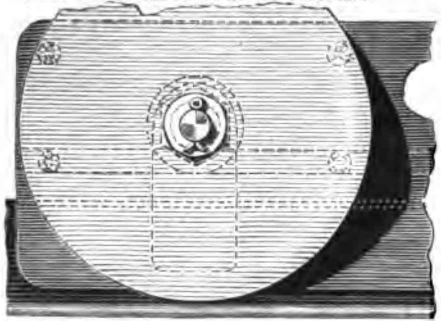


FIG. 2

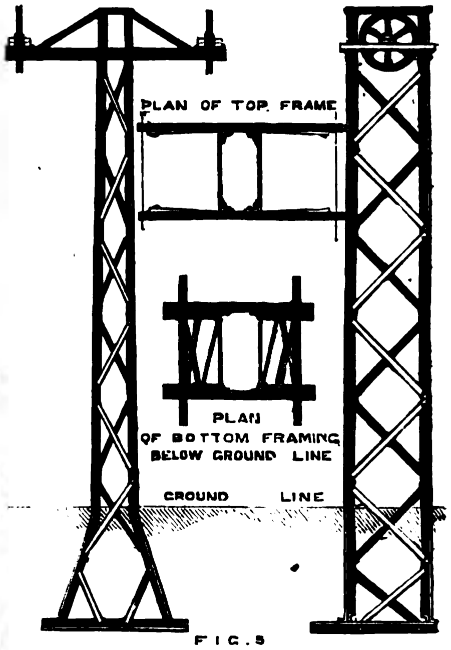


FIG. 7
END VIEWS OF TERMINUS

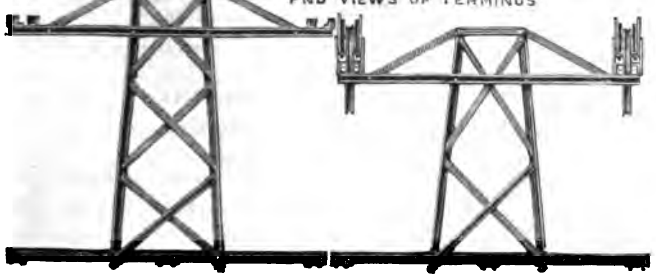
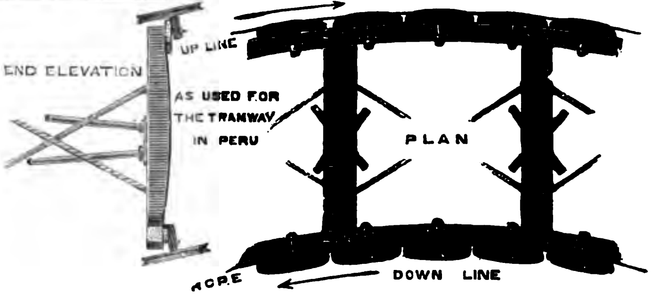


FIG. 5
SLANTING WHEELS FOR A CURVE OF 11°



SHEAVE PULLEY AND FRAME

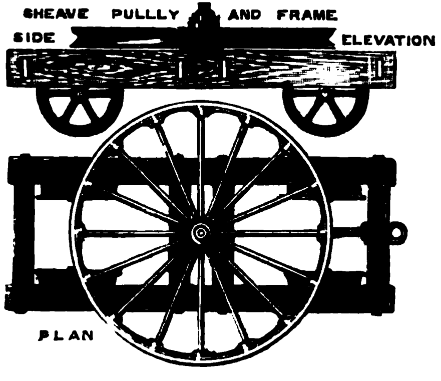
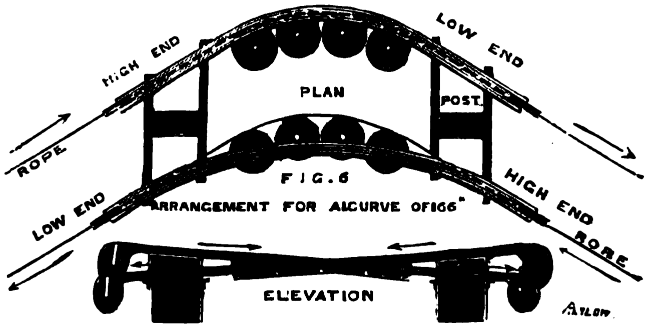


FIG. 6
ARRANGEMENT FOR A CURVE OF 166°



SCALE ON STEAM BOILERS.

SIR,—Having charge of a number of steam boilers, I feel anxious for some information on the following important results (the boilers used are single-flued Cornish boilers):—For a lengthened period of time we have used cold water feed. The result has been, in those parts of the boilers least accessible to hand labour being for cleaning, a gradual formation and increase of thick, hard, stony scale on the boiler plates. In order to increase the steaming capacity of the boilers, the owners adopted "Barton's patent self-acting feed water heater," changing the feed water to a temperature of 212°. I may here mention that the feed water is heated by the exhaust steam. Since the change to hot water feed, the scale has fallen away from the boiler plates, relieving itself in large flakes, leaving the boilers quite free from incrustation or scale of any kind. I am quite at a loss to understand how this occurs, and am very anxious for information as to cause and effect, as resulting under my own particular notice. I would deem it a great favour to have the opinion of any one of your correspondents on what I consider a very important subject in reference to future management of steam boilers. S. C., Birkenhead.

THE "ENGLISH" VELOCIPEDE.

SIR,—I perceive there are one or two of your correspondents that seem puzzled as to the way in which the "English" velocipede is guided. I believe this may in some measure be owing to the printer's mistake in my letter, where the fourth property of this machine is described. As it stands it reads, "the driving wheels not slipping." It should be, "the driving wheel not slipping."

In answer to "C. T. W.," p. 142, No. 2583, the machine is not guided by the hind wheel, but it is driven by the hind wheel exclusively. The guiding wheels are the front ones, on each side of the driver.

In answer to "Garibaldi," p. 190, No. 3735, there is a connecting rod from the guiding wheel axle to the guiding lever. It is jointed at each end. The fulcrum of the guiding levers may be above or below the connecting rod. I have preferred it below. The cranks are set at the quarter circle. I would recommend four alterations:—Make the crank 1in. longer, place the lever bar 1in. further from the seat, raise the seat 2in., and bend the hand lever about 3in. towards the seat.

A THINKER.

DARK LINES IN SOLAR SPECTRUM.

SIR,—Permit me to assure Mr. Proctor of my firm belief in the earnestness and honesty of our physicists; it is not there they fail; but I believe very obvious considerations are being constantly overlooked, simply because of their familiarity. What is more commonly observed than the gradual fading of the light of the sky after sunset; but can Mr. Proctor affirm that the received explanation of its cause is supported by a solitary observed fact? Yet Kirchhoff, patient, cautious, and clear-sighted though he was, seemed completely blind to the unsatisfactory character of the evidence sustaining it; for if he had only suspected this was something more than simply reflected solar light, he would readily have understood how our atmosphere could contain such a widely diffused element as iron in sufficient quantity to score the solar spectrum with dark lines through the light generated by its chemical combination with oxygen. The same remark applies to calcium, magnesium, sodium, hydrogen, carbon, and other elements, whose chemical combinations with oxygen are known to evolve light, and which are also constituents of the surface matter of the globe. For I hold it to be a demonstrable truth that the earth is continually receiving matter from space, which, chemically combining under solar action, generates the diffused light of the sky. The geologist gives valuable testimony upon this point. With reference to the Editorial remarks on p. 183, I have further to observe that the ordinary employment of a photographer is nothing less than a series of very delicate investigations concerning the nature and properties of light. I enclose my card to satisfy our worthy Editor regarding the profession of his guessing correspondent.

T. A.

EMIGRATION.—TO "F.R.G.S."

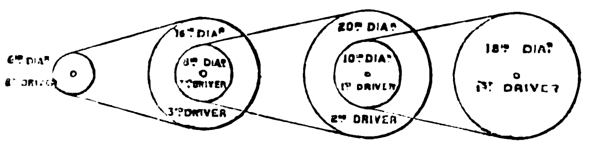
SIR,—In answer to "F.R.G.S.'s" invitation, I will lay my case and wants before him. I am a clerk in a cotton mill, 20 years of age, and receiving 12s. a week, and if I get 20s. a week by the time I am 25 years old I may think myself lucky. There is little prospect of getting a better situation, as there are far too many clerks already, and the profits of cotton manufacturers are so small, in consequence of the keen competition which exists at present, that they are unable to pay fair wages. Well, I think it folly to stay in England at my present situation, any longer than I can possibly help, and so I have come to the conclusion that it is not only wise, but necessary, to emigrate, though doing so will be about as painful as cutting off a limb, for I am a Sunday-school teacher, and a member of a Christian church, and have kind parents and good friends. After some consideration, I have decided to turn farmer when I emigrate, as that trade appears to be the best and most lasting; and during the next three years, while saving up enough to enable me to emigrate, I shall do my best to acquire some knowledge of farming. What I wish "F.R.G.S." to do, is this, to inform me in what part of Canada or Australia, are lands to be had free, or at least for a nominal price, what sort of lands they are, and how to reach them.

I must say that I have a decided preference for Canada at present, though quite open to conviction, should "F.R.G.S." think otherwise. I hope that "F.R.G.S." will also mention which is the most suitable climate, nor should I wish him to confine his information to Canada or Australia, but hope that he will give us the benefit of his wide, accurate knowledge, of other parts of the world, and the means of reaching them, where any working man might, in a few years, by pluck, energy, and self-denial, have a comfortable farm, or other occupation, and be able to bring up a family comfortably. I will conclude by stating that I believe my case is but one of thousands; indeed, several of my personal friends are in the same position, which I can assure you we should be glad to mend.

COTTON CLERK.

RENOVATING OLD FILES.

SIR,—I notice an article in your last publication on renovating old files by the use of the battery. I herewith give you a simpler and cheaper method, which I have used for a long time, and found to be a great saving in the mechanics' shop. Clean the files with a hand brush and a concentrated solution of soda or caustic lye, placing them in a dish or water-tight wooden box containing water, adding to the latter one-eighth part concentrated nitric acid, and mixing well by agitation, then leaving them at rest for five-and-twenty minutes; next, withdrawing them, and washing them with water and a brush, replacing them in the dilute acid, to which is added a second eighth of nitric acid, and letting them lie for fifty minutes, then again washing and brushing, and replacing in the bath, to which is added one-sixteenth of sulphuric acid, finally, washing in pure water and milk of lime, to remove all traces of acid, and drying. A smart boy could renovate two dozen of large files in two and a half hours.



In my communication about making fishing rods, I made an error in stating the weight of the salmon rod, it should have been 27oz.

VIVIS SPERANDUM.

COTTON SPINNING.

SIR,—"Harmonious Cotton Spinner" has not penetrated very deeply into the mysteries of cotton spinning if he has not yet discovered a draught between the feed roller and lap roller of a carding engine. He says there is not, nor ought there to be a draught here, and asks "of what use a draught would be?"

That there is a draught the letter of E. Slater, Burnley, on the same page as his own, 183, will perhaps convince him; as to its use, I may tell him that it is to keep the lap stretched between the two rollers to prevent its bagging, which it otherwise would do, causing irregularity in the feed. His other assertion about there being no draught, but a "contraction" between doffer and delivery roller, is rather inconsistent with a statement made by him to "Factory Lad" on draughts, in the same letter, in which he speaks of a draught of 1·25 and 2 in the draw-box of engine, which, of course, is between doffer and delivery rollers.

E. Halmshaw, Gomersal, is wrong in stating (p. 183) that I said "it is immaterial whether the bobbin leads the flyer, or the flyer leads the bobbin" in the roving frame. I offered no opinion on the two methods, as there was none called for. I merely attempted to describe the *working* of the cone, sun and planet wheels, and reversing motion, which was all that was asked for by the correspondent who requested an explanation of these parts, and I said it was immaterial to the *description* which of the two methods was taken to illustrate the matter, as the mechanism was alike in both cases, the only difference being in the arrangement of the gearing; so that when the bobbin led the flyer, the wheel D (p. 112) would revolve in the same direction as the wheel *b*, and in a contrary direction when the flyer led the bobbin (for "wheel *a*," in the sentence "which in this case revolves in the same direction as the wheel *a*," read "wheel *b*").

I am not aware that there is any superiority in the make of the thread when the bobbin leads the flyer. The roving is more compressed, consequently a greater length and weight can be laid on the bobbin. There is also less waste made, as the roving is not thrown off from the bobbin when the end is broken, as is sometimes the case when the flyer leads the bobbin; but these advantages are more than counterbalanced by the extra power required to drive, and the extra wear and tear of machinery.

B. W. R.

SIR,—*Draught of Carding Engine.*—Our new correspondent, "Harmonious Cotton Spinner," seems to understand his business. He is perfectly right in stating that there is not, or ought not to be, any draught between the lap and feed rollers; it would not only be of no use, but would cause irregular feeding in proportion to the draught or pulling out of the lap.

The callender or delivery rollers should be so arranged as to take up from the doffer without being slack or very tight. If slack, the sliver probably enters the funnel lumpy; and if very tight, it would be stretched unevenly. Let the rollers take up properly, and there will not be any material draught between the doffer and rollers. This decides the question of draught to be between feed rollers and callender rollers (not doffer).

Draught of Drawing Frame.—There are four replies to this question, including one from myself, page 162. The one from "B. W. R." I think is rather too keen in the preparing draughts. With regard to Mr. Slater, of Burnley, there must be some mistake, judging from his two lengthy communications. I must give him credit for knowing better than equalising the three draughts. Surely he is not in earnest in advising people less informed than himself to set rollers as he is represented to have stated.

I cannot now drop on the question of E. Habergham respecting weights, but the following may prove serviceable to many readers:—

Avoirdupois.—27 11-32 grains = 1 drachm; 16 drachms = 1oz., or 437½gr.; 16oz. = 1lb., or 7000gr.

Troy.—24 grains = 1dwt.; 20dwt. = 1oz., or 480gr.; 12oz. = 1lb., or 5760gr.

For cotton-spinning purposes a combination of these two tables is used: thus, 24gr. = 1dwt.; 18·23dwt. (say 18dwt. 5½gr.) = 1oz., or 437½gr.; 16oz. = 1lb., or 7000gr.

I notice Mr. Slater's remark respecting draw-box rollers to a card being "penny wise and pound foolish," and have given some thought to the subject, but must confess my inability to understand why such is the fact. With all due deference to his opinion, it is stated that some of our most successful spinners in the country work them; and if it be not asking too much, will Mr. Slater kindly give us his reasons for condemning them, as it is a point which I am sure the spinners of the district would be glad to have explained.

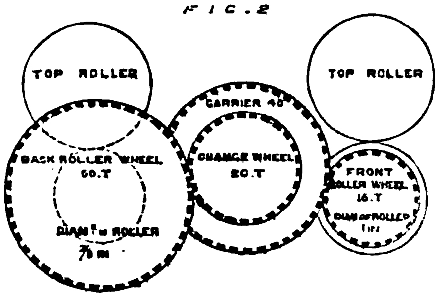
Scutcher Draught.—My experience goes to prove that a down draught is as good as an up one, and an up one equally so to a down one. I prefer a down draught, as the quantity of dust tins required at a large concern not only make a room look ugly, but are often in the way.

MUTUAL IMPROVEMENT.

SIR.—*Draughts.*—In my last letter to the lads, to whom this is also addressed, I endeavoured to show them why the draught should not be called "simply the difference between two surface speeds." And now as I cannot bear to see a *rule* put into a lad's head without the reason of it, I will try to make them understand the *rules* that are given in books "for finding speeds and draughts." If a lad knows a rule I admit he can work by rule, but if he knows the reason of it as well he can make the rule work also; and circumstances often occur that render such knowledge necessary. A principle thoroughly understood is easily applied. To the subject, then. I told you in my last that the expression "a given time," which occurs so often in subjects of this kind, means nothing more than the length of time you fix upon during which a thing may act, so that you may know what it will do in a long time from what it does in a short one. I remember the expression, simple as it may seem to me now, bothered me a great deal when I was a lad. I dare say, from the example I gave you in my last, you would infer that the travelling speed of any point or mark you might make upon the diameter of a wheel would depend upon its distance from the centre of the wheel or the point around which it revolves. If so, you were right; the travelling speed increases in proportion to the distance from the centre, and it is to the advantage that is taken of this plain truth that we owe all the various speeds of revolution that we have in the cotton mill, from that which gives to the "fans" and "scutching beaters" their terrific roar, and to the "mule" or "throstle" spindles their whirling buzz, to that of the slowly creeping "worm wheel." You will observe, too, that the terms "driving wheel," "driving strap," &c., are very suggestive. A thing that is driven must be occupying some space or position continually that another is as continually taking from it by pushing it forward out of its way, so that from this circumstance you may properly infer that both "driving straps" and "driving wheels" communicate their motion upon the same principle. I do not mean that you must call power the principle, but that the power in the two cases operates, not upon two distinct and separate principles, but upon an identical one only in a modified manner. If you will, I call the hindmost pushing the foremost the principle. It may also have occurred to you that the diameter of a wheel and the number of its teeth correspond to each other. So they do; not that every wheel of 6in. diameter will be found to have the same number of teeth, because there are different "pitches" of teeth, but in all calculations of speeds or draughts you may either take the diameters of wheels or the numbers of teeth and they will answer as one. As an instance—a pulley 6in. diameter drives by means of a strap another one 2ft. 6in. diameter; how much oftener in a given time will the driver revolve than the driven? You know 6in. = ½ft., and 2ft. 6in. = 5 halves, so that it must be 5 times oftener. But if the two were wheels, the driver having 12 teeth and the driven 60, then we could divide 60 by the 12, and the quotient would be the same as $\frac{60}{12} = 5$. Or if, instead of calling the driven pulley 2ft. 6in., we had called it 30in., we might have divided the 30 by 6 with the same result, as $\frac{30}{6} = 5$. This little example, if you think for yourselves, will enable you to see that you may measure wheels or pulleys by any standard you find most convenient, as feet, inches, ¼in., ⅛in., $\frac{1}{16}$in., just as you can deal with £ s. d. You can reduce £1 to 20 shillings, or 240 pence, or 480 halfpennies, &c., so you may reduce 1ft. to 12in., 96 eighths, or $\frac{92}{16}$in. Another instance. You have two rollers, one $\frac{6}{8}$in. diameter, the other 1¾in., then you would call the first 6 and the last 14, because $\frac{6}{8}$in. bear the same proportion to 1¾in. that 6 does to 14, or $\frac{14}{8} = 1\frac{3}{4}$in. There is another thing that I am sure must have occurred to you: it is this, that in a set of rollers it is often the case that both the diameters of the rollers themselves, as well as the diameters of the wheels by which they are geared together, are taken advantage of to produce the draught. If you have thought upon the subject even but so far as to see this fact, you may easily master it entirely; so with a few more examples I will leave the subject with you; I know you will fight it best in your own way. Look at the sketch Fig. 1:—There are three drivers and three driven. The first driver is 18in. diameter, the first driven is 10in. diameter. Now, supposing the first driver to make 50 revolutions per minute—you will perhaps know that "per" is a prefix, and signifies through, by, or in—then how many revolutions will the first driven make in that time? You can put it this way, 10 : 18 : : 50, and $\frac{18 \times 50}{10}$ = 90. You see it is in proportion to their diameter, because 50 bears the same proportion to 90 that 10 does to 18, as $\frac{18}{10}$ are of the same value as $\frac{90}{50} - \frac{90}{50} = \frac{140}{50}$ or $1\frac{4}{5}$ and $\frac{18}{10} = 1\frac{8}{10}$, or $1\frac{4}{5}$. If now you were asked to give a "rule" by which the speed of the driven could be found from that of the driver, you would say, *multiply the speed of the driver by its diameter, and divide the product by the diameter of the driven.* But just think for a moment how silly the rule sounds—multiply the speed by the diameter! It would be just as easy to multiply a pound of cheese by a cartload of turnips. I have no doubt but that you have sense enough to see that numbers alone are all we can multiply, or multiply by. I have not forgot being bothered with this silly thing myself, and the worst of it was I had no MECHANIC to help me. However, when we say the diameter is 18in. and the speed 50 revolutions, the 18 is the value of the diameter and the 50 the value of the speed, so that we convert both into the numbers which represent to us their value, and then we can either multiply or divide them. Now to the next pair, driver and driven. We find that the 2nd driver must make 90 revolutions, being fixed to shaft of the 1st driven, then it being 20in. diameter, and the one it drives 8in. diameter, how many revolutions must the latter make? Here, again, 8 : 20 : : 90. And $\frac{90 \times 20}{8}$ = 225, and $\frac{225}{90} = \frac{20}{8}$, as $\frac{225}{90}$ = 2½, and $\frac{20}{8}$ = 2½. So the 2nd driven makes 225 revolutions. Now, then, to find the speed of the last. We have 225 revolutions and 16in. diameter driving 6in. diameter, and again, 6 : 16 : : 225 is to the sum required, and $\frac{225 \times 16}{6}$ = 600, $\frac{600}{225} = \frac{16}{6}$, or $\frac{600}{225}$ = 2⅔, and $\frac{16}{6}$ = 2⅔. We have now found the speed of the last driven pulley to be 600 revolutions to 50 of the first driver, 12 to 1, what then would be the draught between them? The 1st driver is 18in. diameter = 56·52in. circumference, and this × 50, the number of revolutions = 2826in., the distance it would travel. The last driven is 6in. diameter = 18·84in. circumference, and this sum × 600 = 11304in. Now if we divide the two sums, we must, as we already know, obtain the draught there s between the two speeds of travelling, and $\frac{11304}{2820}$ = 4. With 12 times the speed of revolution only 4 of a draught? How is this? Look at the sketch again and you will remember that the diameter of the 1st driver is 18in., or 3 times greater than that of the last driven, so that if you multiply the draught 4 by 3 it becomes 12, or in proportion to the two speeds. You will see this more distinctly if you observe that the surface speed of both 1st driver and 1st driven is the same, both being connected by the strap. The same is the fact also with the 2nd and 3rd pairs. But observe that the 2nd strap must move twice as quickly as the 1st one, because it receives its motion from a diameter twice as great as the 1st is driving. The same difference likewise exists between the 2nd and 3rd straps, so that from the motions of these alone you have obviously the draught. The 2nd moving twice as fast as the 1st causes a draught of 2, and the 3rd moving twice as fast as the 2nd, causes a further draught of 2, so that we have 2 1st draught × 2 the 2nd draught, and 2 × 2 = 4. From what has been already said I think you will readily apprehend that if we had converted the values of all the drivers into one term by multiplying them together, and called the product the value of the drivers, and done in the same way with all the values of the driven, we should have made the whole process much shorter. As, value of all the drivers 18 × 20 × 16 = 5760, and value of all the driven 6 × 8 × 10 = 480, and $\frac{5760}{480}$ = 12, and 12 × 50 = 600. Therefore 480 bears the same proportion to 5760 that 50 bears to 600. But if we apply the principle to getting at the draughts of different lines of rollers in a "set," the former course is the best. Look now at sketch, Fig. 2. Here you see two drivers, the first called the "front roller wheel," its value is 16, the second called "change wheel," its value is 20; also two driven wheels, the "carrier," value 40, and "back roller wheel," value 60. The diameter of "back roller" is ⅞in., its value then is 7, the diameter of "front roller" 1in., or $\frac{8}{8}$, its value then is 8. Now the object of this example is to show you that it is not necessary that we should know the speed of revolution in order to find the draught that any arrangement of wheels and diameters would cause, because we are certain of finding the draught if we divide the value of the driven by that of the driver, the ratio between them being the same whatever be their speed of revolution. What is the draught, then, that such an arrangement as this sketch illustrates would cause? Let us see first what is the ratio between driver and driven; then, 16 × 20 = 320, value of driver, and 60 × 40 = 2400, value of driven; then, 320 : 2400 : : 1 to the number we seek, and $\frac{2400}{320}$ = 7·5, or 7½. You must observe that this is only the ratio between the values of the wheels, drivers and driven, no account having been taken of the diameters of the rollers "back" and "front." The diameters have been left out so far in the calculation that you might see clearly to which term or sum their respective values belong. And I think you will be able to discern that the surface of the front roller must be looked upon as a driven surface, and that of the back as a driving one. If their diameters had been equal, then, of course they could have been left out altogether, but the "front" diameter having a value of 8, or $\frac{8}{8}$, and the back of 7, or ⅞, obviously we must bring them in, and as they affect the amount of the draught in the same proportion as they affect the values of driver and driven, we can either multiply the sum of the draught by the value of the "front," or driven roller, and divide the product by that of "back" one, or driver, as draught from value of wheels 7·5 × 8 value of front roller ÷ 7 value of back roller = $8\frac{4}{7}$, or we can bring them in altogether as the value of driver and driven. Thus, the value of driver is 16 × 20 × 7 = 2240, and value of driven is 40 × 60 × 8 = 19200, and $\frac{19200}{2240} = 8\frac{1280}{2240}$, or $8\frac{4}{7}$. I hope now that you will fight your way through the subject. Never mind how the wheels are made to twist and turn, nor how many of them there may be, the principle that holds good with 5 holds good with 50, and you may understand it if you will. My object in writing is to set you thinking. You will see at the end of my last letter I told "Factory Lad" to divide a total draught of 7, obtained from 4 lines of rollers, by 3, and make his draughts equal, as 2⅓ + 2⅓ + 2⅓ = 7. I purposely in this case left my meaning obscure, because no person ought to act upon a short isolated answer from any correspondent, especially when, as in this case, the subject is a very important one; if he does, he has no right to complain, when, too late, he finds it out that both he and his fellow-correspondent have misunderstood each other. My meaning was (from front to back) between front and 2nd roller, 2·5; between 2nd and 2rd, 1·69; between 3rd and 4th, 1·67; or, reversing their order, 1·67 × 1·69 × 2·5 = 7·05575, or something as near this order as he should find convenient. I was once rarely puzzled by a similar answer given to me by a very intelligent old man; however, I learnt something from it, and if you *think*, you will do the same. E. S., Burnley.

P. S.—If no one else answers "Oldham," 2861, I will do so, though I do not like to recommend books, as I would rather see information given through the pages of our MECHANIC; besides, books seldom answer the particular question a person may wish to ask. You will generally find anything in them but just the one thing you are fast with, and that which is worth putting in a *good* book is worth the space it will take up in our MECHANIC, for the sake of those who cannot come at the *good* book.

F I G . 2



SIR,—I am greatly obliged for the numerous answers to my question respecting the proper method of arranging the draughts in a drawing frame. I find that "Mutual Improvement" comes the nearest to what I have practically found to be the best arrangement, as I have my draughts at present 3·41 × 1·75 × 1·17 = 7·06 working "fair Dhollera." I am rather surprised at the figures given by E. Slater, for if I put 2⅓ draught between each line, the total draught would be 12·64, because 2·33 × 2·33 × 2·33 = 12·64; the error appears to have been made, by adding instead of multiplying together the separate draughts. With respect to "B. W. R.'s" remark on scutchers, I prefer the down draught machines, as they do their work better, and are not so clumsy in appearance. I have both sorts working, but am decidedly in favour of the down draught machines. FACTORY LAD.

SEWING MACHINES.—REPLY TO "STUDY."

SIR,—I am thankful for the good intention of "Study" to point out one or two slight errors in my letter at page 158, but the errors, such as they are, only amount to a difference of opinion. I must acknowledge myself wrong *if* a $\frac{7}{16}$in. shuttle *will make as good a stitch on boot-work as a smaller one.* Finding the majority of workers on boot-work do not approve a $\frac{7}{16}$in. shuttle in a No. 2 Thomas, a smaller size was taken fairly for comparison. If "Study" has compared things unlike, his conclusion may be wrong, and my statement that Singer's shuttle holds most, Howe's next, and Thomas's least, is not a slight error.

I quite agree with "Study" that Thomas's cam is defective. By the way, if through the ENGLISH MECHANIC the makers and blind imitators could have been convinced of this years ago, boot makers, tailors, &c., would have experienced much less trouble in their work. The question of the pause, and other matters, will be considered in due cause. Having laid down a plan for the treatment of the subject, including descriptions of a variety of machines, and comparing them fairly, so as to be interesting to the general reader, I wish to adhere to it. When the subject is sufficiently advanced, such remarks as "Study" has kindly offered, will be better appreciated, and will then be thankfully received and replied to by the permission of the Editor of the ENGLISH MECHANIC by

A PRACTICAL MAN.

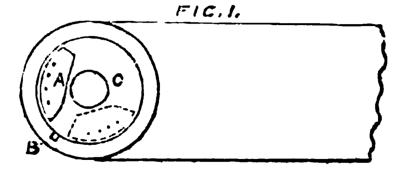
SEWING MACHINES.

LOCK STITCH.

(*Continued from page* 114.)

SIR,—It is difficult to conceive of any method of making a lock stitch not already tried. The shuttle to pass through the needle loop, the hook to carry the needle thread around the lower thread contained in a spool, the form and working of such hooks, spools, and spool holders, and their influence in determining the character of the stitch, deserve here special attention. Hereafter it will be expedient to give a description of some of the machines invented since 1846. Of these some display great ingenuity, true mechanical principles, and simplicity of construction; others, the simplicity of the inventors. Many of the unsuccessful have been ruined in mind, body, and estate. While these may receive our sympathy and the successful our praise, all should consider how insignificant is the work of the best compared with the accumulated labour of all. From the weavers' shuttle in the time of Job, to the English lace machine, with its many shuttles and eye-pointed needles (from which Howe may, or may not, have got his idea) and to the latest or best production, we trace a gradual improvement —a Darwinian development. The best examples will be selected, and predominate from their fitness and beauty; the inferior will die out. It is well known to the trade that some varieties have already died out, while others have advanced. In no particular did the Exhibitions of 1851 and 1862 display a greater contrast than in the matter of the sewing machine. In 1851 it was scarcely known, and the one in the Exhibition appeared a mere novelty. In a few years they were in general use, and were among the most interesting displays in the Exhibition of 1862. Machines making the lock stitch, the two-threaded chain stitch, and the single thread chain stitch, were all at work. Anxious inventors vied with each other to please the public, whose judgment was decidedly in favour of two-threaded machines, especially the lock stitch. Since then, untiring efforts have been put forward to advance the sale of single thread chain stitch machines; it has been named the best stitch with unwarrantable boldness; with surprising impudence its superiority has been asserted over lock-stitch machines. A proof to the contrary is shown by an official return of the American sewing machine makers. The actual business done in the year ending June, 1867, was, for the chain stitch, by Willcox and Gibbs, 14,152; for the lock stitch, by five makers, 106,338. Thus seven and a half times more lock stitch than chain stitch machines were sold according to the American official return, and if proper returns were made for Great Britain there can be no doubt that for every single chain-stitch machine sold there would be twenty lock stitch sold. The chain stitch is easy to learn, and has such merit as to entitle it to notice, but twenty reasons to one claim for the lock stitch the preference.

F I G . 1.



In the development of the lock stitch sewing machine, one of the earliest attempts to improve it was to substitute a carrying for a sliding motion of the shuttle. The shuttle was placed on a horizontal working disc and revolved with it, the rounded part being supported on the disc, the face of the shuttle being curved to correspond to the perpendicular face of the frame against which it worked. In another machine the disc revolved vertically, the shuttle face being flat, and worked against a perpendicular ring surface. This circular motion of the shuttle had two serious defects—first, it must either twist or untwist the shuttle thread; and, secondly, it nearly doubled the travel of the shuttle, whereby a grinding tendency was produced, so that the shuttle would oftener want repairing or renewing. This arrangement was a step made towards a machine displaying the very highest class of design and practical ability, known as the Wheeler and Wilson machine. This revolving shuttle arrangement has been followed by other modifications. The shuttle has been made to travel in a nearly circular form, in a recently invented machine, but with an important improvement to prevent the twisting or untwisting of the thread, by causing the shuttle to be carried around without somersaulting, by placing it on a shuttle frame worked from a supporting guide by a crank motion. The rounded part of the shuttle is supported on this shuttle frame, the shuttle face being thus kept against the perpendicular face of the machine. Instead of the shuttle reciprocating with the least waste of movement, this plan makes it travel over a largely extended surface, which is a mechanical defect in itself, and has no advantage in working the needle thread. If a motion could be contrived for passing the lower thread through the needle thread loop without touching it, it would be perfection. The Howe system is the nearest to it, and the plan last described the most remote from it. An ascending and descending motion of the shuttle serves no useful purpose, it wears the shuttle faster, strains the needle thread, and thus limits the speed of the machine.

Other machines of recent production resemble an older patent which provides for the carrying the shuttle on the top end of a vibrating lever. This arrangement imparts a curved motion to the shuttle vertically; it rises and falls less than in the case last noticed, and is consequently to be preferred, the defects being so much reduced. An example of this class may be seen in the Little Wanzer hand sewing machine. All the machines under the class here referred to have failed to come into manufacturing or trade use—it would not pay for rich or poor to use them in trade.

It may be taken as a rule that a shuttle should travel horizontally, and no more than the actual distance required for the formation of the stitch; travelling beyond it wears out the shuttle faster, as may be observed in the Singer class of machines driving the shuttle by a crank motion or its equivalent, instead of a cam. The cam movement has a special advantage over any other known plan for driving the shuttle, although in many cam machines it is not made available. When the shuttle has passed the needle loop, the shuttle carrier should recede a distance sufficient for the needle thread to pass between the shuttle and carrier without touching the carrier. Many cam machines work on this plan, and it is a decided improvement. Other minute defects or improvements will come under notice when a machine is illustrated completely. The present plan of collection, classification, and comparison of instruments for the formation of the stitch is chosen as the best method to convey the information desired.

A more correct motion for working the shuttle than the class of circular moving shuttles, will now be considered. The shuttle slides with a movement reciprocating, as in the Howe machine, horizontally, but in a curved instead of a straight direction. The advantage here gained is reduction of the wearing joints and parts for driving the shuttle. The same system has been successfully applied to work a shuttle in the end of an arm machine; the arm being specially arranged for stitching side springs into old boots, or any work that can only be stitched on the extreme end of the arm. The arm is so narrow as to admit the boot over it, with freedom to turn the work in all directions. A circular recess is formed in the end of the arm, and in it works the shuttle horizontally; on the axis of the shuttle driver is fixed a pinion, which is actuated by a rack working lengthways in the arm from a cam on the main shaft, similar to Thomas's machine. Fig. 1 represents a plan view of the end of the arm containing the shuttle. The shuttle A is shown ready to enter the loop of the needle thread. B is the slot in which the needle rests while the shuttle is passing through the loop. To complete the stitch the shuttle travels as far as represented by the dotted lines, and then back again for the next stitch. For the purpose intended a better arrangement cannot be conceived, but for general work it is defective as regards wear, owing to the circular surface C being so small. The part around which the shuttle travels soon wears, and then the curved face of the shuttle is not kept to frame, whereby the shuttle falls backward from the needle, and slips or misses stitch. It also requires too long a needle thread loop to pass around its body, the defect of which has been already explained.

It may be interesting now to notice how few of those *improved* (?) shuttles and drivers have come into use; yet they afford a rich store of experience for experimentors. Passing from the circular movement shuttle to a better contrivance, yet still working on the same idea of a direct circular movement, a wonderful success has been achieved by the production of a machine substituting for the shuttle a metallic bobbin or spool to contain the lower thread, and carrying the needle thread around it by a rotating hook, as in the Wheeler and Wilson Machine, or by an elliptic moving hook, forming the stitch in a somewhat similar manner. Fig. 2 represents a front view, and 3 a section of the metallic bobbin or spool. It is formed of two thin metallic discs *a b* fixed on a brass axis *c*, with a hole through it which fits on the shaft of the machine to receive a rotary motion for winding on the thread, and in the space between the double convex spool. It holds 18¾ yards in the Wheeler and Wilson, and in the Elliptic spool 14¾ yards, of No. 24 cotton. Unlike the shuttle, there are neither holes nor springs to regulate the tension of the lower thread. The formation of the stitch in its pulling and straining on the needle thread is less perfect than a shuttle stitch. The needle thread is sunk well in the upper surface of the fabric and pulled below too much, where it forms a ridge. The two sides are not alike, but, while inferior to a good shuttle stitch, it is immensely superior to a chain stitch, either single or double thread, in appearance, strength, and economy of thread.

The spool is held to its work and rests between a spool-ring or holder and the revolving hook which carries the needle thread around the spool. In due course the machine will be illustrated, and no doubt will amply repay a careful study of its working.

A PRACTICAL MAN.

NEEDHAM'S PATENT "STARTER" FOR SEWING MACHINES.

SIR,—A description of an American invention, patented by Mr. O. H. Needham, of New York, which has for its object the removal of a difficulty well known to workers of sewing machines, may be of interest. Although it is claimed by some machine operators that they know by the pitch or inclination of the treadle whether its movement should be up or down in setting the machine in motion, the difficulty of so doing is evident on reflection that there are four positions of the crank near the upper and lower dead centres, in which the pitch of the treadle is the same, but requires different motions of the foot to produce the movement of the shaft in the requisite direction. Consequently, after stopping, the operator, not seeing the crank, cannot be positive that it will turn the right way in starting without using the hand, or in its stead some automatic device like that under consideration. Fig. 1 shows a sewing machine fitted with the appliance, and Figs. 2 and 3 exhibit, on an enlarged scale, the appliance itself, in different positions, detached from the machine. A collar A is secured upon the rock-shaft carrying the treadles, and is furnished at one end with an enlargement or disc. Upon the face of this last, next to the treadles, is fitted a slotted slide B, capable of moving transversely to the rock-shaft, which, of course, passes through its slot. This slide B, furthermore, is furnished with a lateral arm *a*, which extends over the adjacent one of the treadles, as will be seen by reference to Fig. 1, in such manner that the application of the foot upon such treadle will depress the slide B, the purpose of which will presently appear. The upper end of slide B is connected by a rod C with a rocking disc or sleeve D, placed upon the crank-shaft above, and having pivoted to it a pawl *b*, arranged in appropriate relation with a ratchet-wheel F, securely attached to the crank-shaft. The sleeve D, just mentioned, is formed with an upwardly projecting lever-arm *c*, the upper extremity of which is connected with a spring *f*. The action of this spring is to draw the lever-arm, and consequently the sleeve and pawl, backward with reference to the direction of the teeth on the ratchet-wheel F.

FIG. 1

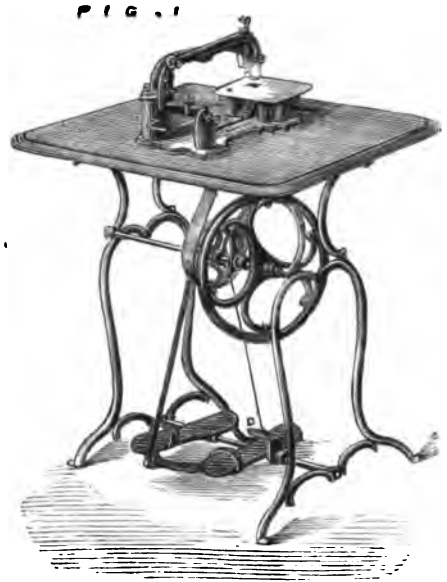


FIG 3

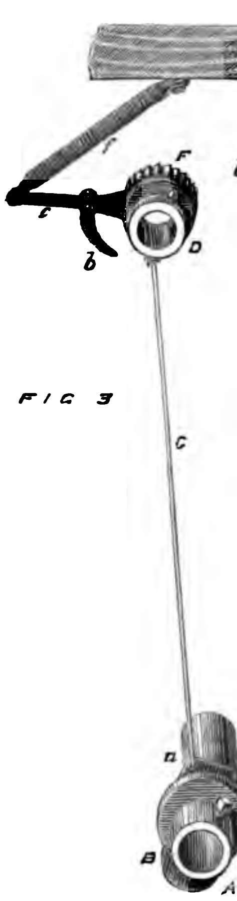
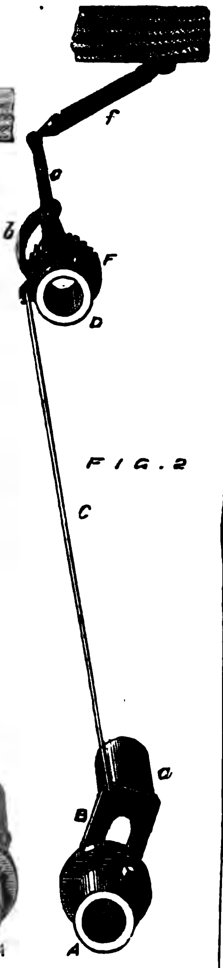


FIG. 2



When the foot is applied to the treadle in starting the motion of the machine, it acts upon the arm *a* of the slide B, and depresses the latter, whereupon the rod C actuates the sleeve D, and moving the pawl *b* forward, the latter acts upon the ratchet-wheel secured to the crank-shaft as previously explained, and of course starts the rotation of the latter before any movement has been communicated to the treadles, or through them and the pitman to the crank. As soon as the crank-shaft has thus received an initial impulse, the treadles are worked to continue the motion in the ordinary way. The movement of the slide, moreover, is sufficient not only to thus impart motion to the crank-shaft, but also to bring the pawl *b* into such position that by its own weight it will drop out of gear with the ratchet-wheel, to permit, without interference, the rotation of the crank-shaft. When the machine is stopped and the foot raised from the treadle, the spring *f* draws back the arm of the sleeve D to bring the pawl in suitable relation with the ratchet-wheel to repeat its action thereon when the machine is again started, the movement of the lever-arm operating of course through the connecting parts, lifting the slide B, to its original position.

KAPPA.

COLOUR-BLINDNESS.

SIR,—As I perceive that the subject of colour blindness is one to which you have devoted considerable space, I wish to ask permission to describe my own case, which I think involves a peculiar form of the evil that has not been dwelt upon by "Omicron," in his interesting, and probably exhaustive, memoir. The peculiarity to which I allude is a tendency in my eye to see *red* as *black*, not as any intermediate shade between black and white, but as a decided black. It is not a little singular that, notwithstanding the great difference there is usually admitted to be between black and red, it was not till I was more than twenty years of age that I discovered that I had never seen red as a distinct impression, and considering the remarks that "Omicron" has made on congenital colour-blindness, I believe I never have, and never shall see it. The way in which I discovered my defect was singular enough, and as it evidences my complete disability to distinguish red from black, I make bold to tell the "little circumstance," though it may not be thought to be of sufficient value for the pages of your magazine that are devoted to correspondents' letters. On one occasion I splashed some white material, I believe white paint, over a nearly new black vest, and as the effect was rather a disfigurement, I thought I would remedy it by covering the spots with black ink. I did so, and produced, to my eye a result that I thought infinitely superior to the speckled aspect it had before presented; but I noticed that my friends did not at all appreciate the improvement that I flattered myself I had effected, and one more intimate than the rest explained to me that, in point of fact, to end quickly an unimportant matter, I had employed *red* ink—imagine my disappointment. Since that time, I have made many unfortunate and ridiculous mistakes, and my own impression is, whatever ingenious theory may account for it, that the defect is incurable, and I have not much faith in the use of coloured glasses, or other ingenious apparatus, to cure, or at least to mitigate, the inconveniences of colour-blindness. I may mention that I recognize *other* colours as a normal eye. I express my thanks to "Omicron" for his entertaining memoir,

AN IDIPOT.

STEAM LIFE BOAT.

SIR,—Concerning the steam life boat to which you refer, my sentiments on the subject are embodied in the enclosed copy of a letter I had the pleasure to address to Mr. Luff on the 14th ult. I feel assured that nothing like a steam life boat has so far been invented; most of the plans merely aim at putting an engine in one of our life-boats, which is absolutely impracticable. RICHARD LEWIS, Royal National Life-boat Institution, 14, John-street, Adelphi.

[COPY.]

DEAR SIR,—I have your note of the 12th inst. It is most kind of you to take such a warm interest in the life-boat cause. I trust, however, that the ENGLISH MECHANIC will not, on any account, solicit contributions for a life-boat to be propelled by a screw. After mature consideration, I assure you we are of opinion that such a boat is impracticable in the present state of things, and perhaps you will also be of the same opinion if you will kindly give your attention to the following reasons, which, in my opinion, militate against the adoption of steam life-boats. 1st. That owing to the large quantity of water which must break over life-boats in heavy surfs, amounting often to three or four tons, it would be very difficult to keep the fires from being put out, and at the same time provide sufficient ventilation. 2nd. That the motion of boats, under such circumstances, is so great and violent they sometimes standing almost perpendicular, with either the bow or stern uppermost, that the propeller would work at great disadvantage, and the machinery be perhaps liable to disarrangement. 3rd. That since the space occupied by the engine, &c., would make it impossible to use oars if the former should become disabled whilst afloat, the boat would be at the mercy of the sea, and her own destruction, and that of the crew, might follow. 4th. That wherever such boats were placed, this institution would require to have a qualified engineer to keep the machinery in order and work it when afloat, with a salary sufficient to maintain him, since the fishermen and other local boatmen who now, as coxswains, for a small salary devote only a trifling portion of their spare time to keep the boats in order and ready for service, would neither have the time at disposal nor the skill to keep machinery in order and to work it when afloat. 5th. That some time would be lost in lighting the fires and getting up steam. 6th. That it would be difficult to apply the self-righting property to such boats, and if they were to remain more than momentarily keel up, the fires would be put out, or they might set the boat on fire. 7th. That the cases of failure of the present life-boats are so rare that the committee of the institution have not felt called on to expend large sums of money on experiments, which might not afterwards be attended with any beneficial results. 8th. That wherever steam tugs are available, I think it probable that steam power can be more advantageously applied through their instrumentality. I hope the ENGLISH MECHANIC life-boat fund will be a success, and that you will secure a good attendance at your forthcoming concert. RICHARD LEWIS.

THE LUNAR CRATER PLUTO.

SIR,—The results of observation of the floor of the lunar crater Pluto which have appeared elsewhere see *Student*, April, 1870, p. 161 being of interest in connection with questions now agitated relative to changes on the moon's surface, the following summary of further observations during the April lunation may not be uninteresting to your numerous readers.

The observations were made by Mr. Gledhill; of Mr. Crossley's Observatory, Halifax; Mr. Pratt, of Brighton, and Mr. Elger, of Bedford. Sixteen only of the 35 known spots were seen; they are numbered 1, 3, 4, 5, 6, 9, 11, 14, 16, 17, 22, 24, 25, 30, 32, and 33, but Mr. Gledhill detected an unrecorded one, which is numbered 35. Of these the following were seen by the three observers—viz., Nos. 1, 3, 4, 5, 16, and 17; no doubts, therefore, can be cast on their visibility during April. No. 14 was observed by Messrs. Elger and Pratt on seven occasions, but missed by Mr. Gledhill. The spots seen by Mr. Gledhill only were Nos. 6, 9, 11, 30, 32, 33 and 35; by Mr. Elger only, Nos. 24 and 25, and by Mr. Pratt only, No. 22. Taking spot No. 1 (the most constantly seen) as the standard = 1·000, the degrees of visibility are as under:—

Spot	1	4	3	17	5	16	14	9	25
Vis.	1·000	1·000	·895	·780	·474	·421	·368	·263	·263
Spot	30	6	11	24	22	32	33	35	
Vis.	·210	·105	·105	·105	·053	·053	·053	·053	

The number of observations of the spots between April, 1869, and March, 1870, inclusive, amounted to 771 in 108 series; those during April amounted to 118 in 19 series. These numbers give 7 for the average number of spots visible on any one evening. The curves of visibility of 14 spots have been projected for the 12 lunations ending March, 1870, and of these 14 spots 5 were not seen on any one of the 19 sets of observations—viz., Nos. 2, 7, 10, 13, and 19.

The intermittent character of the above unrecorded spots in April is becoming more and more manifest. No. 2 has been observed 7 times only between August, 1869, and March, 1870, inclusive. No. 7 invisible in June and July 1869, and in February, March and April, 1870. No. 10 invisible between Oct., 1869, and January, 1870, inclusive. No. 13 seen on 28 occasions during the past year, invisible in April, 1870. The same may be said of No. 19, it having been seen 27 times during the last year, and invisible in April, 1870. No. 22 may be included in the same class, for although it was recorded on every fine evening in August and September, 1869, it is now but rarely seen. The variations in the visibility of the spots more constantly seen lead to the same conclusion—viz., that their visibility is also intermittent. It must, however, be borne in mind that the visibility of spots very rarely seen, once or twice for example, in the course of a lunation, may depend upon the state of the earth's atmosphere; it is, nevertheless, difficult to conceive that the earth's atmosphere is capable of obscuring spots for months together, while others quite as difficult of perception are visible.

An increased accuracy is attainable by the number of observers being augmented, for, as in all observations of the kind, errors that necessarily affect the few are eliminated in the case of the greater number, so errors arising in the visibility of the spots from differences in the state of the earth's atmosphere at distant stations, and also in consequence of the overlooking of minute objects by one observer which are distinctly visible to another, disappear to a great extent, when the observers are numerous, the greater weight being accorded to the visibility of those spots that are seen by the greatest number of observers.

W. R. BIRT, Cynthia Villa, Walthamstow.

"OTTER" FOR LIFE BOAT SERVICE.

SIR,—Amongst the requirements for life boat service, it has been held to be a desideratum to find means for depositing an anchor on emergencies at a distance from the shore convenient for using a block and double rope attached thereto, to enable those on shore to haul off a boat through surf, and to the various schemes for this purpose, I wish to offer an additional one. There is a certain fishing implement of the pot hunting or poaching class, by which a line can be carried out (with hooks, &c.) called an "Otter," the construction and action being this: A flat board is (by being weighted with lead) made to swim edgeways; to it is attached a loop similar to the bellyband of a boy's kite; to the loop is fastened the fishing line in a certain position upon launching and paying out the line. The "Otter" leaves the shore in an oblique direction, and is hauled along to the extent of the line. On this principle it is proposed to construct a machine of the following description. Fig. 1, A B O is an anchor, of which the ring is at A, and single fluke B O attached to a flat frame built up of board and cork, A B D C, the upper portion of which, C E F D, is removeable, sliding out from the lower portion backwards, having line and ring fastened to it L E, the whole of such buoyancy as to float the entire machine level at about the line E F; G K H loop or bellyband, to which, in proper position for effecting the oblique motion in hauling off, are fastened a block and double line rove there through I K. A stronger connection is to be made between the block K and anchor ring A, by line or rope A K. In use, the upper sliding portion of the frame is to be fastened by a line ⅓rd the strength of the line L E, also the bellyband is to be so contrived that the sliding out of the upper part of the frame shall let it fall loose. The action is presumed to be this (*i.e.*, supposing this salt water "otter" behaves equally well with its fresh water progenitor, and there seems no reason to suppose it otherwise), that upon launching, the machine drawn by double rope K I, will proceed to sea, and gain offing according to length of rope K I, trailing behind it the line L E. On acquiring proper offing and position, the travelling line is to be jerked so as to break the fastening ⅓rd its strength, and pull out the upper sliding portion of the frame, which is to be hauled ashore, and also detach the bellyband. The anchor will then, deprived of sufficient floating power, sink fluke downwards; a position secured the better by the floating power of the frame still attached; and on hauling in, the double rope, will, with that and the stronger piece attached to the anchor ring, be drawn into the direction required, and, finally, the double rope be in position to be efficiently used for hauling off the life boat. Fig. 2 shows a sketch of the position of the "Otter" floating, seen from above. A B shore line. L E trailing line, by pulling which the upper frame is drawn away. K I double rope to shore. The machine to be fitted on a small carriage with long pole and launching ropes, as in life boat carriages. Two wheels only are wanted for carriage. The whole affair might weigh from 4cwt. to 6cwt., including carriage. SUFFOLK AMATEUR.

FIG. 1

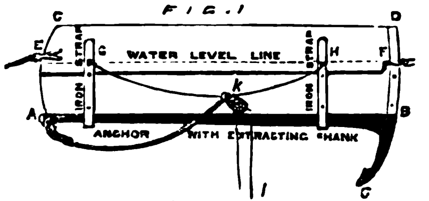
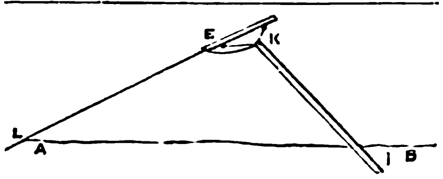


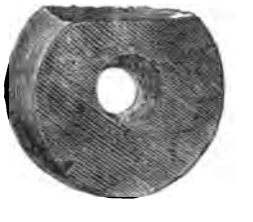
FIG. 2



P.S.—I may just add an idea about self-righting life boats. The principle is as old at least as any grown man who, as a small boy, put a leaden keel to his play boat, and deduced from the observation that the form of the upper works has nothing to do with the matter, but that it depends altogether upon the centre of gravity or otherwise on weight below overbalancing weight above.

FAIRY WHEELS.

SIR,—I enclose you the only one I have left of these ancient stone discs, trusting you, or some of your correspondents, may be able to throw some light as to the purpose for which so much trouble has been bestowed on them; they are only found in one field on the farm, but were much more plentiful forty years ago than now; at that time, we used to suppose they had been made by children, as wheels for toy carts. One of my ploughboys, about this time last year, picked up about a dozen of them; he brought four or five home, throwing the others away. The one I forward is much the smallest, and the thickest. I am sorry to say the others are all lost; the one I send is much more carefully made than any of the others were. None of them were the same size or thickness; some of them showed the saw marks very distinctly; they had been sawn out of cylinders of different sizes; the holes through have been bored after each disc was cut off, some of them quite oblique, but all rimmed from each side as this is; they were all thick in the middle, though none were so much rounded off as the one side of this, neither had any of them the perfectly flat side you see in this one. I do not know of any stone in this neighbourhood that at all resembles this they are made of. I recollect seeing them with serrated edges, as though the notches had been cut with a file; I also believe I saw some of the same dug up at Uriconium (Uttoxeter), about two miles from here. From the careless manner with which the holes were drilled through them, I should say it has been for the purpose of threading them on a string; the one I send has evidently lain in the ground very many years, by the gravel being so firmly attached to it. The opinion of some of your readers on it will oblige.



I have seen some quite twice as large, and above half as thick. A SUBSCRIBER.

SILVERING SPECULA.

SIR,—Although I am no chemist, and am therefore unprepared to account for some of the failures which may happen in the above art, my own repeated failures have, nevertheless, taught me a few lessons, and have led me to the opinion that nine cases out of ten of these failures occur chiefly through want of sufficient care in *cleaning* the glass surface intended to be silvered; and although the few hints I have to offer do not perhaps apply entire to the "Rochelle salt" process, your correspondents, M. Gray, p. 163, and "Interested." p. 191, may, I hope, find them useful as regards the *washing*.

The following particulars as to chemicals refer to Liebig's process as given by Browning, this being the only process I have attempted. The proper cleansing of the glass is doubtless equally as necessary in both processes. In the first place, distilled water, that is, chemically pure, must be used, I have not tried rain water, but should think it would succeed when collected in clean vessels and properly subsided. 2nd. The chemicals should be obtained of a reliable chemist nitrate of silver is, I believe, ordinarily good. The potash must be pure by alcohol. The ammonia should be the strongest obtainable. In cleaning the glass, the strongest nitric acid should be used; if good it gives out copious fumes, and may be easily known by the prompt manner in which it attacks the eyes and nose. First place the mirror face upwards (previously cemented to the wooden block) in a large dish, pour the nitric acid on it, and gently rub the glass all over its surface and sides with a pad of medicated wool plugged into a glass tube; then rinse the wool in common water, and repeatedly wash off the excess of acid, taking care to give the same attention to the sides as to the surface; this done, do not touch the glass with the fingers, but take hold of the block to which it is attached, and hold it under running water from a tap for about five minutes, continually moving it, that the jet may play freely over the back, the sides, and lastly the surface; then examine the surface of the glass, and if the water has a tendency to run away from the edge of the disc, as if greasy, the process must be repeated until all greasiness disappears. The glass is then laid in a sloping position, and another woollen brush used to cleanse it with distilled water; this brush should not be touched with anything but distilled water, into which it is now dipped, and the glass repeatedly rinsed all over with it, until any apparent greasiness which the first contact with distilled water may occasion entirely disappears.

The glass is now ready for silvering, and is laid wet, face downwards, in a dish containing a little pure alcohol (just sufficient to touch the entire face of the glass) until the silvering bath is quite ready. Caution must be observed throughout the entire process not to touch the face of the glass once with the fingers if possible. One or two particulars as to the silvering fluid may be serviceable. If the process is conducted in cold weather, it is advisable to warm the solution slightly; this may be done when the distilled water is added, by warming some of it in a clean cup placed in a basin of hot water for a few minutes; this helps to subside the precipitate more quickly, and renders the fluid transparent before pouring into the silvering dish, which is necessary to prevent spots in the silver film. Another essential item is to completely dissolve the milk sugar; this can scarcely be done in cold water, but is quickly done by warming in a cup placed in hot water, as before. The slight warmth given to the silvering fluid has also the important advantage of giving a harder and more adhesive film.

In placing the mirror face downwards in the bath, care should be taken to enclose no bubbles under its surface; one side should be lowered first, and then the entire surface brought gradually level; it should not sink too deep into the fluid; the nearer the surface the better, providing the face is fairly immersed. When the film is complete, it is removed and *immediately* washed under the tap for five minutes as before, then stand the mirror on edge in a dish, and gently rinse with distilled water either with the woollen brush or with a piece of soft clean sponge; when it is thoroughly dry, polish first with clean wash leather, then with rouged leather.

In answer to Mr. Gray's query, the proper aperture of a diagonal plane for a Newtonian may be estimated at ⅕th or $\frac{1}{6}$th the aperture of the speculum, whatever its size, providing the focus of speculum is thrown just outside the great tube, as is usual.

As the "Harmonious Blacksmith" and "F.R.A.S." have associated my name with the subject of "platinised mirrors," I must admit my entire ignorance of the process, and as to the advantage of platina over silver in point of reflecting power, I should have serious doubts, and as to the "baking process" for such sensitive things as specula I should have very little doubt, and should require positive evidence to convince me that it could be anything else than a failure.

W. PURKISS, 9, Cumberland-street, Roman-road, N.

EXPANDING DRILLS FOR MINING PURPOSES.

SIR,—In the issue of the ENGLISH MECHANIC of the 6th inst., I find you have inserted a short paragraph (taken from the *Mining Journal*) relating to an invention by Mr. E. P. Gleason, of an expanding drill for boring purposes, by means of which a chamber or cavity can be made at the *bottom* of a drilled hole, for the reception of the blasting powder, and by which means a vast additional force can be obtained for disintegrating and blowing up the rock. Now, it so happens that I myself invented a similar drill borer about seven years ago, a description of which, at the time, appeared in the *North Wales Chronicle*, which was extracted the next week after its appearance in the columns of the *Mining Journal*. Judging from it in the note in question, it would appear that Mr. Gleason's invention and my own are precisely similar in principle, and pretty nearly so in the carrying out of it in detail, which certainly is a somewhat strange coincidence. In my invention, the cutting part is composed of two cast steel blades, which are inserted about 4in. above the bottom of the iron rod, the blades being screwed in so as to be the more easily taken out or replaced when they require sharpening. The chamber at the bottom, has a diameter of 3½in. (the hole made by the common borer being 1¼in. in diam.), and as the perpendicular hole is continued by the operation 4in. or 5in. below the chamber, the latter can be extended to any reasonable depth. My expanding drill-borer has been successfully tested in several slate quarries in the neighbourhood, and notably so at the Hendre Ddu slate quarry, near this town. Sir Edward Poore was at that time the managing director of the said quarry, and was assisted by Mr. W. Jones, a thoroughly practical miner. We experimented on a large piece of rock, and a hole was drilled to the depth of 11½ft. The charge was 10lb. of rock powder, and above 500 tons of rock were blown up, the explosion being a tremendous one, and the rock was shattered in all directions. This result was considered to be most satisfactory by all who were present and witnessed it, as the quantity of slate rock obtained by the powder charge of 10lb. was equal to what was usually obtained in the quarry by the expenditure of 100lb., to say nothing of the great expense saved in the matter of labour. From this you will perceive that Mr. Gleason's invention has been long since anticipated by myself, in an obscure town in North Wales. As a contributor to your valuable paper for the last four years, I trust you will do me the justice to admit this letter in the next number of the ENGLISH MECHANIC.

JOHN WILLIAMS (Joan Madoc), shipsmith, Port Madoc, Carnarvonshire,

"C. R. O., HANTS," ON SEVERAL MATTERS.

SIR,—"Salopian," on page 190, wishes to know how it is that the circumference of the earth at the Equator is greater than the circumference drawn through the poles; he quotes the difference at 25 miles. A moment's reflection will show him what a mere trifle this is when we take into consideration the vast dimensions of our globe; I question very much if many billiard balls—perfect as they apparently are—can boast such a slight departure from the form of a true sphere. I believe myself that centrifugal force certainly causes what "Salopian" refers to, and that its power, exerted throughout the whole mass of the revolving earth, is just so much, and no more than sufficient to occasion this swelling out at the Equator. This opinion will, I think, in no way stultify the arguments in my previous letter on the earth's rotation.

Touching this same subject, I must confess that it was with the greatest possible gratification I read Mr. Proctor's kindly-worded comment on my letter; encouragement from that gentleman is worth something. Will he allow me, in my turn, to present my compliments to him, and trust we may often have the pleasure of reading his most valuable contributions to our MECHANIC?

An apology is due to "An Adept," inasmuch that I have delayed so long acknowledging his kindness in replying to my question on the construction of Bourdon pipes. The fact is, I have been waiting, unwilling to bother him during his unfortunately still continued indisposition, but seeing that other correspondents are not so considerate, and fearing that he may perhaps deem me ungrateful, which I assure him is very far from the case, I can hold out no longer. The plan that gentleman suggested—viz., to place the pipes in two rows, would have been obvious to me, had the special circumstances of my case admitted of it; I worded my letter badly, and "An Adept" naturally thinks depth is no object. What I wish to ascertain is, could a pretty good quality of tone be obtained from pipes constructed with a much greater depth than usual in proportion to their width? For instance, could CCC be made 4½in. by 8in. internal measurement? The double row plan I wish to avoid if possible, for many reasons. I trust our correspondent may soon be restored to perfect health.

What in the name of all that is polite and charitable, can "Eleve"—himself, I presume, a musical man—mean by putting such a question as this to your correspondents? "Tell me why a double manual instrument should be preferred to a single, if the single set of keys can be made to do the work as well?" Is this from Lord Dundreary, or what? One might just as sensibly put the query, why eat bread and butter when bread alone could probably do its work just as well in nourishing the animal system? Amateurs, and intending purchasers, make no mistake, you will get incalculably more real and lasting satisfaction from a double manual than a single; ask any organist. Chorus and fugue playing may be performed very well on a single manual, but how about "He was despised," from the "Messiah," or, "O, rest in the Lord," from "Elijah," and the hundred and one other pieces depending for their very life and soul on a clear, distinct, and individual melody? To my mind the harmonium, especially, requires two manuals, from the very nature of its tone, whose most marked characteristics are, in a good instrument, an apt capability for producing grand and majestic harmonies, but there always seems to be a falling off when anything of a melodic character is attempted, hence the value of two rows of keys. I on my side appeal to the "Harmonious Blacksmith" for his verdict; his writings, which every one must enjoy, speak well for the value of any opinion he may offer.

The subject of harmoniums naturally associates itself with Mr. Hermann Smith, and if you, Sir, have been instrumental in bringing him back among us, you have my most cordial thanks. Let any one peruse Mr. Smith's chapters on the harmonium, from their commencement, and see what ground he has broken up, before untrodden, and what vistas of thought, apart from the mere dry details of construction, he has opened out to a thinking mind. A painstaking and conscientious writer, Sir, and a comrade we cannot afford to lose from our ranks.

I am delighted to see such a long list of extracts from various correspondents relative to the success of our paper. You merit our very warmest praise and congratulation. There can be no doubt that to your own able and talented leadership all the increasing excellence of this periodical is due; you have indeed reason to be proud, Sir, of your achievement, for the press has certainly never before sent, through the length and breadth of the land, such a mass of useful literature at such a nominal price—no, nor at any price. My best wishes are yours. C. R. O.

TURNING.—BORING CYLINDERS.

SIR.—On page 189, Query 3701, a question is asked relative to turning, which, with your permission, I will answer.

I imagine the cause of "Amateur Turner's" failure the speed at which he drives his work, as no tool will and, even against soft wood, if it is driven at too eat a rate. The best way that I find to take the ale off cast iron is take a moderately deep cut at first, as to get underneath the scale, and the point of the tool buried in the clean metal under it; but some castings are so uncommonly hard that no tool will touch them, especially those cast in the country, and it is impossible to do anything with them. If "Amateur Turner" will tell me the diameter of his work, I shall be able to inform him how many revolutions the mandrel should make in one minute to give the proper cutting speed.

As to the second part of the question; a cylinder may be bored very fairly by setting it up on the faceplate of the lathe, if a large one (a small one may be soldered on to a brass chuck or held in the cup chuck) by one flange, and running an inside tool through it by means of the upper slide of the rest, taking care to get the slide set perfectly parallel to the axis of the mandrel, and frequent use of the callipers is the only means of ascertaining this. But there is another plan which I think is superior to the above (if "Amateur Turner" is the happy possessor of a screw cutting lathe), and that is to set up the cylinder to be bored on the saddle of the slide rest (the rest itself removed) and fixing a cutter bar with projecting cutter between the centres of the lathe and causing it (the cutter) to traverse through the cylinder by the sliding of the saddle; this, if properly managed cannot fail to produce a truly cylindrical bore. Cylinder covers are turned by chucking them in a wood chuck, and turning one side and edge, then reverse them to turn the other side. And now, having answered the above questions, allow me to ask one of my fellow-readers—viz., What is the construction of Holtzapffel's screw cutting tool-holder or cutter bar for V or square threads, by which the tool may be adjusted to the exact rake of the thread. A drawing to scale would oblige. G. W. A.

COLOUR BLINDNESS AND ASTRONOMICAL OBSERVATION.

SIR,—The readers of the ENGLISH MECHANIC have recently been entertained with a rather acrimonious discussion on the subject of the colour of the belts of Jupiter by two of its most valued contributors. In one of the letters I perceive that one of the disputants admits that an eye "successful in detecting minute forms of detail may altogether fail to notice gradations of colour."

This fact has been considerably enlarged upon by "Omicron" in the series of articles on Colour-blindness, and it appears to me that there is clear evidence in the columns of the MECHANIC of a case of colour-blindness, although there is not, perhaps, sufficient evidence to determine which one of your correspondents is affected with abnormal vision.

Mr. Browning says of the drawing of Jupiter that appeared in the *Student* that "the yellow and red are too bright, and the ashy blue or gray far too dark." Mr. Denning says that the colour of Jupiter, as seen in his telescope, was very apparent, but not so dark as shown in the print. Mr. Grover says that the colours in the drawing are certainly too vivid. In opposition to these remarks, Mr. Purkiss holds the opinion that Jupiter appeared even more vivid than the engraving in the *Student*. Perhaps these conflicting remarks are hardly sufficient to warrant the charge of colour-blindness, as "Omicron" has employed the expression, for the discrepancy in the description is one rather of quantity than quality. But as the term appears to be applied to every degree of deficiency of appreciation of colour, I have adopted it here.

Since three observers are inclined to one opinion, and one only holds the contrary, I should be inclined to suspect some anomalous vision to have vitiated Mr. Purkiss's observation; and the object of the present communication is to ask your readers whether an abnormal vision, manifested in any considerable degree, as in some of the cases specified by "Omicron," would be likely to produce telescopes in which chromatic aberration would not be duly corrected. It appears to me that if the correction can be computed by mathematical formulæ, it is not likely to produce any ill effect; but if the correction be determined by continued examination of the image of an object, and continual grinding, till the object is seen to the satisfaction of the observer, depending upon no fixed law, but left to the option of the observer, the question is one of some importance.

It is needless for me to say that I am ignorant of the method employed by makers for correcting the chromatic aberration of telescopes; and if it is not asking Mr. Purkiss to reveal the secrets of his guild, I should be glad if he would give me some information, especially as regards refractors. COLUMBUS.

THE TELESCOPE.

SIR,—Many thanks to "F.R.A.S," for his kind answers to my last queries. The reason I asked would he think a 3in. telescope good, was because I saw among the testimonials to Solomon's £5 telescope, the following from the Rev. F. E. Winslow, "In Mr. Proctor's book on the Telescope, I find the following passage about the trapezium. 'The trapezium affords a useful test for the light-gathering power of the telescope. Large instruments exhibit nine stars; but our observer may be well satisfied with his instrument and his eyesight if he can see five with 3½-inch aperture: a good 3in. glass shows four distinctly, but with smaller apertures only three are visible, and in a note he adds, 'I have never been able to see more than four with 3½in. aperture.' Now with the telescope I obtained from you last year, I can see five stars in the trapezium." All Solomon's £5 telescopes are warranted to show five stars in the trapezium θ Orionis. It was in page 34 of the current volume, that "F.R.A.S." said, in answer to "A Poor Lad," "A 2½in. object glass could not possibly divorce anything closer than a pair of stars 2"·5 apart;" however, "F.R.A.S." may not have meant a 6 mag. pair. And now, Sir, I must with your permission, trespass on "F.R.A.S.'s" kindness a little more.

Would he be so kind as to answer the following queries:—1st. Where can I obtain the "Nautical Almanac," and what is its price? 2nd. What moderately cheap book gives the best list of R.A. and declinations? 3rd. Is there any essential difference in the mounting of reflectors and refractors? That is would it not do to take a model for a small refractor from an Equatoreal reflector. 4th. How can I calculate the field of view that any given Huyghenian eyepiece would have with any given O. G.? An example would greatly oblige. 5th. How are the webs in a transit eyepiece protected? 6th. What is the plan of the pancratic eyepiece? I have often heard of it, but never saw one. 7th. Is Kepler's third law exact? 8th. Would not "F.R.A.S." describe a spectroscope more minutely than he did in No. 267? I am sure it would be interesting to a great many of us, especially now as he is going to tell us something of its uses. 9th. What is the size of the Cambridge (U.S.) refractor, and also the Melbourne Telescope? SCORPIO.

P.S. How could I find the focal length of a small concave lens.

WATER ANALYSES.

SIR,—With reference to the letter signed "W. R." in your issue for May 13, page 187, there are or rather were four modes of estimating the organic matter in water. Firstly, the original old method of treating the solid residue obtained by evaporating the water to dryness, and estimating the loss, which was ascribed to "organic matter." This is now quite abandoned as being unsatisfactory and altogether erroneous.

Secondly, there is the system of estimating the "organic matter" by means of an acid solution of permanganate of potash, as detailed by Prof. Miller in his paper entitled "Observations on Some Points in the Analyses of Potable Waters," in the "Journal of the Chemical Society," 1865, Vol. XVIII. This, however, has been proved to be quite unreliable, besides being unsatisfactory at the best. In fact, Prof. Frankland's comment on it, "totally untrustworthy," has been thoroughly well sustained by succeeding trials with it.

The third system is that of Messrs. Wanklyn, Chapman and Miles Smith, and is detailed at length in their paper on "Water Analyses," read before the Chemical Society on the 20th of June, 1867. This system which was criticised by Mr. Dugald Campbell ("Laboratory," Vol. I.,) and again verified and slightly amended by Prof. Wanklyn in his "Verification of Messrs. Wanklyn, Chapman and Smith's Method of Water Analyses" in the "Journal of the Chemical Society," new series, Vol V., p. 591, disputes with Professor Frankland's method the claim for pre-eminence.

The fourth system is that of "Frankland and Armstrong," the principle of which is detailed by Mr. Davis on page 87 of the ENGLISH MECHANIC. This system is based on a gasometric estimation of the organic nitrogen and carbon, and *theoretically* is the finest and most accurate of the four. Professor Frankland's paper in the "Journal of the Chemical Society" violently attacks the method of Messrs. Wanklyn, Chapman and Smith, and in it the author attempts to demonstrate the thorough unreliability of their system by means of a systematic series of analyses, comparing the results obtained by *his* use of Messrs. Wanklyn's, &c., method, with the results furnished by *his* and *Armstrong's process*, and putting down the former as wrong on account of the difference between the former and the latter, which is assumed to be correct.

Prof. Wanklyn retaliated, and in the "Journal of the Chemical Society," Vol. XX., attempts to prove the unreliable character in practice of Frankland and Armstrong's method of gasometric analysis, and vigorously defends his own system. He also shows by reference to Mr. Miles Smith's paper in the "Laboratory," Vol. I., p. 114, the danger and liability to error of any result based on the analyses of the residue obtained by evaporating to dryness a large quantity of water. Since then the discussion and rivalry between the two methods has waxed hot, Professors Wanklyn, Schenk, and Chapman having improved their position by their masterly analysis of the "Action of Limited Oxydisation on Nitro and Nitrogenous Organic Bodies," and of the action of alkaline permanganate of potass on organic bodies. Professor Frankland in turn has improved the reliability of his system by Mr. Herbert McLeod's papers "On a New Form of Apparatus for Gas Analysis," in the September number of the "Journal of the Chemical Society," 1869, and "Apparatus for Determining the Quantities of Gases Existing in Solution in Natural Waters," in the "Journal of the Chemical Society," Vol. VII., new series; and Dr. Russell's paper read before the British Association, 1869.

It is at present difficult to determine which is absolutely the best. With our present knowledge, perhaps, theoretically Frankland's is the most accurate, but a systematic research may at any time turn the tables, and leave Wanklyn's the best, while chemists are undecided, many taking each side, while others, the majority, take neither.

Neither the alkaline permanganate process of Prof. Wanklyn and his colleague at the London Institution; nor the gasometric system of Prof. Frankland, and the Royal College of Chemistry, however, are perfect, and, strange as it may seem, neither of them are capable of correctly and accurately estimating the actual amount of the nitrogenous organic matter, as Dr. Phipson and Mr. Paul remark. It is true Dr. Frankland, in his article in Vol. XX., page 72, of the "Journal of the Chemical Society," goes so far as to deny its practibility at present, but that is too sweeping a conclusion.

At present, therefore, Professor Frankland's system used in connection with the Royal College of Chemistry apparatus, as detailed in No. 81 of the new series of the "Journal of the Chemical Society," and by experienced hands, is theoretically the best, and in practice *may* yield the most accurate results. But, on the other hand, it is long, difficult, and complicated, utterly unreliable in inexperienced hands, and, from its very complication, liable to grave errors, which the number of reductions and calculations afford every chance of being increased to a serious extent in passing through these manipulations. These, in connection with other matters, operate to such a degree as to render it possible that no two analyses of the same water will agree.

Finally, therefore, in practice, Frankland and Armstrong's process is not to be depended on unless a long series is taken, and the average struck off; while its complication, difficulty, and length, together with the complex apparatus and many reductions and calculations, render it so liable to serious errors as to quite outweigh the advantage it has of affording the total empirical formulæ of the organic substance. It also has the disadvantage of giving no easy standard of comparison with others, and of not in the slightest classifying the organic matter.

Messrs. Wanklyn, Chapman, and Smith's process is indisputably the shortest and easiest, and moreover is such as can readily be done by anyone. It enjoys the advantage of classifying direct the nitrates, nitrites, ammonia, urea, and albuminoidous and nitrogenous organic matter into separate classes. It is very little liable to error, and besides affording an easy standard of comparison, can always be depended on to afford an exact agreement in its result between waters of the same composition.

It has been alleged against it that with waters containing the same exact amount of nitrogenous organic matters, but of different constituents, it will yield different analyses, and that with waters of different quantities of oxydised and nitrogenous organic matter of different constitution it will yield similar results. This is true; to a slight extent it will, but the gasometric system does the same to a far greater extent. It has also been stated that Messrs. Wanklyn, Chapman, and Smith's, permanganate of potass process suffers under the objection of being liable in a certain degree to under-estimate the nitrogenous matter; this is also, to a certain extent, true, as it is indisputably *possible* for it to so happen, but it could only so occur with perfectly harmless compounds, not known to exist in water, and then to but a very small degree. Messrs. Frankland and Armstrong's gasometric system labours under the much more serious difficulty of being extremely liable to very considerably over-estimate the nitrogen, and of confounding the innoxious and the dangerous nitrogenous matters together.

From the above, your correspondent "W. R." will gather that personally I am of opinion that at present, for general purposes, Messrs. Wanklyn, Chapman and Smith's permanganate process is the best, though for some purposes, Messrs. Frankland and Armstrong's gasometric system in preferable.

In reply to his queries, it is possible to use both Wanklyn and Frankland's process for sewage analyses, and, perhaps, for that course of analysis, it would be as well to estimate the total nitrogenous matter by Frankland's system, and confine Wanklyn's to free ammonia, urea, and albuminoids.

Nessler's test can satisfactorily be employed for estimating ammonia salts, and for small quantities is much better than standard acid.

Finally, it is practicable, but not advisable, to use Wanklyn's system for manures; neither should I recommend Frankland's. URBAN.

EXTRACTS FROM CORRESPONDENCE.

TESTED RECIPES.—"A Morayshire Man" says:—"I am of opinion, with a number of other correspondents, that those furnishing answers to queries for recipes should add whether they have been tried and proved, or, if they were extracted from some author, as the case may be. I am confident a number of these answers are not worth the space they occupy, and, consequently, a loss of time and money to many a one who tries them, both of which the person may be ill able to spare. And with a few consecutive failures, many a person may become disgusted with the recipes (never blaming himself of course), and if not the loss of a subscriber to the Mechanic, at least the loss of a correspondent. I have found a number of these recipes useless. Not at all times so much the fault of the recipe itself, as to the manner of preparing it."

THE EAR.—"H. de S." says:—"Dr. Usher writes of having often been an hour in removing a plug of wax, and adds a caution against the common and indiscriminate use of the syringe. Will he allow me to inform him that glycerine dropped into the ear dissolves the cerumen, which is occasionally secreted in morbidly excessive quantity in the outer meatus of the ear in old people and in young children; and also that in certain forms of deafness, arising from a deficiency of the waxy secretion, it works often like a charm when dropped into the meatus, so as to lubricate that passage and the external surface of the membrana tympani? For this I am indebted to Dr. Abbotts Smith's two little books on glycerine."

MIND AND BODY.—Edmund Lawrance says:—"Being deeply interested in the subject of 'Mind,' I joyfully hail the appearance of Dr. Maudsley's lectures in the English Mechanic. Man consists of two parts only—soul and body Mind is the *action* of the soul. The soul *per se* is not only ignorant and dark, but totally unconscious of its own existence; as, during perfect sleep, a faint, or upon concussion of the brain. When, however, the nerve waves are set in motion, the soul not only becomes conscious of existence and recipient of present impressions, pleasurable or painful, but it also finds it has the faculty of marshalling and reviewing the impressions received and registered by the nervous system during a whole lifetime. But the soul is utterly dependent upon the integrity of the brain register. If the images be distorted or misplaced by disease, the soul still accepts those in simple faith, and, attempting to reason upon them, produces the well-known phenomena of insanity."

COTTON SPINNING.—"B. H., Rochdale" writes:—"I have read with interest the several letters on 'Cotton Spinning,' on page 182 and 183, and in reply to 'H. C. S.'s' assertion that there is not, or ought not to be, any draught between the lap roller and feed rollers, he cannot have examined the question in a proper manner, or he would find that it is as needful in that part of the engine as any other, although it is very small—say, $1\frac{1}{10}$in. With respect to the rule he gives for the draught of drawing rollors, he is perfectly right, as far as computing them together goes, and E. Slater will find that by his rule (if he gives the rollers the proportion he has set out, and then takes the whole draught of the rollers together) that he has a draught of 12 instead of 7."

READINGS FROM THE GLOBES.—J. Dyer states:—"In 'T. S. H.'s' letter, entitled 'Readings from the Globes,' at page 208 of the English Mechanic, the following statement is made:—'As the globe turns on its axis from west to east, those who live in west longitude must have their time earlier than those living in east longitude, because they will not come into the enlightened hemisphere so soon.' The word *earlier* should be *later*. As the sentence stands, the last part contradicts the first."

THE WANDSWORTH TELESCOPE.—E. Salter says:—"Having recently come to reside in this locality (Clapham Junction), and noticing Mr. Webb's late remarks respecting the great Wandsworth Telescope, I have been induced to try to seek it out. After two or three failures I met near the spot on which it used to stand a gentleman named Stilwell, an inhabitant of Wandsworth, who gave me the following particulars from his own personal knowledge. Pointing out the enclosure within which the instrument was erected, and indicating markings in the ground left by the tower from which it swung, he said that the whole affair was removed four or five years ago. The bricks were employed to aid in the erection of an hotel visible a few hundred yards off; the tube was bought by a Wandsworth broken, who cut it into sections, and sold them to a gentleman at Wimbledon. These sections, with bottoms inverted, formed *tanks*, from which the gentleman's cattle now drink. About the tramway there was some four tons of wrought iron, which Mr. Stilwell himself had converted into *horse-shoes*. As to the object glass, my informant could tell me nothing."

REPLIES TO QUERIES.

[2007.]—TEMPERING DRILLS.—If the drill is a small one hold it in a jet of gas till a cherry red heat appears, then dip the point, or as far up as you wish it tempered, into water or oil immediately. Then try if a smooth file will bite or file it; if it does, it must be done over again, but if it does not bite, but slips over the face without making any impression on it, it will do. Next clean the point or side of the face carefully on an oil stone, then twist a piece of wire round the end of the drill, or hold the end of the drill in pliers, or a candle or gas light till you see it (on the clean piece of the face) gradually turn from a light to a dark straw colour; withdraw from the heat, and allow it to cool gradually. If it goes past the dark straw colour to a blue it will be rather soft, and must be dipped in water or oil at once, or else the process gone over again. The above dark straw colour will bore brass beautifully. If it is to bore steel or iron, I have mine just as hard as when they come out of the water or oil in the first process, but care needs to be taken with them if very small in that condition, as they are very brittle. I have made several dozens in the above way during the last 14 years I have been working at my present profession.—A Morayshire Man.

[2186.]—BAROMETER TUBES.—"Compensation" can clean his barometer tubes by washing with soap and warm water, and drying in an oven, or on a stove; or wash with spirits of wine, and it will dry itself when the spirit evaporates, or if the tube is very dirty, I have used fine sand with soap and warm water. But I do not approve of the sand, because it is apt to scratch the inside of the tube, which causes more friction on the mercury rising in the tube, and consequently the barometer cannot be so correct.—A Morayshire Man.

[2363.]—SILVERING CLOCK DIALS.—If "Poor Clock Jobber," 2363, page 68, carries the recipe given him by "J. M., Birmingham," into execution, without further or fuller instructions, he will find his clock dial in about two or three months covered over with green spots, not because the recipe is a bad one. It is good if fuller explained. If "Clock Jobber" will put a piece of silver in a tea cup, cover it over with nitric acid (aquafortis), he will find the acid begin to boil. If it does not, hold the cup over a jet of gas, or put it on a slow fire till it begins to boil. Take it off the fire, and it will boil away till the silver is dissolved. If he requires more acid (owing to the acid not being pure) he can add a little, but the first quantity should do for dissolving a 6d. When dissolved, he will have a green deposit. Fill the cup with warm water, stir well to wash the silver, throw in gradually as much table salt as a penny piece will lift, desist stirring after the salt is put in, and allow the solution to settle a few minutes. The salt will precipitate the silver to the bottom of the cup. Pour off the water in the cup, care being taken not to pour off any of the solution, and when poured off as clean as can be without taking any of the solution with it, evaporate the remainder of the moisture above a jet of gas, or otherwise, till the solution is in a thickish kind of paste; when this is done, fill up the cup again with warm water, and repeat the process till the solution comes to a milky whiteness, and you are sure all the nitric acid is out of the solution. Two or three washings is amply sufficient; if any trace of the acid remain it will in time (notwithstanding the varnish) eat into the dial or other article, causing a number of greens pots to appear, as it were, on the surface of the silver. "Poor Clock Jobber" will at once see the advisability of well washing his solution. The parts to be silvered must be well cleaned with fine flour, emery sheet, or paper. No grease or dirt must touch the article, especially when finishing, not even the hands must touch it if possible. When well cleaned, and all traces of previous silvering, or lacquering off the article (I would not advise "Poor Clock Jobber" to wash the article at this stage of the preceedings), take a piece of wash leather or soft cotton rag, soak it in water, dip it in a little salt. Rub the dial over with this first, pretty smartly. This makes the solution take on better. Then dip the rag in cream of tartar, and also in the solution (for they may be mixed together), and rub well on, and if this does not silver "Poor Clock Jobber's" dial, I shall be apt to say with the Editer (see p. 68). After it is well silvered, wash in clean water (only). Dry with a soft towel; when dry hold the back of dial close to a fire or on a stove till it heats a little, not to be so hot as to melt the wax in the chapters. Then varnish with a soft brush, varnish to be made by dissolving gum mastic in spirits of wine; the varnish requires to be rather thin, and the article will be ready in five minutes to be sent home. I have done the above frequently with brass dials, and found no trouble with them afterwards. "Poor Clock Jobber" may think I have been too long in answering the above. But to explain, I get the Mechanic only in monthly parts at the beginning of each month, and when it leaves the bookseller's shop from whom I get it, it comes 18 miles by rail ere I get possession of it, the carriage by rail of which I pay over and above the regular price of publication.—A Morayshire Man.

[2445.]—GALVANIC BANDS.—The width of metal strips for galvanic bands is of no consequence; the broader the more action. I have generally made them about ¾in. wide. To "whip" the joints with thread is merely to wind thread round them in a close coil. List is the woolly selvage from cloth, for which ask your tailor; it matters not which side is worn next the skin, provided the bare metal at the end of the band touches it.—Suffolk Amateur.

[2518.]—GAUGE FOR KITCHEN BOILER.—My opinion is that if the boiler is properly fixed at the back of the kitchen range, the flow and return pipes properly erected from the boiler to the hot water cistern, a water gauge would be useless. For this reason, when hot water is drawn for use, it is not drawn from the boiler but from the hot water cistern, through pipes connected to the return pipe. Consequently when there is no hot water, it is a proof that the cistern is empty, and not the boiler, and a fitter is called in before any damage is done to the boiler.—J. O.

[2528.]—MUSICAL BOX.—From the poor way in which I expressed myself on p. 164, I may not quite be understood. The 16th and 17th lines should read. "The *right end* of the roller comes slightly over the *edge* of the *same (that's the roller)*, and is caught in a slit," &c.—Harry Bertram.

[2567.]—CHIMING CLOCK.—If "Toodles" will get three or four spiral springs something like what are found in the inside of couches, easy chairs, &c., lay them in the bottom of his clock case, lay a flat board on the top of them, or a bag of wood shavings, hay or straw, he will find that when the weight falls, coming in contact with the springs they will cause the weight to rebound, and so break the fall.—A Morayshire Man.

[2577.]—BORING GLASS.—This question relative to cutting circular holes in glass, does not appear to have been satisfactorily answered. As I, some time ago, required certain glass discs with holes in them, I went to Palmer's, in St. Martin's-lane, and I will, with your permission describe how their cutter proceeded. There was, on a low table, a circular disc of about a foot in diameter, covered with cloth, and mounted on a pivot, so as to revolve on its centre, and there was a mark to indicate this centre on the top of the disc. Then there was a firm upright fixed in the table near the circumference of the disc. Through a hole near the top of the upright slid a graduated arm, and to the end of the arm was affixed a glazier's diamond pencil which could be slid down so as to bear upon the disc. Now supposing I wanted a circular plate 6in. in diameter, with a hole in the middle of 2in. diameter, A square of glass of rather more than 6in. in the side was placed on the disc, the arm was adjusted so as to bring the diamond to bear at 3in. from the centre, the disc was turned by the hand, and a circle of 6in. thus described on the glass; the arm was now set at 1in. from the centre and the inner circle scratched. The glass was then removed and placed on the usual flat cutting board, a rule was applied and a few cuts made with another diamond from the outer circumference to the sides of the square. This enabled the workman to remove the superfluous glass from the outside of the circle. He then applied the rule again, and made 8 or 10 cuts across the inner circle, and crossed these again with about as many more. Then taking the glass in his left hand, and a pair of iron pliers in his right, he began tapping lightly on the part that was cross cut, when nearly the whole fell out in fragments, and any obstinate pieces were taken off with a grasp of the pliers. The whole process was gone through with great radidity, and was very dexterously done.—F. R. C. S.

[2582.]—WEIGHT OF FRUSTUM.—TO Mr. TOLHAUSEN.—

$$V = \frac{H}{3} \times \pi (R^2 + r^2 + Rr) = 4 \times 3{,}1416 (4 + 1 + 2 \times 1) = 12{\cdot}5664 \times 7 = 8{\cdot}79648$$

which, multiplied by $\frac{440}{2240}$ or $\frac{11}{56}$ gives very nearly 17 tons 27. By a simple error of copy our friend Mr. T. put 10 for 7.—Bernardin.

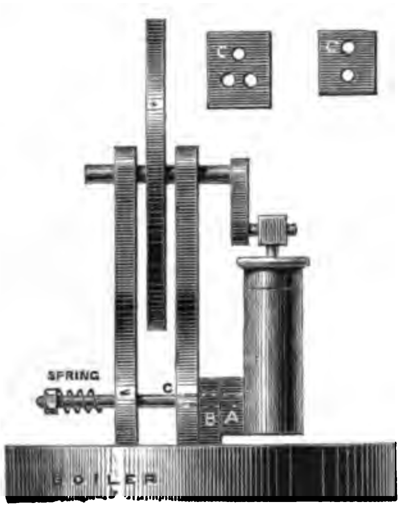
[2600.]—CLEANING OF DIATOMS.—Thanks to Mr. Anderson for his kind reply on the above, which I hope will give the desired result. In answer to Mr. A.'s query as to where I gather Diatoms, I may say that in spring they are to be found in almost any kind of water. There is a small brook near my home, which I have hunted for a mile or two, and here and there where branches of trees and other obstructions lie across the stream, so as to be only partly submerged, I have several times discovered the *deep brown yeasty scum*, which betokens the presence of Diatoms. The most successful gatherings I have yet made, were in ditches cut amongst osier beds. They may be found also in ponds and ditches; if reeds, rushes, &c., be growing in them, so much the more likely are they to contain Diatoms. I have found the following:—Amongst the *Naviculæ*, *N. Rhomboides*, *N. Amphisbæna*, *N. Westii N. Didymi. Pleurosigmæ P. Attenuatum*, *P. Angulatum*, *P. Spencerii*, *Cocconema Lanceolatum*, *Pinnularia viridis*, *Gomphonema Capitatum*, *Encyonema* *cæspitosum*, and several others, many of which I have not yet identified to my satisfaction, as I am only a beginner in this interesting study.—**BEATEN.**

[2634.]—PAPER HANGINGS.—As a continuation to A. Boughey's information (which applies only to what is termed block printing) the question asked referring to machine printing, in machine work there are three principal divisions, viz., pulps (plain), grounds (coloured), and satins (both coloured and glazed). The first is printed plain—that is, without any preparation; the second is coloured with either white or any tint that may be required, and then printed; the third is coloured and polished before it is printed. To make grounds there is a grounding machine (of these there are several sorts); the colour is put on by it and smoothed with brushes, after which it runs through a long hot stove to dry, and at the end is formed either into folds or rolls, according to circumstances; it is then ready for printing. Satins are made somewhat similar to grounds, only that they have to go through what is called the polishing machine to be glazed. The printing machine is cylindrical, with revolving rollers pressed against it, on whose surface is placed or *cut* the pattern or form which each roller is intended to produce. When dried the printed paper is taken to the rolling machines and cut by young girls into pieces.—**PRACTICAL P.S.**

[2661.]—GALVANISING CAST IRON.—The method is essentially the same as for sheet iron, but there is more difficulty in getting the zinc to adhere.—**J. MEREDITH.**

[2667.]—PAINT TO COVER TARRED WOOD.—All paint is affected when on a tarred surface, and the colour is generally turned to a green tint, a coating of lime, white wash, or two, would answer the end desired.—**J. MEREDITH.**

[2676.]—MODEL STEAM ENGINE.—"C. R." was right when he said the model engine he saw had a cylinder, piston, fly-wheel, &c. Steam only acts on the piston during half a revolution of the fly-wheel, as will be seen by the following. A small block of metal is fixed to the side of the cylinder at A, the face of which works steam-tight against the block B. The piston rod is fixed directly to the crank pin, so that when the engine is in motion the cylinder oscillates upon the pivot C. There are two holes in B, one the exhaust and the other the steamway. The hole in A serves for exhaust and steamway both. The action will be understood by examining the drawing.—**W. H. THORPE, Reading.**



[2679.]—HOW TO CURL AND CURE HORSE HAIR.—In the first place I teased the hair well, then twined it into a long rope with a hand twiner with the assistance of another person, having rolled it up into a ball, steeped it in water 24 hours, after that put it into an oven, taking care that the oven be not too hot to singe it; after getting perfectly dried, I began to teaze it again, it is now ready for use, such as stuffing chairs, sofas, &c.—**A HELPER OUT OF A FIX.**

[2683.]—IRON PALISADINGS.—The durability of ordinary paint or varnish would much depend upon whether the surface was free from rust or not. I would advise the use of Webster's patent zinc paint, which may be had from the patentee at Ozels-street, Birmingham.—**J. MEREDITH.**

[2693.]—KEEPING COPPER PLATES FLAT.—Try reversing the plates.—T. S. U.

[2695.]—GEOGRAPHICAL QUERY.—"Key," as a correspondent, has said, is metimes the meaning of "quay," but also in several German languages "keizel, kei," has the meaning of flint or stone. Let me propose then the translation "nether set key"—a stone where burdens were set down, or, a stone for sitting on; key-house, a stone-built house; "key-spink"—stone finch, stone sparrow, the doubtful sparrow, *Fringilla petronia, Linn.* Those acquainted with the locality will decide if I am right.—**BERNARDIN.**

[3598.]—"EMIGRANTS'" INQUIRIES.—Upon reference to a map it will be seen that Australia is nearly at the same distance to the south of the Equator as England is to the north; in fact it lies very near our antipodes—that is, if by any means a line could be drawn directly through the centre of the earth from this country, Australia would lie near the point at which the line appeared upon the other side of the world. It may, under these circumstances, be at once inferred that Australia possesses a somewhat similar climate to our own. Climate is influenced by many local features, and to these we must assign the differences of temperature which exist between the two countries. Australia, however, is superior to England in many respects: its winters are not so cold; its atmosphere is neither so foggy nor so damp; but is uniformly genial, mild, and dry. The summers, although occasionally *much higher* in temperature from the prevalence of north-west winds blowing from the heated coast of Asia are scarcely so enervating or trying to the constitution from the bracing nature of the sea breezes. Beyond this the purity and freedom of the air from miasmatic influences and the usually noxious effects of night dews are such that a person may sleep under "the open canopy of heaven" at night during the greater part of the year without endangering his health or constitution. Regarding the colony of South Australia more particularly, I may say that generally the above description of climate is applicable to this part of the continent, although of course the proximity of mountains, rivers, arms of the sea, &c., will cause slight differences, according to locality. The resources of this colony are chiefly mineral, yet agriculture and sheep-farming are pursued to an enormous extent. The colony, however, may still be said to be in an embryo state, and is capable of sustaining a population of probably not less than 50,000,000 of people, whilst at the present moment there are not more than between 1 or 200,000 scattered over its enormous extent. The land is fertile, the yield of grain being large; of carefully cultivated, giving frequently 60 or 70bshl. to the acre. Its capabilities have been briefly summed up by one of the governors as ⅓ adapted to agriculture, ⅓ to pasturoage, and ⅓ barren and unfit for either. The above will give J. Francis some slight information about the colony. If it is too superficial, I am ready to enter into detail, but wish as far as possible to condense this kind of writing, so long as the required information is imparted, so as not to occupy too much space. No one should emigrate to South Australia who is afraid of work. Do not go there with a firm intention to stick to your trade, for the probability is that you will find yourself before long following the calling of a shepherd. There is no shame in this, doctors and lawyers, &c., have tried their hands, and have succeeded admirably. The man who can handle tools, mend carts, repair farming implements, &c., is fortunate, he can command higher wages than his more unskilled fellow, even if employed upon a sheep-run, for being at a long distance from a large town, resources at hand are of great value. The best time of the year for sailing from England is during the autumn, as you will then arrive in Australia during the summer. I cannot state the best place for your ultimate destination; the demand for labour varying, as in all other places. Speaking of the neighbouring colony of Victoria, Mr Westgarth says:—"Hence a long array of miscellaneous arrivals, new and old, continuously out of work, while the skilled workman—the blacksmith, the carpenter, the stonemason—is but little beholden to employers, fights with them successfully at times over an eight hours' instead of ten hours' labour question at the same wages; and withal, in a country now on the whole cheaper to live in than England, earns as much in one day as many a home family must be content with for a week." This is a little exaggerated, for which allowance must be made. (Books consulted for information—"Guide to Australia, by a Merchant;" "Westgarth's Colony of Victoria;" "Maury's Physical Geography of the Sea;" "The Harrow School Atlas"—Essays.)—F.R.G.S.

[3703.]—PASTEBOARD.—Screw them up in a napkin press before they are quite dry for 12 hours; air them and repeat the process. 2nd, paste the edges of the first sheet of paper on a board or door; add as many sheets as you require for thickness, and cut off when quite dry. I have made equally good boards by both methods.—T. S. U.

[3706.]—PANCRATIC TUBE.—This may be illustrated on a small scale with any telescope. Unscrew the eyehole, draw out the small tube containing the two eyglasses as far out as it can conveniently be held by the fingers to be steady, and push in the focusing tube for distinct vision. An immediate increase of magnifying power will at once be evident. In all glasses with this appendage, the eye-tube mentioned above is contained within another, to which the thread of the eyehole screw is fixed, instead of to the outside polished brass tube. In Solomon's 3in. telescope, this tube reaches nearly to the field glass (the 4th from the eye), so that when fully drawn out, the length of the day eyepiece is doubled, and the sun and moon can be distinctly examined throughout the length of the tube, the magnifying power increasing according to its length. It is so long since I had them made, I forget the price, but should say from 4s. to 6s. Can be made by any optician. With a clear-sky and good light this tube is equally applicable to terrestrial objects. For this telescope, I find the "Dean disc glass" for day powers, supplemented by one of deep blue for solar observation, answers perfectly, absorbing all the glare, and reducing the sun to the brightness of a white cloud. For a $2\frac{2}{8}$ in. telescope, I find a glass of "London smoke," one of deep and one of a lighter blue required. "Dean's disc" of "London smoke" may now be had from Messrs. Solomon's for 4s. 6d., the other glasses will be cut by any plumber for a 1d. each.—**AMATEUR.**

[3709.]—TURNING.—There is an error; the word "never" should not be there. It reverses the very meaning of the answer. It should read "An amateur will find a coarse, sharp, new file," &c.—**Q. YORKE.**

[3709.]—TURNING.—See answer amongst the Letters.

[3710.]—ARITHMETICAL QUERY.—If C *c*, represent the circumferences of any two different circles, and D *d* their diameters, then

$$C : c :: D : d$$

$$C : D :: c : d$$

$$\frac{C}{D} = \frac{c}{d}$$

or the circumference of a circle bears an invariable ratio to its diameter, and of course to its radius. This fixed number is generally represented by the Greek letter π (read pi), the first letter of the word periphery or circumference. So that if

$$\frac{C}{D} = \pi$$

$$C = \pi \times D$$

Now this number is the same for every circle, and it is obvious that a single accurate measurement should be sufficient to determine it. It might appear at first sight that nothing can be more easy than to take a perfectly constructed circle and measure its circumference with a cord: and then measure the diameter in like manner, and find the ratio of two measurements, which will give the numerical value of π. But it is found that the ratio of the circumference of a circle to its diameter cannot be exactly expressed in numbers. Each separately can be measured with perfect exactness, but both do not admit of being measured exactly by the same linear unit, however small that unit may be. Practically $\frac{22}{7}$ or $3\frac{1}{7}$ is found to express for many purposes with sufficient exactness the value of π: $\frac{355}{113}$ is still nearer, but 3·1416 or 3·14159 is in general use. Now, suppose we have a regular polygon with a perimeter of 8 and number of sides 4. Then 1· is the rad. of inscribed circle, and 1·414213 is found to be the radius of circumscribed circle. Also if we have a regular polygon of 4096 sides with the same perimeter, the rad. of inscribed circle is 1·273239, and that of the circumscribed circle is the same. Thus the circumference of either circle will not differ from the perimeter of the polygon between them by a quantity so great as ·00001 because the radii do not. So that we may conclude that the circle whose circumference is 8 has a radius equal to 1·273239

But

$$\pi = \frac{\text{circum.}}{2 \times \text{rad.}} \text{ or } \frac{\text{circum.}}{\text{diam.}}$$

$$\therefore \quad \pi = \frac{8}{2 \times 1{\cdot}273239}$$

$$= \frac{4}{1{\cdot}273239}$$

$$= 3{\cdot}14159$$

The area of a circle is found by the formula (diameter) ^{2}× ·7854. Now the circumscribed square is equal to the square of one of its sides, which is equal to the diameter of the circle. Therefore we must multiply areas of squares by the decimal ·7854 to get areas of circles; and not areas of circles to get area of squares.—J. G. G.

[3717.]—COPPER AND SILVER COINS.—The first is a French coin of Duke of Rohan; the second an Arabian.—**COLLECTOR.**

[3718.]—TALL CHIMNEYS.—The great chimney at St. Rollox, Glasgow:—

	ft.	in.
Total height from foundations... ...	447	6
Depth from foundations	15	0
Total height above the surface ...	432	6
Diameter at base	45	0
„ surface	40	0
„ top	13	6

There are used in its construction 1,250,000 bricks of first quality, weighing 121lb. per cub. ft., the brickwork is 3½ bricks at the bottom, and 1½ at top. The peculiar construction is that of a double cone, the internal flue is 200ft. high, and is perfectly vertical.—E. N.

[3721.]—GRINDING.—In answering the inquiry of "Sergius," I should say that 4 bush. per hour, more or less, was a fair average for a 4ft. stone running 120 revolutions per minute; but 200 revolutions for a pair of 3ft. 4in. seems to me too fast. Templeton gives 150 as speed for 40in. stone, dividing 6000 by the diameter in inches; but it is a bone of contention with millers as to how much a stone ought to do, even with plenty of power; some not liking to do more than 3 bush., others will advocate 5, much depending on the stone and the dryness of wheat: and I should not be surprised if my letter gives rise to more controversy than the balancing business, of which so much difference of opinion exists—solely, I believe, because a stone that is in standing balance is generally in running balance, or so near to it as not to be felt when there is a moderate amount of feed under; and I believe there are millers who would boast a life of experience without knowing their stones were out of a running balance, simply because they never run them empty to try. I have 2 pairs of 3ft. 10in. which will do 4 bush. per hour well. I have also a pair of 4ft. 6in. which will do 10 bush. per hour well, and work well, but they have 5½in. draft. These said 4ft. 6in. had formerly 2in. draft, and I understand they would only do 4 bush. per hour; the alteration was made by running all the furrows into the master furrow; thus making a second furrow of the master furrow. There is a pair of 4ft. 4in. laying beside them, both driven by wind, running the same speed; but they will not do so much by about 3 bush. per hour, although they had the same alteration made in the draft and furrows at about the same time—say 40 years ago. Now I have seen these two pairs of stones do nearly a load of wheat in 2 hours. We find no disadvantage from the extreme draft, but dare not carry much furrow.—**ONE EYE.**

[3723.]—GLAZE FOR POTTERY.—100 parts white lead, 20 do. flint, 40 do. flint, 5 do. whiting. This glaze is colourless; to make it a brown glaze add 18 parts of oxide of manganese and 18 parts more white lead; to make a blue glaze, substitute for manganese 9 parts of oxide of cobalt. Shall be happy to afford "X. N." any information he may require upon this subject.—R.

[3723.]—GLAZE FOR POTTERY.—Consult specification of Patent 3057, 30th October, 1867, at your nearest public free library, which I think may give the information you require.—A. Tolhausen.

[3725.]—VULCANISING RUBBER.—The rubber ready mixed with sulphur for vulcanising, may be obtained from C. Macintosh and Co., Cambridge-street, Manchester, and London, or David Moseley, Manchester The price will depend on the proportion of sulphur required, which varies for each special purpose, perhaps 2s. 6d. or 3s. per lb., in quantities. The moulds should be pure tin or plaster of Paris. Iron combines with the sulphur, and destroys the nature of the rubber. Any steam tight chamber may be used for vulcanising in (which will stand the pressure) Information respecting the time required, and the pressure, may be obtained from the persons who supply the rubber, or you might try a pressure of 50 or 55lb. on the in. for 3 or 4 hours. When you get it exactly as you want it, adhere strictly to the same time and pressure, as the slightest variation alters the nature of the rubber.—A Dentist.

[3725.]—OILED PAPER.—Hausel, of Neustadt, recommends petroleum applied to writing or drawing paper, and properly dried by blotting paper.—A. Tolhausen.

[3730.]—PAPER COLLARS AND CUFFS.—A neat machine for the manufacture of collars, cuffs, and other articles of dress made of paper and cloth combined, was patented by Mr. Benjamin Browne, in 1868. The material is first operated upon to represent stitching, creased for folding, the button holes punched, and the ends cut off to the desired shape; the article is then discharged from the machine, and another feed of paper supplied and operated upon as before, and so on in succession. Finally the article is passed by an endless belt between rollers for finishing it (vide specification, A.D., 1868, 16th March, No. 1040).—A. Tolhausen.

[3733.]—COTTON SPINNING.—J. A. Hulsse, "Die Tichnik der Baumwollspinnerei," Stuttgart and Augsburg, 1857; J. D. Fischer, "Dir praktische Baumwollspinner," Leipzig, 1855; C. H. Schmidt. "Lehrbuch der Spinnereimechanik," Leipzig, 1857; K. Karmarsch, "Handbuch der mech. Technologie," Hannover, 1858; Bd. 8. 1006—1103—Supplement zu Prechtl's Tichnologischer Encyclopadie, (Karmarsch), Stuttgart, 1857. The above books may be had in London. Trubner and Co., Paternoster-row. Benno Niess, "Die Baumwollen Spinnerei in all ihren Theilen" Voigt in Weimar; Dr. E. Hartzig in Dresden Versuche uber den Kraftbedarf der Maschinen in der Flachs und Wergspinnerei; Schweiz. Polyt. Zutschrift Vol. XIV., Heft 5. Sute 126.—A. Tolhausen.

[3739.]—CHLORIDE OF TIN.—Three chlorides of tin are known, corresponding to the oxides, namely $SnCl^2$, $SnCl^6$, and $SnCl_4$. See Watts's "Dict. of Chem.," vol 5, page 806.—A. Solhausen.

[3739.]—CHLORIDE OF TIN.—If this querist will ask at a manufacturing chemist's for *protochloride* of tin, he will most likely get what he requires.—A. T.

[3741.]—TURBINE.—In answer to "M.R.C.S.," if he will write to me I will try to assist him to see a turbine, as there are three in my neighbourhood.—John Wild, Shuttleworth, near Bury, Lancashire.

[3750.]—SILVER COIN.—Is a penny of Baldred, King of Kent (the last). Obv.: King's bust to right; Baldred Rex. Rev: Moneyer's name—Edelmod Moneta, small cross, 7 rays issuing (scarce). Should be glad to communicate with "Beginner."—J. H. D., Stretton-on-Dunsmore, Rugby.

[3751.]—ASCARIDES.—A great sufferer from ascarides should take 20 drops of tincture of iron in infusion of quassia twice or three times a day for a month, and use an injection of common salt dissolved in water, but not made too strong, occasionally. This generally succeeds, but cases differ, and no case can be satisfactorily treated by correspondence. Any chemist can make up the above prescription.—M.D.

[3753.]—BOTANY.—A "Manual of Botany," by Robert Bentley, Professor to the Pharmaceutical Society, published by Mr. Churchill, 12s. 6d., is the standard work upon which the students are examined, and is decidedly the best.—F. H. H.

[3753.]—BOTANY.—Use Babington's "Manual of British Botany," or a similar work by Johns. The latter is more popular, and easier to work with, and costs about 7s. I believe.—M. D.

[3762.]—PAINTING AND DECORATION.—The best work on house decoration and painting that I have seen, is by William Sutherland, Manchester; obtainable from Simpkin, Marshall, and Co., Stationers' Hall-court; Abel Heywood and Son, 56 and 58, Oldham-street, Manchester.—Painter.

[3763.]—THEINE.—I perfectly succeeded in the isolation of theine by operating on 2lb. of the best green tea as follows:—2gal. of distilled water, where brought to the boiling point in a still of 4gal. capacity; I now shoot in the tea, stir up for an instant, quickly lute the head on, connect it to a worm condenser, and ebullition commences. By the above arrangement of apparatus you will observe I was able to collect, previous to the isolation of the theine, another highly important compound of tea—viz., the essential oil. Note also, by having the water at a boil I avoided the risk of charring the leaves, which doubtless would have occurred if the still had been placed over the fire with cold water along with the tea. I kept it gently boiling for two hours. About 1½pt. of water passed over loaded with the oil. On agitating this water with ether, decanting and evaporating the ether, I obtained the oil in a separate form. This oil appeared to me to be a powerful intoxicant, for on my warming it and applying my nose, it had an effect similar to smelling hydrocyanic acid of high per centage. I now set to work for the theine emptying the contents of the still on to a brown calico strainer suspended from spikes on a frame furnished with four legs, allowing the filtrate to run into a large tin vessel. I now pour 2gal. more of distilled water into the still, which I place over the fire; I collect the leaves off the strainer into a dish, and submit them by portions to powerful pressure in a tincture press, allowing the expressed liquid to flow on to the strainer. The hard cakes of leaves from the press I knock and break into pieces, crumbling them into a loose heap. The water in the still is now boiling, the leaves are shot in again and stirred; not the head this time, but a lid is put on. It is now left for two hours in brisk ebullition, then strained and expressed as before. A boiling solution of subacetate of lead (acetate of lead 5 parts, litharge 3½ parts, distilled water 16 to 20 parts, boiled for half an hour) is poured in just as it is (without filtering) till it ceases to occasion any precipitate. I allowed it to stand all night to settle. Early on the following morning I drew off with a syphon as much of the clear supernatant fluid as I could; the precipitate I submit to pressure. I avoided the disagreeable process of sulphuretted hydrogen by the substitution of oxalic acid. The excess of lead was then thrown down as an insoluble oxalide. I added a little ammonia to take up the free acid, drew off the clear liquid, boiled it down to 2pts. or so, poured it into a ½gal. bottle, then allowed it to get cold (what beautiful crystals fill the liquid as it cools!); when cold I added about 4 fluid oz. of chloroform to the contents of the bottle, and after briskly agitating them for 5 or 6 minutes I let them settle; the chloroform quickly fell to the bottom colourless and clear, whilst every crystal had vanished out of the liquid. The chloroformic solution of theine was then taken up by a glass tube, drawn out to a capillary point, and discharged into a flask. The chloroform was then distilled off by a water bath into a Liebig's condenser, and on detaching the flask from the condenser I found the theine left dry and white. It gave me entire satisfaction in the shape of a good sample of theine. I should be pleased to be equally successful with digitaline. Surely one of my brother readers has attempted digitaline with as happy a result as mine as regards to theine. If there is such a one among our many, may I beg of him to explain the way he proceeded?—Pharmaceutical Student.

[3763.]—CAFFEINE OR THEINE.—The general method adopted in the preparation from tea or coffee is by pouring on these boiling water, and mixing the infusion with subacetate of lead to precipitate the tannin. Piligot adds subacetate of lead in excess, then am monia. The mixture is boiled for some time, the lead-precipitate carefully washed on a filter with boiling water, the filtrate freed from excess of lead by sulphuretted hydrogen, and after a second filtration, evaporated at a gentle heat. On cooling, it yields an abundant crystallisation of nearly pure theine, and an additional quantity may be obtained by concentrating the mother liquid, and leaving it to crystallise. Caffeine being volatile, it may also be prepared by sublimation, gradually heating waste useless tea in a sublimation apparatus. Part of the sublimate is quite pure; the rest may be purified by recrystallisation from water. For further details *vide* "Watts's Dict. of Chemistry," from which the above has been extracted. —A. Tolhausen.

[3768].—POISONING BY CANTHARIDES.—The effects of cantharides are only transient, and the results attributed to it by the querist can only exist in his imagination.—M.D.

[3778.]—LIGHTHOUSES.—The querist will find in "Merveille's de la Science, par L. Figuier" all the particulars he may desire; every number of that work can be had separately; lighthouses occupy, I believe, 5 or 6 numbers.—Bernardin.

[3782.]—BOILER.—I do not know much about small boilers, further than their requiring much bigger fireboxes, in proportion, than large ones, on account of the difficulty of keeping a small fire alight. For such a boiler as "Hydraulican" figures, possibly a well arranged gas fire would do. I should, for a coal fire, put about 14in. square of fire bars, then slope the walls of fire-box outwards at about 30° away from the perpendicular for, say, 8in., and then contract the walls again at about 45°, till your pot will just fit on. It is of an awkward shape to make a flue round to water level, and I should say seven 2″ tubes would be better than one. The brick work might be gradually altered from square at bottom to round at top; and the reason for the form I suggest, is to get a great surface for radiating heat, besides what is conveyed up the tubes. I should put the dead plate on a higher level than the fire bars, even if it has to be made moveable for raking out the fire. Somebody who knows better than I, will, perhaps, give you a hint. I was very successful with a cylinder boiler only 4ft. long, by 2ft. diameter, which drove an engine 4½ diameter, and 8″ stroke, for months, and the man in charge said he always had steam, and the fire-door generally open: of course only doing light work.—J. K. P.

[3794.]—POLISHING STEEL.—TO "CYLINDER." —Use your "red stuff" on a bell metal polisher, which can be had at any watchmaker's tool shop, and you will get the black polish you so much admire. The scratches are caused by dust getting into the polishing stuff. The pivot "Cylinder" has marked A is a straight pivot, with the shoulder turned away after it is made. B is a cone pivot, which is proper for a balance staff. The other is only an attempt. A cone pivot is made by first turning down nearly to size, and then polished with a polisher, the shape made of a stick of straight steel wire. That part held in the hand should be draw-filed, to prevent slipping in the fingers, and the other end filed the shape of a crossing file, to suit any shape, and give it a slight rotary motion backwards and forwards, as well as the longitudinal motion. This will prevent rings forming. When finished, turn a groove close to the pivot, to prevent the oil running up the staff, away from the pivot.—Viator.—P.S.—There are several other watchmaking questions asked this week; but the subject only interests the individuals. I never yet heard of an amateur watchmaker.

[3804.]—WATCH CLEANING.—J. D. Morgan will require for watch cleaning, a pair of tweezers, plyers, cutters, a screw-driver, and a brush. I myself (an amateur) got my tools and part information from the Watch Tool Warehouse, (S. Fauenberg's, of Leeds); but perfection will come by practice.—N. T.

[3817.]—STEAMING WOOD.—The apparatus for steaming wood consists of a wooden chest, large enough to contain the work. This is connected with a covered boiler or copper, in which the steam is generated. "W. B." does not state for what purpose he requires the stuff steamed, or the size of the same, so that his query cannot be answered satisfactorily. Large stuff requires more steam than thin stuff. An inch oak board will take about twenty minutes, and sets in two or three hours. In forming moulds for the hot timber to be shaped to, care should be taken to give a sharper curve than wanted, to allow for a slight reaction.—Boat Builder.

[3821.]—WHEEL CUTTING.—In reply to J. K., England, the teeth I cut were not wheel teeth, but floats similar to cabinet-floats, about 10in. and 12in. long, for roughing the metal off the tubes that gun barrels are made of. The side view of them shows them to be like pit-saw-teeth, and skewed on the face of the instrument like the iron of a skew rebate plane. I merely wished to point out that the difficulty of having change wheel of steel did not lie so much in the expense of merely cutting the teeth, as in obtaining the stuff to make large wheels of.—J. K. P.

[3822.]—FORCE PUMP.—It seems to me that "Guernsey Amateur" is sufficiently exigeant in wanting a drawing first made exactly to his requirements, and then to expect the Editor of the English Mechanic to go to the expense of having it cut and printed; particularly as he does not seem apt at making an ordinary working drawing out. And yet he can give a description of the action of a chuck that he has never seen. I hope he will not think I am pouring the vial of my wrath on him for the abuse I have received from an amateur in another of the Channel Islands. I think the best way of supplying a small boiler is to have a hand pump that will throw at least half a cubic inch of water at a stroke; and to supply the boiler that way, where you see by the water gauge that it wants it. Small pumps are extremely troublesome; at least, I have found them so, as you have to stop the engine directly the pump ceases to act—viz., about once every half minute or so. You can put a dummy, for the sake of appearance, to your model.—J. K. P.

[3823.]—SLOT CUTTING.—Here is another instance of amateurs not understanding a drawing, even with a description. The tool figured was meant to be put in a drill chuck or else in a driller like mine, figured Nov. 12th, last year, and either it or the work travelled backwards and forwards between two stops to regulate length of slot, and fed inwards for metal about $\frac{1}{100}$in. or less during each trip. 1″ in 5 minutes is not bad work for a ½ drill to do, but I do not think the twist form of tool would keep on long at that speed. Mine was meant for wood, and shown with edges too keen for ordinary metal. I cannot give any time to this subject just now.—J. K. P.

[3833.]—FROM "BOAT BUILDER."—J. F. O'Brien does not say whether he wants a drawing of the whole canoe, or any particular parts. If the former, at 1in. to the foot scale, it would be too large for our Mechanic, but if he will publish his address I will post it to him. —Boat Builder.

[3835.]—CLEANING COINS.—I find the following effectually clean old coins so as to read the inscription. First lay them in vinegar, and then rub them with silversand and water.—Tom C. Holloway.

[3835.]—CLEANING COINS.—J. Nash will spoil his coins if he cleans them. To decipher an obscure inscription take a cast of the coin with wax, and a copy of that impression with plaster of Paris. This will show the letters much more clearly than the coin. When a coin or medal is completely worn smooth, if they are heated red hot, say on an iron bar, the original inscription will be generally quite easy to read, although the metal of the coin itself is quite flat.—Q. Yorke.

NOTES AND QUERIES.

[3838.]—PRINTERS' FURNITURE.—Would any reader inform me what plane they use in making printers' furniture, especially reglets, and how they are held while planing them?—A Carpenter.

[3839.]—TRACING CLOTH.—Can any reader inform me of a means of colouring on tracing cloth (such as used by engineers and architects), without injuring the cloth? Also, if there is any substance I could mix with the Indian ink, so as to make the cloth take on the ink more readily?—Tracing.

[3840.]—MUSHET'S STEEL.—Will any reader inform me, through the medium of your valuable paper, how to manage Mushet's special steel, and what shape is the best for roughing tools; a small sketch will oblige. I have tried it many times, and I find it too soft?—J. M.

[3841.]—GRINDING DRUG SEEDS.—Will any kind reader inform me of a cheap and easy method of grinding drug seeds, fenugreek, &c., on a small scale? —F. H. H.

[3842.]—STEEL WIRE.—Would the "Harmonious Blacksmith" kindly inform a musical mechanic, where to get some steel wire of different gauges, such as is used for gongs in American clocks, or the gongs ready made would suit as well? The querist wishes to make a set of chimes, to be put in a model church, and bells are too dear?—J. R. Y.

[3843.]—FLY ROD.—Would "Vivis Sperandum" kindly say how he fitted the end joints on his fly rod, and also where to get wood and all other materials suitable for same, as I have long been wishing to make one. I hope this will not pass his notice, as I think it will interest more than one of us.—Regular Subscriber.

[3844.]—ENTOMOLOGICAL QUERY.—I would feel much obliged to any of your entomological readers, who would describe the larva of *Cosmia trapesina*; it is said to eat its neighbours if placed in the same box with them, which I would avoid if I knew it?—E. N.

[3845.]—BOEHM FLUTE.—Can any fellow reader explain the mechanism of the Boehm flute, also what are the ring holes on clarionets?—Another Flautist.

[3846.]—NICKEL, OR GERMAN SILVER.—Can any reader tell me what is the composition of German silver, and how it is melted or cast?—ANOTHER FLAUTIST.

[3847.]—HANDRAILING.—Could any brother reader kindly inform me which is the best practical work on handrailing?—J. B.

[3848.]—SEWING MACHINE.—Will "Practical Man" give me a little assistance? I want to make a sewing machine, and propose using a shuttle, driven in a direct manner from a cam. What I want to know, is 1. Is there any stand in the motion of the shuttle, or is it a continual motion, same as derived from a crank, and if so, what is the best form of cam? 2. Best size of shuttle, and how to make it? Are they bent out of sheet steel and brazed, or how? 3. How much is the stroke longer than the shuttle? 4. At what time in the stroke of the needle should the shuttle start to go through the loop?—JACQUARD.

[3849.]—STUFFED CANARY.—Will some brother reader inform me how to clean a stuffed canary which has got dirty by being left without a glass shade?—EXCELSIOR.

[3850.]—THERMOMETER.—I have got a thermometer, which by accident got knocked down, the fall causing the mercury to separate into several columns. I have, by gently tapping it, caused some of them to unite, and by applying heat and raising the mercury to the top of the tube, others have united; but I am afraid of breaking the tube by this latter experiment. Will some one tell me how to cause them to unite, or if I shall have to send it to some competent person, how much will it cost repairing?—THERMO.

[3851.]—HARNESS.—I have got a saddle and bridle, that have got very much soiled and dirty through carelessness and neglect, will any of the readers of the ENGLISH MECHANIC be kind enough to tell me the best method of cleaning them?—EQUESTRIAN.

[3852.]—BRASS INSTRUMENTS.—Would some brother reader inform me how bends of brass musical instruments are made; I have something of the sort to make in zinc, but don't know very well how to set about it?—CLUTHA.

[3853.]—THE TELESCOPE.—Is there any subscriber who will favour me with a reply to the following:—In looking at Jupiter with a 3in. refractor, I found the belts brought out more distinct than with a 3·75in., which is in the possession of a friend. The eye-piece used on both occasions was a ½in. Huyghenian. My reason for asking is this; the proportion of light-grasping power between the two instruments is as 9 is to 14·0625, therefore it (the 3·75in.) should show the contrast between the brighter part of Jupiter's body and its belts more apparent, and with greater distinctness due to large aperture. On testing the instruments the same evening, as to spherical abberation, we found the 3·75in. to have been over-corrected. The method used was the one given in Proctor's "Half Hours with the Telescope." A word to those gentlemen who are possessors of telescopes and microscopes; the eye-piece of the microscope can be used with the telescope, and is found to have a large field of view, and necessarily to have a small amplification. I have used the two eye-pieces of my microscope with the telescope; they had a field of 1° 50′ and 2° 15′?—WILLIAM BAGULEY.

[3854.]—SCRIBBLING LONG FLEECE WOOL.—Can any brother reader inform me, what kind of scribbler is best adapted for scribbling long fleece wool, without oil on the wool, as it is liable to lap round the cylinder?—EDDY.

[3855.]—PIANO FELT.—Would some kind reader inform me how piano hammer and damper felt is made, or if I could see it made in England?—TIM BOBBIN.

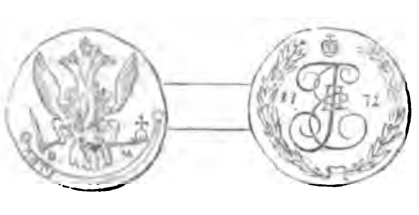
[3856.]—J. A. LEY'S TRICYCLE.—What would a good strong, but light tricycle, made for two, on Mr. Ley's (or any other) principle suitable to go a long distance, with wheels of about 4ft. 6in. cost, speed being a great consideration. At the same time, perhaps, "G. A. L." or some other kind brother, would inform me what speed could be obtained with one having such wheels, if worked by cranks and levers?—W. B.

[3857.]—PICTURE MOUNT.—I wish to know how to cut a picture mount, any shape, and also how to gild it, and the tools required. If one of your subscribers would kindly inform me how to do so, he will greatly oblige.—POOR JACK.

[3858.]—HOLE IN EARTHENWARE JAR.—How can I drill a hole 1in. diam. in the bottom of an earthenware jar—an ordinary large brown pickle jar?—H. JOSEPH.

[3859.]—FLORENTINE BRONZE.—What is the method of bronzing some ornamental pieces of brass work a copper colour, I think the gasfitters call it Florentine bronze?—H. JOSEPH.

[3860.]—COPPER COIN.—Can you, or any of your readers, inform me what the copper coin is, a sketch (half size) of which I enclose?—F. J.



[3861.]—SIZE OF NOZZLES.—If any of your readers can give rules or formulæ for finding size of nozzles (placed one within the other) to produce a given pressure outside of a vacuum within the outer nozzles, and *vice versa*; also, any others that may be useful, they will much oblige.—CARL J. H. COTTHESON.

[3862.]—ELECTRIC CLOCKS.—I noticed some time since, a query from a correspondent about construction of electric clocks, which I believe has not been answered. I should very much like to see it answered as, also I have no doubt, would many others?—CARL J. H. COTTHESON.

[3863.]—PASTILIES.—Will any reader give me a recipe for making pastilles for burning in a sick chamber?—W. R. C.

[3864.]—EXTRACT OF DANDELION.—Would any kind reader tell me how to make extract of dandelion, same as sold by druggists?—A POOR BLACKSMITH.

[3865.]—LABEL MATRIX MAKING.—Could any of your readers inform me how the gun metal matrix, as underneath die of an embossing press is made for stamping up brass or paper lables. I have the steel dies by me?—W. H.

[3866.]—"LATHE AND ITS USES."—Would any reader tell an amateur the dimensions of universal cutter, Vol. V., page 202, Fig. 256, and if the cutter-spindle works on steel bushes?—G. FLACKDEM.

[3867.]—LATHE DIVIDING PLATE.—A description of a dividing or counting index, to prevent errors in using the dividing plate, is earnestly requested.—R.

[3868.]—WATERPROOFING CLOTH.—If some of your numerous correspondents will give me directions how to make cloth waterproof, I shall esteem it a favour?—A. S. A.

[3869.]—WEIGHT OF WATER.—Being a country man, and living in the country, I am obliged to recourse to a well for domestic supply, and I have been often surprised to see such a vast difference in the weight of a bucket of water at the bottom of the well, which is 90ft. deep, to what it is at the top; would some of your talented correspondents explain this, and give me a simple rule to work it out?—COUNTRYMAN.

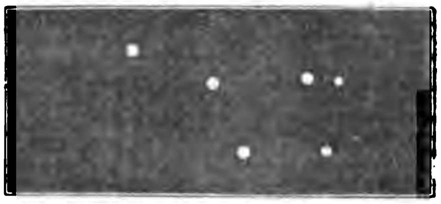
[3870.]—SPRINGS AND AXLES FOR WAGGONS.—Would some of your numerous correspondents kindly give me a simple rule for finding the size of waggon axle bearings, to carry various weights; also the size of springs to carry various weights?—COUNTRY CARPENTER.

[3871.]—THROTTLE VALVE.—Would any brother reader kindly give me illustrations and particulars of a throttle valve for an engine 1 h.p.; the engine I have fitted up myself?—GROCER.

[3872.]—YACHT BUILDING—Will "Boat Builder" kindly fulfil his promise, and give dimensions and kind of wood for the following parts of a 9 ton yacht, to be fast, but at the same time safe? Keel, stem, and stern-post, timbers and planking. Does he approve of the deep and narrow form, depending on ballast for stability, or the broad beams and plenty of bearing. A few sections like what were given for canoes, would greatly assist, as I am totally ignorant of the subject?—STEERSMAN.

[3873.]—BOOKBINDERS' GLUE.—Would any of the correspondents of your excellent journal, kindly tell me the kind of glue used by bookbinders; if it is the same as joiners' use, and where I could get a cheap book on bookbinding, giving price, stationer, &c.?—ARISTOTLE.

[3874.]—CONSTELLATION.—Would any of the astronomical correspondents tell me the name of the cluster shown in the sketch; it has lately disappeared in the west, but doubtless all the astronomers of this paper know it; also, will any of them give me a sketch of the Pleiades, as I could not see them in the spot indicated in "F.R.A.S.'s" map?—ARISTOTLE.



[3875.]—BLEACHING POWDER.—I should esteem it a favour if some of your correspondents would inform me the method of making the commercial "bleaching powder," on a large scale?—GRATUS.

[3876.]—TOOLS FOR TURNING PIVOTS, &c.—I shall be very much obliged if some of our friends will be kind enough to explain and describe the latest modern tools for turning pivots, cylinders, &c., and the probable cost?—WATCH JOBBER OF AN OLD STAMP.

[3877.]—RE-TINNING CAST IRON HOLLOW WARE.—Will any brother reader be good enough to inform me how to re-tin cast iron pans, &c., and say what ingredients are used?—ONE IN A FIX.

[3878.]—DAILY TEN O'CLOCK TIME SIGNAL.—Will any reader who understands the working of the telegraph system kindly explain how the daily 10 o'clock time signal, which is sent through all telegraph offices, is given? Are all the wires at this time in connection with the clock at Greenwich, or is the signal left to the tender mercies of telegraph clerks? Does the movement of the needle take place when the Greenwich clock is at the stroke of ten!—INVESTIGATOR.

[3879.]—GINGER BEER.—Would some one oblige me by giving a recipe for making ginger beer and gingerade?—A. B. C.

[3880.]—VENEERING.—Will one of your subscribers kindly inform me how to veneer a table, &c., and the tools required?—H. E. D.

[3881.]—DYEING AND COLOURING GRASS, LEAVES, &c.—I want to know the best way of dyeing or colouring grass, leaves, &c., so as to give them a natural appearance. Perhaps there is some chemical, by steeping them in which, would cause them to retain their colour when dry? I have tried a good many ways without success?—TAXI.

[3882.]—DOUBLE MOTIVE POWER.—When two motive powers, such as a water wheel and a steam engine, are used in connection with each other for driving machinery, do the two motive powers communicate their motion to the same shaft, and if so, by what arrangement is one motive power prevented from overrunning the other, when its velocity may exceed it? Any reader who will reply to this, will much oblige?—ENQUIRER.

[3883.]—OXYGEN.—Will any of my brother readers kindly tell me whether they have practically tried the following, taken from a first-rate American paper, if so, whether it succeeds: "Manganite of soda is alternately exposed to the action of steam and atmospheric air. Oxygen is absorbed from the atmosphere and is then discharged by the steam; when the oxygen is expelled, the steam is shut off, and a current of air is passed through the pipe, which restores to the manganite of soda, the oxygen it had lost, and it is then in a condition to be again acted on by the steam. The manganite yields 14¼ per cent. of its own weight of oxygen. What is the manganite?—M. P. C. S.

[3884.]—CANADA.—Will "F.R.G.S." please say what he considers the best work on Ontario?—M. P. C. S.

[3885.]—CANOE.—Would it be possible to make canoe in three separate water-tight compartments, for the convenience of transport?—G. B. D.

[3886.]—WATER ANALYSIS.—Will Mr. Davis, or some other correspondent, tell me how to prepare the standard solutions for testing water; also, what quantity of any solution to use to a given quantity of water? How to estimate the quantity of organic matter by means of the permanganate of potash solution.—AQUA.

[3887.]—SEWAGE.—Can any one tell me the names of any pamphlets treating upon the utilisation of sewage?—SEWER.

[3888.]—ALARUM FOR DUTCH CLOCK.—Will any brother subscriber inform me how to make an alarum to a common Dutch clock, not having a striking part?—AMATEUR HOROLOGIST.

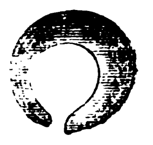
[3889.]—PREPARING CANVAS.—Can any reader of the ENGLISH MECHANIC give me the recipe for the composition used by artists' colourmen to coat canvas for oil painting?—ANIMAL PAINTER.

[3890.]—TO PRACTICAL OPTICIANS.—Will some fellow reader kindly answer my request in No. 260 of the ENGLISH MECHANIC, page 661, Query 2105? Surely there are plenty of practical opticians, readers of our paper, that my question would be no puzzle to?—L'OUVRIER.

[3891.]—SLIDE VALVE.—Could some of my brother readers inform me on this subject? I have the idea of a new slide valve for steam engines, and I want to know what is the smallest size engine that I could experiment upon for satisfactory results to be obtained from it?—SLIDE VALVE.

[3892.]—DISSOLVING PLUMBAGO.—Will any chemical brother reader kindly inform me of a solution or solutions to dissolve plumbago, and oblige—A SISTER READER.

[3893.]—PRECIPITATING GOLD.—Will any correspondent tell me how I can precipitate gold from its solution in turpentine?—J. M.



[3894.]—IRISH RING MONEY.—I enclose a drawing of an article met with occasionally in Ireland, and known as "ring money." It is like a link of a golden chain, and may have been one. One in my possession is worth about 17s. 6d., and is of pure gold. Some have been found as heavy as ¼lb. Can H. W. Henfrey give date?—DAUKOSEN.

[3895.]—CANARY.—Can some kind friend inform me by what means I can eradicate parasites in a canary. I have tried a hollow perch, but to no effect; for although it destroys a great many, yet they breed quite as fast in the bird. Is there not some wash that would have the desired effect?—PAKEAN.

[3896.]—LADDER PROBLEM.—A man has to paint a spout 22ft. 10in. from the ground. A ladder is fixed 24ft. from the base of the wall, and the head of the man, when standing 5ft. from the top of it, is exactly level with the spout. Find the length of the ladder, and the height from the ground where it rests against the wall.—IGNORAMUS.

[3897.]—NAPOLEON.—Will any coin collector inform me whether a gold Napoleon of 1848, in the time of the revolution, is valuable and rare; and if so, of what value?—H. B.

[3898.]—WALKING STICK AIR-GUN, &c.—Will some of my brother subscribers kindly give me instructions for making a walking-stick air-gun?—W. JONES.

[3899.]—TELESCOPE.—I wish to construct a telescope capable of distinctly defining the features of a man at the distance of five miles; could any one answer the following? How many lenses shall I require? The focal length of each lens, and the kind? I mean, whether convex or concave?—WALTER JONES.

[3900.]—ASPHALTE PASTEBOARD FOR ROOFING.—The gutter of a return building in my house being in very bad repair. I am told I must get a new one. This in zinc will not last long, and in lead will cost £4 10s. Now this is a heavy pull from the purse of a working man, and the thought struck me, would this new asphalte pasteboard I have lately heard of, be available for the purpose? I shall take it a great kindness if some of your readers can enlighten me on the point, and if they would also inform me how it is to be laid on?—A DUBLIN PRINTER.

[3901.]—SLATE CISTERN.—Can any subscriber inform me how to prevent the slate of a large cistern from splitting. It is coming off in great flakes from the overlapping sides?—SALMO SALAR.

[3902.]—RAD RHEII.—Would any brother inform me through your columns, the mode of restoring the colour to rad rheii, of which I have a large quantity, which has completely lost its colour?—AJAX.

[3903.]—GRADUATING BRASS CIRCLE.—Would some one be so kind as to tell me how I could best graduate a brass circle to 30′?—SCORPIO.

[3904.] — SLATER'S SPECULA.—What kind of specula are Slater's, for I see that one gentleman says that he got a 6in. for 15s. 6d.; are they finished, or to what stage are they brought?—Scorpio.

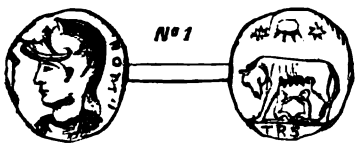
[3905.]—THE ROCHELLE SALT SYSTEM.—Mr. Gray (page 163) says, that he silvered a flat by the Rochelle salt system. I tried it on some pieces of glass for experiment, but found that it did not do it the same way as Browning's at all. In the Rochelle salt system, it is silvered on the back, like a looking-glass, and so there is the double reflection, whereas, in Browning's plan, it is at the silver you look directly, and do not see the glass at all. Is the silvering on the back my fault, or that of the system? —Scorpio.

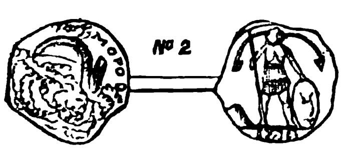
[3906.]—REPAIRING INDIA-RUBBER COMBS. —Is there any cement which will unite a broken black india-rubber toilet comb. The composition of which these combs are manufactured, becomes very brittle. If there is not a suitable cement known, would it bear rivetting?—Inquirer.

[3907.]—UNIVERSITY EXAMINATIONS.—Will any one of your readers, who may have a calendar of the University of London for 1870, inform me what are special Latin and English subjects for the first B.A. examination in 1871.—Xanthos.

[3908.]—OLD COPPER COIN.—Thanks to Mr. Henfrey for information. Perhaps he will be kind enough to tell me what this is, and what it is worth. Oblong, approaching to oval; obverse, female bust, head to right; inscription, AVSTINA. AVGV. Reverse nothing is clear, but there is a ridge of metal across, sloping from right to left; weight about ⅜ oz. —J. Nash.

[3909.]—COPPER COINS.—Will any reader inform me what the coins are of which I send sketches, and





their value? they are both copper and the size of the sketch.—Cæsar.

ANSWERS TO CORRESPONDENTS.

**** All communications should be addressed to the* Editor *of the* English Mechanic, *31, Tavistock-street, Covent Garden, W.C.*

ANOTHER TESTIMONY.

Sir,—I enclose you a further order for my advertisement; the result has far exceeded my anticipations.

F. Watson.

Green Mount-street, Beeston Hill, Leeds,
May 14, 1870.

The following are initials, &c., of letters to hand up to Friday morning, May 20, and unacknowledged elsewhere:—

Jas. Beardsley, Omicron, R. A. Proctor, Verax, Thos. W. Smith, J. R. T., G. S. and G., S. R. D., J. M. P., John Crowther. E. C., T. Selby, J. Ashton, J. Thomas, Watts Brothers, W. H. P., W. C., E. A. C., E. Bubb, F. H, M., Hermann, Ye Drole Bodger, Investigater, George Davies, E. Perry, J. W. Beaford, T. C. Holloway, A Dentist, G. Luff, Anti-Egyptian, W. Mather, G. S., H. Cotton, Economy, B. B., H. T. Savory, H. de S., H. C. Stroud, C. J. H. C., A. B., The Welsh Shepperd. Forder and Co., R B., J. B. C., J. H., W. Cattell, Kate Douglas, Tasmania, F. H., Jonath, Pitman. Alpha, Sable, Mus., Amateur. E. Hatchin, Gimel, Constant Subscriber, J. S. W., J. H., J. Hardy, W. A., O. H. S., E. R. Shipton, Thos. O'Connor, F.R.A.S., Headstrong, W. B., R. T. S., Watertight, W. W., J. W. T., S. M., J. H. M., Rev. E. B. Patience, Rob. Maguire, W. Cox, O. W., Capt. C. S.

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C. Leni.—See recent back numbers.

E. Letts.—Out of print. Stamps credited as requested.

Constructiveness.—F. W. Brearer, is the Secretary of the Aëronautical Society. His address is,—Maidenstone Hill, Blackheath, S.E.

A Sympathiser.—The "risings in the throat" of the young lady may be symptoms of nervousness at your approach. Seriously, however, such matters can only be satisfactorily attended to by a medical man.

Edw. Malson.—Letter returned. At the Patent Office. Cannot say the cost.

T. J. O'Connor.—We think it would, but could not say certainly without seeing it. Thanks for your kind efforts in our behalf.

Jaundice.—See recent back numbers.

G. Flackdem.—An index is published to each of the first 10 Vols.

A. T.—At the Government Patent Office, Southampton-buildings, Chancery-lane.

Doubt.—We cannot say. As a rule we distrust quasi-medical works, which end by recommending some particular medicine. We do not know of such a work as you require.

Le Diable.—Consult a physician.

N. G. Lambourne.—Read the first Article of Faith in the Prayer Book and you will find that "Sigma's" views are orthodox and your own unorthodox.

The "Sixpenny Sale Column" is the only place in which can appear queries sent by J. Blomfield, and Aqua,

Gordon Douglas.—Send the information to us.

J. G. G.—Several replies containing formulæ for the manufacture of a hard white metal appeared in a recent back number.

L. De Fontainemoreau.—We do not know any more than that it is a French patent.

Maurice Ashton.—We do not exactly make out what you wish us to do. We should think your protege's best place would be, if he could afford it, to become a pupil of some marine engineer.

B. Hall.—The numbers can be sent for four stamps.

J. W. (Crayford).—Your questions will probably be dealt with by "A Practical Man" as he goes on. See his letter this week.

W. B. B.—Try benzine.

Wm. Tell.—No more space for designs of crossbows at present.

J. Cooper.—We should be glad to receive the information respecting carpet looms.

J. P.—The number is exceedingly scarce, but the offer of a good price through the "Sixpenny Sale Column" might procure you a copy.

A New Subscriber would pardon any apparent discourtesy if he knew the unreasonable requests of many correspondents for information, in some cases many times previously given.

Benjamin.—Many recipes for joining broken glass, china, &c., have been given in back numbers.

Still a Brick, and as soulless.

James Shaw congratulates the English Mechanic on taking up "Cotton Spinning," as that branch of industry is one of the bulwarks of our commercial success.

Slot Cutting.—"M. R. C. S," says he has much pleasure in reporting that the tools indicated by "J. K. P." p. 112, have proved quite successful for the purpose of slot cutting, and he cordially thanks "J. K. P." for his advice, and other kindness.

R. G. B.—You ask too much. The list would be a long one, and then only of service to the inquirer.

B. H., Rochdale.—Other letters on "Cotton Spinning" coming before yours have had the preference.

Ab Initio.—The letter is in type, but the sketch of the "Bookbinders' plough" got lost. "Ab Initio" says Mr. Beardsley has an undoubted right to *think* as he does, but not to occupy our space with such absurdities.

Bernardin.—Boring Insects, Algebra, &c., next week.

Silver Coin.—"A Beginner" may possibly find a purchaser for his coin, qy. 3750, p. 190, by communicating with Mr. H. W. Henfrey, Markham House, Brighton.

W. Reeve.—We have again and again stated that we cannot recommend the goods of any particular manufacturer.

R. G. B.—See other replies on "Ascarides."

A Four Years' Subscriber.—It is a self-made professorship. You may call yourself "Professor of the Concertina" if you like, as any fiddler may call himself professor of the violin.

A Belfast Subscriber wants to know if the earth is round how can the Suez Canal be level? It is not level any more than the Bedford Canal is level, or the sea is level.

J. M. O.—An interesting subject, but we should prefer it discussed in such a paper as the *Lancet*.

A Drummed-out Correspondent (H. H.).—We beg to inform "H. H." that I. W. Wolfe, who sometimes signs himself E. G. Wolfe, and who sometimes gives his address as over Winsford, Cheshire, and at other times Townfields, near Middlewich, Chester, is the veritable correspondent who made so many mistakes in our pages as "Pax Dei," and who afterwards wrote under the *nom de plume* of "Lynx." He copied from books so inaccurately that we were obliged at last to take no notice of his letters, a quantity of which we have by us unused at the present time. (See letters from Saul Rymea, pp. 360 and 432, and by "F.R.A.S.," page 279, Vol. X.) We consider it a compliment to be abused by so characteristic a correspondent.

W. S.—We cannot insert "low-priced" advertisements.

J. H. Thompson.—Recipes for making blacking were given on pp. 28 and 81, Vol. X. Consult indexes.

Augustus, who wrote under Notes and Queries, No. 248, is inquired after under "Addresses Wanted."

A Thomas.—"A Thinker's" velocipede, p. 65, is evidently not patented. We cannot answer the other questions.

Thomas Baskerfield.—On slide valve next week.

C. H. W. Biggs.—On mathematics next week.

J. R. S. C.—On Caterpillars next week.

J. R. W.—The correspondent ought not to have been troubled. Ask for information through our columns.

Convexity of Water.—Next week.

Woods for Cabinet Making.—See Mundy, Horley, and Co.'s advertisement in this week's number.

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THE ENGLISH MECHANIC LIFEBOAT FUND.

Subscriptions to be forwarded to the Editor, at the office, 31, Tavistock-street, Covent Garden, W.C.

	£	s.	d.
Amount previously acknowledged	£180	1	4
E. Letts	0	0	6
Asa..	0	1	0
Sheet Iron	0	5	0
M. Clarke, Wolverhampton	0	2	6
Gore Hird, Shipley	0	0	6
	£180	10	10

THE INVENTOR.

In obedience to the suggestions of a number of readers, we have decided on appropriating a portion of our space to a condensed list of patents as nearly as possible up to the date of our issue.

APPLICATIONS FOR LETTERS PATENT DURING THE WEEK ENDING MAY 16, 1870.

1337 F. Broughton, 3, Hanover Cottage, Regent's Park, new perforated fire bars, applicable to boilers

1338 P. R. Jackson, Salford, construction of segmental toothed wheels

1339 A. A. Rossignol, 4, Rue de Villiers, Paris, writing music

1340 H. A. Dufrené, 10, Rue de la Fidelite, Paris, an improved water moter.—A communication

1341 T. W. Wedlake, Hornchurch Ironworks, Romford, steam engines and boilers

1342 J. Crouzieres, Museum-street, Bloomsbury, an improved gas and water-tight joint

1343 J. Howard, Cromwell House, Northampton, hand signal lamps

1344 T. J. Guy, 252, Goswell-road, apparatus for facilitating travelling on foot

1345 W. R. Lake, Southampton-buildings, London, improvements in paddle-wheels.—A communication

1346 J. Nicholson, Shoreditch and J. W. Jones, Stoke Newington, fastenings for windows, doors, &c.

1347 C. W. Harrison, Westminster-chambers, improvements in applying electricity or electro-magnetism on board ships in order to prevent incrustation or fouling of their bottoms

1348 E. Smith, Birmingham, improvements in locking or securing nuts for screw bolts

1349 W. B. Hendle, 68, Welbeck-street, Cavendish-square, glazed structures for horticultural purposes

1350 F. Perry, Fenchurch-street, and J. I. Bengough, Hackney, improvements in the preservation of meats

1351 W. E. Newton, 66, Chancery-lane, improved machinery for pointing and finishing nails.—A communication

1352 E. P. H. Vaughan, 54, Chancery-lane, improvements in the construction of and methods of working gas engines.—A communication

1353 L. W. Weeks, New York, U.S.A., manufacture of ball floats

1354 G. W. Wigner, 1, Saint Swithin's-lane, deodorizing and purifying sewage

1355 L. O. Deschamps and S. D. Oudit, Paris, Boulevard de Strasbourg, No. 23, an improved tool for cutting net, lace, and other like fabrics

1356 J. F. Rogers, Featherstone-buildings, Holborn, an improved fuse

1357 W. E. Newton, 66, Chancery-lane, improvements in the construction of steam valves or cocks.—A communication

1358 J. H. Johnson, 47, Lincoln's-inn-fields, an improved construction and arrangement of grate bars.—A communication.

1359 A. Campbell, Glasgow, a new dip or smear for destroying vermin in sheep

1360 J. H. Johnson, 47, Lincoln's-inn-fields, improvements in projectiles.—A communication

1361 C. Churchill, Darnley-crescent, Hackney, an improved window fastener.—A communication

1362 G. Fawcus and G. Lunge, North Shields, improvements in the coatings for iron ships

1327 E. A. Inglefield, 10, Grove End-road, St. John's Wood improvements in steering tell-tales for vessels

1328 H. Johnson, 1, Essex-street, West Ham, Essex. and R. J. Lecky, 24, Stock Orchard-villas, Caledonian-road, London, locking screw bolts and nuts

1329 B. H. Chameroy, Brussels, improvements in cocks

1330 H. Aitken, Falkirk, disintegrating, or pulverising lumps or clods of soil in agriculture

1331 W. Hunt, Castleford, near Normanton, a new or improved detergent compound to be used in the manufacture of soap

1332 J. Jones, West Bromwich and E. R Dunn, a new alloy for the bearings or brasses of shafts, and axles of carriages

1333 B. J. Edwards, 6, The Grove, Hackney, London, apparatus for photographic printing

1334 W. Dangerfield, Chalford, improvements in walking-sticks and sticks for umbrellas

1335 W. R. Lake, Southampton-buildings, London, improvements in apparatus or machinery for making gas from liquid hydrocarbons for illuminating purposes.—A communication

1336 W. R. Lake, Southampton-buildings, London, improvements in the process of brewing ale and other malt liquors.—A communication

1363 H. Law, 15, Essex-street, Strand, improvements in meters for measuring fluids

1364 W. Daniell and H. Lund, Holborn, an improved electro-magnetic engine

1365 W. E. Gedge, 11, Wellington-street, Strand, an improved machine applicable to agricultural work of every kind.—A communication

1366 J. W. Elliot, Toronto, Canada, removing snow from rail-road tracks

1367 T. Perkins, Hitchin, apparatus for ploughing or cultivating land

1368 W. Young, 98, Richmond-road, Bayswater, improvements in crates, packing cases, and boxes

1369 J. Miller and J. Miller, jun., 38, Clifton-road, Peckham elastic fabrics suitable for gussets

1370 T. Coles, and W. Henderson, Castle Cary, Somerset, machinery for scutching flax and other fibres

1371 J. Heddle, Leith, preparing, clarifying, and preserving vegetable juices and other liquids

1372 A. McAlister, West India Dock-road, improvements in hammocks

1373 E. G. Peacock, 14, Union-street, Bath, improvements in apparatus for refrigerating and for heating purposes

1374 J. A. Gardner, Bristol, apparatus for signalling between passengers, guards, and drivers

1375 W. E. Newton, 66, Chancery-lane, construction of vessels, and in the means of propelling the same.—A communication

1376 J. Dodd, Oldham, improvements in machinery for spinning and doubling cotton

1377 T. B. Gilbert, Gipsy-road, Norwood, improvements in fire-escapes

1378 R. Mellard, Rugeley, pressing machines applicable to pressing cheese

1379 P. Pimont, Rouen, composition for preserving the surfaces of walls, metals, wood, and other materials

1380 C. R. Simey, Sunderland, improvements in stuffing boxes

1381 J. J. Hignette, 75, Rue de Turbigo, Paris, improvements in apparatus for dressing, glazing, and pearling grain

1382 H. Ormson, Stanley-bridge, Chelsea, improvements in warming and ventilating horticultural buildings

1383 W. R. Lake, Southampton-buildings, improvements in sewing machines.—A communication

1384 F. N. Meixner, and J. Watmough, both of Manchester, improvements in boilers for domestic and other purposes.

1385 P. Jensen, 89, Chancery-lane, the writing ball, being improvements in means for writing and telegraphic purposes.—A communication

1386 J. Warne, Blackfriars-road, improvements in apparatus or vessels for cooling

1387 L. Turner, Leicester, manufacture of elastic fabrics

1388 A. Fisher, jun., Paisley, apparatus to be used in dyeing yarns

1389 J. B. Handyside and T. R. Yarrow, Glasgow, improvements in springs

1390 B. Hunt, 1, Serle-street, Lincoln's-inn, improvements in shirts.—A communication

1391 R. H. Murray, Walsall, improvements in casting mould boards

1392 C. Wickstead jun., Swaffham, apparatus to be employed in the filling of water carts with water

1393 G. G. De Byron, New York, improvements in apparatus for washing and rinsing

1394 G. W. Hemans, Victoria-street, Westminster, a process for the recovery, purification, and revivifycation of sulphuric acid spent and deteriorated in the refining of petroleum, coal, and shale oils.—A communication

1395 H. A. Biertumpfel, Albany-street, and W. J. Loveday Kennington-road, machinery for shaping wood

1396 A. S. G. Sauer and L. Cachal, of 6, Rue des Filles du Calvaire, Paris, a liquid for raising paste and dough

1397 W. Gilbey, Pantheon, Oxford-street, an improved fastener to boxes, packing and other cases

1398 T. Fawcett, Saw Mills, Dewsbury, York, improvements in sewing machinery

1399 R. L. Hattersley, Keighley, beaming warps or supplying warp in the weaving of fabrics for which some of the warp threads require to be of a different tension to the others

1400 J. H. Banks, Brook-street, Knutsford, manufacture of school furniture

1401 J. H. Johnson, 47, Lincoln's-inn-fields, improvements in bearings, slides, and packings for steam engines and other machinery.—A communication

1402 A Pocock, New City Chambers, Bishopsgate-street, apparatus for enabling invalids and other persons to drink in a recumbent position

1403 J. Yates, Birmingham, improvements in taps or stop-cocks

1404 J. Needham, Overstone-road, Hammersmith, construction of ships and other navigable vessels

1405 A. W. C. Williams and C. M. Talcott, 1, City-road improvements in lawn mowing machines

1406 D. Smith, Liverpool, improvements in furnaces

1407 T. Page, improvements in apparatus to be used in subaqueous operations

PATENTS SEALED.

3207 G. R. Mather, apparatus for cutting or giving form to wood

3300 W. H. Tucker, improvements in locks

3306 J. G. Garrard, improvements in the construction of buffers adapted for railway carriages

3307 W. Niell, improvements in blast engines

3308 J. Oppenheimer, fixing and staying telegraph posts

3312 S. J. Mackie, construction and propulsion of floating vessels

3313 J. Crofts, R. Dawson, and J. King, apparatus for combing wool or other fibres

3314 T. Marshall, composition for the prevention of fouling of ships' bottoms

3321 G. B. D'Adelsward, apparatus for the removal of dross out of blast furnaces

3324 O. Faure, improvements in galvanic batteries

3329 G. Petrie, improvements in the preparation of ashes for the manufacture of manure

3336 R. Clews, improvements for weaving textile fabrics

3354 D. Morgan, lubricating oil or grease

3399 M. Henry, improvements in apparatus for moving or transporting railway carriages.—A communication

3404 T. Richardson, desks or tables for schools and other similar purposes

3563 J. F. Alexander, improvements in undulating propellers for steam ships.

3634 J. Heap, improvements applicable to earth closets or commodes and urinals

3705 J. Bourne, apparatus for the production of heat, and the generation and application of motive power derived therefrom

3722 W. E. Newton, improvements in adjusting and packing the rails of railways.—A communication

3723 W. E. Newton, 66, Chancery-lane, improvements in forming the joints of the permanent way of railways.—A communication.

371 A. B. Childs, machinery for cleaning, scouring, and decorticating wheat and grain

539 J. J. Aston, improvements in machinery for propelling vessels on the water

697 G. Fowler, improvements in smelting iron ore

827 R. F. Fairlie, improvements in wheels for rail or tramway locomotive engines and carriages or vehicles

837 W. R. Lake, improvements in wheels for railway engines and carriages.—A communication

847 J. H. Johnson, improvements in locomotion.—A communication

3309 F. Delacroix, an improved metallic manometer

3319 K. Ogden, improved deodorising compound to be employed in chambers or receptacles containing dead bodies

3334 T. E. Lundy and J. L. Dunham, new or improved means of communication between passengers in cabs, private carriages, omnibuses, and other vehicles

3340 W. Bayliss and M. Bayliss, improved means for making cast-iron earth screws for the lower parts of fence, telegraph, and other posts or supports

3346 H. Wilson, lubricating apparatus for steam engines, steam hammers, and other mechanism

3347 G. Betti, improvements in steam boilers

3353 T. R. Hetherington, improvements in machinery for preparing, spinning, and doubling cotton

3358 W. R. Lake, improvements in machinery for distributing type.—A communication

3360 S. L. Loomis, a new and improved apparatus for tightening and holding window sashes

3361 Sir J. Macneill, improvements in lucifer match and fusee boxes or cases

3382 W. E. Gedge, an improved system of hydraulic traction on railways and other roads.—A communication

3387 H. C. Lobnitz, improvements in motive power engines

3397 J. Turnbull, improvements in connecting and disconnecting carriages and waggons

3411 T. Brown, improvements in the construction and arrangement of machinery or apparatus for drilling or boring rocks.—A communication

3432 A. Barclay, improvements in condensers

3470 J. F. Crease, improvements in the construction of tank filters

3474 J. Forbes, improvements in dessiccating malt, grain, and other similar substances

3482 H. C. Ash, improvements in the manufacture of churns

3504 T. R. Crampton, improvements in burning powdered fuel

3510 H. M. Nicholls, apparatus for cutting continuous paper into sheets

3651 W. Foulds, improvements in apparatus for heating feed water.—Communicated

3665 J. Smiles, improvements in breech-loading fire-arms

144 W. Richards, improvements in breech-loading fire-arms and cartridges

191 F. Hocking, a new or improved means of securing or fastening the leaves in music, periodicals, and books

220 G. A. Buchholz, improved machinery for manufacturing semolina and flour

332 G. E. Harding, an improved device for imparting to toothed wheels and racks, and to mechanism connected therewith, a variable reciprocating motion

523 W. E. Newton, improvements in springs for carriages and other purposes—A communication

639 J. S. Johnstone, a new improved motive-power engine

754 G. Brown, improvements in velocipedes

755 W. H. Samuel, improvements in friction lights and in apparatus to be employed therewith

783 J. Watkins, improvements in dies or tools used in draw-

796 J. Davis and W. N. Davis, improvements in the construction of two-furrow ploughs

ing metallic tubes

906 W. R. Lake, improvements in anchors.—A communication

914 J. A. Lund, improvements in keys for watches.

OUR EXCHANGE COLUMN.

"Exchange" advertisements are inserted at the rate of threepence for the first twenty-four words, and threepence for every succeeding ten words.

Spanish FOWLS' EGGS for pigeons. A gentleman has a sitting from first-class birds, which he will exchange for pair of fancy pigeons, either jacobins or tumblers.—H. CANNING, Harpenden, Herts.

BUTTERFLIES, moths, eggs, or breech-loading double barrel gun, for anything useful, good bicycle preferred.—JAMES GERRARD, Builder, Lyndhurst.

Eighty SCIENTIFIC AND MUSICAL ARTICLES for exchange; for list and particulars enclose stamped and directed envelope to JABEZ FRANCIS, Rochford, Essex.

About 15 cwt. BLACK WAGGON GREASE in casks about 3 cwt. each, for first-class bicycle (36in.) or offers.—B. G., 28, Castle-place, Belfast.

Exchange for a bicycle or tricycle, a six chambered new BREECH-LOADING REVOLVER, and 100 cartridges, value £3.—C. M., the Nursery, Lewisham-road, S.E.

A fine old VIOLIN AND BOW, and a 4 keyed ivory mounted boxwood flute, value 30s., for set of 36in. and 30in. bicycle ironwork, spring not wanted.—SAMUEL ASHMAN, Wine-street, Frome, Somerset.

A good BICYCLE wanted, a first class concertina, cornet, flageolet, self filling portable air swimming belt for a good one; all the articles in first-class condition, worth any one's while to see them.—G. COLLINS, 6, Park-grove, Battersea-park, Battersea.

A powerful STAMPING OR PUNCHING PRESS, to be exchanged for anything useful of the same value.—W. SWEET, 15, Canterbury-road, Kilburn.

BLACK, TRAINED, RETRIEVER DOG, and kennels, books, skates and a number of other articles for books or scientific articles.—T. COWAN, Beckenham, Kent.

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The English Mechanic
AND
MIRROR OF SCIENCE AND ART.
FRIDAY, JUNE 3, 1870.

OTHER WORLDS THAN OURS.*

AVAILING himself of the results of the most recent researches into the physical condition of the visible Universe, Mr. Proctor has in the volume whose title heads this notice, re-opened a discussion carried on within the memory of a considerable proportion of our readers, between the late Dr. Whewell and Sir David Brewster, as to the inhabitability of the various bodies which people space.

His justification for having done so is well set forth in his introductory chapter; in which, after referring to the great strides which knowledge has made since the appearance of the "Plurality of Worlds," and "More Worlds than One," he proceeds to say—

> "We stand in a position much more favourable for the formation of just views than that from which Whewell and Brewster surveyed the planetary and stellar systems. Never, since men first explored the celestial depths, has a series of more startling discoveries rewarded the labours of astronomers and physicists than during the past few years. Unhoped-for revelations have been made on every side. Analogies the most interesting have brought the distant orbs of heaven into close relationship with our own earth, or with the central luminary of the planetary scheme. And a lesson has been taught us which bears even more significantly on our views respecting the existence of other worlds; we have learned to recognise within the solar system, and within the wondrous galaxy of which our sun is a constituent orb, a variety of structure and a complexity of detail, of which but a few years ago astronomers had formed but the most inadequate conceptions. My object, then, in the pages which follow, is not solely to establish the thesis that there are other worlds than ours, but to present in a new, and, I hope, interesting light, the marvellous discoveries which have rewarded recent scientific researches."

It was only to have been expected, from the scientific antecedents of Mr. Proctor, that the task which he thus imposes on himself would be ably performed; and this expectation, we may say at once, every reader of his thoughtful, suggestive, and very interesting book, will find most fully realised, as he peruses it. It is divided into thirteen chapters, in addition to the introduction. 1. What the Earth teaches Us. 2. What We Learn from the Sun. 3. The Inferior Planets. 4. Mars, the Miniature of Our Earth. 5. Jupiter, the Giant of the Solar System. 6. Saturn, the Ringed World. 7. Uranus and Neptune the Arctic Planets. 8. The Moon and Other Satellites. 9. Meteors and Comets; their Office in the Solar System. 10. Other Suns than Ours. 11. Minor Stars, and of the Distribution of Stars in Space. 12. The Nebulæ, Are They External Galaxies? and, 13. Supervision and Control.

In the first chapter our author derives a striking and cogent argument from the extraordinary varieties of external conditions under which organised life exists on our own globe: drawing his illustrations from the imperishable stone record contained in the stratified layers of the earth's crust; from the accounts of our most philosophical travellers; and notably from the marvellous discoveries of Dr. Carpenter, made during his recent dredging expeditions, of the illimitable profusion of animal existence at depths in the ocean so vast that the mere aqueous pressure crushes the instruments by which we seek to investigate it.

He then proceeds to examine the physical structure of our great centre of light and heat—the Sun, and traces the curious connection which subsists between the period of Sun spots, and that of certain terrestrial magnetic disturbances. Considering the very small portion of the Sun's disc which is at any time obscured by spots, as compared with the illuminated part, the notion advanced that our Sun, viewed from one of the fixed Stars, would appear a "'variable,' having a period of ten and a half years," seems a little fanciful; although we are scarcely prepared actually to deny that it *may* be so. As a matter of course, the spectroscope plays an important part in the chapter under discussion, and Kirchhoff's magnificent discovery is put forward with all that prominence to which its vast importance entitles it. Its leading features have been too recently discussed by a writer in these pages to render any more explicit reference to it necessary. Mr. Proctor successfully, as we think, combats the notion of Mr. Lockyer that the Solar Corona has a terrestrial origin; but we confess our inability to find any proof of the implied identity of that Corona and the Zodiacal light which his pages contain.

In the chapter on the Inferior Planets, Tyndall's remarkable discovery as to the part played by aqueous vapour in our atmosphere in regulating our supply of Solar heat, is made the foundation of an attempt to show how the surfaces of Mercury and Venus are, by no means, *ex necessitate*, burned up. With reference to Venus though, our author seems to be in a curious state of indecision; as while on p. 79, he seems to lean to the idea that she may be inhabited b. a race of beings as highly organised as ourselves, on p. 215, he appears to imply that all probability is in favour of such an inclination of her axis as would render her practically unfit to be the abode of any thing resembling human life Incidentally, the curious question as to the existence of a satellite to this planet is discussed; a moot point which has arisen within the last few weeks in our own columns.

In Chapter IV. Mars is dealt with. And here Mr. Proctor's task is a relatively easy one, as his intimate knowledge of Martial detail, enables him to show conclusively how singularly striking is the resemblance between this planet and the one on which we live.

The two following chapters, those on Jupiter and Saturn, develop the very curious theory that instead of being habitable, these two huge globes are themselves Suns; or act as such to their Satellites; and that it is these Satellites in which we are to look for *Worlds*. The same idea is propounded with regard to Uranus and Neptune, the Moons of which we are invited to conceive as the abode of creatures who derive their light and heat from those planets. With regard to the two chapters more especially referred to, we may observe that they contain one assertion, or, perhaps, rather hypothesis, so startling, that we must demur to it at once. It is no other than that the changes of figure which observers have imagined they have detected in Jupiter and Saturn (and notably in the latter), have their origin in an actual alteration in the planets' outline caused by some stupendous convulsion! Of the nature and character of the force which should cause a change of such mighty magnitude as to be easily visible some seven hundred and eighty millions of miles off, it would be idle to speculate.

In "The Moon and Other Satellites," the probability of these attendants being themselves worlds is discussed.

The Ninth Chapter—that on Meteors and Comets—is one of singular interest, and is treated in a way worthy of its writer. He combats Laplace's theory as to the relative age of the planets, and denies that they have been ejected by the Sun in order, beginning with the exterior ones; which would of course then be the Older. He looks to the aggregation of meteoric and cometic systems for the formation of the various Globes which circulate about the Sun.

"Other Suns than Ours," is the title of Chapter X., which, dealing with the constitution of the Fixed Stars, fully sustains the interest of its predecessor.

In Chapter XI., on Minor Stars, and of the distribution of Stars or space, the author treats of a subject which he has made peculiarly his own, and shows, as it appears to us conclusively, upon how very erroneous a principle the appearance presented by the Stellar Vault has hitherto been interpreted. We would commend the very instructive woodcut on p. 254, to all who may be disposed to cling to the existing explanation of the structure of the galaxy, and of our visible sidereal system.

The Nebulæ form the subject of the twelfth chapter; and here again we meet with much that is new and suggestive.

The book concludes with a bold, but reverent, attempt to meet the religious difficulties which it is assumed will be felt by many to whom the idea of other inhabitants of the universe than our own race, may prove a stumbling block. How ably and eloquently this has been done, and how, by the aid of arguments pervaded by a tone of the most fervent piety such difficulties are, one by one met and disposed of, the reader must go to the work itself to learn. He must be curiously constituted if he do not rise from its perusal a wiser and a better man.

Thirteen illustrations adorn this volume; some of them of very great beauty. Among these we may particularly specify the chromo-lithographs of Jupiter, Saturn and Mars, and the view of the Nebula 17 Messier, which faces p. 292. We had marked several passages for extract; but (even were we not prevented by the exigencies of our limited space) we feel that to pick out small portions from a close and connected sequence of argument would be to render an injustice to the author, and to give no adequate idea of one of the most interesting scientific works which have for a long time issued from the press. And so we pass it on to the reader.

WHAT STRIPES THE SUNBEAM.

BY A FELLOW OF THE ROYAL ASTRONOMICAL SOCIETY.

(*Concluded from page* 218.)

FROM the spectra of the fixed stars, Mr. Huggins naturally turned to those of the nebulæ. The first of these anomalous bodies which he examined was the one known as 37 Hersch. IV., Draconis (Vol. X., p. 6). This, as many of our readers are aware, appears in the telescope as a small bluish disc of light. We may conceive Mr. Huggins's astonishment when, on getting this image on to the slit of his spectroscope, and regarding it with that instrument, not a vestige of a continuous spectrum was to be seen! At first all that he could detect was one bright line: further observation, however, revealed a second at some little distance, and finally he could just perceive a third of extreme faintness. It is scarcely needful, then, for us at this stage to inform the student that this was the spectrum of some incandescent gas or gases. As a matter of fact, a direct comparison of these lines with those of certain terrestrial elements showed that the brightest line was caused by nitrogen; the exceedingly faint one by hydrogen, and that the third was very near, though not absolutely coincident with, one line of barium. We refrain giving an illustration of this spectrum, inasmuch as no engraving could adequately reproduce its extremely dim and ghostly appearance; in point of fact, had it not been that it consisted of three lines of light upon a black ground it would have hardly been perceptible even in Mr. Huggins's large refractor. Our great English philosopher was not long in following up this very remarkable discovery by others in the same field. The nebula Struve 6, Tauri Poniatorii, presented the same three bright lines as the object just described; as did 73 Hersch. IV., Cygni, but the last-named object showed also a faint continuous spectrum. This was conclusively traced to an eleventh magnitude star in the middle of the nebula! 51 Hersch. IV. Sagittarii, 1 Hersch. IV. Aquarii, (Vol. X., p. 65), and 18 Hersch. IV. Andromedæ, presented the same spectrum too, but with the addition in the last case of a fourth very faint and more refrangible line. The ring nebula, 57 Messier Lyræ (Vol. X., p. 65), and the Dumb-bell Nebula 27 Messier Vulpeculæ, showed merely the nitrogen line. Mr. Huggins also examined several well known clusters, more or less resolvable, and found, as might have been expected, that they one and all gave continuous spectra. Now it may here be asked, *Do all* the nebulæ give this same three-line gaseous spectrum? Mr. Huggins who examined some seventy of their bodies, shall answer for himself. "Of these seventy nebulæ," he says, "about one-third belong to the class of gaseous bodies: the light of the remaining nebulæ and clusters becomes spread out by the prism into a spectrum which is apparently continuous." The great nebula, 31 Messier in Andromeda (Vol. X., p. 65), presents a very remarkable spectrum; in fact, a kind of hybrid one. It is seemingly continuous, and yet all the red, and some of the orange end of it is absent from it, and the brighter parts are striped or mottled in an odd and unequal manner.

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* "Other Worlds than Ours. The Purality of Worlds studied under the Light of Recent Scientific Researches." By RICHARD A. PROCTOR. B.A., F.R.A.S. London: Longmans, Green, and Co., 1870.

Every one who has begun the survey of the heavens with a telescope is familiar with that most striking object, 42 Messier, the great nebula surrounding the multiple star θ Orionis (Vol. X., p. 495). Now for many years previously to Mr. Huggins's investigations there had been a growing disposition to believe that all nebulæ without exception consisted merely of clusters of stars at such an infinitely remote distance as to render their component stars individually invisible, and to cause them to present their well known appearance; but that increase in the aperture of our telescopes was all that was needful to resolve them into their constituent glittering atoms. It is true that the grand mass of which we are now speaking had resisted the power of Herschel's 40ft. reflector, and that his son Sir John Herschel, and, after him, the Earl of Rosse with his reflector of 3ft. in aperture, and Lassell, with a 2ft. mirror, one and all failed to resolve it; but yet there was a general disposition to believe that increased optical power would turn this mysterious cloud into the minute stars of which it was imagined to be composed. The truth of the poet's aphorism that "the wish is father to the thought," is a matter of common experience with us all, and it is therefore not surprising that when Lórd Rosse acquired his gigantic 6ft. mirror, he should have persuaded himself that he could see some faint indications of resolvability in this nebula; nor that Bond in America, and Secchi at Rome should each have done the same. But now Mr. Huggins appears upon the scene, and applies his crucial test to determine the vexed point. Let us listen to what he says: "The light from the brightest part of the nebula near the trapezium was resolved by the prisms into three bright lines, in all respects similar to those in the gaseous nebulæ . . . The whole of this great nebula, as far as lies within the power of my instrument, emits light which is identical in its character; the light from one part differs from the light of another in intensity alone." There is something most particularly striking and impressive in the first view of the spectrum of a nebula, and we can never forget our own of the strange object under discussion. In the darkness and quiet of our observatory, the death-like stillness only broken by the measured tick of the sidereal clock, the sight of the dim bands of light emanating from this mysterious body, impressed us with a feeling something akin to awe.

From Nebulæ, the transition is not wholly unnatural to comets, and we need therefore feel no surprise that Mr. Huggins availed himself of the earliest opportunity to examine the spectrum of one of those strange wanderers. Passing over his results as obtained from two insignificant comets which appeared in 1866 and 1867, we will proceed to notice the remarkable conclusion which he was enabled to announce with reference to what is known as Comet 2 of 1868, which was first discovered by Dr. Winnecke on the 13th of June in that year. Nine nights afterwards Mr. Huggins directed his instrument to it with the curious result of which we are now about to speak. Instead of presenting a spectrum of narrow lines, the comet's light was resolved into three broad bright bands, as shown in Fig. 10. It would be foreign to our purpose, even had we space to do so, to copy Mr. Huggins's minutely-detailed account of the shading, &c., of these bands. It must suffice to say that the spectrum differed wholly from that of the gaseous nebulæ of which we have been speaking above, and that, suspecting its analogy to that of carbon, he compared it directly with the spectrum of that substance obtained by passing the electric spark through a current of olefiant gas. The carbon spectrum which he thus got is shown in Fig. 9, and its identity with that of the comet will be seen on inspection. It is very necessary to state, though, that although Winnecke's comet undoubtedly consisted mainly of carbon in some form, yet that it by no means follows that others have the same chemical composition. In fact Brorsen's comet, a small periodical one, which also appeared in 1868, gave three lines which do not correspond with those of any known terrestrial substance.

We had intended to have given some general notion of the mode in which the rate of motion of our most brilliant star, Sirius, has been determined, and of the extraordinarily ingenious manner in which Mr. Huggins has shown that it is travelling from the Earth. We had also some idea of [illegible]ng some rude and makeshift apparatus by which rudimentary spectroscopic obser- [illegible] be made; but failing space warns us [illegible] conclude. In doing so, we would fain express a hope that our descriptions may have been found intelligible by those for whom they were more especially written. We commenced by speaking of the difficulty of giving a popular explanation of the subject we proposed to discuss; and now, as we approach the end of our labours, that difficulty appears more formidable even than it did then. We have, however, used the very plainest language that we could command, and have never scrupled to repeat ourselves, whenever such repetition would conduce to the elucidation of the point under discussion, or tend to render the understanding of it by the student easier. So, then, conscious as we are of the shortcomings of this essay, let us hope that it may not have been wholly without use in teaching those who have so far followed us, what Stripes the Sunbeam.

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THE END.

ON THE RELATIONS BETWEEN BODY AND MIND.*

(Continued from page 222.)

LECTURE II.

GENTLEMEN,—In my last lecture I gave a general survey of the physiology of our mental functions, showing how indissolubly they are bound up with the bodily functions, and how barren must of necessity be a study of mind apart from body. I pointed out that the higher mental operations were functions of the supreme nerve centres; but that, though of a higher and more complex nature than the functions of the lower nerve centres, they obey the same physiological laws of evolution, and could be best approached through a knowledge of them. I now propose to show that the phenomena of the derangement of mind bear out fully this view of its nature; that we have not to deal with disease of a metaphysical entity, which the method of inductive inquiry cannot reach, nor the resources of the medical art touch, but with disease of the nervous system, disclosing itself by physical and mental symptoms. I say advisedly physical and mental, because in most, if not all, cases of insanity, at one period or other of their course, there are, in addition to the prominent mental features, symptoms of disordered nutrition and secretion, of disordered sensibility, or of disordered motility. Neither in health nor in disease is the mind imprisoned in one corner of the body; and when a person is lunatic, he is, as Dr. Bucknill has remarked, lunatic to his fingers' ends.

Mental disorders are neither more nor less than nervous diseases in which mental symptoms predominate, and their entire separation from other nervous diseases has been a sad hindrance to progress. When a blow on the head has paralysed sensibility and movement, in consequence of the disease in the brain which it has initiated, the patient is sent to the hospital; but when a blow on the head has caused mental derangement, in consequence of the disease of brain which it has initiated, the patient is sent to an asylum. In like manner, one man who has unluckily swallowed the eggs of a tænia, and has got a cysticercus in the brain, may go to the hospital; another who has been similarly unlucky goes to an asylum. Syphilitic disease of the brain or its arteries lands one person in an asylum with mental symptoms predominant; another in an hopital with sensory and motor disorder predominant. The same cause produces different symptoms, according to the part of the brain which it particularly affects. No doubt it is right that mental derangements should have, as they often require, the special appliances of an asylum, but it is certainly not right that the separation which is necessary for treatment should reach to their pathology and to the method of its study. So long as this is the case, we shall labour in vain to get exact scientific ideas concerning their causation, their pathology, and their treatment.

Clearing, then, the question as completely as possible from the haze which metaphysics has cast around it, let us ask—How comes idiocy, or insanity? What is the scientific meaning of them? We may take it to be beyond question that they are not accidents; that they come to pass, as every other event in nature does, by natural law. They are mysterious visitations only because we understand not the laws of their production—appear casualties only because we are ignorant of their casualty. When a blow on the head or an inflammation of the membranes of the brain has produced derangement of mind, we need not look further for a cause: the actual harm done to structure is sufficient to account for disorder of function in the best-constituted and best-developed brain. But it is in only in a small proportion of cases of insanity that we can discover such a direct physical occasion of disease. In a great many cases—in more than half, certainly, and perhaps in five out of six—there is something in the nervous organisation of the person, some native peculiarity, which, however we name it, predisposes him to an outbreak of insanity. When two persons undergo a similar moral shock, or a similar prolonged anxiety, and one of them goes mad in consequence, while the other goes to sleep and goes to work and recovers his equanimity, it is plain that all the co-operating conditions have not been the same, that the entire cause has been different. What then has been the difference? In the former case there has been present a most important element which was happily wanting in the latter—there has been a certain hereditary neurosis, an unknown and variable quantity in the equation.

Perhaps of all the erroneous notions concerning mind which metaphysics has engendered or abetted, there is none more false than that which tacitly assumes or explicitly declares that men are born with equal original mental capacity, opportunities and education determining the differences of subsequent development. The opinion is as cruel as it is false. What man can by taking thought add one cubic either to his mental or to his bodily stature? Multitude of human beings come into the world weighted with a destiny against which they have neither the will nor the power to contend; they are the step-children of Nature, and groan under the worst of all tyrannies—the tyranny of a bad organisation. Men differ, indeed, in the fundamental characters of their minds as they do in the features of their countenances, or in the habits of their bodies; and between those who are born with the potentiality of a full and complete mental development, under favourable circumstances, and those who are born with an innate incapacity of mental development, under any circumstances, their exists every gradation. What teaching could ever raise the congenital idiot to the common level of human intelligence? What teaching could ever keep the inspired mind of the man of genius at that level?

The congenital idiot is deprived of his human birthright, for he is born with such a defect of brain that he cannot display any, or can only display very feeble and imperfect, mental functions. From no fault of his own is he thus afflicted, seeing that he must be held innocent of all offence but the offence of his share of original sin; but it is nowise so clear that it is not from some fault of his parents. It is all too true that, in many cases, there has observably been a neglect or disregard of the laws which govern the progress of human development through the ages. Idiocy is, indeed, a manufactured article; and although we are not always able to tell how it is manufactured, still its important causes are known, and are within control. Many cases are distinctly traceable to parental intemperance and excess. Out of 300 idiots in Massachusetts, Dr. Howe found as many as 145 to be the offspring of intemperate parents; and there are numerous scattered observations which prove that chronic alcoholism in the parent may directly occasion idiocy in the child. I think, too, that there is no reasonable question of the ill-effects of marriages of consanguinity: that their tendency is to produce degeneracy of the race, and idiocy as the extremest form of such degeneracy. I do not say that *all* the children of such marriages may not sometimes be healthy, and *some* of them quite healthy at other times; but the general and ultimate result of breeding in and in is to produce barrenness and sterility, children of a low degree of viability, and of imperfect mental and physical development—deaf-mutism, and actual imbecility or idiocy. Again, insanity in the parent may issue in idiocy in the offspring, which is, so to speak, the natural term of mental degeneracy when it proceeds unchecked through generations. It may be affirmed with no little confidence, that if the experiment of intermarrying insane persons for two or three generations were tried, the result would be sterile idiocy and extinction of the family. Certain unfavourable conditions of life tend unquestionably to produce degeneracy of the individual; the morbid predisposition so generated is then transmitted to the next generation, and, if the unfavourable conditions continue, is aggravated in it; and thus a morbid variety of the human kind, which is incapable of being a link in the line of progress of humanity. Nature puts it under the ban of sterility, and thus prevents the permanent degradation of the race. Morel has traced, through four generations, the family history of a youth who was admitted into the asylum at Rouen in a state of stupidity and semi-idiocy; the summary of which may fitly illustrate the natural course of degeneracy when it goes on through generations.

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* Two lectures delivered at the Royal College of Physicians in 1870. By HENRY MAUDSLEY, M.D., F.R.C.P., Professor of Medical Jurisprudence in University College, London.

First generation:—Immorality, depravity, alcoholic excess, and moral degradation, in the great-grandfather, who was killed in a tavern brawl.

Second generation:—Hereditary drunkenness, maniacal attacks, ending in general paralysis, in the grandfather.

Third generation:—Sobriety, but hypochondriacal tendencies, delusions of persecutions, and homicidal tendencies, in the father.

Fourth generation:—Defective intelligence. First attack of mania at sixteen; stupidity, and transition to complete idiocy. Furthermore, probable extinction of the family; for the generative functions were as little developed as those of a child of twelve years of age. He had two sisters who were both defective physically and morally, and were classed as imbeciles. To complete the proof of heredity in this case, Morel adds that the mother had a child while the father was confined in the asylum, and that this adulterous child showed no signs of degeneracy.

When epilepsy in young children leads to idiocy, as it often does, we must generally look for the deep root of mischief in the family neurosis.

No one can well dispute that in the case of such an extreme morbid variety as a congenital idiot is, we have to do with a defective nervous organisation. We are still, however, without more than a very few exact descriptions of the brains of idiots. Mr. Marshall has recently examined and described the brains of two idiots of European descent. He found the convolutions to be fewer in number, individually less complex, broader, and smoother than in the apes; "in this respect," he says, "the idiots' brains are even more simple than that of the gibbon, and approach that of the baboon." The condition was the result neither of atropy nor of mere arrest of growth, but consisted essentially in an imperfect evolution of the cerebral hemispheres or their parts, dependent on an arrest of development. The proportion of the weight of brain to that of body was extraordinarily diminished. We learn, then, that when a man is born with a brain no higher—indeed lower—than of an ape, he may have the convolutions fewer in number, and individually less complex, than they are in the brain of a chimpanzee and an orang; the human brain may revert to, or fall below, that type of development from which, if the theory of Darwin be true, it has gradually ascended by evolution through the ages.

With the defect of organ there is a corresponding defect of function. But there is sometimes more than a simple defect. A curious and interesting fact, which has by no means yet received the consideration which it deserves, is that, with the appearance of this animal type of brain in idiocy, there do sometimes appear or reappear remarkable animal traits and instincts. There is a class of idiots which may justly be designated *theroid*, so like brutes are the members of it. The stories of so-called wild men, such as Peter the wild boy, and the young savage of Aveyron, who ran wild in the woods, and lived on acorns, and whatever else they could pick up there, were certainly exaggerated at the time. These degraded beings were evidently idiots, who exhibited a somewhat striking aptitude and capacity for a wild animal life. Dr. Carpenter, however, quotes the case of an idiot girl, who was seduced by some miscreant, and who, when she was delivered, gnawed through the umbilical cord as some of the lower animals do.

In the conformation and habits of other idiots, the most careless observer could not help seeing the ape. A striking instance of this kind is described by Dr. Mitchell, Deputy Commissioner in Lunacy for Scotland. "I have never," he says, "seen a better illustration of the ape-faced idiot than in this case. It is not, however, the face alone that is ape-like. He grins, chatters, and screams like a monkey, never attempting a sound in any way resembling a word. He puts himself in the most ape-like attitude in his hunts after lice, and often brings his mouth to help his hands. He grasps what he brings to his mouth with an apish hold. His thumbs are but additional fingers. He has a leaping walk. He has heavy eyebrows, and short hair on his cheek or face. He is muscular, active, and not dwarfish. He sits on the floor in ape fashion, with his genitals always exposed. He has filthy habits of all kinds. He may be called an idiot of the lowest order; yet there is a mischievous, brute-like intelligence in his eye. His head is not very small, its greatest circumference being twenty inches and a half, but in shape it strongly exhibits the ape-form of abnormality."

Pinel has recorded the case of an idiot who was something like a sheep, both in respect of her tastes, her mode of life, and the form of her head. She had an aversion to meat, and ate fruit and vegetables greedily, and drank nothing but water. Her demonstrations of sensibility, joy, or trouble, were confined to the repetition of the ill-articulated words *bé, ma, bah*. She alternately bent and raised her head, and rubbed herself against the belly of the girl who attended her. If she wanted to resist or express her discontent, she tried to butt with the crown of her head; she was very passionate. Her back, her loins, and shoulders were covered with flexible and blackish hairs, one or two inches long. She never could be made to sit on a chair or bench, even when at meals; as soon as she was placed in a sitting posture, she glided on the floor. She slept on the floor in the posture of animals.

Dr. Crichton Browne has now under care in the West Riding Asylum, a deformed idiotic girl, who in general appearance and habits has points of resemblance to a goose; so much so, that the nurses who received her describes her as just like "a plucked goose." Her father died in the asylum, and her mother's sister was also a patient in it at one time. She is 4ft. 2in. in height, has a small head, and thin and scanty hair, so that the crown of the head is partially bald. The eyes are large, round, prominent, and restless, and are frequently covered by the eyelids, as if by a slow forcible effort at winking. The lower jaw is large, projecting more than one inch beyond the contracted upper jaw, and possesses an extraordinary range of antero-posterior, as well as lateral, movement; the whole configuration of the lower part of the face having a somewhat bill-like appearance. The neck is unusually long and flexible, and is capable of being bent backwards so as actually to touch the back between the scapulæ. The cutis anserina is generally over the body, but is most marked on the back and dorsal aspects of the limbs, where it looks exactly as if it had been just deprived of feathers. The inferior angles of the scapulæ stands prominently out, and, moving freely with the movements of the arms, have precisely the appearance of rudimentary wings. The girl utters no articulate sounds, but expresses pleasure by cackling like a goose, and displeasure by hissing or screeching like a goose, or perhaps like a macaw. When angry, she flaps her arms against her sides, and beats her feet upon the floor. She knows her own name, and understands one or two short sentences, such as "Come here," and "Put out your hand." She recognises the persons who attend upon her and feed her, and is much agitated if touched by a stranger. She cannot feed herself, but swallows voraciously all that is put into her mouth, showing no preference for one article of diet over another. She is dirty in her habits, and no amount of attention has improved her in this respect. She is very fond of her bath, cackling when she is put in, and screeching when she is taken out of it.

(*To be continued.*)

CHAPTERS ON CURIOUS CATERPILLARS.—JUNE.

BY J. R. S. CLIFFORD.

THE thoughtful observer of Caterpillar life can hardly fail to be impressed with the endless varieties of shading and colouring, and the numerous variations in form, which occur amongst these creatures, even if we confine our attention to our native land. Looking upon the imago, the butterfly or moth, as the true embodiment of the form of each species, we might have said that it would have mattered very little what appearance it had in this or any preparatory stage; and had we no knowledge to the contrary, we might have expected to find all caterpillars very much of the same colour—perhaps of a uniform green or brown. Instead of this, we have sometimes displayed as much beauty as in the perfect insect—in some cases more—while there are very few caterpillars indeed that are of a uniform colour. It is singular, though, that in very few cases is there any resemblance between the markings exhibited by the caterpillar and those which adorn the wings of the imago produced therefrom. Discernment is sadly at fault here amongst those non-entomologists who, from the circumstance that they work in gardens or fields, come into contact with many different kinds of caterpillars. As a rule, they notice no differences amongst them, but class them all together as "green varmint" or "blight," and regard them as things to be squashed out of existence as speedily as possible. So that of many a gardener we might say, parodying the poet's lines, that all he notices is—

> A blight upon the shrubs or trees,
> Some common blight, 'tis all he sees—
> To him 'tis nothing more.

Well, in these times, the schoolmaster is abroad and we will hope that such being the case he will look a little beyond his books, and getting a good insight into Nature and its operations himself, he will be the better fitted to make "the rising generation," the "coming men," rather wiser in these matters than we can expect to find those who are now too old to be apt pupils of natural history lore.

A host of caterpillars is feeding in June, especially in the early part of the month; towards the close, however, a good part will have become *pupæ*, and await the change to the imago, or perfect state. There is some difference in each year, according to the weather and the state of the vegetation; this present year (1870) has as yet retarded insect life, and many species are a fortnight or three weeks behindhand. In some of our woods, more particularly in the south of England, the caterpillar of that handsome and remarkably agile butterfly known as the Silverwashed Fritillary, may be detected by a very careful search in its food plant, the violet. This caterpillar, besides feeding on the species of violet, is also said sometimes to be found on the wild raspberry, but this is extremely doubtful. As such low-growing plants cannot be "beaten," the best plan is to crouch down and turn over the leaves, disregarding the stiffness in the back thereby produced, and keeping in view the fact that the caterpillar has the trick of falling off the plant at a very slight touch, doubling itself up partly. The parent butterflies deposit their eggs in July or August, and as these hatch shortly after, and the caterpillars are not adult until the beginning of June, they thus pass about nine months in this state. The ground colour is black; down the back are two yellowish stripes, with a black stripe between them; along the sides in a triple series are delicate lines of a rust colour. On each segment are six spires, which give off fine bristles; on the second segment there are two out of the six, which project over the head of the caterpillar, and have black tips. (See Fig. 1.) Suspending itself against some twig or stem, when it has ceased to eat, the caterpillar's skin is cast off and the chrysalis state assumed, and in this case the name is really correct, for the shell of the chrysalis is decorated with spots and dashes of gold.

In the early part of the present century, the singularly-formed Comma Butterfly (*Vanessa C. Album*) was taken pretty freely near the metropolis; it has now disappeared, nor does it apparently occur in the southern and eastern counties of England. In Herefordshire, Mr. Newman reports it as still occurring, and in the Lake District, and a few other localities, individuals are seen on the wing most seasons. During 1864, an entomologist obtained the caterpillar of this species, and it is one of some singularity, feeding, as far as observed, only upon the hop-vine. As it is sluggish in its movements, and a day-feeder, it might probably be obtained by beating this climber. It is also supposed to feed on the currant and on nettles. Like the preceding, it has two processes projecting in front of the head, but in the caterpillar of the Comma they actually spring from the head, and are of a horny nature; these are black, as is the head and the next segment of the body, though the general colour of the remainder is grey, chequered with fulvous; from the seventh to the twelfth segment there is a white stripe down the back; on the sides and back are seven rows of branched spines; the eyes, as may be observed by a magnifier, are crowded to-

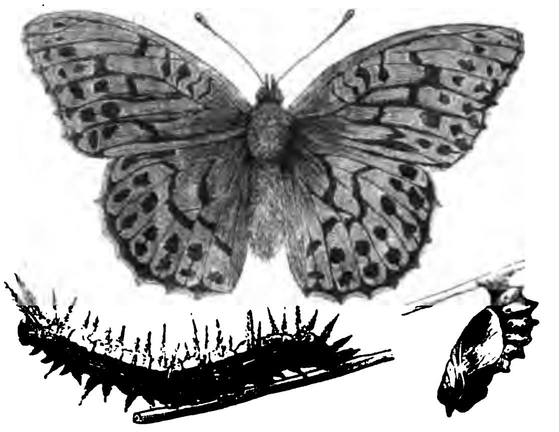
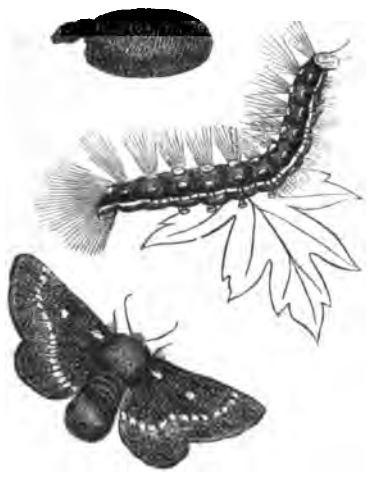


FIG. 1.

gether. The chrysalis is suspended, head downwards, from some leaf-stalk, and has a few silver blotches, on an umber ground; it is also marked with fine black lines. The butterfly emerges in August and September; it is also found in the spring of the year, and individuals then on the wing have possibly lived through the winter.

Common in most parts of Britain, and occurring also in Ireland, is the moth known as the Beaded Chestnut. (*Anchocelis Pistacina.*) The caterpillars emerge in the spring from eggs laid the previous autumn, and as they feed on the buttercup and other meadow plants growing amongst the grass; they may be conveniently taken by sweeping the grass which is growing for the hay crop, but not during the middle of the day. They fall into the net rolled up closely, but soon relax and march off briskly, and present, as they move, an odd appearance, for, at the interstice of each segment is a fold of skin of a yellow colour, and these folds appear and disappear, looking like yellow rings. The body is velvety and cylindrical, apple-green in tint, with an extremely slender white stripe down the back, and



EGGER CATERPILLAR.—Described in No. 266.

broader one along the sides; there are also a few dots sprinkled along the back. Early in June, these caterpillars enter the earth, and beneath it form compact cocoons of grains intermingled with silk. It has been noticed by Mr. Newman that they remain some weeks unchanged, but ultimately become chrysalides, which produce moths in September and October. An instance how certain species simulate the appearance of the plants on which they feed is furnished by the caterpillar of the Mallow Moth. (*Eubolia Cervinaria.*) When the Common Mallow is shaken, and there are any of these caterpillars feeding upon it, they roll themselves into rings, the legs, head, and claspers being hidden, and resemble the seed of the plant, well-known to all country children as "cheeses;" also when not disturbed they extend themselves along the stalks, to which they assimilate in colour, and thus again escape notice. The whole body is covered with minute warts, each tipped with a tiny bristle; these are white, while the general colour is dull green; down the back is a darker line, showing the course of the alimentary canal; the legs are curious, being very le and nearly transparent. These caterpillars full grown in June.

The caterpillar of the Small Chocolate Tip (*Clostera Reclusa*), may be beaten off dwarf sallows in many places throughout England in this month. It is slightly hairy, marked with grey and yellow, the under surface, legs, and claspers being smoke-coloured, and the head black. The cocoon is spun amongst the leaves, and the moth flies forth in August, giving birth to another brood of caterpillars in September. A much handsomer caterpillar than that of *Reclusa* is its congener, the Scarce Chocolate Tip. (*C. anachoreta*), which, however, no entomologist is very likely to find at large, as it is of exceeding scarcity. Nevertheless, specimens of the moth are common enough in collections, nearly all of which are the descendants of some caterpillars found at Folkestone, a few years since. It is a species which will breed in confinement, and by this means an abundance of the caterpillars have been got year after year. The general hue of the body is velvety black, mottled with smoky-grey; a stripe of dingy white runs down the back, and when the caterpillar is crawling, we can perceive that this apparent stripe is composed of square markings, which are connected by lines running between the segments; a double series of similar markings runs along the sides, one row above the spiracles, the other below them; there is a bump of chestnut-brown on the fifth and twelfth segments; that on the fifth is surrounded by a white patch; in addition there are smaller prominences on three other segments; the head is black, and also the legs; the claspers of a smoky hue. Towards the end of June, or early in July, this caterpillar (at least, when in captivity) has reached its full size; and spins itself a cocoon between the leaves of the food-plant; it apparently thrives best on sallow or poplar.

A truly ferocious caterpillar is that from which the rather elegant moth, the Dun Bar (*Cosmia Trapezina*), is developed. So eager for prey is he that, when he is beaten into the net or umbrella, ere he has hardly recovered from the shock, he begins to crawl with rapidity after some unfortunate smaller caterpillar that may be at hand, especially preferring that of the Common Winter Moth; and Mr. Newman points out the curious fact, that the caterpillar of the Dun Bar does not seize its prey by the extremity, should that be nearest, but advances until he can grasp the neck of the victim. He rarely devours the body entirely, though his appetite is considerable, preferring, after awhile, to look after a fresh victim. This caterpillar is found on oak and hornbean, the leaves of which it probably eats occasionally, though most partial to animal food. In appearance it is of a dull green colour, the body plump, and the head rather narrower, and shining; there are five pale stripes running from head to tail, and it is also freckled over with numerous small warts, which are black, surrounded by a white ring. The under side, legs, and claspers are of a delicate green. It is adult about the middle of June, and changes to a chrysalis on the surface of the ground; the moth appearing a few weeks after.

A not very common moth is known as the Lilac Beauty (*Pericallia Syringaria*), and it deserves the name it bears, for the wings, which are of a lustrous grey, are tinged with red and yellow, mingled with white and brownish markings. The caterpillar feeds on lilac and other shrubs in this month; when of full size, it is rather of a rose-coloured hue generally, though sometimes grey, along the back is a pale line, and there are two singular processes, like hooks, on the ninth segment, and four rather conspicuous warts on the sixth and seventh segments. The chrysalis is enclosed in a silken cocoon of slight texture, and it displays numerous brown stripes and spots. I believe this species is partial to woodlands—at least, this appears to be the case in the south of England.

REGENERATIVE HOT BLAST FURNACES.

AT a recent meeting of the Institution of Civil Engineers a paper read was "On Recent Improvements in Regenerative Hot-blast Stoves for Blast Furnaces," by Mr. E. A. Cowper.

The Author stated that when, in 1828, the late Mr. J. B. Neilson (M. Inst. C.E.) introduced the plan of heating the air employed as blast, by means of iron placed in or near a fire, the increase of temperature was at first only from 60 deg. to 100 deg. Fahr. Subsequently, Mr. Neilson obtained a temperature of 600 deg. or 650 deg., and the pipe stoves had since been urged up to 900 deg., and in a few cases to 1000 deg. The wear and tear, however, with such temperatures of blast were considerable, there was great loss of heat by conduction, and the pipe stoves were, as a rule, worked in a leaky condition, necessitating the expenditure of engine power for blowing air uselessly.

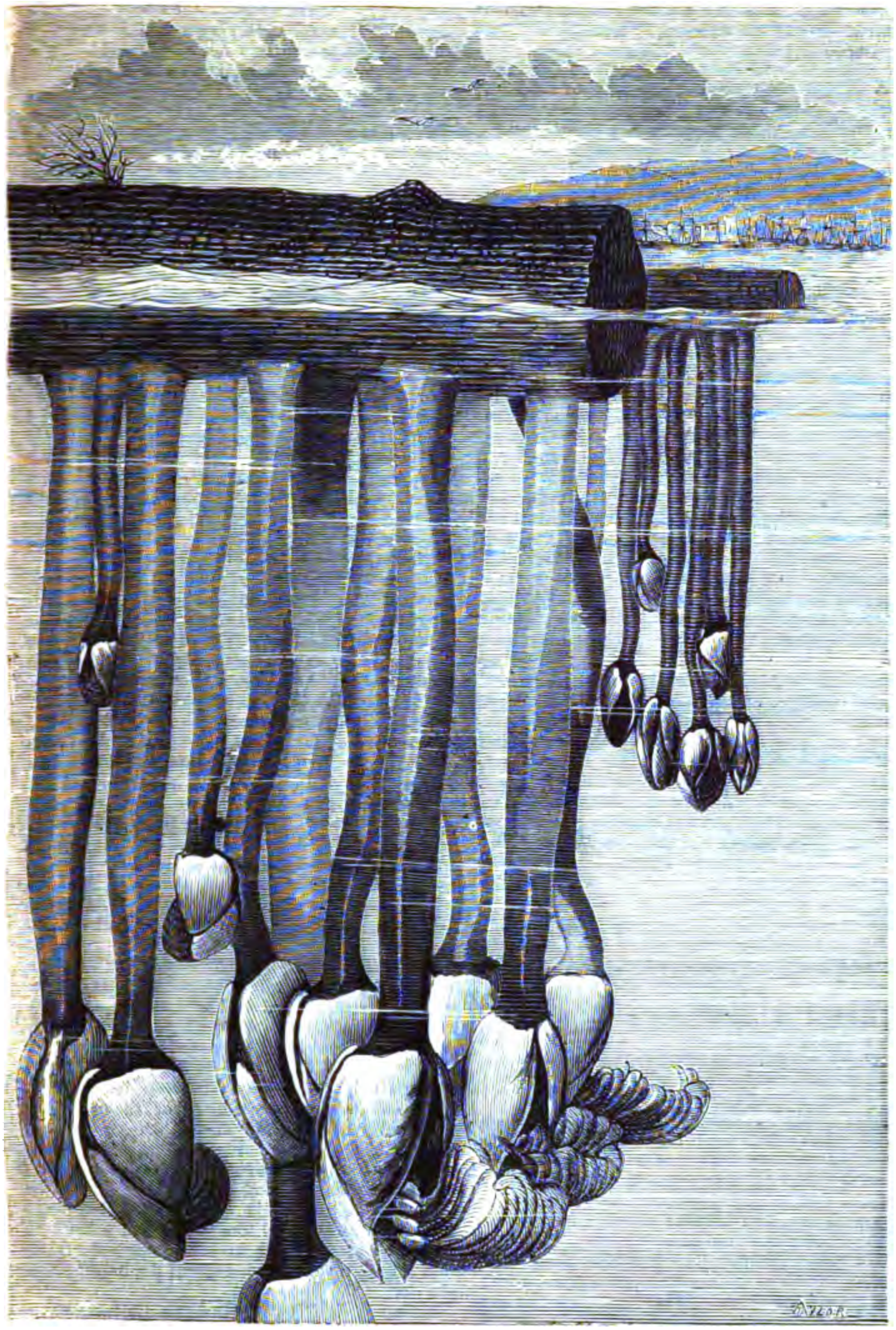
The improvements described in the paper were based upon Mr. Siemens' regenerative furnace. Each stove of a pair consisted of a wrought-iron cylindrical casing, lined with fire-brick, and provided with a central shaft or flue, which extended to within a few feet of the brick dome forming the top. Around this shaft there were a number of compartments, or boxes, formed of bricks so placed that those in one course were not exactly coincident in position with those in the courses either above or below, though a passage was left open from the bottom to the top of the mass of brickwork. This wrought iron casing was provided with several valves, three being for the admission of cold blast, of gas, and of air for combustion, and two being for the exit of the hot blast and of the products of combustion. When a stove had been at work heating blast, and it was wanted to re-heat it, the first thing to be done was to put another stove in operation, then to shut the hot and the cold blast valves, allowing the air in the stove to be blown out at a small valve to reduce it to atmospheric pressure. The gas, air, and chimney valves were next opened, and the gas, igniting as it entered, gave a large volume of flame right up the central shaft and over and into the regenerator, thus heating the top course of brickwork considerably, the next course rather less, and so on, the products of combustion passing away to the chimney at a temperature of about 300 deg. In the course of a few hours, a large amount of caloric was stored up in the bricks forming the regenerator, a good red heat penetrating nearly to the bottom, when the stove was again ready to heat the blast to a temperature of 1400 deg. or 1500 deg. In these stoves the cost of dust catchers was avoided, and the expense of producing gas was also saved, as the gas was used direct from the top of the blast furnace, and the stoves could be cleaned out with the greatest facility. The construction of the regenerator in compartments or boxes, connected together vertically but not horizontally gave the power of applying the blast with efficiency (inasmuch as the whole force of the blast was confined to the one passage that was being blown at the time), and admitted of a brush being passed up or down the boxes to remove the dust. The form and proportion of the passages had been found, after numerous experiments to produce an excellent effect in mixing the air, thereby ensuring a rapid and perfect conduction of heat from the brick to the air, or *vice versa*, from the products of combustion to the bricks.

The results obtained by Messrs. Cochrane from the adoption of these stoves at Ormesby, as regarded the quality of iron, the increased make, and the saving of coke in the blast furnace, had been most satisfactory. Thus there was a saving of 4 cwt. of coke per ton of iron produced, by the use of the regenerative stoves for heating the blast, when compared with good cast-iron pipe stoves, and the saving was still more over ordinary pipe stoves. With a large furnace, producing 475 tons a week, the first cost of these stoves was somewhat less than the cost of pipe stoves, while the expense of working was less, so that the profit, taking every thing into account was estimated to amount to about £4162 a year.

BARNACLES.

WE give this week an engraving of a group of barnacles—a most accurate representation.

It requires a good deal of faith to believe that barnacles are related to crabs, for they are not the least alike, and the first is fixed like a shell-fish on to pieces of timber floating about in the sea, or to the rocks washed by the tide; while the last has legs, claws, eyes, and the power of moving and swimming. Yet it is quite true that the



BARNACLES.

barnacle belongs to the same class of animals that includes the crabs, shrimps, and lobsters. If a piece of rock is put into a large glass full of sea water, many things may be seen on it which are of a white colour, and whose shape is something like that of a thimble with the top battered in. If they are examined it becomes evident that the conical outside is formed of several little bits of hard shell joined together very carefully, and that the top has a valve in it. When the water is quite clear and quiet, a small flapper is forked out through the valve, and is moved to and fro with a motion like that of opening and shutting the fingers. The flapper has some long bristles attached to it, and they are beautiful, feathery-looking things when examined under a microscope. The movement goes on for hours, and ceases upon the least alarm. Then the flappers are withdrawn, the valve closes, and the barnacle—for such is the creature—looks again like a conical piece of stone The flappers are the lungs as well as the hands of the barnacle, and minute living creatures are entangled by them and passed by a current of water into the mouth, which is within the shell. When the barnacle produces its eggs, it ejects them with a stream of water, and they float about in the sea, being very minute things. They soon become hatched, and then it is that the reason becomes clear why barnacles and crabs are placed by zoologists in the same class. The young barnacle is just like a shrimp, with a long body, many long legs close to its head, and a large tail; it has eyes, and swims about most vigorously. It appears to be constantly in movement, and although actively employed in swimming, and in crawling, it does not care to seek for food. After a while the young free-swimming creature rests upon a piece of rock, or wood, or even on the back of a fish, and then a wonderful alteration takes place, The long legs and feelers near the head grasp the substance on which the creature is to live for the future, and a gummy substance comes from a gland which has been growing for some time close to the head. The gum sticks the legs and the feelers to the substance, the eyes diminish in size and are no longer seen, the tail and the hind legs grow into the feathery flappers already noticed and the shell of many pieces encloses all. The barnacle is then fixed for life, head downwards, and it loses its organs of sight, and receives a mouth and stomach, which it had not before, when in the free-swimming state. All barnacles do not undergo this change, for the males of some kinds live inside the conical house which holds the female, and never have houses of their own, for they remain in the free-swimming state. All the animals of the crab class have to undergo a change of form before arriving at maturity, and the common shore crab, when it is first hatched, is a long thing with a great head, and legs fitted for swimming, and not for crawling. As it grows the body shortens by curling the tail end underneath, and the legs and claws grow out of the swimming apparatus. Some of the barnacles that live on coral reefs are very beautiful, and their shells are ornamented in imitation of the flower-like polypes of the stony madrepores.

The accompanying illustration will give the reader a good idea of the appearance which a family of barnacles presents, clinging to the under surface of a floating log.—*Scientific American.*

NOTES ON RECENT DISCOVERIES IN SCIENCE, AND THEIR PRACTICAL APPLICATIONS.*

POISONOUS PROPERTIES OF NEW DYES.

A FURTHER step has been made in the investigation of the reputedly poisonous properties of some of the new dyes. There can be no doubt that cases have occurred in which intensely irritating effects have been produced by a few of these colours, but they have been rare relatively to the frequent use of articles, such as stockings, dyed with them. The researches of M. Guyot go to show that these dyes are poisonous or not according as they are pure or impure. Thus, it is said that azuline, the blue, is poisonous if it contains an excess of aniline. The same colour also produces irritation of the skin when prepared with coraline containing excess of phenol. The coraline red, as we have mentioned before, is the colour which in most cases produced the effects which caused the alarm on the subject. It is not necessary to say more on the matter, for, as the manufacture of the dyes improve, the effects now seen but rarely will never be observed.

ELECTROLYSIS OF NITRIC ACID.

When a very dilute acid is operated upon, hydrogen only is evolved at the negative pole, and no secondary product is found in the liquid contained in the negative compartment. With a less dilute acid, that is, an acid with about 125 equivalents of water, hydrogen is first given off, then a little nitrogen, and the liquid is found to contain traces of ammonia. In the case of a stronger acid with only 15 equivalents of water, while oxygen is freely given off at the positive pole, no hydrogen for some time escapes at the negative, all that gas re-acting on and combining with the acid in the compartment, the liquid assuming a distinctly blue colour. After some time, however, hydrogen mixed with some nitrogen comes off, but soon gives place to an evolution of binoxide of nitrogen, which in its turn ceases, and hydrogen again appears. In the end a good deal of ammonia is found in the negative liquid, and also much nitrious acid. Nitric acid with two equivalents of water gives off at first only binoxide of nitrogen, then hydrogen. Thus we see that the reducing action of hydrogen on nitric acid, according to the strength of that acid, produces nitrous acid, binoxide of nitrogen, nitrogen, and ammonia.

LOGWOOD IN WINE.

A very easy way of detecting logwood colour in wine has been published in France, which, if good for anything, will be useful in discovering the adulteration of port. We have only to moisten a strip of paper with a strong solution of neutral acetate of copper, and dip it into the suspected vinous fluid, which, if it contains logwood, will give a blue colour to the paper. If, however, the colour of the wine be the natural product of the grape the paper changes to a grey shade.

TENSION OF LIQUIDS.

An observation has been made which has resulted in the discovery of a new mode of estimating the strength of alcohol. M. Ducaux has been experimenting on the superficial tension of liquids with an apparatus which exhibits the variations of it in a very remarkable way. A dropping tube, for instance, is arranged to let fall in air 100 drops a minute. If, now, the experiment be repeated in air saturated with vapour of alcohol, instead of 100 drops, 110 will fall in the minute. This is caused by the solution of some alcohol in th water, by which the superficial tension of th liquid is diminished. Further experiments led t the discovery that the strength of alcohol could be exactly determined by ascertaining how many drops would fall in a minute from a given orifice.

TO DYE LINEN WITH ANILINE BLACK.

A simple process is given in the *German Dyers Journal*, which is said to produce a very deep and beautiful black on linen goods by means of aniline. The goods are first immersed in a bath consisting of a solution of acetate of aniline of 4 deg. Baume, to which is also added 4 per cent. of sal ammoniac, 4 per cent. of chlorate of potash, ½ per cent. of nitric acid, and 1 per cent. of sulphate of copper. The goods are then wrung out, and are taken moist to an oxidising chamber and exposed to moist warm air. After two or three days the black is fully developed, and the goods only require to be rinsed in a weak solution of ammonia, and finally in weak soap and water. The result is said to be an extraordinarily beautiful colour.

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* From the *Mechanics' Magazine.*

To Detect the Adulteration of Rice Flour.

Rice flour is said to be often adulterated with wheaten, rye, and maize flour, as well as cheaper materials. The detection of these depends upon the recognition of cerealine, or, if pea or some other meals have been used, leguminosin. Picric acid has the property of precipitating these substances, and thus becomes an important agent in the detection of the above adulterations. It is employed in the following way:—The suspected flour is first digested with cold water for an hour or two, the mixture being frequently stirred. Then the liquor is quickly filtered, and the filtrate is gradually mixed with about an equal volume of a cold saturated solution of picric acid. Any precipitate produced shows that the rice flour has been adulterated with one of the above-named substances. Two per cent. of most of them may be detected in this way.

A Useful Cement.

We mentioned a year or two ago that an excellent cement for fixing iron or stone was made by mixing together commercial glycerine and ground litharge. To-day we read of many other applications of this compound, which seems to be extremely useful. As a cement for joining chemical apparatus, it offers many advantages, for it is unaffected by chlorine, hydrochloric acid, sulphur vapour, sulphurous acid, nitric acid, and, indeed, resists most corrosive vapours. Further than this, it withstands the solvent action of alcohol, ether, sulphide of carbon, and all hydrocarbon vapours. It hardens in from ten to thirty minutes if mixed of the consistence of a thick dough, and sets under water as quickly as in air. Moreover, it will stand a very much higher temperature than any oil cement. The composition may be also employed for moulds for electrotyping. For this purpose glycerine must be stirred with the litharge until a mixture of the proper consistence is obtained. The article to be copied must be smeared with dilute glycerine before the mixture is poured on, and plenty of time must be given for it to set.

Action of Heat on Diamonds.

A jeweller at Marseilles had a couple of diamond shirt studs sent to him for the purpose of having the gold setting enamelled. Not being able to remove easily the stones from the setting he determined to leave them. Not having any charcoal, moreover, he heated his muffle furnace with coal. When the studs were taken from the muffle he found that the enamel was perfect, but to his surprise the diamonds were black. Vain were his endeavours to restore the brilliancy of the stones. Rubbing only made them shine like black lead. The stone of the lapidary, however, cut away the black layer, and then it was found that the weight of the stone had not been diminished. This curious result induced M. Morren to make some experiments on the behaviour of diamonds exposed to heat under different conditions. First, he heated one to a white heat in a current of coal gas, and obtained exactly the same result as the jeweller. The stone appeared to be covered with a layer of plumbago, which could not be removed by friction, and the stones were found to have increased in weight. M. Morren succeeded in burning the black deposit away by simply heating the stone to redness in the air, after which it was as brilliant as before. Heated in hydrogen the diamond remains completely unaffected, even at the temperature at which platinum melts. In carbonic acid, however, it loses brilliancy and also weight if the exposure to heat is prolonged. M. Morren tells us that it is often difficult to burn diamonds, which is a matter of little consequence, since it is what people seldom wish to do. If anyone, however, desires to indulge in the expensive amusement he may be glad to know that in most cases it is sufficient to make the stone white hot on platinum, and plunge into oxygen, when it is quietly consumed without blackening, remaining brilliant to the last. M. Morren tells us further the diamonds have different crystalline structures, revealed by the appearance of half-burnt specimens.

A Modification of Smee's Galvanic Battery.

A Frenchman, M. Figuier, has succeeded in producing, but with considerable trouble, a cheap battery on the same principle as Smee's. Instead of a simple platinum plate he makes plates of retort coke, paints them over with a strong solution of chloride of platinum, dries and then reduces the metal upon the coke by heating it in the fire. Silvered carbon may, however, be used, instead of platinised, but these plates are obtained with more trouble. The carbons are first done over with a solution of nitrate of silver, and are then, while moist, exposed to hydrochloric acid gas. In this way, a coating of chloride of silver is procured which may be fused into the coke by heating. The silver will be reduced upon the carbon by the first action of the battery. Plates made in either of these ways, M. Figuier says, are superior to the platinised silver or platinum plates hitherto used in a Smee's battery, the irregular surface promoting the escape of the hydrogen. The author details a method of giving a rough surface to the cut plates of retort coke. It consists in spreading the plates over with a mixture of diluted white of egg or blood albumen and syrup, and then carefully burning them until smoke is no longer given off. The process being repeated two or three times, myriads of points, the débris of minute vesicles, remain firmly attached to the original carbon plate. The plates thus made must be well washed in a large quantity of water, to remove any loose particles which might otherwise fix themselves accidentally upon the zinc, and set up local action. These carbon plates are very durable, the author having had some in use for three years. They are comparatively cheap if troublesome to make, and the simplicity of the arrangement of the battery will, no doubt, recommend this modification.

ON STAR-GROUPING, STAR-DRIFT, AND STAR-MIST.[*]

Nearly a century has passed since the greatest astronomer the world has ever known—the Newton of observational astronomy, as he has justly been called by Arago—conceived the daring thought that he would gauge the celestial depths. And because in his day, as indeed in our own, very little was certainly known respecting the distribution of the stars, he was forced to found his researches upon a guess. He supposed that the stars, not only those visible to the naked eye, but all that are seen in the most powerful telescopes, are suns, distributed with a certain general uniformity throughout space. It is my purpose to attempt to prove that—as Sir Wm. Herschel was himself led to suspect during the progress of his researches—this guess was a mistaken one; that but a small proportion of the stars can be regarded as real suns; and that in place of the uniformity of distribution conceived by Sir Wm. Herschel, the chief characteristic of the sidereal system is *infinite variety.*

In order that the arguments on which these views are based may be clearly apprehended, it will be necessary to recall the main results of Sir Wm. Herschel's system of star-grouping.

Directing one of his 20-feet reflectors to different parts of the heavens, he counted the stars seen in the field of view. Assuming that the telescope really reached the limits of the sidereal system, it is clear that the number of stars seen in any direction affords a means of estimating the relative extension of the system in that direction, provided always that the stars are really distributed throughout the system with a certain approach to uniformity. Where many stars are seen, there the system has its greatest extension; where few, the limits of extension must be nearest to us.

Sir Wm. Herschel was led by this process of star-grouping to the conclusion that the sidereal system has the figure of a cloven disc. The stars visible to the naked eye lie far within the limits of this disc. Stars outside the relatively narrow limits of the sphere, including all the visible stars, are separately invisible; but where the system has its greatest extension these orbs produce collectively the diffused light which forms the Milky Way.

Sir John Herschel, applying a similar series of researches to the southern heavens, was led to a very similar conclusion. His view of the sidereal system differs chiefly in this respect from his father's, that he considered the stars within certain limits of distance from the sun to be spread less richly through space than those whose united lustre produces the milky light of the galaxy.

Now it is clear that if the supposition on which these views are based is just, the three following results are to be looked for.

In the first place the stars visible to the naked eye would be distributed with a certain general uniformity over the celestial sphere; so that if on the contrary we find certain extensive regions over which such stars are strewn much more richly than over the rest of the heavens, we must abandon Sir Wm. Herschel's fundamental hypothesis, and all the conclusions which have been based upon it.

In the second place, we ought to find no signs of the aggregation of lucid stars into streams or clustering groups. If we should find such associated groups we must abandon the hypothesis of uniform distribution, and all the conclusions founded on it.

Thirdly, and most obviously of all, the lucid stars ought not to be associated in a marked manner with the figure of the Milky Way. To take an illustrative instance. When we look through a glass window at a distant landscape, we do not find that the specks in the substance of the glass seem to follow the outline of valleys, hills, trees, or whatever features the landscape may present. In like manner, regarding the sphere of the lucid stars as in a sense the window through which we view the Milky Way, we ought not to find these stars, which are so near to us, associated with the figure of the Milky Way, whose light comes from distances so enormously exceeding those which separate us from the lucid stars. Here again, then, if there should appear signs of such association, we must abandon the theory that the sidereal system is constituted as Sir Wm. Herschel supposed.

It should further be remarked that the three arguments derived from these relations are independent of each other. They are not as three links of a chain, any one of which being broken the chain is broken. They are as three strands of a triple cord. If one strand holds, the cord holds. It may be shown that all three are to be trusted.

It is not to be expected, however, that the stars as actually seen should exhibit these relations, since far the larger number are but faintly visible; so that the eye would look in vain for the signs of law among them, even though law may be there. What is necessary is that maps should be constructed on a uniform and intelligible plan, and that in these maps the faint stars should be made bright, and the bright stars brighter.

The maps exhibited during this discourse have been devised for this purpose amongst others. There are twelve of them, but they overlap, so that in effect each covers a tenth part of the heavens. There is first a north-polar map, then five maps symmetrically placed around it; again, there is a south-polar map, and five maps symmetrically placed round that map; and these five so fit in with the first five as to complete the enclosure of the whole sphere. In effect every map of the twelve has five maps symmetrically placed around it and overlapping it.[*]

Since the whole heavens contain but 5932 stars visible to the naked eye, each of the maps should contain on the average about 593 stars. But instead of this being the case, some of the maps contain many more than their just proportion of stars, while in others the number as greatly falls short of the average. One recognises, by combining these indications, the existence of a roughly circular region, rich in stars, in the northern heavens, and of another, larger and richer, in the southern hemisphere.

To show the influence of these rich regions, it is only necessary to exhibit the numerical relations presented by the maps.

The north-polar map, in which the largest part of the northern rich regions fall, contains no less than 693 lucid stars, of which upwards of 400 fall within the half corresponding to the rich region.

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[*] The substance of a lecture delivered by R. A. Proctor, B.A., at the Royal Institution on May 6.

[*] It will be understood that the description here, and all which immediately follows, replaces portions of the discourse which would only be intelligible when illustrated by means of the diagrams and illuminated maps actually employed.

Of the adjacent maps, two contain upwards of 500 stars, while the remaining three contain about 400 each. Passing to the southern hemisphere, we find that the south-polar map, which falls wholly within a rich region, contains no less than 1132 stars! One of the adjacent maps contains 834 stars, and the four others exhibit numbers ranging from 557 to 595.

It is wholly impossible not to recognise so unequal a distribution as exhibiting the existence of special laws of stellar aggregation.

It is noteworthy, too, that the greater Magellanic cloud falls in the heart of the southern rich region. Were there not other signs that this wonderful object is really associated with the sidereal system it might be rash to recognise this relation as indicating the existance of a physical connection between the Nubecula Major and the southern region rich in stars. Astronomers have indeed so long regarded the Nubeculæ as belonging neither to the sidereal nor to the nebular systems, that they are not likely to recognise very readily the existence of any such connection. Yet how strangely perverse is the reasoning which has led astronomers so to regard these amazing objects. Presented fairly, that evidence amounts simply to this:—The Magellanic clouds contain stars and they contain nebulæ; therefore they are neither nebular nor stellar. Can perversity of reasoning be pushed farther? Is not the obvious conclusion this, that since nebulæ and stars are *seen* to be intermixed in the Nubeculæ, the nebular and stellar systems form in reality but one complex system.

As to the existence of star-streams and clustering aggregations, we have also evidence of a decisive character.* There is a well-marked stream of stars running from near Capella towards Monoceros. Beyond this lies a long dark rift altogether bare of lucid orbs, beyond which again lies an extensive range of stars, covering Gemini, Cancer, and the southern parts of Leo. This vast system of stars resembles a gigantic sidereal billow flowing towards the Milky Way as towards some mighty shore-line. Nor is this description altogether fanciful; since one of the most marked instances of star-drift presently to be adduced refers to this very region. These associated stars *are* urging their way towards the galaxy, and that at a rate which, though seemingly slow when viewed from beyond so enormous a gap as separates us from this system, must in reality be estimated by millions of miles in every year.

Other streams and clustering aggregations there are which need not here be specially described. But it is worth noticing that all the well-marked streams recognised by the ancients seem closely associated with the southern rich region already referred to. This is true of the stars forming the River Eridanus, the serpent Hydra, and the streams from the water-can of Aquarius. It is also noteworthy that in each instance a portion of the stream lies outside the rich region, the rest within it; while all the streams which lie on the same side of the galaxy tend towards the two Magellanic clouds.

Most intimate signs of association between lucid stars and the galaxy can be recognised,—(i.) in the part extending from Cygnus to Aquila; (ii.) in the part from Perseus to Monoceros; (iii.) over the ship Argo; and (iv.) near Crux and the feet of Centaurus.

Before proceeding to the subject of Star-drift, three broad facts may be stated. They are, I believe, now recognised for the first time, and seem decisive of the existence of special laws of distribution among the stars:—

First, the rich southern region, though covering but a sixth part of the heavens, contains one-third of all the lucid stars, leaving only two-thirds for the remaining five-sixths of the heavens.

Secondly, if the two rich regions and the Milky Way be considered as one part of the heavens, the rest as another, then the former part is three times as richly strewn with lucid stars as the second.

Thirdly, the southern hemisphere contains one thousand more lucid stars than the northern, a fact which cannot but be regarded as most striking when it is remembered that the total number of lucid stars in both hemispheres falls short of 6000.

Two or three years ago, the idea suggested itself to me that if the proper motions of the stars were examined, they would be found to convey clear information respecting the existence of variety of structure, and special laws of distribution within the sidereal system.

In the first place the mere amount of a star's apparent motion must be regarded as affording a means of estimating the star's distance. The nearer a moving object is, the faster it will seem to move, and *vice versa.* Of course in individual instances little reliance can be placed on this indication; but by taking the average proper motions of a set of stars, no untrustworthy measure may be obtained of their average distance, as compared with the average distance of another set.

For example, we have in this process the means of settling the question whether the apparent brightness of a star is indeed a test of relative nearness. According to accepted theories the sixth-magnitude stars are ten or twelve times as far off as those of the first magnitude. Hence their motions should, on the average, be correspondingly small. Now, to make assurance doubly sure, I divided the stars into two sets, the first including the stars of the 1st, 2nd, and 3rd, the second including those of the 4th, 5th, and 6th magnitude. According to accepted views, the average proper motion for the first set should be about five times as great as that of the second. I was prepared to find it about as three times as great; that is, not so much greater as the accepted theories require, but still considerably greater. To my surprise I found that the average proper motion of the brighter orders of stars is barely equal to that of the three lower orders.

This proves beyond all possibility of question that by far the greater number of the fainter orders of stars (I refer here throughout to lucid stars) owe their faintness not to vastness of distance, but to real relative minuteness.

To pass over a number of other modes of research, the actual mapping of the stellar motions, and the discovery of the peculiarity to which I have given the name of star-drift, remains to be considered.

In catalogues it is not easy to recognise any instances of community of motion which may exist among the stars, owing to the method in which the stars are arranged. What is wanted in this case (as in many others which yet remain to be dealt with) is the adoption of a plan by which such relations may be rendered obvious to the eye. The plan I adopted was to attach to each star in my maps a small arrow, indicating the amount and direction of that star's apparent motion in 36,000 years (the time-interval being purposely lengthened, as otherwise most of the arrows would have been too small to be recognised). When this was done, several well-marked instances of community of motion could immediately be recognised.

It is necessary to premise, however, that before the experiment was tried, there were reasons for feeling very doubtful whether it would succeed. A system of stars might really be drifting athwart the heavens, and yet the drift might be rendered unrecognisable through the intermixture of more distant or nearer systems having motions of another sort, and seen accidentally in the same general direction.

This was found to be the case, indeed, in several instances. Thus the stars in the constellation Ursa Major, and neighbouring stars in Draco, exhibit two well-marked directions of drift. The stars β, γ, δ, ε, and ζ of the Great Bear, besides two companions of the last-named star, are travelling in one direction, with equal velocity, and clearly form one system. The remaining stars in the neighbourhood are travelling in a direction almost exactly the reverse. But even this relation, thus recognised in a region of diverse motions, is full of interest. Byron Madler, the celebrated German astronomer, recognising the community of motion between ζ Ursæ and its companions, calculated the cyclic revolution of the system to be certainly not less than 7000 years. But when the complete system of stars showing this motion is considered, we get a cyclic period so enormous, that not only the life of man, but the life of the human race, the existence of our earth, nay, even the existence of the solar system, must be regarded as a mere day in comparison with that amazing cycle.

Then there are other instances of star-drift where, though two directions of motion are not intermixed, the drift character of the motion is not at once recognised, because of the various distances at which the associated stars lie from the eye.

A case of this kind is to be met with in the stars forming the constellation Taurus. It was here that Mädler recognised a community of motion among the stars, but he did not interpret this as I do. He had formed the idea that the whole of the sidereal system must be in motion around some central point; and for reasons which need not here be touched on, he was led to believe that in whatever direction the centre of motion may lie, the stars seen in that general direction would exhibit a community of motion. Then, that he might not have to examine the proper motions all over the heavens, he inquired in what direction (in all probability) the centre of motion may be supposed to lie. Coming to the conclusion that it must be towards Taurus, he examined the proper motions in that constellation, and found a community of motion which led him to regard Alcyone, the chief star of the Pleiades, as the centre around which the sidereal system is moving. Had he examined farther he would have found more marked instances of community of motion in other parts of the heavens, a circumstance which would have at once compelled him to abandon his hypothesis of a central sun in the Pleiades, or at least to lay no stress on the evidence derivable from the community of motion in Taurus.

Perhaps the most remarkable instance of star-drift is that observed in the constellations Gemini and Cancer. Here the stars seem to set bodily towards the neighbouring part of the Milky Way. The general drift in that direction is too marked, and affects too many stars, to be regarded as by any possibility referable to accidental coincidence.

It is worthy of note that if the community of star-drift should be recognised (or I prefer to say, *when it is recognised*), astronomers will have the means of determining the relative distances of the stars of a drifting system. For differences in the apparent direction and amount of motion can be due but to differences of distance and position, and the determination of these differences becomes merely a question of perspective.*

Before long it is likely that the theory of star-drift will be subjected to a crucial test, since spectroscopic analysis affords the means of determining the stellar motions of recess or approach. The task is a very difficult one, but astronomers have full confidence that in the able hands of Mr. Huggins it will be successfully accomplished. I await the result with full confidence that it will confirm my views.

(To be concluded next week.)

MECHANICAL MOVEMENTS.

(Continued from page 221.)

119 Compensation balance. *t a t'* is the main bar of balance, with timing screws for regulation at the ends. *t* and *t'* are two compound bars, of which the outside is brass and the inside steel, carrying weights *b b'*. As heat increases, these bars are bent inward by the greater expansion of the brass, and the weights are thus drawn inward, diminishing the inertia of the balance. As the heat diminishes, an opposite effect is produced. This balance compensates both for its own expansion and contraction, and that of the balance-spring.

120. Endless chain, maintaining power on going-barrel, to keep a clock going while winding, during which operation the action of the weight or main-spring is taken off the barrel. The wheel to the right is the "going-wheel," and that to the left the "striking-wheel." P is a pulley fixed to the great wheel of the going part, and roughened, to prevent a rope or chain hung over it from slipping. A similar pulley rides on another arbor *p* which may be the arbor of the great wheel of the striking part, and attached by a ratchet and click to that wheel, or to clock-frame, if there is no striking part. The weights are hung, as may be seen, the small one being only large enough to keep the rope or chain on the pulleys. If the part *b* of the rope or chain is pulled down, the ratchet-pulley runs under the click, and the great weight is pulled up by *c* without taking its pressure off the going-wheel at all.

121. Harrison's "going-barrel." Larger ratchet-wheel, to which the click R is attached, is connected with the great wheel G by a spring S S'. While the clock is going, the weight acts upon the great wheel G through the spring; but as soon as the weight is taken off by winding, the

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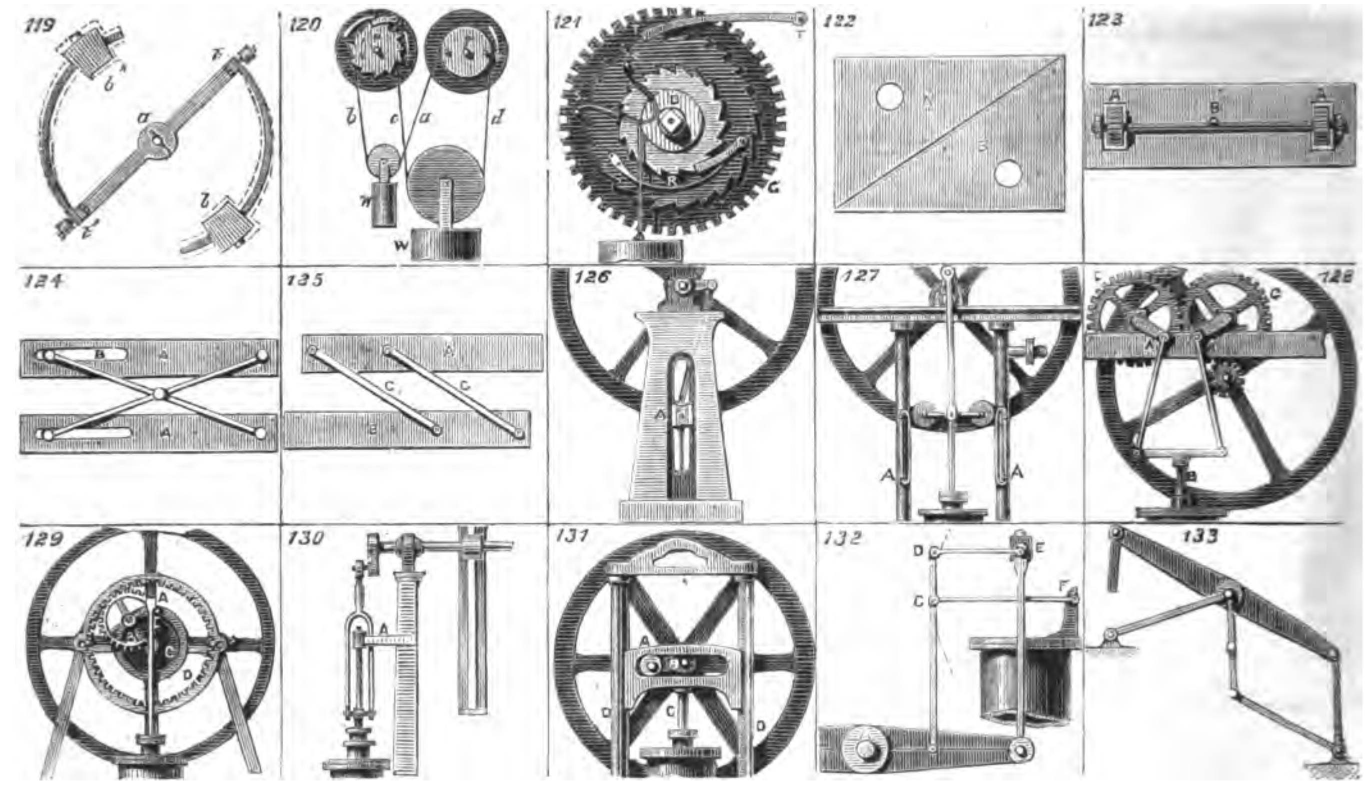
* Here, again, without the illustrative maps the argument is necessarily rendered imperfect.

* Here no account is taken of the motions of the stars within the system; such motions must be minute compared with the common motion of the system.

† Extracted from a compilation by Mr. H. T. Brown Editor of the *American Artisan*.



MECHANICAL MOVEMENTS.

click T whose pivot is set in the frame, prevents the larger ratchet from falling back, and so the spring S S′ still drives the great wheel during the time the clock takes to wind, as it need only just keep the escapement going, the pendulum taking care of itself for that short time. Good watches have a substantially similar apparatus.

122. A very convenient construction of parallel ruler for drawing, made by cutting a quadrangle through the diagonal, forming two right-angled triangles A and B. It is used by sliding the hypothenuse of one triangle upon that of the other.

123. Parallel ruler consisting of a simple straight ruler B, with an attached axle C, and pair of wheels A A. The wheels, which protrude but slightly through the under side of the ruler, have their edges nicked to take hold of the paper and keep the ruler always parallel with any lines drawn upon it.

124. Compound parallel ruler, composed of two simple rulers A A connected by two crossed arms pivotted together at the middle of their length, each pivotted at one end to one of the rulers, and connected with the other one by a slot and sliding-pin, as shown at B. In this the ends as well as the edges are kept parallel. The principle of construction of the several rulers represented is taken advantage of in the formation of some parts of machinery.

125. Parallel ruler composed of two simple rulers A B connected by two pivotted swinging arms C C.

126. A simple means of guiding or obtaining a parallel motion of the piston-rod of an engine. The slide A moves in and is guided by the vertical slot in the frame, which is planed to a true surface.

127 differs from 126 in having rollers substituted for the slides on the cross-head, said rollers working against straight guide-bars A A, attached to the frame. This is used for small engines in France.

128. A parallel motion invented by Dr. Cartwright in the year 1787. The toothed wheels C C have equal diameters and numbers of teeth; and the cranks A A have equal radii, and are set in opposite directions, and consequently give an equal obliquity to the connecting-rods during the revolution of the wheels. The cross-head on the piston-rod being attached to the two connecting-rods, the piston-rod is caused to move in a right line.

129. A piston-rod guide. The piston-rod A is connected with a wrist attached to a cog-wheel B which turns on a crank-pin, carried by a plate C which is fast on the shaft. The wheel B revolves around a stationary internally toothed gear D, of double the diameter of B, and so motion is given to the crank-pin, and the piston-rod is kept upright.

130. The piston-rod is prolonged and works in a guide A, which is in line with the centre of the cylinder. The lower part of the connecting-rod is forked to permit the upper part of the piston-rod to pass between.

131. An engine with crank motion, the crank-wrist journal working in a slotted cross-head A. This cross-head works between the pillar guides D D of the engine framing.

132. A parallel motion used for the piston-rod of side lever marine engine. F C is the radius bar, and E the cross-head to which the parallel bar E D is attached.

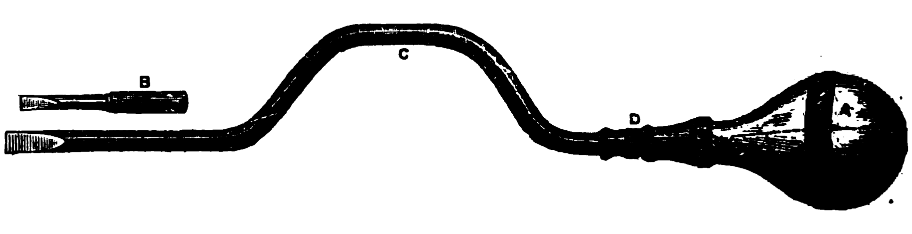
133. A parallel motion used only in particular cases.

(*To be continued.*)

IMPROVED SCREW DRIVER.

THE device of which an engraving is given, secures increased leverage at the will of the workman without increased length, and will for many kinds of light work also take the place of the bitstock or brace for drilling, boring, &c.

In the engraving A represents a wood handle, having a recess to receive and retain, when not in use, a second and smaller point, B. This recess is indicated by the dotted line. This supplementary point has a sleeve, indicated by a dotted line, which slips over the point of the larger screw driver.



The shank C of the larger screw-driver is bent in the form shown. At D is a clutch, one portion of which is formed on the shank, and its counterpart on the handle, and underneath the ferrule.

The extremity of the shank C in the interior of the handle, has a turned groove, into which the point of the screw E enters, and holding the handle so that the two portions of the clutch cannot engage with each other, permits the shank C to be revolved like an ordinary bit stock.

When it is desired to use the tool with one hand, the screw E may be turned out a little distance, when its point no longer enters the groove, and the counterparts of the clutch at D engage with each other. The shank will then turn with the handle, and may be used precisely like the ordinary screw-driver, except that when it is necessary to use the power of both hands in driving home a large screw, an increased leverage is gained by the curvature of the shank.

It will also be obvious that bits properly formed may be placed on the end of the large screw-driver in the same manner as the supplementary point B above described, when the instrument will take the place of the ordinary *bit-stock*.

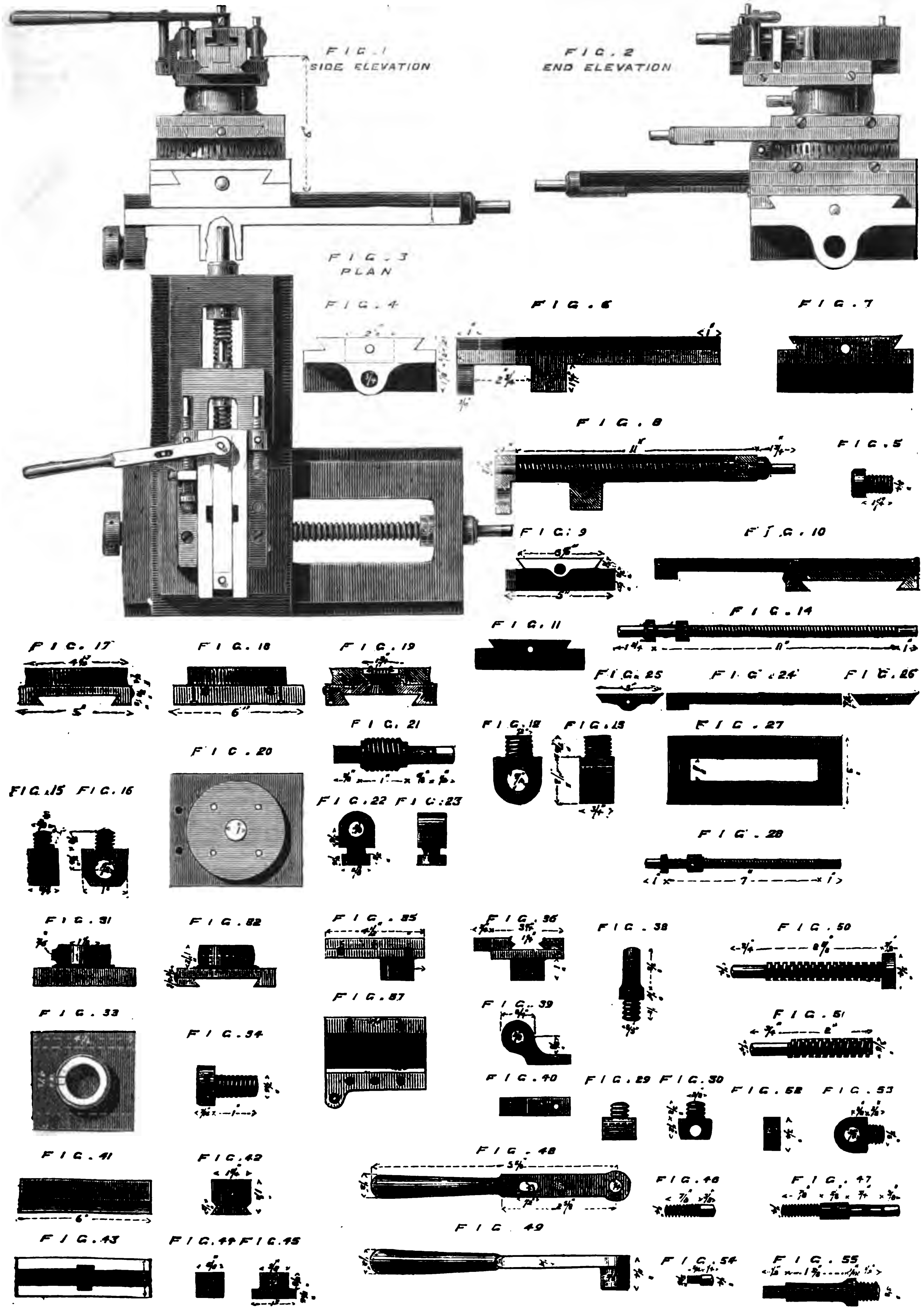
David Drummond, of McGregor Iowa, *U.S.A.*, is the patentee.

THE LATHE AND ITS USES—THE SPHERICAL SLIDE-REST.

WE give this week very complete working drawings of the slide-rest for spherical and curvilinear work, described in the ENGLISH MECHANIC for November 19th. As a full general description of the rest was then given, it will suffice if we now simply explain the various detailed figures.

Fig. 1 gives a side elevation; Fig. 2 an end elevation; and Fig. 3 a plan of the slide-rest complete; Fig. 4 is a back-end elevation of the main slide; Fig. 5, the screw at back; Fig. 6, a side elevation, and Fig. 7 a front-end elevation of the main slide; Fig. 8 is the side elevation of the slide in section, showing also the position and arrangement of the traverse screw; Figs. 9, 10, and 11 are elevations of the second slide; Figs. 13 and 13 show the nut for traversing this slide; Fig. 14 shows the second traverse screw; Figs. 15 and 16 give the nut for this screw; Figs. 17 and 18 are elevations of the slide which carries the tangent wheel; Fig. 19 is also an elevation of the same slide, but in this the slide and tangent wheel is shown in section. This Fig. also shows the met[illegible] attaching the tangent wheel to the slide; is a plan of this slide and tangent wheel;

THE LATHE AND ITS USES.—THE SPHERICAL SLIDE REST.



is the endless screw for gearing into the tangent wheel; Figs. 22 and 23 show the lugs or bearings which carry the endless screw—the nuts of these lugs are recessed into the underpart of the slide; Figs. 24, 25, and 26, are elevations of the third slide, a slide which is fastened to the tangent wheel; Fig. 27 is a plan of this slide; Fig. 28 is the traverse screw for this slide; Figs. 29 and 30 show the nut belonging to this traverse screw; Figs. 31 and 32 are elevations of the top slide, which has a boss or socket for receiving the too slide; Fig. 33 is a plan of this slide; Fig. 34 is the nipping screw for holding the tool slide in position; Figs. 35 and 36 are elevations of the tool slide; Fig. 37 a plan of the slide; Fig. 38 is one of the side stops; Figs. 39 and 40 show the lug, which is attached to the tool slide; Figs. 41 and 42 are elevations of the tool receptacle; Fig. 43 is a plan of the tool receptacle, which shows also the opening for inserting the holding nuts; Figs. 44 and 45 show the holding-down nut, of which there are two; Fig. 46 shows the nipping-screw for one of these nuts; Fig. 47 is the screw for the other nut, the top part of which is differently shaped to receive the lever for moving the tool into cut—this lever is shown at Figs. 48 and 49; Figs. 50 and 51 show the two screws for regulating the cutting depth for the tool; Figs. 52 and 53 show the lug nuts for these screws; Fig. 54 is the small screw which is used for nipping the two regulating screws; and Fig. 55 is a stud, which forms the fulcrum for the forcing lever.

W. H. N.

FRICTION.—VIII.

By C. Draper, A.B., L.C.E.

(*Continued from page* 83.)

The Screw.—This mechanical power is generally so fully described in elementary works on mechanics, that we may dismiss it with a few remarks.

As the screw with a rectangular thread may be described to be a cylinder round which is wrapped a triangular plate of uniform thickness, from which the lower portion is cut away so as to leave a projection of uniform breadth and depth whose upper and lower surfaces project at right angles to the surface of the cylinder at every point, we see that the screw is merely a modification of the "inclined plane," for it is clearly a matter of indifference, with regard to the forces engaged, whether we urge the body up the inclined plane or force the inclined plane under the body.

Suppose now the screw to be placed vertically, let i be the angle of inclination of the thread to the horizon, P' the power applied horizontally at the circumference of the screw, and W the resistance overcome acting vertically, then, referring to Vol. X., page 598, we have

$$P' = W \tan (i + \phi)$$

Or if, as is always the case, P be applied at a distance R from the axis, we have, since $P = P' \times \frac{r}{R}$,

$$P = W \times \frac{r}{R} \tan. (i + \phi)$$

where r is the radius of the screw.

This formula can be put into a form which contains the lineal dimensions of the screw alone. Let h be the "pitch" of the screw, or distance from any point of one thread to the corresponding point on the next, measured parallel to the axis, then $\tan. i = \frac{h}{2\pi r}$, and since

$$\tan. (i + \phi) = \frac{\tan. i + \tan. \phi}{1 - \tan. i \tan. \phi}, \text{ we have}$$

$$P = W \times \frac{r}{R} \cdot \frac{\frac{h}{2\pi r} + \mu}{1 - \frac{h\mu}{2\pi r}}$$

$$P = W \times \frac{r}{R} \cdot \frac{h + 2\pi r\mu}{2\pi r - h\mu}$$

In this formula we have supposed i and r to be definite quantities for any given screw; but this is not strictly the case, since the angle of inclination of the thread increases continually from the outside of the thread to the circumference of the cylinder. We shall, therefore, consider i to be the inclination of the thread at half its depth, or midway between the circumference of the cylinder and the outside of the thread, and r to be the distance of this point from the axis; these average values will give an approximation sufficiently near the truth.

The ordinary screw press, a sketch of which is given in Fig. 15, affords a good example of the manner in which friction affects the working of machines. Before the lever P can be turned, the following frictions must be overcome in addition to the resistance of the body *c c* to be compressed:—1st. The friction of the thread of the screw A in the groove of the nut B, which may be divided into two parts, the friction of the upper or lower surfaces of the thread and groove, and the friction of the cylindrical surfaces of the thread and groove. 2nd. Between the vertical guides M and N and the moveable plate D; 3rd. Between the flat surface of the extremity of the screw and the piece D, which we shall shortly speak of under the head of "Friction of a Pivot."

Example 14.—The diameter of the screw of a screw press is 3in., the pitch is ½in., what effort can this press exert if a power of 25lb. be applied at the end of a 3ft. lever, neglecting all friction but that between the screw and nut, which is most important, and of which the coefficient is ⅛?

Here

$$P = 25,\ r = 1\tfrac{1}{2},\ R = 36\text{in.},\ h = \tfrac{1}{2},\ \text{and}\ \mu = \tfrac{1}{8}$$

Therefore

$$25 = W \times \frac{1\frac{1}{2}}{36} \times \frac{\frac{1}{2} + \frac{3 \times 22}{8 \times 7}}{\frac{3 \times 22}{7} - \frac{1}{2 \times 8}}$$

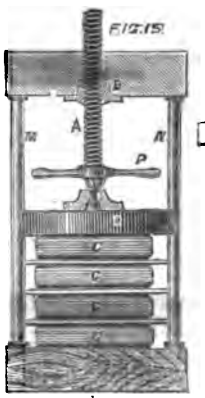
or

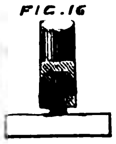
$$25 = W \times \frac{1}{24} \times \frac{28 + 66}{528 - 3{\cdot}5}$$

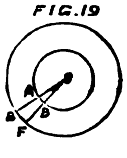
or

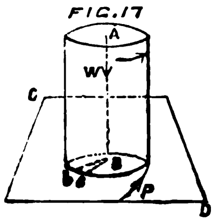
$$W = \frac{25 \times 24 \times 524{\cdot}5}{94} = 3348\text{lb., or } 1\tfrac{1}{2} \text{ tons nearly.}$$

Example 15.—The diameter of the screw of a small bench vice is ¾in., and the thread makes 5 turns to the inch; the handle is 7in. long, and 5in. distant from the joint of the jaws, which are 7in. long; find with what force the jaws are pressed together when the handle is turned with a force of 100lb. if the coefficient of friction is ⅛, neglecting the friction of the joint.









Here

$$P = 100,\ r = \tfrac{3}{8},\ R = 7,\ h = \tfrac{1}{5}\text{in., and}\ \mu\ \tfrac{1}{8}.$$

therefore

$$100 = W \times \frac{3}{8 \times 7} \times \frac{\frac{1}{5} + \frac{3 \times 22}{4 \times 7 \times 8}}{\frac{3 \times 22}{4 \times 7} - \frac{1}{5 \times 8}}$$

or

$$100 = W \times \frac{3}{56} \times \frac{56 + 82{\cdot}5}{660 - 7}$$

or

$$W = \frac{100 \times 56 \times 653}{3 \times 138{\cdot}5} = 8801\text{lb., or } 3\tfrac{7}{8} \text{ tons nearly.}$$

As this is a power applied between the fulcrum and resistance of a lever whose arms are 7 and 5; to find the force at the jaws we must reduce 8801 in the proportion of 5 to 7, *i.e.*, $8801 \times \frac{5}{7} = 2{\cdot}8$ tons nearly. As friction increases in direct proportion to the pressure, it is manifest that the screw press has this defect, that the work lost by friction goes on increasing during the process of compressing any substance, and that at the close, when the greatest effect is desired, we have the greatest loss from friction to contend against.

Friction of a Pivot.—A pivot may be defined as the support of the lower extremity of a vertical shaft. The pivot may be formed on the shaft itself or attached to it as in Fig. 15, or the pivot may form the support, and enter a socket in the end of the shaft, as in Fig. 16. In either case, we have a circular surface pressed against another with a certain force, and capable of turning round its centre.

The question is now, to find what force applied at the circumference in a tangential direction will be just sufficient to turn it round. In Fig. 17, let W be the force, which, acting along the axis of the pivot, urges the surface B against the fixed plane C D. We may assume that the pressure is uniformly distributed over the surface B, hence if we suppose the circle B to be divided into elementary triangles, such as B *b c*, the pressure on each must act vertically downwards through its centre of gravity, which is distant ⅔ r from B. The moment of the friction of this elementary triangle round B must therefore be the pressure on it multiplied by μ and by ⅔ r, therefore the moment of the whole friction of the pivot round B must be the sum of the moments of the frictions of all the elementary triangles which make up the entire circle, or the total pressure, W, multiplied by μ and by ⅔ r. But the moment of the required force is P r, therefore

$$P r = \tfrac{2}{3} \mu W r \text{ or } P = \tfrac{2}{3} \mu W.$$

Example 16.—The pressure on a pivot is 1000lb., its diameter is 6in., and it makes 5 revolutions per second; if $\mu = \frac{1}{10}$, find the work expended per minute on friction. A pressure at the circumference of ⅔ μ W being equal to the friction, in every revolution of the pivot a pressure of ⅔ μ W is overcome for the length of the circumference, or $2\pi r$, therefore, if n be the number of revolutions per minute $\frac{4}{3} W n \mu \pi r$ will be the number of units of work expended per minute on friction.

Here

$$W = 1000,\ n = 300,\ \mu = \frac{1}{10} \text{ and } r = 3\text{in. or } \tfrac{1}{4}\text{ft.}$$

$$\therefore \text{ work} = \frac{4 \times 1000 \times 300 \times 22}{3 \times 10 \times 7 \times 4} = 31428 \text{ foot-pounds.}$$

Example 17.—A circular block of dressed granite (specific gravity = 2·6), 3ft. in diameter, and 1ft in height, rests on a rough horizontal plane; if the coefficient of friction = ½, and the block be capable of a motion only of rotation round a vertical axis, passing through its centre of figure, calculate the magnitude of the force, which, applied tangentially at its circumference, will suffice just not to move it.

Since a cubic foot of water weighs 62·5lb., we have

$$W = \pi r^2 \times 62{\cdot}5 \times 2{\cdot}6 \text{ pounds,}$$

$$\therefore\ P \text{ (in cwts.)} = \frac{2 \times 22 \times 1{\cdot}5 \times 1{\cdot}5 \times 2{\cdot}6 \times 62{\cdot}5}{7 \times 3 \times 2 \times 112} =$$

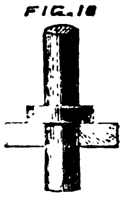
3·42cwt. nearly.

From the above formula for the friction of a pivot, we see that in the screw, when the friction on the end as well as the friction on the thread is taken into account, that

$$P = \frac{W}{R} \left\{ r \tan. (i + \phi) + \tfrac{2}{3} \mu r' \right\}$$

where r' is the radius of the end or pivot.

Frequently we support a vertical shaft by means of a collar, as in Fig. 18. In this case the surface of contact between the collar and its support is clearly an annulus, whose external radius is the radius of the collar, and the radius internal radius of the shaft.



In Fig. 19, let C A, the radius of the shaft, = r, and C B the radius of the collar, = R, then the element of area is in this case a trapezium A B D E, the pressure in which acts through its centre of gravity, equal to which is situate at a distance

$$\tfrac{2}{3} \times \frac{R^2 + R r + r^2}{R + r}$$

from the centre C. We have, then, in this case also the moment of the friction of the collar equal to the sum of the moments of the frictions of all the elementary trapeziums, which make up the entire annulus,

or

$$P R = \tfrac{2}{3} \mu W \times \frac{R^2 + R r + r^2}{R + r}$$

Had we first investigated this formula, we could easily have reduced that for a pivot from it by making $r = 0$, for then

$$P R = \tfrac{2}{3} \mu W R$$

or

$$P = \tfrac{2}{3} \mu W$$

as before, we thought it better, however, to begin with the simpler case.

(*To be continued.*)

ASTRONOMICAL NOTES FOR JUNE.

By a Fellow of the Royal Astronomical Society

The Right Ascension of the Sun at Greenwich Mean Noon on the 1st of June is 4h. 36m. 34·47s., and his North Declination 22° 4′ 12″. He is therefore situated to the North of Aldebaran and the Hyades, and not very far from the small star τ Tauri (vide map of "Eastern Sky," Vol. X p. 64). His meridian altitude is now very considerable, attaining its maximum on the 21st of the month, when at his culmination in London he will be nearly 62° high. The Sun rises in London on the 1st at 3h. 51m., and sets at 8h. 4m.; so that the day is 16h. 13m. long. On the 21st (the longest day) the Sun rises at 3h. 44m., and sets at 8h. 18m., so that he is 16h. and 34m above the horizon. From the cause explained on p. 169 of the present volume, there is no real night in any part of the United Kingdom during the present month in fact, in the extreme North of Scotland, small print may be read easily enough now up to nearly 11 p.m. The equation of time on the first day of June is 2m. 29·71s., and is to be subtracted from the hour indicated by a sundial to obtain that which a properly-regulated clock ought to show. The equation diminishes to 0·14s. on the 14th, after which it becomes additive, and on the last day of the month, 2m. 29·63s. must be added to apparent noon to obtain the mean time at the instant of its occurrence.

The Moon enters her First Quarter at 11h. 16·3m. on the night of the 6th; is Full at 1h. 47·2s. in the afternoon of the 13th; enters her Last Quarter at 9h. 35·8m. on the evening of the 20th, and is New at 11h. 33·2m. p.m. on the 28th. She is in Perigree on the 11th at 1 p.m., and in Apogee at Noon on the 23rd. Her age at Noon on the first is 2·1 days, at Noon on the 2nd 3·1 days—and so on. At 2 o'clock in the afternoon of the 4th, Libration will bring an additional portion of her surface into view in her S.E. quadrant. At 4h. a.m. on the 22nd, more of her S.W. surface will come into sight from the same cause; and finally, at 15h. on the 30th (or, speaking ordinarily, at 3 o'clock in the morning of the 1st of July), the South Easterly portion of her surface will, for a similar reason, be once more seen in excess. The Moon will be in conjunction with Uranus at 5h. 41m. on the afternoon of the 2nd, of course in brilliant daylight. At 59m. past 6 on the 15th she will be in conjunction with Saturn; at 9·35 a.m. on the 25th with Venus; at 9·22 on the 26th with Mars, and 41m. later with Jupiter. She will be in conjunction with Mercury at 49m. past 3 a.m. on the next morning, and finally, once more with Uranus at 14h. 43m. on the 29th. Three stars only, of the 6th magnitude, or larger, will be occulted during June. The first occultation will be of θ Libræ on the evening of the 11th. The star will disappear at the Moon's dark limb at 9h. 43m., and reappear at her bright limb at 9h. 51m. On the night of the 13th, B. A. C. 6088 will disappear at the bright limb at 11h. 55m., and reappear at the dark limb at 12h. 38m. Lastly, on the 16th, η Capricorni will disappear at the Moon's bright limb at 12h. 50m. a.m. and reappear at the dark limb at 13h. 58m.

Mercury is practically invisible for the first third of the month, being too close to the Sun. He Souths only about 19m. after Noon on the 1st, and is in inferior conjunction with the Sun on the 4th. Towards the end of June he becomes a Morning Star, and is on the Meridian about half-past 10 a.m. on the 30th. Venus is a Morning Star throughout the month. She Souths on the 1st at 34m. past 9 a.m., and on the last 17m. past 9. She is becoming less interesting as a telescopic object, and it is getting apparently smaller daily. She travels during June through Aries, and the greater part of Taurus. Mars is still a Morning Star too, Southing at 10h. 43·4m. a.m. on the first day of the month and at 10h. 15m. a.m. on the 30th. He is passing through

Taurus, and is in conjunction with Jupiter at 7h. 12m. on the afternoon of the 27th. Jupiter is a Morning Star likewise, and too close to the Sun to be well seen. Owing to this proximity the phenomena of his satellites are invisible. He is on the Meridian on the morning of the 1st only, about 25m. before Noon, and on that of the 30th about 9m. past 10. Jupiter will remain in Taurus during the entire month. Saturn, were he not so very low down, is now conveniently situated for observation. He is on the Meridian at 13h. 2·9m. on the night of the 1st, and about 11 on the last night of the month. He continues on the N.W. confines of Sagittarius. He is in opposition to the Sun at 5m. past 4 in the afternoon of the 16th. His rings being now practically at their greatest opening, he presents (under favourable atmospheric conditions) a telescopic object of the very highest interest. Uranus, still in Gemini, and Neptune, on the confines of Pisces and Aries, are both too close to the Sun to be visible.

June is the month in which the smallest number of Shooting Stars has been observed; and would appear to be the one most free, of all the twelve, from the apparition of these phenomena.

LETTERS TO THE EDITOR.

[We do not hold ourselves responsible for the opinions of our correspondents. The EDITOR respectfully requests that all communications should be drawn up as briefly as possible.]

*** All communications should be addressed to the EDITOR of the ENGLISH MECHANIC, 31, Tavistock-street, Covent Garden, W.C.

All cheques and Post Office Orders to be made payable to J. PASSMORE EDWARDS.

I would have every one write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that, as to other things, knows no more than what everybody does, and yet to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks: a vice from whence great inconveniences derive their original.—*Montaigne's Essays.*

THE USE AND CONSTRUCTION OF THE TELESCOPE.

SIR,—If "Herbert," p. 204, will look through the ENGLISH MECHANIC from its commencement, he will find that his idea is by no means a novel one. It last appeared in its only practical form on pp. 78 and 152 of your tenth volume.

Mr. A. W. Blacklock (on the same page) will perhaps forgive me for pointing out that he observed ζ Ursæ Majoris with 10in. of aperture—I with 4¼.

I must also ask the forgiveness of "J. V. B.," p. 211, when I express my conviction that an account of a few words uttered by Mr. Buckingham at the Royal Astronomical Society, contained in some journal unnamed and unknown, can scarcely be held to be strictly a "definite report of the optical performance" of his telescope.

If "Turton" (3797), p. 215, wants merely a simple stand, he will find a detailed description of a rough but effective form of Equatoreal mounting at p. 394 of your second volume. The best kind of Equatoreal with which I am acquainted is certainly that of Cooke, of York. The description of the water clock of Lord Rosse—then Lord Oxmantown—will be found at p. 265 of vol. 26 of the Royal Astronomical Society's "Monthly Notices."

I may inform "E. M. B." that a pancratic eyepiece is nothing in the world but a common terrestrial one, with a provision for separating the double combinations at the eye-end from that at the object-end; the farther these pairs of lenses are removed from each other the greater being the power acquired. If my querist will refer to Vol. III. of the ENGLISH MECHANIC, he will find a diagram in a letter by Mr. Moss (Fig. 2) on p. 381, which will illustrate this. Assuming him to have this diagram before him, I need only observe that when the combination C D is pushed towards the combination A B the power is diminished. When, on the other hand, they are separated, the power is increased. This eyepiece would screw into the adapter of a Newtonian telescope, just as an ordinary Huyghenian one does; but I should not expect it to be, in the least degree, a practically useful form with that instrument. I may say, in reply to your correspondent's second question, that the lenses of the Ramsden eyepiece are of the same focus, but not of the same diameter, the eye-lens being the smaller of the two. In an eyepiece of this construction now before me, the diameters of the eye and field lenses are as 4 : 7.

Turning now to the letter of "Scorpio" on p. 234, I find a mixture of queries which, with his permission, I will reply to separately under their appropriate headings. *Imprimis*, though, I should remarkably like to know the exact value and meaning of the assertion that "All Solomon's £5 telescopes are *warranted* to show five stars in the trapezium θ Orionis." Suppose (rather a wild supposition, by the way) that I bought a £5 telescope, and failed to see the fifth star in the trapezium with it, should I have my money returned, or be told that my own eye was in fault, or what? Again, before proceeding to answer your correspondent's questions, I must just remark that turning back to the page he specifies I certainly find that I am there made to speak of 2″·5 as the limit of separating power of a 2½in. telescope, but I *wrote* 2″·0, and the 0 must have got turned into a 5 in the press. Beginning now with his third query, as the first having reference to the telescope, I may tell him that one great difference between the mounting of a reflector and that of a refractor, is that the latter is supported about the middle of its length; while all the weight of the former being at the bottom of the tube, it has to be held near that part of it. This necessitates a compacting and compressing of an Equatoreal mounting for a reflector, bringing it all, so to speak, near the ground, and a general massiveness in the details which are rather drawbacks when applied to a refractor. Your back volumes contain some illustrations from which "Scorpio" may derive many useful hints. The simplest way to calculate the diameter of the field of a Huyghenian eyepiece is to set the telescope so that a star shall cross the field accurately on a diameter, and to note the seconds and fractions of a second which it occupies in doing so. Then this interval in time × 15 × cos. star's declination = the angular diameter of the field. I append an example, as requested. It is worked by logarithms to obviate the necessity for half a column of mere common multiplication. Suppose that your correspondent has observed the transit of Regulus diametrically over the field of his Huyghenian eyepiece, and has found that it occupied 1m. 8·4s. by a sidereal clock in crossing it, then the calculation would stand thus:—

	68·4s.	log.	1·8350561
	15	log.	1·1760913
Dec. N. of Regulus	12° 36′	log. cos.	9·9894128

log. of 1001″·29 .. .. 3·0005602 : that is to say the angular diameter of the field of his eyepiece is 1001″·29 or 16′ 41″·29. I have employed seven places of decimals, but five will be ample in practice. It will be further pretty evident that if we were observe a star *on* the Equator, the operation would resolve itself into multiplying the seconds of sidereal time occupied in its passage by 15, to convert them into seconds of arc, as there is, obviously, no allowance to be made for declination. Stars like δ Orionis, η Virginis, γ Virginis, ζ Virginis, α Aquarii or κ Piscium, will furnish results quite sufficiently accurate for my querist's requirements, when treated in this way. I need scarcely add that this determination must be made afresh with each new object-glass to which the eyepiece is applied. Next, the webs in a transit eyepiece are enclosed in a tube, but are only "protected" by the care of the observer. It is not considered *de rigueur* in the best observatories to poke your fingers through them. "Scorpio" must read the reply given above to "E. M. B." with regard to the Pancratic Eyepiece. The Cambridge (U.S.) Refractor is of 14·93in. aperture, and 22·38ft. focal length. The Great Melbourne reflector, a Cassegrainian of 30·5ft. focal length, and 4ft. in clear aperture, will be found described in great detail with engravings in Vol. VIII. of the ENGLISH MECHANIC (No. 194), pp. 247 to 252. "Scorpio" should certainly buy the volume containing the description referred to, if he be interested in this monster instrument.

The formula for obtaining the geometrical focus of a double concave lens is simply this, divide twice the product of its radii by their sum. Or, more simply, in the case of a double concave lens of glass of equal curvatures, the principal focus is at the centre of the first surface. I cannot think of any method of determining such focus practically. Perhaps opticians have some way of doing this, and one of them might enlighten us.

Mr. Baguley (3853), p. 238, almost answers himself. The large telescope, from the spherical aberration of the object-glass remaining uncured, would give a quantity of overlapping images which must inevitably be fatal to sharp definition. It scarcely requires one to rise from the dead to announce authoritatively the fact that a small object-glass which is good, will always give clearer and crisper definition than a larger one which is bad.

Mr. Walter Jones (3899), same page, should really treat himself to a set of our MECHANICS. He will find his question answered over and over again, so far as it is susceptible of a reply, in former volumes.

A FELLOW OF THE ROYAL ASTRONOMICAL SOCIETY.

ASTRONOMICAL.

SIR,—The "doctors" who "disagree," in the case to which "Ab Initie," refers on p. 207, are the *Thanet Guardian*, and "The Nautical Almanac;" from the latter of which I obtained the data on which I founded my replies on pp. 525 and 579 of your last volume. The "Establishments of the Ports" for the different localities given on pp. 496 and 497 of the National Ephemeris, are reckoned from *Apparent* Noon. The tides at London Bridge are given for Mean Noon; but as the Establishment of the Port for London is obtained in the same way as that for Margate, or anywhere else, the difference remains constant. I really do not see what I have to add to what I said on p. 579 of Vol. X. If I rightly remember the request of "Saul Rymea," and my present correspondent, it was that *I* should myself furnish tide tables; but I really must ask to be excused for declining to wade through a mass of the most merely mechanical computation. Why does not "Ab Initio" undertake it himself? He will find it a Tidy little job.

The mention of the "Nautical Almanac" brings us back to "Scorpio" and his string of questions on p. 234. Noticing now those having more special reference to Astronomy, I may tell him that the "Nautical Almanac" is published by John Murray, of Albemarle-street, London, and that its price is half-a-crown. Any bookseller will procure it. It contains the R.A. and Dec of 147 fixed stars. The object of your correspondent, however, in asking for particulars of a book containing Right Ascensions and Declinations, is probably that he may be enabled to find objects of interest in the Heavens. If such be his intention let him get forthwith Webb's "Celestial Objects for Common Telescopes;" it is published by Longmans and Co., London, for 7s. 6d., and is essentially *the* book which the incipient amateur will find indispensable. "Scorpio" asks for a "moderately cheap" work, but if he will take my advice and buy the book I recommend him, I shall feel grievously disappointed if he does not consider it dirt cheap, when he sees what a mass of information it contains. The map of the Moon alone is honestly worth 5s. out of the 7s. 6d. Turning to a third question, I may briefly say that Kepler's third law is not rigidly exact, because of the perturbations caused by the various bodies of the Solar system, *inter se*; but that it is sufficiently nearly so to get an excellent approximation in any given case, where either the periodic time, or the mean distance is known.

Surely the "Cluster" figured by "Aristotle" (3878), p. 238, cannot be meant for the Pleiades? and yet, the Stagyrite speaks of it as a "cluster," and having "lately disappeared in the West." With regard to my Map, on p. 64 of your last volume, I can only say that, when I drew it, the Pleiades occupied the precise position I have there indicated; and that although just now I walk by faith and not by sight in the matter, I have not the very slightest doubt that, at this present writing, they are in exactly the same place, as they were then.

A FELLOW OF THE ROYAL ASTRONOMICAL SOCIETY.

THE *ENGLISH MECHANIC* LIFEBOAT.

SIR,—Will you permit me once more to appeal to my fellow-subscribers for their more cordial co-operation in the matter of the lifeboat? Though much disappointed, I cannot yet believe that they are really indifferent, and positively refuse to lend a helping-hand to this Godlike work. Comrades! will you longer shirk your responsibility? Can you allow a few of us to struggle on, hoping almost against hope, when a single united effort from you would make our hearts rejoice, and be the means of saving numbers of fellow-creatures' lives? The refrains of two of the songs sung at our concert are still ringing in my ears:—

"Then three times round went our gallant ship,
And three times round went she;
For the want of a lifeboat they both went down,
As she sunk to the bottom of the sea."

And

"They're in the boat! they're all afloat!
Hurrah! they've gained the shore!
Bless the lifeboat! bless the lifeboat!
Oh, God, thou'lt hear our prayer!
Bless the lifeboat! bless the lifeboat!
No longer we'll despair."

Can there really be any amongst our body who would willingly be even in part responsible for the disaster detailed in the Mermaid, or think a few pence too much with which to purchase a share in the blessings which hundreds of grateful hearts may pour upon *our lifeboat*?

Our undertaking, though important, is not difficult, if only a reasonable proportion of subscribers will help. It is not even novel in itself, unless we make it so by either unprecedented success or signal failure. Other journals have their lifeboats, and why should not we? I find *Routledge's Magazine for Boys* has subscribed £306 12s. 6d., and built *one* lifeboat; the *Dundee People's Journal* has subscribed £822 15s. 10d., and built *two* lifeboats; and the *Quiver* has subscribed £1878 1s. 11d., and built *three* lifeboats. It is my belief that the ENGLISH MECHANIC can do more than any of these, and with all my heart I will make one to say that it shall.

GEO. LUFF, Staunton Harold, Ashby-de-la-Zouch.

P.S.—Success to the Mutual Improvement Societies! Country residents are almost powerless to aid in such matters, or I should be delighted to join in the movement. I know it would be a great boon to me could I discuss certain subjects appearing in the MECHANIC with a few kindred (but more practical) spirits. May I ask if our mechanical friends at Derby could not attempt a branch?

SIR,—In the black days of the Cotton Famine a celebrated "Launcashire lad"—viz., the late Lord Derby—wrote to the *Times* in these forcible, if not elegant, words:—"Can yo help us? We be clemming"—*i. e.*, starving. I quote these memorable words of our "Rupert of debate" in behalf of "poor Jack," substituting "drowning" for "clemming."

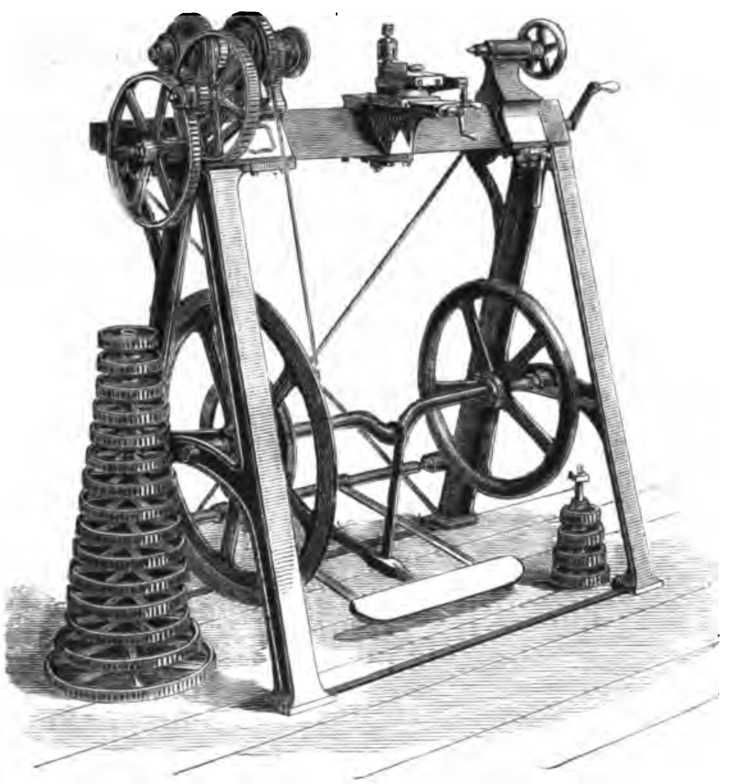
It was said or sung by Dibdin that

"A sweet little cherub sits up aloft,
And looks out for the life of poor Jack."

This may be quite true, although how he manages to *sit* at all, with his peculiar conformation, is a mystery past my solving, assuming ye cherub's portrait in our old City churches to be accurate in de*tail*; so I must leave it to Owen or Huxley. But as we can hardly expect the aforesaid cherub to don a cork jacket and *sit* on the thwarts of a lifeboat, or any conceivable number of cherubs, to man it; and even if they could, having no arms, to row, it would be impossible to them. I think it logically follows that instead of trusting to the assistance under difficulties which cherubs may afford, we ought to provide the lifeboat ourselves, trusting there will be no want of stout arms and stout hearts, able to *sit* in and row it on its blessed errand at need.

I am in no sense of the words a clever *beggar*, but however my friends may doubt the fact, and think it quite impossible that one so lamentably addicted to "chaffing" can be in earnest, I do assure my fellow-readers that I am terribly in earnest in the matter of the lifeboat, and do most earnestly entreat them to aid and assist this meritorious attempt to provide the means of saving the life not only of poor Jack, but the ship's passengers also; and I trust they will *stamp* it with their approval in the most effectual manner possible by sending at least one—I hope many more than one—stamp of her Majesty's kind countenance impressed on gold, silver, or paper; for the precious metals are doubly precious when employed on works of mercy and benevolence. If the constable is legally empowered to call on all good men and true to aid and assist, in the Queen's name, to keep the peace, how much more are we morally empowered to call on all good men and women also to aid and assist this good work.

I have before said I am not a clever beggar—sooth to say, begging is not my forte—but I trust the want of ability in the *solicitor* may not in this instance cause any injury to the case. What is impossible to one is easy to many; and we English mechanics *are* many—enough, surely, to do what Capt. Busk has done single-handed—viz., to launch one lifeboat. It only wants the will—and I trust we have enough of that—to prevent the captain's princely liberality from "making us ashamed." THE HARMONIOUS BLACKSMITH.



SMALL SLIDE SCREW CUTTING LATHE.

SIR.—We beg to send you above a photograph of a small description of screw cutting lathe, which we have lately constructed.

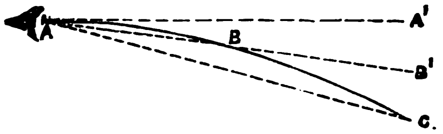
This lathe is constructed with bed on the triangular bar principle, cast hollow to receive the leading screw, which is thus protected from dust and injury.

The mandrel head is fitted in the usual way with back gear, the mandrel of the steel running in double conical collars of hardened steel. Compound slide rest. Full set of change wheels, and arrangement for cutting screws of right and left hand thread to any pitch. This lathe complete weighs about 2cwt., and runs very easily with the foot wheel and treadle motion.

BOOTH, BROS., Engineers, Dublin.

CONVEXITY OF WATER.

SIR,—Your readers who have been interested in these experiments will be aware that Mr. Carpenter's argument for the *non*-convexity of the canal was entirely based on the equidistant appearance of the signals in the field of view when looking through the cross-air telescope. Now, so far from this proving that the canal was flat, it proves exactly the opposite, as the subjoined diagram will show.



Let A B C be objects which appear equidistant in the field of view of telescope. A is the hair line in the telescope; B is the signal 3 miles distant; C is the signal 6 miles distant. Join A A¹, A B B¹, and A C as represented by the dotted lines—the angles subtended by these lines are equal. Now join A B C, the points which are equidistant in the field of view. The line that joins them cannot be other than convex.

VERAX.

THE AIR PUMP.—THE HIGHEST VACUUM.

SIR,—Can any of your scientific readers assist me in the following difficulty? I have a large doubled-barrelled air pump, which I bought in order to produce such vacuo as would exhibit the phenomena of the induced current in vacuo. I find, however, that I cannot get a vacuum good enough to show Gassiot's fountain, the Aurora tube, or the rotation of the electric light round the magnet. Now if some of your *practically* scientific readers can and will answer the following queries, I shall be deeply obliged. I say *practically* scientific, because, theoretically, I know as much about the subject as most, but I want the opinions and advice of someone who has *done himself* what he recommends and not merely taken it undigested from books, most of which I have read.

1. What is the highest vacuum, as indicated by the syphon gauge, that an ordinary, well-made double-barrelled air pump, with oiled silk valves, is capable of producing?

2. Is there any way of adapting other valves, such as Babinet's plan, so as to produce a better result.?

3. The machine admitting it, could not an extra barrel on some other plan, such as Grove's or Newman's be adapted so as to produce the higher vacua?

4. If so, which is the *best, simplest, and most effective*? and would your correspondent describe its construction practically?

5. What degree of exhaustion is necessary to produce the phenomena mentioned in the former part of my letter?

Theoretically considered, Grove's plan seems to me the simplest and best. Can anyone describe minutely (for I make all my own instruments) its construction? I know its general principle, as described in scientific books, but I want one to work by.

In return for such information, I can give your readers such information on the construction of induction coils as I know they cannot get anywhere else in England. I have a plan of construction, so simple, and yet so effective, that I get such results as have never been yet obtained by any maker. I have one just containing only 4 miles of secondary, and yet with one small Grove's battery with the platina only 4in. by 2in. I produce *splendid sparks 4in. in length*. Any information on the above subject to the purpose will greatly oblige.

INDUCTORIUM.

WRAY'S 20-INCH O. G.

SIR,—Inquiries have been made in your columns as to the performance of the above glass now in the possession of Mr. Buckingham, and the only answer as yet given has been by "F.R.A.S.," to the effect that "with regard to its optical quality we have no definite report."

In the absence of this, perhaps it may be interesting to some of your readers to have the maker's own report in a letter to the Astronomical Register in Aug., 1867. It is as follows:—"Sir,—Permit me through your pages to inform Mr. Darby that the new 20in. clear aperture object glass which I have just furnished for Mr. Buckingham shows γ Andromedæ separated with all powers above 200, and that with a power of 450 the distance between the components is much wider than in proportion to Mr. Dawes's diagram, evidently showing that the separating power depends mainly on the size of the aperture, &c. To the 20in. object glass just finished ζ Herculis and δ Cygni are astonishingly easy objects. We have not as yet had time to make much scrutiny, but the most difficult tests have hitherto, with the full aperture, been instantly resolved even in an indifferent state of the atmosphere.—I am, &c., W. WRAY."

This account is I think very interesting, and makes one earnestly wish to hear more. Mr. Buckingham can hardly think it other than complimentary to him to be asked for such information, and I am surprised that he withholds it, more especially as I think the wish for it has been strongly expressed at a meeting of the R. A. S.

G. T.

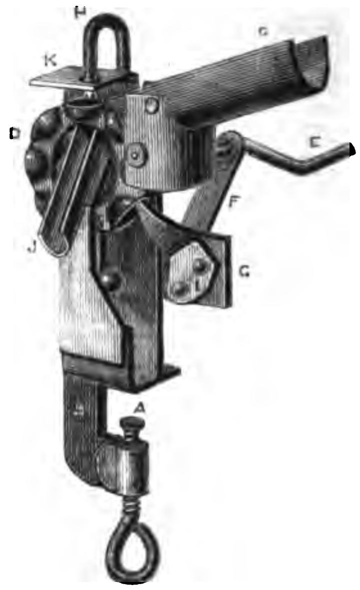
CHERRY STONING MACHINE.

SIR,—I send a clipping from the *Scientific American* illustrating a new cherry-stoner.

It is screwed to the table by a hand screw A. An upright B supports the body of the machine. The fruit is held in the left hand as shown in the engraving, and rolls down along a gutter C, and enters the small cups in the periphery of the annular wheel D.

E is a double crank from which a link F imparts vertical reciprocating motion to the cross bar G, and also to the recurved punching bar H. Each time the cross bar G rises, a stud I engages with one of the cups on the annular wheel D, turning it along one-eighth of a revolution, and bringing another cup directly under the point of the punching bar H, carrying with it the fruit which has fallen into it from the gutter C. Each of the cups has a hole through the bottom large enough to permit the passage of the pit; and when the punching bar descends by the rotation of the crank, it pierces the fruit and forces the pit through the bottom of the cup, into the chute J, whence it falls into a dish placed to receive it.

The point of the punching bar is branched short sharp prongs, so that it cannot slip to o the pit; and a plate K prevents the fruit from with the punching bar.



Thus the pits may be removed almost as fast as a child can turn the crank, and the operation is so rapid that the juice does not escape, and the fruit retains its natural shape and appearance.

This invention is manufactured by Geer, Stewart and Brother, Galesburg, Illinois, U.S.

KAPPA.

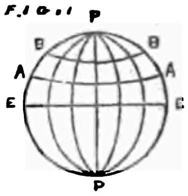
READINGS FROM THE GLOBES.

SIR,—One of the consequences of the rotation of the earth upon its axis (which we take for granted as having been proved) is that man, animals, trees, and atmosphere are carried round with it from W. to E. at different degrees of swiftness, according to their proximity to the equator; but the rotation is so rapid and silent with which we proceed, that none of us can feel it, for the earth rotates

> "With inoffensive pace that spinning sleeps
> On her soft axle, while she paces even,
> And bears thee soft with the smooth air along."

By reference to Fig. it will be easily seen that while she spins on her axis P P from west to east, those who live at the equator E E must be carried around with much greater velocity than those living on the parallel, A A, and these again than those living at B B, while the pole will have scarcely any motion whatever. This will be readily understood by turning round a terrestrial globe, and having once ascertained the length of a degree on the earth's surface, we can then know at what rate per hour any point on the earth proceeds, and it is a matter of considerable nicety to determine the length of a degree, which has been found to vary a little, and to be longer near the pole than the equator. The importance of an accurate measurement of the number of miles in a degree cannot be too highly estimated, for upon it the great Newton founded his theory of universal gravitation, and he was for some time prevented from propounding it from the inaccurate measurement of his age; but for the sake of illustration we will take it as commonly estimated 69½ miles in a degree. Now, as the globe completes its rotation in 24 hours, it of course passes through 15° every hour, and by multiplying 69½ by 15 we get 1042·5 miles per hour, which is more than 1 mile per second. This is speaking of its actual rotation through 360°, or till it arrives opposite to the same fixed star from which it started, but in reality it revolves nearly 361°, because the sun has a motion of its own, having preceeded about this distance on its annual course in the interval. This, then, is only a close approximation to the actuality. We have seen that the parallels of latitude differ in length as they approach the poles, and consequently London is carried round with less velocity than Quito. If we wish to ascertain its speed we must find the number of miles in a degree in this parallel—namely, 51½, which is done by measuring the distance between the meridians 15° apart, which is equal to 9½, and then we have a simple proportion sum—15° : 9½° : : 69½ miles : 43, which gives 645 miles per hour as the rate at which London revolves. The most accurate way, however, of determining the number of miles in a degree in London's latitude, is by an easy formula in trigonometry—R : 69½ : : cos. 51½ : x. Thus:—

FIG. 1



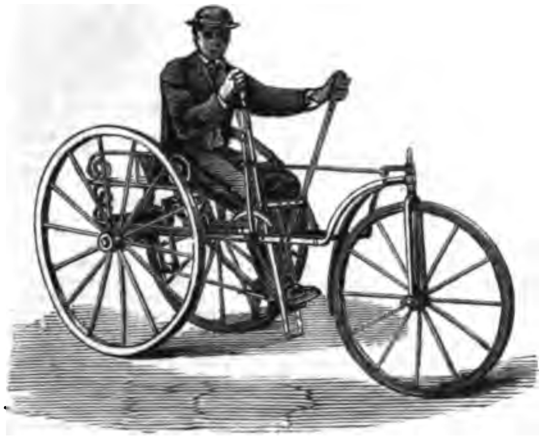
$$\begin{array}{rcr} \text{log. } 69\cdot5 & = & 1\cdot841985 \\ \text{cos. } 51^\circ\ 30' & = & 9\cdot794150 \\ \hline & & 11\cdot636135 \\ \text{Subtract R.} & & 10\cdot000000 \\ \hline & & 1\cdot636135 \end{array}$$

which answers to the natural number 43·26. Thus we find that the number of miles in a degree varies, for whilst at the equator there are 69½ in one degree, in the latitude of London there are 43·26, but at the poles 0. These results have been verified by actual measurement, the methods of which and the men who have achieved it are beyond the limits of a letter. Perhaps "F. R. A. S." would upon some occasion enter into more particulars, which I feel persuaded would prove highly interesting to many readers. If we wish to find the distance between two or more places on the globe, we must measure by the arc of a great circle, and the number of degrees between the places will give the result. The difference of longitude is an inaccurate guide except at the equator, because although every circle contains 360°, the number of miles in each, as has been shown, considerably varies. The terrestrial globe, therefore, being the shape of the earth, even supposing there were no maps upon its surface the distance between places may be ascertainedby finding their respective latitudes and longitudes and having made marks to denote them, measure the distance between the marks and proceed as above, and the thing is done.

T. S. H.

THE "SHIPTONIAN" VELOCIPEDE.

SIR,—Having for a long time carefully read the different articles respecting velocipedes in your valuable journal, and being deeply interested in the subject, I found that not one of the many varieties which have appeared were calculated, to my mind, to economise power and ensure speed. I have therefore at last decided upon and made a tricycle, as per photograph herewith, which I find answers every purpose admirably. As will be seen from it, the whole of the muscles of the body are brought into action, working as it does with both hands and feet. It is very light in construction, neat in appearance, and easy to work, and having india-rubber springs, is free from jolting. It will turn the sharpest corner with the greatest comfort, and can be steered with great nicety. There is not the slightest danger of falling, and it is safe uphill, downhill, or on level ground, as there is an excellent brake attached, by which you can quickly stop when descending the steepest hill. You can also carry a carpet-bag or box on the seat behind, and on level ground or downhill a passenger can easily be carried, and by an arrangement which I have already



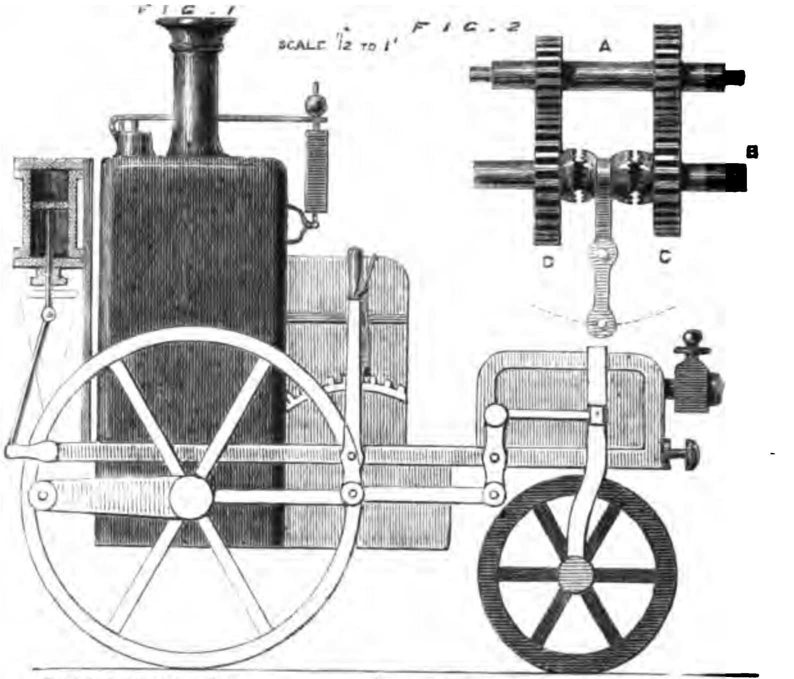
planned (and but for sickness would have carried out), I could make it for two to work without increasing the weight of the machine more than 10 or 15lb., by which means I should obtain double power, and make it to travel at a much greater speed with two persons on it than with one. The levers could, nevertheless, be put on or taken off in a few minutes, so that either one or two could ride. The woodwork is French polished, and the iron painted black, and then varnished. Its speed is such that although I have run with several two-wheelers (and among them were some very skilful riders), I have never seen the person who could keep up with, much less pass, me. Several gentlemen have advised me to secure it by patent, but I prefer giving my brother readers the benefit of it, if they think it of service.

ERNEST R. SHIPTON, Vine Cottage, Knowle,
near Bridgwater.

ALGEBRA.—A QUIET CHALLENGE.

SIR,—I am glad to have "C. H. W. B." agreeing with me that many of the most pretentious algebraic problems of the day are worthless. Let me remind "C. H. W. B." that even Colenso (Alg. 8vo., p. 390) stigmatises a search after just such "impossible" roots in the Equation Papers of St. John's College, Cambridge, as "useless and profitless." Still, "C. H. W. B." maintains that "algebra is extremely useful." I admit, the notation is useful; but, Euclid observed the very principle long before algebra began. In Euclid, A is an angle, B is a triangle, C is a square, or any square, and E F, F G is a rectangle, though only two sides of it are thus given. This is all the good there is in $x\ y\ z$. Arithmetic has as much; for instance, in "Walkinghame's Tutor's Assistant," by Young, interest is i, and p is principal, r is rate, t is time, a is amount; so the formulæ is conveniently given as $p\ r\ t + p = a$." This is not algebra, though it may look algebraic. The real essence of "Algebra" is in its equations; here, if anywhere, the "science" is distinctive. Let, then, "C. H. W. B." adduce some common-sense question; let it be intrinsically some serviceable affair; let it be fairly and fully stated, and plainly worked out, intelligible to the "meanest capacity," with answer and all; let its drift be to exemplify how algebra is the best or the only method. And then I will engage to prove, that the algebraism is no advantage; and that the point can be discovered, easier and better when the whole science of algebra has been utterly discarded.

GIMEL.



ROAD LOCOMOTIVE.

SIR,—Enclosed I send a sketch of a road locomotive suitable for two or three persons. The boiler is 2ft. in diameter, and 4ft. in height. The firebox is 20in. in diameter, and 2ft. 8in. in height, and is made of copper, and contains two horizontal tubes. The engine consists of two cylinders, each 4in. in diameter, and 8in. stroke, and is two speeds action. The gearing is 1 to 1 and 1 to 2, and is changed by a friction-clutch arrangement, shown in Fig. 2. A is the engine axle, and has two cogwheels keyed on it, one of them 7½in. in diameter, working a loose wheel of the same diameter on the axle B. The other is 5in. diameter, working a loose wheel 10in. diameter, on the axle B.

On the latter axle is a sliding friction clutch, which engages with either the wheel C or D, and can be disengaged altogether, so that the engine can pump water into the boiler when standing. On one side of each loose wheel are small projections, with which the friction-clutch engages, and the gear can be changed whilst the engine is in motion, or whilst standing, independent of any position the engine may be in. The front wheels are each fixed in a forked shaft, and connected by means of a rock shaft to a spring-catch lever, by which the engine is steered. The water is contained in a small cistern under the carriage, and the coal is placed in front of the driver. The engine works up to 150lb. pressure.

This form of steam carriage may not be in accordance with the ideas of every one, yet, taking all things into consideration, I do not see how it can be much improved upon, and in design I have put the steam carriage through more than twenty different metamorphoses.

WILLIAM STANLEY, Eyre-street, Chesterfield.

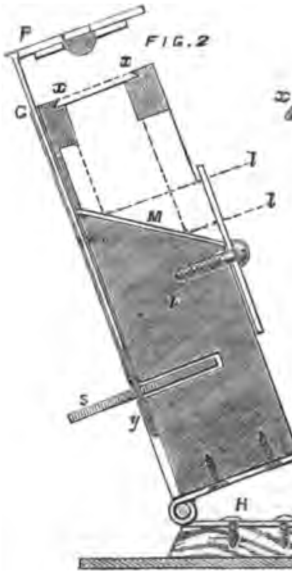
PERRY'S MICROSCOPE.

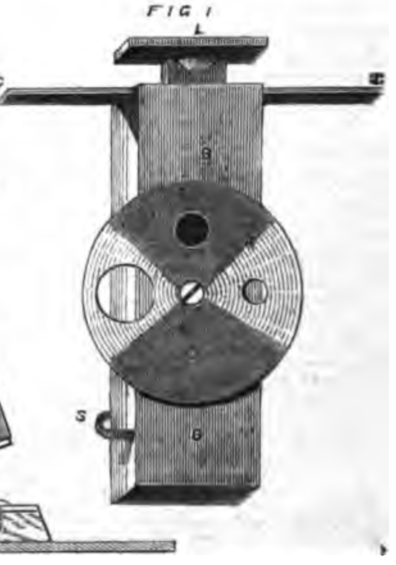
SIR,—Enclosed I beg to hand you sketch of my new microscopes, which will no doubt meet the approval of many readers of the ENGLISH MECHANIC. These microscopes are made from square brass tubes same size as drawings; the advantages they possess are as follows:—They are made to fasten to a table or block, or better, to the box which contains them, they have a reflecting mirror, a fine screw motion for focussing, a circular diaphragm for regulating the incident light, and last, but not least, they are strong, cheap, and well-made. Fig. 1 is a front view, B is the square body of the microscope, R the revolving diaphragm, with four different sized holes; L the eye lens, and S the back thumb-screw for focussing; the hinge at bottom is omitted in this figure.

Fig. 2 is a section—M is the inclined mirror resting on a block of hard wood t; the light, after passing through the diaphragm hole, is reflected upwards in the direction of the eye lens (dotted $l\ l$), causing the object under examination to be well illuminated; the light is regulated by using a larger or smaller hole of diaphragm, as the case may require. The top of the microscope has a dove-tailed groove for receiving a strip of glass $x\ x$. P is the slide carrying the lens; this slide, after passing down the groove G, terminates in a screw, y, which, passing through the thumb-piece S, gives the motion for focussing. H is the hinge for fixing the box; the microscope can, however, be held between the thumb and finger, if so preferred.

The power of this little instrument may be roughly estimated at from 20,000 to 30,000. The heart and blood of a flea are distinctly seen in motion; a few human hairs resemble a bundle of faggots, and hundreds of lively beings are seen in a small drop of water. Cheese-mites appear like horned beetles, and a flea resembles a young lobster!

E. PERRY.





WATER ANALYSIS, &c.

SIR,—In your impression of the 13th a correspondent signing himself "W. R." asks for my opinion as to the relative capabilities of Wanklyn's and Frankland's processes for the estimation of organic matter in water. I am sorry he has required my opinion on the subject. I must decline depreciating either, as there is no doubt they are both very good for general purposes, in their way, the preference being generally given to the simplest, and that which is easiest of execution. This process of estimation (Wanklyn's) which has been used with such good results by Angus Smith nevertheless has its defects; the other process

(Frankland's) also has serious defects, the greatest of which is in the supposition that all nitrates and nitrites are formed by oxidation of nitrogenous animal principles; Boussingault's experiments, to my fancy, prove the contrary.

With all the estimations around us of organic nitrogen, carbon, nitrates and ammonia, it is very little the public in general understand. They want water analysed at as low a figure as possible, and the analyst generally reverts to "chameleon" as the most ready, and one which with ordinary manipulation gives good results.

As regards the relative proportion of organic carbon to the nitrogen present in waters, "W. R." has instanced 3. 1st, 2 to 1; 2nd, 5 to 1; 3rd, 10 to 1. Now, although there seems no proportion existing between them, there really is, though in an indirect way. The third sample of water would probably be the purest, which may be proved by examining the reports of analysis; thus, above Reading the proportion is nearly 10 to 1, and the nitrates stand at 0, but it must not always be inferred that the impurity may be measured by the proportion of organic nitrogen present, taken as regards the organic carbon, for, in one instance, a proportion of 3 to 1 was obtained, yet the water was purer than that which contained 11 to 1. I think the best method for practical purposes is to express the amount of organic matters by the number of grains per gallon of oxygen necessary for its complete combustion.

I am not aware that it has been tried to convert the quantity of organic nitrogen and carbon into grains per gallon. If it has been, and an approximate result gained only, why it is best to use permanganate at once. One part of nitrogen might correspond to many different weights of organic residue, and the same may be said of the organic carbon.

Now with regard to W. R.'s" four queries:—

Frankland's process may, I should think, be applied to sewage water, but after evaporating to a small bulk the fluid should be finished at a very low heat, or preferably in vacuo, to avoid loss of volatile constituents. 2nd. There is no doubt that ammonia in ammoniacal salts may be estimated by the Nessler test, but, to my fancy, normal acid is preferable. 3rd. Same answer as above. Question 4th. That quantity of organic matter which requires one equivalent of oxygen for complete combustion, measured by the number of 10cbc. of a chameleon solution containing 0·159 grms. per litre, required to produce the permanent tint.

GEORGE E. DAVIS.

STRENGTH OF CHAINS.

SIR,—I see Mr. Tolhausen, Jun., hails from Manchester; he may, therefore, inform me upon the following:—I have read his article on "The Tenacity of Chains and Ropes." Will he be good enough to say if the formulæ he gives are practically carried out? From all I know they are not, for chains are required and do actually work with heavier loads than his rules estimate. For instance, the Lancashire and Yorkshire Railway Company at Manchester have $\frac{7}{8}$ chains to lift 10 tons, but according to his rules it should be over $1\frac{1}{16}$ Their other chains have a working load in proportion. From what I can see, the proof strains in his Table II. are more agreeable to the actual weights chains work at on cranes.

Anent his remarks in same article of the difference existing between the strength of studded and short link chains, I do not think the proportion is 7 to 9. I know from actual tests made at our works that a short link chain has broken a studded chain of equal diameter of link, and although the Board of Trade provide in their tables of proof for a stud chain to bear more than short link, they say nothing of the breaking strain or ultimate strength. You see, after a certain weight is on chains, the iron begins to stretch—*i.e.*, the link becomes longer but narrower, and having got to a certain point the stud between does not suffer it to go farther, but as strain is still applied and link extended in point of length, it separates, generally top and bottom, or at A A in Mr. Tolhausen's sketch of link. In short link or unstudded chains, however, the oval link, by being stretched, becomes *straight* sided having nothing to stop it, so that the strain is not applying itself to one portion only. When these links go it is generally at the hinder part, or at the neck of the shut.

W. A. E. W.

COLOUR BLINDNESS.—PHRENOLOGY.

SIR,—I was much surprised to read the articles on colour blindness inserted in the MECHANIC. I always thought that phrenology fully accounted for such phenomena. To suppose that defects in the formation of the eye is the cause, is about the same as malformation in the construction of the ear would be in relation to music. I know a person who is so defective in his perception of music that he cannot tell one tune from another—every tune to him is about the same; and why should it not be so in regard to colour? Besides, some people have great difficulty in recollecting and distinguishing forms and shapes, sizes and distances of objects, localities, &c. But we never think of attributing such defects to the eye. I should like to know why an exception is made in regard to colour. Some people don't believe in phrenology. Now, if they would take the trouble to examine it and try to understand it, I think they would. I feel as certain of its truth as I do of my own existence. If I am asked for reasons for being so confident, I will give a few. If I look at an object such as a chair or table, I know that they are such by the form and dimension of each. It is simply observation combined with reflection. Now I do the same by the head. I find that the form of the head corresponds with any peculiarity which the person to whom it belongs possesses, whether intellectual, moral, or animal. I find that those who are fond of constructing, inventing, making various things have one particular part of the skull prominently developed, while those who have no such inclination have the same part depressed. If the heads of all those who read the MECHANIC were examined, I believe that the lump of constructiveness would be found fully developed in most of them. I will now give another reason. We can always tell by the form of the body whether a man has much muscle; we cannot see the muscle because of the skin, but we judge by the outward form and development, which always corresponds. The same kind of reasoning will apply to any other portion of the body, such as the stomach, bowels, lungs, &c. If any of these are small or large, that part of the body where they are located is either enlarged, contracted, and diminished. I consider my own head to be an overwhelming proof of the truth of phrenology. The extremes are so great, large and small, and so various, that if a million heads were examined I don't think one would be found like it, and yet it exactly corresponds with my peculiarities in every respect, including *both* intellectual, moral, and animal faculties. Now, taking into consideration that the similitude is is so exact and complete, I say most seriously that it is more than a million to one against such being the case if there be no truth in phrenology.

AN INVENTOR AND SELF-TAUGHT MECHANIC.

[Our correspondent considers his "own head an overwhelming proof of the truth of phrenology." We dare venture to affirm that if he were introduced into a room of, say half a dozen men, including a poet, an engineer, a statesman, a botanist, a preacher, and a merchant, he would not be able to distinguish one from the other by their heads; neither do we believe the cleverest phrenologist living would be enabled to distinguish them if he were permitted to manipulate their bumps in the dark. This may be an experiment worth trying.—ED. E.M.]

COTTON SPINNING.

SIR,—Your querist, Edward Habergham, p. 104, No. 269, asks for information about the backing off (not baking off) motion of a mule frame, and also about the working of the cam shaft. Perhaps he will not be offended if instead of giving him the required information (which would take up too much space to give clearly), I give him a little advice which is also seasonable for other correspondents. The sum total can be written in a few words, "Think for yourself." When a person gets into the habit of asking other persons' assistance as soon as the least obstacle presents itself, without trying to surmount it, he has a great tendency to place no reliance at all on his *own* ideas, but to float along with the stream, and at length probably finds himself in the whirlpool of complete ignorance—which, by-the-bye, is not altogether bliss—Charles Rabache to wit. For my own part I would not place entire dependence on a statement made by even such a genius as our harmonious brother the "Blacksmith," except his ideas would agree with my own, or else by careful study I could come to the conclusion I was wrong. Of course I don't mean to say that every man's reasoning powers are equal—by no means—or that a Rabache will balance a Proctor if weighed in the scales of Science, but I do mean to say that it behoves all who intend to progress either in cotton spinning or any other study to think deeply and earnestly for themselves, and learn to depend on their own discretion and judgment. When they cannot arrive at a firm decision, or there is any doubt on the subject which they cannot themselves remove, *then* is the time to fall back on the advice of other persons. They should bear in mind that there will not *always* be "Harmonious Blacksmiths," Sigmas," and "Adepts," to refer to when they are "fast." My advice to E. H. is to go and stand behind the headstock of his mule, and "mark, learn, and inwardly digest" all its different movements, and be *determined* to find what he requires, and I'll guarantee if he has any brains at all (no offence) he will know more in an hour than I could write in five.—I mean as regards the principle on which it works. But if my prediction does not happen to "come true," and he gets stuck in the mud, which no doubt he will before he gets a practical knowledge of it, *then* I shall be most happy to help him out and render him any assistance he may require.

I hope these remarks will be received in the same spirit as that in which they are written.

THE HARMONIOUS COTTON SPINNER.

SIR,—In reply to your correspondent, "Harmonious Cotton Spinner," page 204, respecting the benefit to be derived from the flyer of a roving frame leading, and *vice versá*, he says, that with the bobbin leading, no waste will be made, which is perfectly true, but his latter statement, that they cannot be run at as great a speed, is at variance with my experience so far, for having had the management of three frames with the bobbin leading, and one of the other construction, we run the three at a greater speed than the one with flyer leading, although it was going as fast as the machine would stand. Possibly, with other makes of frames, the results might vary considerably; this I am inclined to think is one main cause. With respect to the size for cop bottoms, I have used, and found the following mixture to suit best in our case—namely, 1½lb. best starch, and 2oz. sweet soap; put these in a bucket, and fill three parts with water, then turn a small jet of steam into it until it boils; should the mixture get too sad as it boils, add a little more hot water until you get the proper consistency. This composition was liked best by us, and I have no doubt will suit elsewhere if carefully tried. Any further aid I can give, I shall be happy to do so.

JOSEPH B. CROSSLEY.

TO MILLERS.

SIR,—I presume from "J. S.'s" inquiry, on page 182, that he wants to know the advantages of dressing flour through silk, over dressing it with a wire machine. As I have had great experience in the manufacture and erection of both, I will state a few of the advantages of the former method. In the first place, in a silk bolter there is, if I may so term it, no artificial means used to force the flour through the silk, but it is done simply by the revolving of the reel; whereas in a wire machine, it is forced through by the brushes, by which means there are quantities of small greys forced through the wire with the flour; consequently you can make a better sample of flour with silk than with wire. In the second place, a silk bolter, if properly constructed, does not take more than one-fifth of the power that is required to drive a wire machine that will do a fair amount of work. In the third place, there is a great saving effected by using silk instead of wire, as a silk clothing for a reel, if it is constructed right, and the silk put on properly, will last from five to eight years at an average, according to the quality of silk; for instance, the Swiss silk will generally out wear the French, whilst every miller will know the trouble and expense generally attending a wire machine, for if they are overfed, or a piece of iron gets in them, there is a stoppage of the machine, and a sheet of wire, or perhaps several, to put in. But with a properly constructed silk, nothing of the sort can happen. There are other advantages, but I am afraid I am trespassing upon your space. In my next, if you think it will be of interest generally to millers, I will point out some disadvantages of the present silk bolters, and suggest means by which they may be obviated, as there does not seem to be the slightest doubt that ultimately, for dressing flour, silk must supersede every thing else at present in use.

E. DAVIES, 92, Spring-street, Edgbaston, Birmingham.

ON THE "LEAD" OF THE "SLIDE VALVE" IN STEAM ENGINES.—ANSWER TO "STEAM SPIRIT."

SIR,—The "travel" of the slide valve, the amount of its "lap," and the extent of its "lead," are the three essential elements of that most important part of the steam engine, and these three elements, or proportions are so inseparably connected, so completely dependent on each other, that they cannot be considered separately or independently; and to speak of or attempt to discuss the effects of any one of the three upon the distribution of the steam to the cylinder, without at the same time taking the other two into consideration, is nonsense, and cannot possibly convey any practical or useful idea on the subject.

A quarter of an inch of "lead" for a given engine, may be too much, or it may be too little, or it may be neither, and no engineer (unless he knows nothing of the subject) can undertake to say which it is, without knowing at the same time, the "travel" of the valve and the amount of its "lap." What is the object, the use, and this history of the lead of the slide valve? In the early days of the steam engine, the slide valve was made with but little or no lap, and when set without lead, as it frequently was, the piston would arrive at the end of its stroke before the exhaust port commenced opening for the escape of the steam from one end of the cylinder, and the admission of steam to the other end, preparatory to the commencement of the return stroke. Indeed, owing to the wear and slackness of the joints of the connections between the eccentric and the valve, it was often late in the performance of its duty, and in many an old engine the piston often made two or three inches of its stroke before the change took place at all; it was then found that an improvement in the working of the engine resulted from giving the valve some lead; by-and-bye a little lap was added by some genius, bolder and more speculative than his neighbours, and a still further improvement was found to result, inasmuch as a collateral advantage followed in the shape of expansive action, to a trifling extent, as the small lap and lead combined, caused the steam to be cut off a little before the termination of the stroke.

From that time out, no more valves were made without lap (except in special cases, which I shall not notice at present, as I am now discussing the common simple slide valve in general use), and new valves, with more or less lap, were put into many old engines, whose valve chests were long enough to accommodate longer valves with longer strokes, but, in general, the valve chests were not long enough to admit of the improvement, and hundreds of these antiquated machines have struggled on to the present day without improvement, and not susceptible of any, and, in all human probability, will see most of us laid under the "sod," who now smile at their antiquated proportions, their grotesque appearance, and their insatiable appetite for fuel and water.

It will be seen from the above, that the lead was a very important thing with valves which had little or no lap, and short travel, and the proper amount of it was the subject of many a warm dispute amongst the old millwrights (the engineers of former days), and I have myself been sometimes specially privileged, when only a very young apprentice, by being permitted to be present at some of their Saturday night and Saint Monday discussions, and of course I thought the disputants were wonderfully clever fellows, and my great ambition was, in future years, to become such a "shining light" as "big Martin Murphy," or "Red Jack Carter," or "Old Dick Mead," or "Bob Thomas" (all these luminaries have disappeared below the horizon years ago, and have gone to that place where the "wicked cease from troubling, and the weary are at rest." R.I.P.), but in after years, I changed my mind, as the conviction forced itself upon me, that all which these "eminent authorities" advanced, could not be "gospel," inasmuch as no two amongst them could agree on that (or any other) subject, notwithstanding the amount of whiskey they drank, and the quantity of chalk they used in drawing diagrams upon the tables, and walls, and floors of the publichouses, and the incredible amount of profound balderdash they talked in explanation of them, and finally, the quantity of "skin and hair" they made fly from each other when weaker arguments failed or were exhausted, the whiskey all drank, the money all spent, and the chalk all used up.

With valves of modern make, and whose lap is considerable, say one-fourth or one-fifth of their travel, the amount of the lead is not so important, and the difference between an eighth inch, and a quarter inch, and three eighths inch of lead in their effects upon the distribution of the steam, is very inconsiderable indeed. "Steam Spirit (query 2532, No. 265) asks me "why I would give so much lead (¼in.) to the engine in question ("Relwot's" engine; see my letter on page 39, No. 262). He says, "he should have thought a quarter inch of lead decidedly too much for any stationary engine, except it was a very high piston speed." "Steam Spirit" has not favoured us with his reasons for thinking so, "he has given no account of the faith that is in him."

Now let us investigate the subject properly and systematically, throwing mere opinion, and hearsay, and the rule of thumb, and tradition, aside, and endeavour to come at the actual facts of the case, and I will venture to say that we will all find ourselves both "wiser and better men" on this particular subject, at the end of the discussion, than we are at the beginning. If we do not, it will be no fault of mine, for I shall "put down" all I know about it. The lead of the valve exercises an influence on each of the four principal events which take place in the distribution of the steam during the stroke of the piston, viz., first, "pre-admission," or the admission of steam to the cylinder before the termination of the stroke. Second, "admission proper," which ends in the "cut off." Third, "expansion," which ends in the "exhaust," and fourth, "compression."

For the purposes of this discussion, I think it better first to take the case of a common slide valve, worked by a single eccentric, in preference to such valves as I recommended for "Relwot's" engine, as they are compound valves to a compound engine, and the investigation of their action beyond what I said in my former letter on the subject, would be very tedious, and would require many illustrative diagrams, and so must stand over till we have gone fully into the performance of the "simple slide valve."

Take a valve of the following proportions, viz., 5in. travel, 1in. of lap. on the admission edges, and having neither lap or deficiency on the exhaust edges, and worked by a common eccentric. The distribution of the steam by this valve, under three different leads—viz., one-eighth, one-quarter, and three-eighths of an inch, is shown graphically on the annexed diagram (Fig. 1), which has reference to a horizontal engine or, in fact, to any direct-acting engine equally. The semi-circle is the path of the crank pin, and the diameter A B represents the stroke of the piston, in this case 20in. The distribution of the steam under the ⅜in. lead is shown by the short dotted lines P‴ C‴ E‴, which are the positions of the crank. The distribution under the ¼in lead is shown by the full dark lines, P″ C″ E″, and P′ C′ E′ show the distribution when the lead is ⅛in.

This diagram shows faithfully, at a glance, the very trifling effects produced by the alterations of the lead of this valve within limits which I presume are seldom exceeded in practice, for few engineers would think of giving it more than ⅜in., or less than ⅛in. of lead. And first as to the effects on the pre-admissions. Under the ⅜in. lead, the valve begins to open when the crank is at P‴ (going in the direction of the arrow), or within 9¼ degrees of the "dead centre line." Under the ¼in. lead, the crank is at P″, or 7° from the centre, and under the ⅛in. lead, the crank is at P′, or 3½° from the centre, when the valve begins to open for the admission of steam. The crank in each case has approached the centre line so nearly, that the "versine" has vanished, and the piston has virtually ceased to move, and consequently the alteration of the lead can have no sensible effect whatever on it.

The "cut off" comes next, when the crank is at C′ C″, C‴, and it is apparent that the alteration of the lead is more felt on this event, as measured on the motion of the piston, although less on the angular motion of the crank than on either the "pre-admissions" or the exhaust at E′ E‴. Under the ⅜in. lead the steam is cut off when the crank is at C‴, and the piston has made 15¾in. of the stroke. Under the ¼in. lead it is cut off when the crank is at C″, or 16in. of the stroke, and with the ⅛in. lead it is cut off at C′, or 16⅝in. nearly, the whole difference being comprised within less than 1in., or less than one-twentieth of the stroke, a trifle not worth speaking about. Lastly, we come to the exhaust at E′ E″ E‴, and we see that with ⅜in. lead the exhaust takes place when the crank is at E‴, or 18⅜in. of the stroke; with the ¼in. lead it takes place when the crank is at E″, or 18⅝in., and with the ⅛in. lead the crank is at E′, and the piston at 18¾in., the two extremes being only ⅜in. asunder, or about one-fortieth of the stroke. I have not noticed the event of compression, for with this valve, whose exhaust edges have neither lap nor deficiency, that event and exhaustion occur in all cases at the same instant.

Let us now suppose that this same valve has its travel reduced from 5in. to 4in., by driving it by an eccentric of that amount of throw, or what is the same thing in effect, let it be driven by the common "link motion," for the movement imparted to a slide valve by a correct link motion, is identical with that received by it from a single eccentric, whose throw is equal to the vibration of that part of the link which drives the valve for the time being. Fig. 2 shows the distribution of the steam with the reduced travel, and under the influence of the the three different leads as before—viz., ⅛in., ¼in., and ⅜in. As in Fig. 1, the short dotted lines P′ C′ E′, show the positions of the crank at "pre-admission," "cut off" and "exhaust," under the ⅛in. lead. The full dark lines P″ C″ E″ show them with the ¼in. lead, and the long dotted lines P‴ C‴ E‴ show them when the lead is ⅜in.

This diagram shows plainly that with the reduced travel of 4in., the lead becomes a more important element than in the first case. Under the ⅜in. lead, pre-admission occurs when the crank is at P‴, or within 14° of the horizontal centre line, and the piston is within about ⅜in. of the end of its stroke. With the ¼in. lead the crank has arrived at P″, or within 8¾° of the centre, and the piston has almost ceased to move; and with the ⅛in. lead the crank is at P′, within 4¾° of the centre, and the piston has no motion. The cut off occurs under the ⅜in. lead, when the crank is at C‴, and the piston has made 13in. of its stroke. Under the ¼in. lead the crank is at C″, when cut off occurs, and the piston has made 13⅝in. of its stroke; and with the ⅛in. lead the crank is at C′, and the piston has made 14¼in. The exhaust occurs under the ⅜in lead when the crank is at E‴, and the piston has made 17¼in. of its stroke. Under the ¼in. lead, the crank is at E″, and the piston has made 17⅝in.; and with the ⅛in. lead the crank is at E′, and the piston has made 18⅛in. in its stroke, when exhaustion occurs.

We will now see what effects are produced upon the "distribution" by a further reduction of the same valve's travel to 3in., and Fig. 3 illustrates its performance under this condition. A single glance at the diagram shows that the influence of the lead is vastly increased, and that its power of altering the time of the occurrence of the several events is very great, as is plainly shown by the wide-spread positions of the lines representing the crank at the times of their occurence.

"Pre-admission," in Fig. 3, occurs under the ⅜in. lead, when the crank is at P‴, and is yet 25° from the horizontal line, and the piston is a full inch from the termination of its stroke. Under the ¼in. lead the crank is at P″ 15¾° from the horizontal, and the piston is full ⅝in. from the end of its stroke, and under the ⅛in. lead the crank is at P′ 7°, the versine has vanished, and the piston has ceased to move when pre-admission occurs.

The "cut off" occurs under the ⅜in. lead, when the crank is at C‴, and the piston has made 6¾in. of its stroke. Under the ¼in. lead, the crank is at C″, and the piston has made 8¼in. of its stroke; and with the ⅛in. lead, cut off occurs when the crank is at C′, and the piston has made 10¼in. The exhaust occurs with the ⅜in. lead when the crank is at E‴, and the piston has made 14in. of its stroke. With the ¼in. lead the crank is at E″, and the piston at 15¼in.; and with the ⅛in. lead the crank is at E′, and the piston at 16¾in. of its stroke when that event occurs.

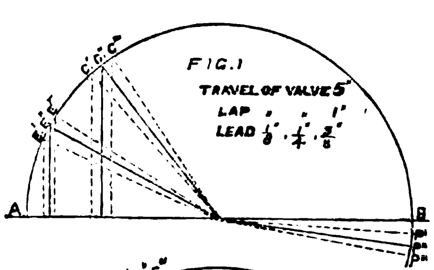


FIG. 1

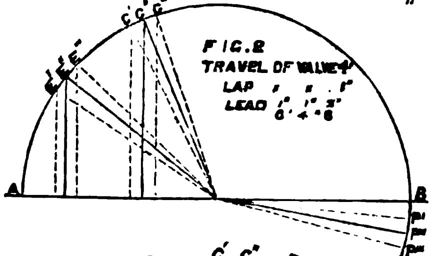


FIG. 2

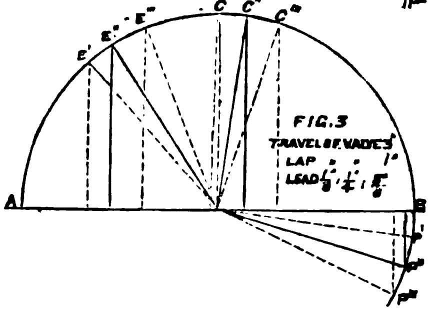


FIG. 3

And now to recapitulate:—

Referring back to Fig. 1, with a valve of 5in. travel and 1in. of lap, we see that within the limits of lead investigated—viz., ⅛in. and ⅜in., there is really nothing to choose—one extreme is just as good or as bad as the other, and the medium is no better and no worse than either, and whether such a valve is set with ⅛in., ¼in., or ⅜in. of lead, can make no appreciable difference in the working of the engine, let it be high or low piston speed, and the proportions indicated here (of travel five times the lap), is one in very general use, and is a very good proportion too. But the case assumes a slightly different aspect in Fig. 2; with the travel of the valve reduced to 4in., the influence of the lead is more felt on the times of the occurrence of the several events of the distribution than in Fig. 1; but who shall say, even in this case, which of the leads is best, the ⅛in., the ¼in., or the ⅜in., for the difference caused by them in the distribution of the steam is not much after all. On the "pre-admissions" it is not worth notice, and shall receive none. On the cut off, there is a difference of only about 1⅛in., and on the exhaust, the difference is but 1in. If the ⅜in. lead cuts off the steam a little sooner than the ¼in. or the ⅛in., it also exhausts it earlier than either of them, and the three expansion periods are nearly equal. The ⅜in. lead uses a little less steam, but it also does a little less work than either of the others, and either of the three exhausts the steam quite early enough for the very quickest piston speed in use. Clearly, then, we have as yet seen no great reason for preferring one degree of lead over another, within the limits investigated.

We have now only to consider the influence of the different degrees of lead under the 3in. travel, Fig. 3. In this case, the very early pre-admission caused by the ⅜in. lead, which occurs when the crank is at P‴, some would perhaps consider objectionable, because the piston has to move during the last inch or so of its stroke against the incoming steam, but when that is said, I believe all is said which can be said against the ⅜in. lead, and, after all, this early preadmission is not a positive evil, because there is no power lost by the piston having to move against the steam the last inch of the stroke, inasmuch as the power it exerts in doing so, is stored up in the valve chest, ready for use on the return stroke, just like any ordinary spiral spring, which will restore to the object compressing or winding it up, all the power employed in that operation. The ¼in. lead causes pre-admission at P″, when the crank is within 15¼° of the centre line, and the piston has scarcely ⅛in. farther to go; and if, as I have just shown, there is no substantial objection to the ⅜in. lead, on the ground of early pre-admission, there can, of course, be none against the ¼in. lead, and as to the ⅛in. lead, which causes pre-admission at P′, and when the crank is within 7° of the centre line, and when the piston has ceased moving, I need say nothing about it.

Then as to the cut off. The ⅜in. lead causes this to occur when the crank is at C‴, and the piston has made 6¾in. of its stroke. The ¼in. lead causes cut off when the crank is at C″ and the piston has made 8¼in. of its stroke; and the ⅛in. lead cuts off when the crank is at P′, and the piston has made 10¼in. of its stroke.

Exhaust occurs with the ⅜in. lead, when the crank is at E‴, and the piston has made 14in. of its stroke; with the ¼in. lead it occurs when the crank is at E″, and the piston is at 15¼in., and with the ⅛in lead, the crank is at E′, and the piston is at 16¾in. when exhaust occurs. Now, the 6¾in. of steam admitted under the ⅜in. lead expands into 14in. previous to exhaustion, or 2·07 times its original bulk, and if its efficiency during admission be represented by 1, its total efficiency will be equal to 1·7 nearly. The 8¼in. admitted under the ¼in. lead expands into 15¼in., or 1·82 times its original bulk, and its efficiency during admission, being 1. its total efficiency is 1·6 nearly.

The 10¼in. admitted under the ⅛in. lead, expands into 16¾in., or 1·63 times its original bulk, and its total efficiency is represented by 1·48, nearly; this shows an advantage in favour of the greater lead, as it develops more of the expansive principle of the steam than the lesser leads. I have only noticed the expansive action which takes place before exhaust, as after that event occurs, the reduction of pressure with large ports is so rapid and complete as to leave no pressure on the piston worth notice; but whatever it is, it is still in favour of the ⅜in. lead, as it acts for a greater length of the stroke in its case than it does with either of the lesser leads.

I have now said all I can think of at present on the subject of the "lead of the slide valve." I have investigated the effects of three different degrees of lead on the three principal events of the "distribution," with three different amounts of travel, or twenty-seven aspects of the question altogether, and these include all that is done in general practice, as far as the common single slide valve is concerned, and I must confess that I have not been able to see or to show any good reason for preferring one degree of lead to another, within the limits I have discussed, except in the case of Fig. 3, there is a little advantage in using the ⅜in. lead, as it gives more expansive action, and consequently a greater economy of fuel than the others; and the same may be said in a much less degree of Fig. 2, and a still less degree of Fig. 1.

I now leave the question here, and hope to see it taken up by abler hands, for I agree with "Steam Spirit," when he says that he "would like to see this question well argued out in these columns by some one who can fight." "Steam Spirit" asks me for a "single rule" to find the proper weight and size of engine fly wheels," I am not surprised at him asking such a question, as the rules generally given in "the books," are so elaborate, and so deeply learned, and withal so contradictory, as to knock a plain practical man into a complete "doldrum," if he only looks at them, and to drive him back upon the good old "rule of thumb" for his guidance, and I am by no means sure but that the rule of thumb, in the hands of a man of good sound judgment in mechanical matters, is infinitely better in this case than any mere "book rule" I have yet seen, but I cannot give "Steam Spirit" my mind upon this subject, till my next letter.

James Baskerville, Manager, City Foundry,
Limerick.

STEAM PROPELLERS IN STEAM VESSELS.

Sir,—Your readers may be interested to learn that ere long it is probable that steel will be extensively employed as a material for propellers in steam vessels, which are not unfrequently disabled from their fracture or that of the screw shaft, several such accidents having befallen Cunard ships of late, *vide* Samaria and Siberia. The experiment has already been tried with entire success, and several large owners of steam lines are discussing the question of their adoption. The advantages are, one-third diminution in weight, a vast increase in strength, and a certain elasticity quite absent in cast-iron. It is probable also that with the fine edge which can be given to the blades, the embarrassing and costly delays which at times occur through fouling of hawsers would be prevented, as they would be at once cut by the revolving screw as soon as any strain was exerted thereon.

Magellan.

SYSTEMS OF SHORTHAND.

Sir,—I am very much pleased with the present form of your or "our" Mechanic, and look forward to its arrival every week as a choice bit of mental food. I should think that amongst your correspondents you number a small army of shorthand writers. I should much like to see a few opinions on the comparative merits of different systems of shorthand; the ease or otherwise with which it may be learned; the probable time required; and the advantages and disadvantages (if it is possible that there can be any) of the knowledge of this art. Any information will be thankfully received. Hermit.

EMIGRATION.—TO "COTTON CLERK."

Sir,—I will at the earliest possible moment attend to your request, both as regards Canada and Australia. Can you not during the interval acquire some knowledge of farming? You will find that the information required to ensure prosperity is not intuitive, but must be learnt.

R.G.S.

THE SOLAR SPECTRUM.

SIR,—I gather from a perusal of your interesting paper of the 20th inst., that some of your readers are in doubt as to the dark lines of the solar spectrum being really due to absorption in the solar atmosphere.

Permit me to remark that a final proof of this lies in the fact that when a vividly incandescent prominence is seen on the sun by the method I proposed in 1866, some of the dark lines *change from dark to bright*.

Mr. Proctor, who writes (page 211) that an increase in the density of our own atmosphere would not increase the breadth of the atmospheric lines (that is the dark line produced by the absorption of our own atmosphere) has doubtless overlooked the results of the experiments carried on by Dr. Frankland and myself, in which we show that increase of density does increase the breadth both of bright and dark spectral lines.

J. NORMAN LOCKYER, 4, Victoria-road, Finchley-rd.,
London, N.W.

THE SOPER RIFLE.—MATHEMATICS.

SIR,—In the account of the Soper rifle, I should have stated that it is fixed by means of two screws, not one, as mentioned.

"T. J. O'C." wishes for some information upon algebra; if he will kindly have patience the reward will follow. We mathematicians can scarcely claim more of your space than we do now. This may be seen by the fact that your waste paper basket contains no small quantity of paper spoiled by being covered with "letters" and figures. How do I know this? Why some of my longest lucubrations have been found therein, helped downwards by a shorter if not better solution. It is really a difficult matter to cater for so many and diverse minds, and I for one give you great credit for the discrimination used, and the excellent results obtained.

Would "Bernardin," and R. A. Proctor, Esq., kindly favour me with their private addresses through our Editor?

C. H. W. B.

[We certainly do not insert all the mathematical matter sent us, and for the following reasons. It would occupy too much space, and it is difficult and expensive matter for the compositors to compose from manuscript copy. When the slightest mistake occurs in the formulæ very frequently all the calculations are thereby vitiated. We have, however, too much respect for "C. H. W. B." to give the waste basket many of his contributions, and particularly what he contributes on other matters under another name.—ED. E.M.]

VELOCIPEDES—THE "PHANTOM" WHEEL.

SIR,—It may be mere stupidity on my part, or it may be that I am not yet used to the "style" of Mr. Henry W. Reveley's English, but for the life of me I cannot make out the drift of his letter on page 131.

If I rightly understand what he says about the "Phantom" wheel, I must tell Mr. Reveley, with the greatest deference, that he altogether misunderstands us. We have never "proposed" thin plates for rubber tires. We actually make and use half-round rubber tires $\frac{1}{8} \times \frac{3}{8}$, which we are prepared to match for speed, safety, ease of work, and lasting qualities, with anything he can bring against them in the way of velocipede wheels. He tells us that the tires of what I suppose I may call the velocipede of the future "must not" be tired in the way we propose. Well, in spite of this dictum, we are satisfied with what we are doing and have done with our rubber-tired wheels for several months past.

A word, too, as to the "velocipede of the future." Would it not be a real mercy to the general reader, and a grateful boon to practical velocipedists as well to confine mere proposals and schemes such as this of a "light carriage for 30 miles an hour with a *slow* treadle movement," and all the tall talk about them to occasional special numbers? We shall never be tired of your admirable articles and illustrations of machines which have been actually made and driven, even where they have only *gone* a very short distance. But let us have done with railways to the moon.

I remember being very much struck at hearing Mr. Glaisher, the eminent aëronaut and astronomer, express at a meeting of scientific men an ironical desire that the Society should be favoured with a series of papers "On Failures," for he felt, he said, that a great deal more good could be accomplished if gentlemen would be frank enough to come forward and confess wherein and how their experiments had been resultless than by the continued iteration of new theories and speculations as to what *might* be done. Now may it not be so in regard to velocipedes? How many of your readers may have stopped short on the threshold of great improvements, which may be reached after all with a little help from the experience of some one else! Try and induce some of your correspodents to go in for this part of the subject. It will be a healthy change, and may help to keep others upon solid ground. If Mr. Reveley could only be induced to put together his 30 miles an hour light carriage with slow walking motion, and all the rest of it, what a nice chapter he might be able to write for your new heading!

J. A. MAYS, Manager and Secretary, The "Phantom"
Veloce and Carriage Wheel Company (Limited), 10,
King-street, Tower-hill, London, E.C.

COLOURS OF STARS, &c.

SIR,—Will some of our astronomical readers inform me which is the proper time to see the correct colours of the stars? Our "F.R.A.S.," Mr. Proctor, and Mr. Webb call Sirius a pure white star. Now I do not think I am colour-blind, but, to me, it appears at night (which I should call the proper time to see the stars), a pure green with dashes of red; several friends agree with me; and in Lockyer's "Elementary Lessons" it is classed as a green star. In twilight it appears white, but not so as the night advances. Will Mr. Proctor [illegible] "F.R.A.S." kindly give me the comparative brightness of the chief nebulæ visible to a 3in. achromatic, so as to get an idea of what I am to expect, when looking for the fainter ones.

"Omicron" stated that the light of D'Arrest's comet was to be 0·126. What does that mean? I beg to second the resolution proposed by J. Brown, p. 228, in regard to an index for "Notes and Queries"; as it is much wanted and ought, I think, to have been done before. I hope it will be carried unanimously.

H. W. BISHOP.

MESSRS. CUNNINGHAM AND M'CARTHY'S IMPROVEMENTS IN MOTIVE POWER.

SIR,—The invention described in your last number (page 223) in a most extraordinary one, especially as put forth by gentlemen evidently possessed of great knowledge in the practical details of machinery. The application of spiral springs as a motive is a very old device, which cannot be usefully employed except in the case of watch and clock machinery, or such like, and for this reason, that the power required to wind up such spiral springs is greater than that required to do the actual work proposed to be accomplished, owing to imperfect elasticity, friction, and other obstacles.

But Messrs. Cunningham and M'Carthy are not content with these so-called improvements in motive power, their aim is apparently perpetual motion. For by having two separate spiral springs, they propose that, while one is uncoiling and driving the carriage, it shall at the same time cause the other to be wound up by means of its winding wheel touching the road, so as to be ready to act when the first shall be exhausted.

Nothing more or less than perpetual motion.

HENRY W. REVELEY, Reading.

"HOW TO KEEP THE CLOCK RIGHT," &c.

SIR,—I am sorry to see that "Luke the Labourer", (p. 62) gives such an unfavourable notice of the book. "How to Keep the Clock Right," especially as it contains testimonials from such astronomers as Sir J. F. W. Herschel and the Rev. J. Challis, M.A., F.R.S. The former distinguished astronomer says that "so far as he can perceive, the method seems to be a very good way of keeping exact time, and very little costly, as well as attended with hardly more trouble than would be required for merely uncasing the telescope and looking through it." The Rev. J. Challis says, "he considers the method to be good in principle, and *to be very practicable.*" I have not yet tried the method, but intend to do so; and I confidently expect to get the time within a ¼sec. by observations of three or four stars. I think "Luke the Labourer" may overcome his difficulty if he constructs a chart of the 350 stars in the zone to be observed, carefully denoting the star magnitudes by black discs of variable diameters: 8th magnitude stars should be represented by dots only just visible. The catalogue numbers should be placed near each dot. I have made a chart of this kind—scale ·8in. = 1°. I can readily distinguish the mapped stars from others when directing a telescope to the zone on a clear night. On a cloudy night I would recommend "Luke" to observe several supposed catalogue stars, and then to argue from his observations to the catalogue by comparing the time intervals, rather than argue from the clock to a star. I humbly endorse the opinions of the great astronomers above mentioned with regard to this method of keeping the clock right

Will "F.R.A.S." or Mr. Proctor kindly answer the following questions?

1st. What is considered to be the best method of determining longitude by astronomical observations?

2nd. Are all or most of the visible occultations of stars, of which data are given in the "Nautical Almanac," observed at Greenwich or other public observatories?

3rd. Can I obtain the observed times of disappearance and reappearance of certain stars as seen at an observatory whose longitude is known; so that by comparing these times with the observed times at any station the error of the lunar tables might be eliminated and the difference of longitude found by the method given in Loomis's "Astronomy?"

I should like to know the result of any observation of the moon on the meridian made at an observatory for the purpose of detecting errors of the lunar tables; also what is the most probable value of the earth's polar semi-diameter, the equatorial semi-diameter being considered as unity? I have only lately noticed that some corrections are required in the formulæ for computing eclipses and occultations, and for determining longitude from observed eclipses and occultations, given in the Appendices to the "Nautical Almanacs" for 1836 and 1837. These formulæ were prepared when Buckhardt's Tables of the Moon were used; but since they are now replaced by Hansen's Tables the constant

log. of $\frac{s}{P}$ = 9·43537 requires correction.

I find that for the present ephemeris of the moon,

log. $\frac{s}{P}$ = 9·43606; and this constant must be used

instead of the former in the formulæ. This log. appears on pp. 130, 134, 175, 183, and is used in determining two constants on p. 177: here the ogs 0·56394 and 2·99236 must be used instead of the logs. 0·56463 and 2·99167 On p. 134 the nat. number ·2725 must be replaced by ·2729. Of course these alterations are well known to practised computors; they may not, however, have been noticed by some fellow amateurs.

INVESTIGATOR.

R.A. AND DECLINATION OF STARS, &c.

SIR,—"Scorpio" asks for a book containing the above. May I be allowed to recommend Mr. Proctor's "Handbook of the Stars," containing the correct places of 1500 stars from 1 to 6 magnitude, and also a very easy way for laying down the meridians, &c. It is a 5s. book, but very useful. I wish to thank "Amateur," page 236, for description of pancratic tube. Although I did not do it right at first, I succeeded with a small tourist glass, and was greatly surprised at the continual increase of power. Could "Amateur" give the reason?

H. W. BISHOP.

THE ELLIPTICITY OF THE EARTH.

SIR,—That Mr. Beardsley should have failed in the difficult task proposed to himself has probably surprised no one who has devoted himself to the study of astronomy; and however satisfied he may be with his own reasoning, I may venture to say that he has convinced none of your numerous readers; and further, I think I can also say that the reasoning of your correspondents will have failed to convince him.

The answering arguments that Mr. Beardsley's letters have drawn forth, while they have been, perhaps, as good as his reasoning has deserved, have been weak. I believe one gentleman asserted that the fact of a person's travelling continuously in a certain direction, and arriving at the point from which he started, was a proof of the sphericity of the world; another, that if the earth were flat, it would be possible to fall over the edge. It is the use of such weak arguments as these, and which are easily confuted, that give rise to the doubts in the minds of some of the truth of the generally asserted figure of the earth. Neither am I satisfied with the course Mr. Beardsley has pursued. I had hoped that we should have seen in his letters something new, and not have been treated to a repetition of the childish arguments that we are so familiar with. In fact, I had trusted to have seen something original in his letters, but have been disappointed. Perhaps the fault was mine; for I had without sufficient reason concluded that as Mr. Beardsley was not a follower of Newton and Laplace, he was necessarily the inventor of a system himself. It seems to me now that Mr. Beardsley is in the fortunate position of being able to throw stones at other people's glass houses, without erecting one of his own for other people to throw at.

But supposing that Mr. Beardsley limited himself to the wide field of overthrowing the existing theories, there is still much left for him to do; for he has yet to consider those facts with which astronomers more particularly concern themselves, from which the figure of the earth can be deduced without measurement of its surface, and with which geodetical instruments have nothing to do.

I had hoped to have seen the disciple of the school of "Parallax" treat of the theory of precession and nutation, and to have seen him overthrow the reasoning of astronomers that deduce from the magnitude of these quantities, taken in conjunction with the density of the earth, the amount of its ellipticity. Nor did I think that the observed inequalities of the moon's motion would have been forgotten and left unexplained; and I am led to think that it is just possible that Mr. Beardsley was unaware that astronomers are able to discover the form of the earth by other means than measurement of arcs of meridian and pendulum experiments.

It may be interesting to some of your readers to see collected the figures that express the ellipticity of the earth deduced from different methods. The general agreement between them is such as to confirm, were confirmation needed, the expressed opinion of philosophers that the form of the earth does not differ greatly from an ellipsoid of revolution. Airy's discussion of what he considered the most accurately measured arcs of meridian gave $e = 0{\cdot}003352$.

Bessel, from eleven arcs of meridian, some the same and some different from those selected by Mr. Airy, and discussed by a totally different method, deduced $e = 0{\cdot}003356$.

The ellipticity deduced by the Astronomer Royal from the consideration of the pendulum experiments equals 0·003471.

The phenomena of precession and nutation give for a result $e = 0{\cdot}003323$; and finally, the discussion of the inequalities of the moon's motion, in longitude and latitude, give respectively $e = 0{\cdot}003387$ and $e = 0{\cdot}003370$.

A slight discrepancy is noticeable in these figures, but so slight that our surprise is elicited, and our admiration excited, that modern measures and mathematical analyses have been carried to such a point of perfection as to make even these small discrepancies a matter of controversy and speculation.

Should Mr. Beardsley be prepared to battle with the more intricate problems of astronomy, the results of which I have mentioned here, I will venture to beg space for him, although, I must confess, it is only for the gratification of my curiosity. O.

CARBON MONOXIDE—STANDARD SOLUTIONS.

SIR,—Your querist, "P. P. W.," can obtain carbonous oxide by many other means than those he states—for instance, by direct combination of its elements, or by substitution, from cyanide of potassium, or ferrocyanogen, or cyanogen itself. By decomposition of more complex bodies it is also obtained, as by the oxydisation of ethyl, acetyle, methyl, &c.; or the decomposition of formic acid, oxalic acid, &c. None of these methods depend on carbonic acid for the formation of oxide of carbon.

"Aqua" can prepare standard solutions on many bases, as Mohr's, Griffin's, Sutton's, British Pharmacopœia, &c. The best mode is to use as a standard normal solution one of a single equivalent in grammes dissolved in one litre of pure water, and for a decinormal standard a tenth of an equivalent per litre. Then, of course, every cubic centimetre used indicates an equivalent in milligrammes of the substance being estimated. As, for instance, to take a very simple case of estimating nitrate of silver, a normal solution will contain 58·5 grammes per litre of sodic chloride. Suppose we find it requires 20 cubic centimetres of this solution to precipitate the silver as chloride from the nitrate this then indicates 20 equivalents in milligrammes of nitrate of silver, or 20 times 170 milligrammes of the river salt—that is to say, 3·4 grammes. If "Aqua" wishes for practical details, he can have them; and reference to your number for May 27th, letter, "Water Analyses," will show him an answer to his query about permanganate of potass.

"A Sister Reader" will find it quite impracticable to dissolve plumbago.

URBAN.

THE EYE.—INVERTED PICTURES.

SIR,—It is an established fact, and well known, that all objects presented before our eyes project an inverted picture upon the retina, but the picture, when transmitted to our mind, seems to us upright. The question has therefore been often repeated, does our mind, in reality, receive an inverted or an upright image? Without investigating any of the explanations with which we meet in books on optics, allow me to give one fact, which may throw a new light upon this question:—I once knew an intelligent little boy, then about, or nearly, five years of age. His eyes seemed to be in perfect order, yet at candlelight, in certain positions, when an observer was in the line of the reflected ray the left eye was crystalline; there was no black colouring matter in the interior, no optic nerve—in fact, observations proved the boy to be blind in the left eye. Although blind on one side, the boy amused himself by drawing simple objects, such as horses, dogs, fowls, and houses, very correctly, upon paper and slate, but *all these drawings were inverted* (upside down) The boy was often told that his drawings were upside down, but he smiled and said "They are perfectly right." No doubt he saw all objects in that position. The bright little fellow soon proved that his left eye was an exception, was a fearful malady; it inflamed, and fungus developed itself out of the cavity. After about ten months' suffering the boy passed away. While he was ill, in hours free from pain, he still followed his amusement, drawing inverted animals upon slate, which again proved that with one eye, and one optic nerve inverted, impressions were transmitted to his mind.

I may here observe that the above case is different from any case where an eye may be lost by accident. In the latter case the optic nerve is seldom—its rudiments, however, are never—destroyed. With the boy the very rudiments of the optic nerve on the left side were wanting; in its place were the rudiments of the fungus. Taking all the circumstances in consideration, I can only come to one conclusion—that with a pair of normal eyes the image presents itself to our mind in an upright position. The single eye presented inverted images; double combinations produce upright pictures. It seems in normal eyes to be this:—The inverted pictures on the retina are travelling along the optic nerves; the latter, as we know, interlace each other. Here an interchange of impressions must take place. In this very act the pictures are reversed, and, resolved into one upright picture, presented to our mind.

The Welsh Shepherd.

THE MOTIONS OF THE MOON AND EARTH.

Sir,—For years past there has been a great deal of quibbling about the proper term to use to express the motion of the moon in relation to the earth. This motion (not taking into consideration external disturbances) is precisely what it would be if the moon formed part of an immense globe, having the earth for a centre and reaching beyond the orbit of the moon, the period of rotation on its axis being equivalent to a lunar month. Allowing for the accelerated rotation of the earth, it would seem that the earth and the moon might be portions of the same solid globe, and yet retain the same relative motions and distances that they have at present, and that the moon revolves round the earth under precisely the same conditions as any portion of the circumference of a globe revolves round the centre of the same.

F. W. M.

SCIENCE FOR THE YOUNG.

Sir,—Will you allow me to draw the Rev. E. Kernan's attention to a few errors which he has committed in his treatise on "Science for the Young." Under the head of law third, he says, "Time is required to overcome the *inertia* of a body whether at rest or in motion. When force is applied to a body, a certain amount of time is necessary for the production of the effect of motion or rest." In this statement he has committed a serious error by confounding the term inertia with a body in motion as well as at rest. Inertia has nothing whatever to with a body in motion any more than momentum has to do with a body at rest. Let us ask ourselves, what is inertia? and what is momentum? The answers to these questions are extremely easy. The quality which enables a body to resist the sudden communication of motion is termed its inertia, and the quality which enables a body to resist the sudden extinction of motion is termed its momentum. Therefore, he should have written law third, as he calls it, thus:—"Time is required to overcome the *inertia* of a body at rest, or the *momentum* of a body in motion. When force is applied to a body, a certain interval of time is necessary to produce the effect of motion or rest in that body. Where does he intend to insert the law of reaction, which is an axiom of statics, that is, a self-evident truth, or one which admits of no other proof than universal experience, and which tells us that *action and reaction are equal and contrary*, that is to say, A cannot act mechanically upon B without A itself being reacted upon equally, but in an opposite direction, or, in other words, that whatever force one rigid body exerts upon another rigid body, the latter opposes that force by an equal force, which is called its reaction. This law is of as much importance as any other in statics.

Again, at p. 79, he arranges the divisions of mechanical philosophy in the following manner—viz., statics of solids or statics, statics of liquids, hydrostatics, statics of gases, pneumatics, dynamics of solids or dynamics, dynamics of liquids, hydrodynamics, dynamics of gases, pneumatics, palmatics (acoustics) of solids, liquids, gases. Now, I must tell Mr. Kernan that he could not have written them in a more inexplicable manner, and he has not alone written them in this inept manner but he has placed the statics of gases and the dynamics of gases under the same signification—namely, pneumatics, which is most absurd, and not to be met with in any standard work on the subject. The above divisions of mechanical philosophy when properly written should be arranged as follows—viz.,

1. Statics—the rest or equilibrium of solid bodies under the influence of forces.

2. Hydrostatics—the rest or equilibrium of fluid bodies under the influence of forces.

3. Aërostatics.—the rest or equilibrium of aëriform bodies under the influence of forces.

When motion is the result of the application of forces to these conditions of matter, we have the following subjects:—

1. Dynamics—the motion of solid bodies produced by the influence of forces.

2. Hydrodynamics—the motion of fluid bodies produced by the influence of forces.

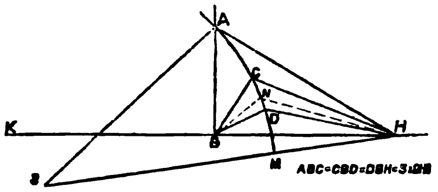
2. Aërodynamics, or Pneumatics—The motion of aëriform bodies produced by the influence of forces.

I think the above arrangement is much superior, both as regards simplicity and comprehensiveness, than that given by the Rev. E. Kernan, because each signification is clearly defined, whereas in his arrangement none of the terms statics, dynamics, &c., are explained at all. I see he has added a new division relative to the vibration of bodies, and which he considers might be entitled palmatics. Well, I will not dispute with him as to this division, as it makes very little matter whether it be considered as a separate division or not.

Thomas J. O'Connor.

TO TRISECT AN ACUTE ANGLE.

Sir,—Draw a straight line K B H. From the point H draw the 3 angles B H D, D H C, and C H A equal to each other. From any point B draw the 3 angles H B D, D B C, C B A each equal to B H A. Through the 3 points A, C and D of intersection draw the circle A M, having the centre S.



Draw the angle H B N equal to the angle which it is required to trisect, and join H N.

Then the angle N H B will be one-third of the angle N B H.

O. H. S.

THE MIDLAND AND WESTERN DISTRICTS OF IRELAND

Sir,—Will you kindly allow me the space in the English Mechanic, to ask a question or two, which I shall feel obliged if some of our courteous geological friends will answer. Travelling through the Midland and Western districts of Ireland, I passed over immense deposits of limestone, some specimens of which were literally crowded with fossil remains, which I believe are called Encrinites. I wish to know whether they are animal or vegetable relics, and whether they existed in the sea or in fresh water. They occur in great abundance near Athlone, in Connemara, and Joyce's country. The deposit assumes a different appearance, that of a mottled grey marble, well suited for building purposes. Other rocks in the vicinity of Ballanahinch gave unmistakeable evidence of I think a good per centage of copper, perhaps not sufficient to pay for the working. I should like the opinion of one who has visited the same locality, and better versed in mineralogy than myself. I was much surprised to hear that this beautiful part was but seldom visited by tourists, a fact I can only account for that its beauties are so little known. To the angler it offers rare attractions; the Loughs Ina and Glendalough are well stocked with salmon and trout, and are situated within an easy distance of the half-way house (usually called Lynch's Hotel), and the Recess Hotel, both of which are passed by the mail cars *en route* from Galway to Clifden. To the antiquarian special interest would be attached to the old abbeys of the neighbourhood, the old abbey of Cong being the resting place of the last Irish King. Part of the cloisters have been restored, and the whole ruins are kept in repair by Sir Arthur Guinness, whose hall they almost join. The bones and fragments of monumental effigies so plentifully scattered about these old places awaken deep interest and speculations as to the lives and characters of those races long gone before. To the lover of natural beauty and quiet solemnity, I would say, visit Kylemore Pass, the group of mountains called the Twelve Pins, ascend the one called Mul Rhea, and he will gain as fine a view of mountain scenery as can be viewed in Ireland. The Sun setting behind the mountains skirting Killery Bay, which in the autumn are covered with the heather bloom, gilds the whole scene with surpassing splendour. But I must close. If any brother reader would wish to visit these scenes and many others in the Western Highlands, and will correspond with me, I shall be most happy to give him any information as to the route, and other incidental matters.

F. Harwood, 33, Newark-street, Leicester.

BELFAST WORKMEN'S EXHIBITION.

Sir,—I herewith send a detailed account in three copies of the *Belfast News Letter* of the Workmen's Exhibition now open in Belfast. The exhibition is very well worth a visit, and many hours could be profitably spent there in examining the various ingenious products of the working man's brain. This item from a provincial town of Ireland augurs well for the success of the main exhibition to be shortly opened in London. Two or three turbine wheels are here at work; in fact, the motive power of the machinery section is given by a turbine made by the eminent engineers, Messrs. McAdam Bros. Soho Foundry, Belfast; they have long been successful makers of these water engines, having devoted particular attention to their manufacture for some years past.

The percussion turbine, exhibited by Mr. Kelly, C.E., the invention of Mr. Cheetham, of. Manchester, is quite a centre of attraction. Its great beauty is its simplicity—nothing to break, and nothing to wear except the axle. I have no doubt it will be heard more of.

The Pneumatic Loom of Mouland and Coulong is particularly worth notice: it does away with picking levers, bowles, peckers, straps, and all these troublesome affairs, and works so smoothly and noiselessly that 100 of them in a shop would not make as much noise as an ordinary sewing machine. A pair of vertical engines combined by Messrs. Coates, occupy a prominent position; they seem to work well. Mr. McCreery exhibits his celebrated spinning wheel, so many of which he has made for the Royal Family and the nobility. It is presided over by a merry old lady, who, with nimble fingers and ready repartee, delights an admiring audience, one of whom made the remark that the wheel worked very quickly. "Is it any wonder" she says; "listen to the fine music she has." "Why? what effect has that upon her?" is asked—"Just" says the old woman, "she's (the wheel) like all other jennies" it puts her clean mad.

A revolving shutter for shop windows or bookcases is well worthy of attention, and will no doubt come into notice. The imitation bronze statues of Holland are very handsome.

Vivis Sperandum.

TRADE AND COMMERCE.

Sir,—Your correspondent "Herbert," writes on these important subjects with a pithiness which is almost convincing. He states that the balance of imports over exports represents the profit of a nation, and illustrates it by an imaginary ship, which, sailing with £18,000 worth of goods, returns laden with £20,000 worth. Here is something for the consideration of our ministers and merchants. Let the Government at once prohibit expertation—all that we import will then be clear profit. Let our merchants send forth their ships empty; the merchandise with which they return will then be so much to the good. But, unfortunately, there is a little flaw in the argument. Your correspondent's assumption would be perfectly correct, if the trade were carried on by barter only, but this is not the case; we might cease to export, and yet, for a time, continue to import as much as ever.

The subject of trading with foreign countries is one of vital importance to the working man, and is not to be settled by a rash conclusion, or even by asking, as one of our Cabinet Ministers did, "Why should we refuse to buy cheaply from foreign countries, because they refuse to buy cheaply from us?" The answer to this is, that by doing so we pay the wages of the foreign workmen, who make these cheap goods, and therefore there is just so much the less for our own workmen. When the amount becomes considerable, as it is at the present time, our men are compelled to emigrate in large numbers. It is pretty plain that for each foreign workman we support in this manner, one English workman is compelled to leave his country, or to become a pauper.

The whole subject is too vast and too important to admit of proper discussion in the limited space you can devote to it. My only object in writing, is to point out what I believe to be an error in your correspondent's reasoning, and to caution your readers that a subject which offers so many points for consideration, cannot be settled by pithy sentences or specious questions.

F. W. M.

DEW CAPS FOR REFLECTORS AND μ^2 BOOTIS.

Sir,—In answer to "Hugo," I must say, that in the cool winter evenings, and indeed on most nights when a deposit of dew occurs on the tube, and when the telescope has been an hour and more in use, he will find a dew cap imperative. My tube has an aperture of 11in., and I find a cap extending to 1ft. beyond the prism, is generally required on dewy nights, although many nights (as at the present time), do occur when the prism may be exposed for a long time. Inside, and at the upper end of my cap, I have placed a ledge, for the lodgement of a series of tin stops, which vary the aperture from 10 to 7in. Before I used a dew cap, I frequently had to remove the prism, warm and dry it before the fire, replace and readjust it. all this took up too much time. In using even a 4in. refractor, I find a cap 8in. long absolutely necessary.

For the information of "H. A. C.," during the present season, I have found μ^2 Boötis well divided with 10in. of aperture, and achromatic power of 300, the same with 9in., but with 8½in. and same power, the discs were in contact; with Huyghenian eye-piece, of about 350, the discs were split. At the same time, I found a of ζ Cancri well divided, with apertures down to 9in. and the same powers, but could not split it with any power of 8½ inches, mainly owing, I suppose, to the components of α ζ Cancri being of greater magnitude than those of μ^2 Boötis, although their distance is somewhat greater.

M. W. B. Coulcher. Downham Market.

BOOMERANG.

Sir,—If "Vivis Sperandum" got a piece of wood, say ash or beech, 2in. square and 2ft. long, and steamed the middle of it well in a box, he could bend it to the shape of outline of boomerang, and leave it till cold and hard, nailed with a few cleats to a flat board; then rip it lengthwise into five thicknesses of ⅜ each, or less, and the grain of all would be the right way to resist fracture. Boomerangs used to be sold at the London toy-shops larger than his dimensions, and with ends about square with each other. Those we see in the museums are frequently scarcely bent at all, and only a foot long, or a little more. Is his name "Vivis" or "Vivus?"

J. K. P.

DARK LINES IN THE SOLAR SPECTRUM.

Sir,—I think Kirchhoff was quite right in his preferring what his spectroscope plainly taught him to what he might have vaguely guessed from the aspect of the crepuscular curve. "T. A." founds his views on the admitted difficulties involved in the problems presented by the sky and its varying lights. But these difficulties need not cause us to blind ourselves to clear evidence of another sort. As for "T. A.'s" explanation, I must say it is too wild for serious comment. If, indeed, he could show reasons for believing either—1st, that iron, magnesium, &c., can combine chemically with oxygen apart from the conditions which have hitherto been found necessary for such combination; or—2ndly, that these conditions exist in the upper regions of the air, he will doubtless be listened to gladly by scientific men—always supposing those reasons to be founded either on observation or on experiment.

I do not consider the ordinary employment of the photographer to involve "a series of very delicate investigations concerning the nature and properties of light," so far as the subject "T. A.' has in hand is concerned. All photography can teach on that subject is that the light from such and such parts of the sky has at such and such times a greater or less active power. The conclusions to be drawn from this are by no means necessarily such as "T. A." imagines.

R. A. Proctor.

FAIRY WHEELS.

Sir,—After having read the letter, p. 233, several times, I cannot discover of what kind of stone those discs are made. If they were not so great, I might have taken them for parts of fossil encrinites, but "Subscriber" says none of them were the same size or thickness; they must then have been made by man, cut, &c.; but for what purpose? Two suggestions present themselves. They were intended for throwing with thongs, or lassoes, or for stringing them as a necklace, or wearing as ornament. Very often pierced objects are found in caves, tumuli, &c. Might not these beads, &c., forming part of necklaces, have become, later, objects of exchange—a primitive money? Might it not be possible to trace by that means the communication ancient tribes had one with another? The note of "Subscriber" affords me the occasion of communicating this idea to my brother correspondents. I hope some other, more acquainted with the question, will bring also his stock of information. Meanwhile I quote a few examples, briefly, Mr. Editor, saying all notes should be drawn up as accurately as possible.

Pierced objects have been found in many excavations in France, Belgium, &c., among what are called the remains of prehistoric times. A necklace of human teeth was found in Belgium; in North America, in the tumuli of Columbia River, Walla Walla, many beads, dentalium necklaces, &c., were found. One tumulus in Virginia gave 1700 grains or beads; with the Celtic warrior found in England, near Salisbury, were two fragments of fossil encrinite and a bead of pottery; a Celtic necklace, made of shells, was found near Dijon, in France; many Indians, negroes, &c., have their shell necklaces; remark among them the cowries—in many places at the same time a money and an ornament. The Egyptian beads, necklaces, &c., of so many different substances, are well known to all those who have visited the British Museum. The Chinese have yet pierced metal discs for their money; the English Hong-Kong coinage is another specimen of it. I have said a word, in another number, about the whampum of North America, also a necklace and a money.

Bernardin.

COLOUR BLINDNESS.

Sir,—Concerning the remarks of "An Idipot," in your last impression, I have little to say. I have never met with a person to whom red appeared black, and I therefore thought it undesirable to dwell upon that particular form of the malady, though I know such an abnormal vision is repeatedly to be found described in books on the subject, though it is generally allowed that such an anomalous vision is only occasional, notwithstanding Sir David Brewster attempted to show that *red colour blindness* is most frequently to be met with, and that a normal eye loses its sensibility to red more readily than to any other colour, and that a defect in the vision of any person will be most strongly marked when examined by *red* light. Though "An Idipot" makes no mention of the fact, I should suppose that the combination of red with other colours does not produce the same sensation of colour that a normal eye perceives. For instance, in a purple the red is not missing, but it appears black, whence it is to be inferred that purple appears as a very dark blue. I would invite "An Idipot" to make some further observations upon his anomalous vision, for it must be admitted that a colour-blind person is better adapted to form a perfect conception of his defect than a normal-eyed person, and can more readily collect his facts; for let him (the colour-blind) be the inquirer, instead of the witness, and he may collect evidence about colours in every possible shape, from the scientific investigations of the philosopher to the artless remarks of the child. He need not go far for an answer to any question he may choose to put, however abstruse; and as to common facts, almost every one he meets is a competent witness from whom he may gather them.

Omicron.

EMIGRATION.—TO "F.R.G.S."

Sir,—I am glad to see "Cotton Clerk's" letter in the Mechanic for this week. Let me also appeal to "F.R.G.S." Will he kindly tell me if there is any hope for me abroad, and where, and how? Although a clerk, I think I know a spade, a hoe, axe, prong, &c, when I see one. I am fast learning how many beans make 5, and can already see nearly as far through a stone wall as some people. I am a clerk 37 years of age, married, with 3 children, eldest 10, youngest 6 (both boys). We have saved a few pounds, and could realise a few more. For the last 3 years I have lived 4 miles from my work, I therefore know how to walk. I have had 110 poles of garden allotment and orchard under my hand alone besides my daily work and law work, accounts, &c. of an evening, insomuch, that I have often seen the sun rise before I went to bed. Pigs, poultry, bees, &c., have also had my attention. I know French and Latin thoroughly. I may, therefore, be said to know what work is, both mental and physical. It is not so much for my own as for the children's sake I wish to go abroad. I should prefer the trade of "earth tickling" to any other, being the only one I know well. Will "F.R.G.S" either pat me on the back or knock me down at once in the matter of hope?

Railway Clerk.

THE "GERM THEORY" AND DEDUCTIONS THEREFROM.

Sir.—The great interest attached to the "Germ Theory" in any of its relations is my excuse for asking your insertion of this letter. It is an acknowledged fact, that on elevated lands of high altitude, 7000ft. to 8030ft. and upwards, the inhabitants enjoy a striking immunity from may diseases, particularly from *phthisis*. It appears also to be the case that a sojourn in such elevated rigions is a sure means of arresting any further phthisical development which might have had its origin at tower levels.

These facts I have always thought most interesting, and well worth of investigation, but although I have continually been on the lookout for a solution of them, I have never yet seen a logical, or even plausible reason propounded. A considerable amount of investigation and attention to the subject—all the *pros* and *cons* duly considered, but into which I need not enter—has convinced me very strongly, or I may say entirely, that the "germ theory" would be found to account completely for the phenomena.

Cold is a well-known arrester of germ development and consequently of their physiological, pathological, and putrefactive effects, but I have never observed it advanced that a *rarefied atmosphere* may be so also—although of course from quite different reasons—simply from the fact that *air of great tenuity will not suspend the germs mechanically and carry them about.* If experimental research proves this hypothisis to be correct, I think it may be logically inferred that those diseases which never appear amongst the inhabitants of high altitudes, or are arrested in others upon going to reside there, are really due to, and sustained by, the presence of animalcular life. This is particularly self-evident I think as regards phthisis, and suggests the trial of a simple means for arresting and curing that dreaded disease.

I propose it might be done either by filtering the atmosphere thoroughly before inhalation—much in the way some of Professor Tyndall's experiments suggest—or otherwise, first heating the animalcular air (to a degree sufficient to destroy the vitality of the germs, and consequently multiplying their morbid action) and then cooling previons to using for respiratory purposes.

Taking for granted that the practical correctness of my theory is demonstrated, let me by way of illustration, suppose that such a building as the Palace of Sydenham, for instance, were applied for utilising it, when hundreds, nay, thousands of invalids could live comfortably and pleasantly together for some months, being all the time *quite excluded* from the—to them—morbid atmosphere of the outer world, and that thin air supply was treated, previous to introduction into the building, in either of the ways I have suggested. I think the same constitutional effects would be found to be produced—and for similar reasons—as already by a few months' residence at high altitudes. A similar arrangement, and for a like object, might be carried out in hospital practice. Such experiments as would place the correctness of my views beyond a doubt are entirely beyond my power.

This being so, my object in bringing the matter before your readers is that, perhaps, in the event of their thinking my ideas worthy of investigation, some of them will not only experiment themselves, and put the theory to the test, but also, it may be, advocate the matter amongst their scientific and medical friends.

With your permission, Mr. Editor, I beg to ask for a discussion and opinions of my proposal in the columns of your widely-known journal.

J—— M——o.

BORING INSECTS, &c.

Sir,—The notice on "Boring Insects," p. 176 of our English Mechanic induces me to forward a few lines on the damage sometimes caused by insects. I extracted them from several agricultural papers.

In 1832 the Hessian fly, *Cecidomyia destructor*, destroyed corn in the State of Maine, Vermont, and in North America, to a value of five millions of dollars.

In 1846 another small fly, *Cecidomyia tritici*, caused in Belgium a loss of 92 millions of francs to the wheat harvest.

From 1740 to '49 nearly all the meadows in Sweden were annihilated by the caterpillar of a phalæna, *Chareas graminis.*

In 1786 the small turnip fly, *Haltica nemorum*, devastated in Devonshire to the value of £100,000.

It is said that in 1784, the wheels of a mill on the Severn were stopped by the abundance of cockchafers in the water, what may be the truth of that assertion, in our times, in 1866, in the Department of Seine Inférieure, France, the premium paid for the destruction of the larvæ or grubs of the cockchafers was 18,000f., and the quantity gathered 160,000 kilog. In 1835 the Department of the Sarthe allowed a premium of 30 centimes for an hectolitre, and 300 millions of cockchafers or larvæ were collected. In 1807, 5150 millions were killed in Switzerland.

The *Bostrychus typographus*, or "printer," committed from 1665 to 1827 incalculable depredations in the forests of the Harz, in Germany, and caused the stopping of the mine works, and nearly the total ruin of some villages. In 1783 alone, 1,500,000 trees were destroyed. There are actually more than 50,000 oak trees attacked by the scolytus in the Bois de Vincennes. The common elm scolytus, *Scolytus destructor* represented, I think, on p. 176, last number, is known in many places, destroying the trees in the public walks. For more particulars see "Die Forst Insectin," von Dr. Ratzeburg. 3 vols., in 4to; "Entomologie Horticole," by Alph. Dubois, Brussels, 1865, 1 vol., in 8vo, with fine plates; "The Farm Insects," by Curtis, &c., &c.

Bernardin.

THE EARTH AND ITS FIGURE.

Sir,—In discussing any matter with such gentlemen as Mr. Beardsley, it is necessary to adhere to one point persistently, and have it distinctly settled before passing on to another. Arguing for victory, and not with a sole aim at ascertaining the truth, such a wri[illegible] acts very much like a small quantity of water [illegible] tained in a bladder; grab it as forcibly as you [illegible] is sure to elude your grasp, and immediat[illegible] position to some other portion of the receptacle, and can only be fairly captured when it is driven up tightly into a corner. Mr. Beardsley, like all men of his stamp, never recurs to a shattered argument, nor, when he finds that an argument has been crushed by a *reductio ad absurdum*, does he either try to rehabilitate it or acknowledge his failure. Thus, with reference to the explanation of the sun's setting by its getting beyond the focal distance of vision, whatever that means, he declines to answer the question as to how it is that the sun does not appear to decrease in size as it, according to his crotchets, increases in distance.

I wish to ask an explanation of a passage in Mr. Beardsley's last letter, and to state a fact which will be something new to that learned astronomer. I refer first to a vessel homeward-bound. In the approaching vessel "the upper masts" and sails are, according to Mr. B., in focus. If so, how comes the hull to be out of focus, for it is as near as the sails (in fact nearer)? Again, how come the upper masts and sails to be apparently growing out of the sea if the curvature of the ocean does not intercept the view? Are we "to believe our eyes," and that the hull and lower sails are under water? Or lastly, are we to believe that the sails have left the hull behind?

The fact I propose to state is relative to the passage. "The sailor knows by the chart the relative position of one country or island to another." Now that is just what, but for the invention of a *distorted* chart, constructed on the supposition of the earth being globular, the sailor never could know from a plane chart. Mercator's chart is so constructed that, in order to preserve the relative bearing the distances are distorted to an unlimited extent, so that a new scale of measurement has to be be used for every degree of latitude, and even then it is only an approximation. Had the true distances of the places been preserved on the plane surface, the sailor would have found the bearings all distorted and pointed wide of the true mark.

Then, Sir, when Mr. Beardsley has made acquainted with the Mercator chart in universal use, he will explain to us why it is that we cannot draw the surface of the earth on a plane without monstrously distorting either the bearings on the distances. I may have something further to say on the subject, but certainly not before.

[It is better that this controversy should now cease.—Ed. E.M.]

F. H. N.

EXTRACTS FROM CORRESPONDENCE.

RUSHES. — "Bernardin" says: — "In reply to 'Camelford,' p. 207, I think he might do better to inquire at a paper mill in his neighbourhood, or to the Editor of the *Paper Trade Review*, 97, Newgate-street, London, as I am not able to give him the particulars he desires about price, &c. I believe rushes should be cut and dried, and packed, so as to present the less bulk possible."

I. W. WOLFE'S "ORIGINAL" CONTRIBUTIONS.—"Vibrator" writes:—"I was rather surprised on looking over a would-be rival to find my method of trisecting published in No. 264, p. 89 of the English Mechanic, copied and contributed without any acknowledgment by a Mr. Isaac W. Wolfe. If he wished it to appear in that paper he might at least have had the courtesy to acknowledge where he saw it, and not contribute it as the result of his own researches,"

INDUCTION COIL.—ANSWER TO "SIGMA."—"M. G. Cunningham" writes:—"Permit me to offer my best thanks to 'Sigma' for replying to my letter, p. 207, I was quite aware of the theory he propounds, but at the same time not quite satisfied about it, and as my plan only involves a slightly increased bulk I think I will persevere with it. Experience has proved that division of the coil by ebonite discs intensifies the current, and the reason is theoretically explained as 'Sigma' puts it. Why, however, if it be so, employ covered wire, which is expensive, and far more bulky than plain, the only object being to insulate the layers? Varnish, paper, tissue or other medium could be employed with greater certainty than any silk covering at a tenth of the price. My coil, now at its 12th layer, and working with four quart Bunsen elements, gives well-defined improvement as each layer is finished, and I think it will answer well; should it not, however, I will not be so thinskinned as to keep my failure from those whom it may interest."

TESTED RECIPES.—"A. Boughey" writes:—"A "Morayshire Man" is quite right in his remarks about the above. Some time ago a recipe was given in the English Mechanic for 'brillantine.' The mixture cost more than what is sold in the shops, and turned out to be a very greasy mixture, with a—certainly not a perfume—which would effectually prevent any one from using it."

THE "PHANTOM" BICYCLE.—"Donald W. Preston" says:—"I can recommend the "Phantom" velocipede wheels to your readers as the best I have have seen, and as fully answering their description in the advertisement. J. Tydeman's unwarrantable letter made me hesitate in ordering a pair; but now I have them, and can say that his description of the

'Spider' in the ENGLISH MECHANIC is quite inapplicable to the 'Phantom' wheel."

READINGS FROM THE GLOBES.—"Ab Initio" writes:—"J. Dyer, p. 235, in attempting to correct 'T. S. H.' appears to me to confound the words *sun* and *time* with each other. Philadelphia, for instance, has its *time* 5 hours *earlier* than London, it being only 7 a.m. there when it is noon *here*."

REPLIES TO QUERIES.

[2628.]—MUSICAL BOX.—I must apologise to Harry Bertram for too severely criticising his description, which, however, I said was well repeated as far as the lesson was learnt. He means that the end of the roller has a flange which moves in the notch of right lever. This may be the case in very common boxes that only play two tunes, and I do not think would act for three; and it is bad, as it enables you to shift the barrel while playing, which has a bad effect, or even to shift the barrel when not playing, which is destruction to the box. In good boxes it is done by a wheel of the same number of teeth or rather spokes (and no rim) as the number of tunes to be played, which is fixed between the barrel and the first toothed wheel, only fixed eccentrically near the outside of that wheel, and every time it is carried round by the barrel turning, one of the spokes is caught by a fixed stud, and is held by it till the next spoke comes to the right place to be itself caught by the stud at the next revolution of the barrel. On the boss of this spoked wheel is a short piece of a screw or a camb which keeps pushing the barrel further and farther until the end of the camb is reached, when a spiral spring pushes the barrel back ready for the first tune again. The music is not stopped by the L-shaped lever dropping into the hole in the end of barrel, but when it does drop in, the curved arm shown in the drawing, p. 164, on the opposite side to the hook, catches hold of one fan of the fly and stops the works. It is a fan-fly not a fly-wheel, as it is not a wheel at all.—J. K. P.

[2639.]—OPINIONS WANTED.—Thanks to Mr. Harrison for his advice about the links and the eccentric. When the lever is in the centre notch the valve spindle end is in precisely the centre of the link, and the eccentrics are properly set, but I think he is wrong when he says the link ought to vibrate on the centre without imparting any motion to either spindle or valve, for I have noticed several since, and they all work the valve a little, but not enough to open the ports, which is caused by the action of the two eccentrics one against the other. If our paper is an *International Mutual Improvement Society* I am surprised that the subject has not been taken up by more of its members.—JOHN W. BEDFORD.

[2640.]—GIRDER PATTERNS.—In "N. L.'s" answer to my query he says that making the pattern bent would not do much good, as the moulder would ram it out of shape. Now suppose the girder to be 40ft. long, section as per sketch (Fig. 1), bottom flange 2¼in. thick, rib 1¼in. thick, how will he ram down the ends, and if he can bend it to suit his requirements is it not just as possible to make the pattern bent, and so save time, and with more surety, for what is to prevent the ends from springing out again, as it would be moulded on its side? Again, a gutter of this section 28ft. long (Fig. 2), thickness at A ⅝in., and at bottom ⅝in., which would be moulded on a block to fit the inside, how would he bend that, and what weight would he require on the middle to keep it down, as it would be moulded with the bottom downhill. And again a foundation plate 33ft. section (Fig. 3) thickness of side A B C D ⅝in., and the top 1⅛in., moulded with the top or round side down hill; and lastly one of a smaller pattern, a tile plate bearer for malt kiln floors of the same size (Fig. 4) section, thickness at point of web ⅜in., A at top B ⅝in., and thickness of top flange ⅜in. and 4ft. 6in. long, which he might bend in the pattern with a bit of trouble and some weights to keep it there; but which would be safest, his plan or to make the pattern bent? And then he finishes by saying that it is a question whether one ounce of practice is worth a pound of theory, but I think from the manner in which he writes he has not got an ounce of theory with a proportionate less part of practice on that subject. The above examples have all been cast, and the whole went straight except one of the foundations, and then the pattern had to be made a little more round. I hope this will be received, as sent, in a free open spirit.—JOHN W. BEDFORD.

FIG. 1.

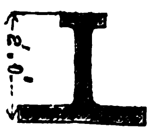


FIG. 2.

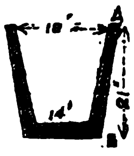


FIG. 4.

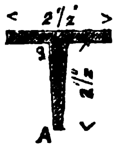
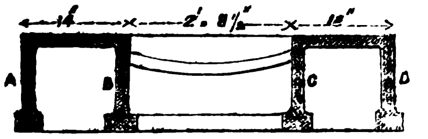


FIG. 3.



[2675.]—POLISHING PIVOTS.—The ridges mentioned by "C. R." are caused by the polisher having the side that polishes the shoulder too much inclined to the side that polishes the pivot. It ought to be nearly at right angles. Pressing too hard against the shoulders has also a great deal to do with it. The polisher ought to have a side as well as a length motion given to it now and then, to cross the marks as it were. The bow takes long strokes, while the polisher moves very little; and always contrary to the direction the pivot turns. "Cylinder" will do well to attend to the above; and I may add, in answer to his query, the conical pivot he marks B is used only for good and best work, in holes furnished with endstones. Cylindrical pivots with the shoulder bevelled off are for more common work, though I have never seen but once or twice a Geneva cylinder with conical points, even in the best work. Cylindrical pivots are the easiest to make, and in foreign work a Swiss pivoting tool and burnishers are used. All English pivots are made with a polisher. I have seen a brass centre used, the pivot laying full length on it, but I prefer the point only supported. "J. A. E." uses the right word when he says 'catching" the centre. He must not file away all the broken pivot, but leave the mark where it was; he will find it much easier to catch the centre of that small ring than if he made the surface uniform. If he cannot mark the point exactly at once he must try to draw it afterwards to its proper place.—NOBODY.

[3707.]—TWISTING POWER OF SHAFTS.—The relative strength of shafts to resist torsion is as the cubes of their diameters, the description of metal being the same. The relative strengths of different metals are as follows:—

Taking cast iron = 1,
then wrought " = 1·12
shear steel = 1·75
cast " = 2·0;

and a shaft to be equal in strength to a cast-iron one, must be, if of wrought iron $\frac{1}{25}$ less in diameter, shear steel $\frac{1}{9}$ cast steel $\frac{1}{8}$.
Q. Q. R.

[3714.]—BOILER.—"One in a Fix," may stop the humming noise made by his boiler by getting two sheet iron plates to fit each ash-pit. and having them drilled with a quantity of ¼" holes; the plates may be attached by hinges, or made to lift away when the ashes are got out; if he will try this I am confident it will cure his noise, having tested it frequently myself. Do not put too many holes in at first, but add them afterwards if the draught requires it.—J. B. CROSSLEY.

[3736.]—AREA OF SAFETY VALVES.—The difference of the areas of the flat and concave valves may be found as follows:—

$$\text{Area of flat valve} = 4^2 \times \cdot 7854 = 12\cdot 5664 \text{ sq. in.}$$

The area of the concave valve may be found by adding the square of the radius of the valve (2in.) to the square of the depth of concave part $\left(\frac{3}{8}\text{in.}\right)$ and multiplying the result by 3·1416. Hence we have

$$2^2 + \left(\frac{3}{8}\right) \times 3\cdot 1416 = 13\cdot 0081 \text{ sq. in.}$$

Then

$$\begin{array}{r} 13\cdot 0081 \\ 12\cdot 5664 \\ \hline 0\cdot 4417 \end{array}$$

0·4417, the difference of the areas of the two valves.—WILLIAM MOOR, Jun.

[3717.]—COPPER COIN.—I beg to inform S. Smith that this is a coin of Emmanuel de Rohan, M.M. of the Knights of Malta. I am sorry I cannot give any particulars; should I be able at some future time I shall be glad to do so.—D. T. BATTY, 9, Fennell-street, Manchester.

[3743.]—SYPHON PIPES.—I think "Calculus" will find that the quantity of water discharged by a syphon will be equal (or thereabouts) to that discharged by a plain pipe of the same bore and length as the syphon, and with a head equal to the difference of level between surface of water in vessel or reservoir, and lowest end of syphon pipe. This can be found by any of the ordinary rules for that purpose, and perhaps the following (I believe by Hawksley) is as good as any:—

$$C = 2252 \sqrt{\frac{h}{L} \times D^5}$$

C = cubic feet per minute
L = length in feet
h = height " "
D = diameter of pipe in feet.

The dimensions and quantities are here given as in feet, but will, of course, do just as well in inches, or any other unit of measurement.—Q. Q. R.

[3744.]—SILVER COIN.—I think there are errors in the legends; the nearest approach to it is a silver penny of James 1st, which reads on obv. "I.D.G. ROSA. SINE. SPINA." and on rev., "IVEATVR. VNITA. DEVS." If there is no mistake in J. Nash's description, the query must stand, but if otherwise, it had better be put right in your next.—D. T. BATTY.

[3745.]—STEAM PIPE JOINTS.—I always use 1oz. of sal ammoniac to every 1lb. of borings, with just a dash of sulphur to quicken it in hardening.—ANTI-EGYPTIAN.

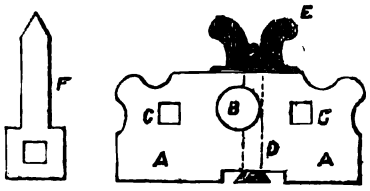
[3746.]—TESTING BOILER.—It will be of no use of Thos. Edwards testing his boiler without he can see the surface and seams of all his plates. If his boilers are only single rivetted, he cannot work them at more than 15lb. pressure. I had two boilers which I worked at 15lb. pressure. I had my boilers tested to 120lb., indicated by Bourdon's pressure gauge; they stood it better than they could be expected, although they (the engineers) will not allow them to be worked with more than 15lb. pressure, being single rivetted boilers.—ANTI-EGYPTIAN.

[3750.]—SILVER COIN.—"A Beginner" will see his coin in Ruding's Appendix, plate 29, No. 12. It is thus described, p. 300:—"Obv., BALDRED REX. Head rudely drawn, Rev., + ETHEL..D MONETA. Double cross with an amulet in the centre. Bodlean Library." I imagine it to be at least scarce, if not very rare.—D. T. BATTY.

[3751.]—ASCARIDES.—"A Great Sufferer" should take half a glass of *good* port wine (not the cheap (!) advertised poison) every morning, fasting, for three mornings, then stop three mornings, after which repeat the dose. This will cure him in a month, provided he is careful in his diet, avoiding fruit, and especially cake or pudding with currants. Proved. —F. H.

[3755.]—TURBINE WHEEL.—"Senex" seems to have asked me almost the same question as I have asked him, which was, what quantity of water and height of fall was necessary to drive an one-horse wheel. However, as near as I can get at it, the fall would be 20ft. through a pipe of ¾in. internal diameter. I would also ask what height of fall or pressure of water is termed high pressure, as in some street mains?—A. B.

[3757.]—A BOOKBINDER'S PLOUGH.—Enclosed is a sketch on the scale of ¼ of an inch to an inch, A A is the right hand cheek of the plough, 19in. long by 4½ high, 1¼ thick; the left hand cheek is of the same dimensions, and traverses between the two strips of hard wood, shown in the sketch of the press on page 65. B is the screw, it is about 20in. long, the screwed part is 1¼in. in diameter, at the shoulder of the handle part it is 2in., a groove ⅜ wide is turned in the plain part, which allows the bolt D to pass through, and act as a sort of garter pin, to cause the two cheeks to recede from or approach each other; the bolt D is of iron ⅜ square, and bevelled out to ⅞ square at the bottom, so as to grip the knife F, which has a square hole, bevelled, to match the bolt. E is a nut, which screws down on a lozenge-shaped piece of iron, so as to grip the knife very tight. C C are two guide rods 13in. long, ⅜ square, firmly fastened into the cheek A, the handle of the screw is 5in. long, as the knife cuts the handle should be gradually turned, so as to keep the knife to the work.—AB INITIO.



[3765.]—NAVAL ARCHITECTURE.—"G. E. J." should write to C. W. Merrifield, Esq., (Principal of the School of Naval Architecture,) South Kensington Museum, who will give him any information he may ask for as to the evening classes.—R. M.

[3768.]—POISONING BY CANTHARIDES.—I am very sorry to see "M. D." states in page 237, Vol. XI. that the effects of cantharides are only transient, &c. They are not so; in small doses it is an irritant of the bladder; in larger or improper doses it produces serious bleedings often resulting in death. It is administered surreptitiously under the idea that it is provocative of physical love, for which purpose it is absolutely useless. No man conscious of his moral responsibility would ever administer it, excepting under and in strict accordance with the orders of a well qualified medical practitioner. I believe any person administering it for improper purposes is liable to a criminal prosecution.—E. DEACON.

[3772.]—OLD COINAGE.—Old copper coins may be sent to the Master of the Mint, Tower-hill, London, who will, no doubt, take them at, I believe, their full value.—R. M.

[3773.]—¼-PLATE PHOTO CAMERA.—If "Snatch Block" will tell me whether he wants to make a portable camera, or one for the studio, I will tell him how I made mine. Of course, if the Editor, be agreeable, I could describe both. ¼-plate is not too small to begin with.—MUS.

[3774.]—LOOSE PULLEYS, &c.—The best plan will be to bore the pulleys about ⅜in. larger than the shaft, and sweat a brass bush in it, or one composed of the following alloy:—(Babbitt's metal) tin 10 parts, copper 1, and antimony 1. I have proved the latter to be a very good wearing metal.—STARK.

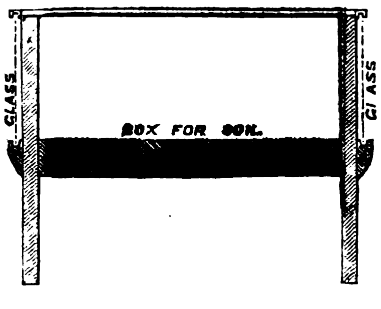
[3774.]—LOOSE PULLEYS, &c.—Wm. Corlett should turn the shaft end true, then bore out the loose pulley, and let the pulley work on a loose bush, bored and turned to fit the two, with a small collar and set pin at the outer end for fastening on the shaft; this would be a much better job than any composition, and is a very general thing nowadays; cast iron and cast iron would then work together, which is to be desired.—MUTUAL IMPROVEMENT.

[3774.]—LOOSE PULLEYS, &c.—When worn in, the hole should be bored out sufficiently large enough to allow substance for the bush, which may be good gun metal, and will wear very well; the bush should be pressed in tight, that it may not move in the hole, and when it wears out, which will not be for a long time, if properly oiled it can be knocked out, and a new bush put in without doing anything to the hole in the pulley.—JONATH.

[3776.]—BOILER SAFETY-VALVE.—"One in Need," has not given quite enough information to enable me to answer his question exactly. Does the weight of valve and lever, as stated by him to be 7½lb., give the true pressure exerted by them on the valve when in place? I expect not, and should imagine their effective pressure on the valve to be at least 21lb. Since the area of a 3-inch valve is 7 square inches, this will give 3lb. per square inch. So the weight will have to balance only 57lb. per square inch, and will be found thus:—

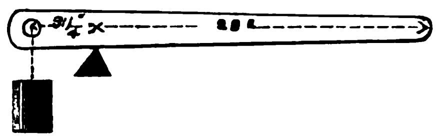
$$\frac{7 \text{ sq. in.} \times 57\text{lb} \times 3\tfrac{1}{4}\text{in}}{20\text{in.} + 3\tfrac{1}{4}\text{in.}} = \text{about } 56\text{lb.}$$

[3776.]—CASE FOR FERNS AND MOSS.—The best form is to make the legs and upright rods which hold the glass in one length, with a light rod running round the top, in the underside of which is a groove, There should also be a groove on the top edge of the box which holds the soil, and the glass made to slide on one side to allow the plants to be got at easily. The grooves must of course be on every side arranged as in sketch, and a sheet of glass lying on the top will complete the case. This is cheap to make, looks well and the



glasses can be easily removed for cleaning, &c. A hot water tank in the bottom heated with a small gas jet underneath will make a tropical stove on a small scale, or a hot water, pipe round the inside, and a small copper boiler underneath will do even better. I have one, and for two years have grown with success the rarest tropical plants, orchids, &c. One year I had orchids only, the next I had caladiums, Egyptian papyrus plant, dwarf palms, tree ferns, &c. Now I have aquatic plants from the Amazons and Borneo, pitcher plants, &c. It costs me little or nothing, as the plants always increase in value, and I have no difficulty in exchanging them. So far as treatment goes, he will learn more from the persons he buys his plants from than any one else, as each plant has peculiar habits. The case should have a reasonable amount of ventilation, so there is no need for care in fitting the glasses and woodwork closely; mine is open ¼in. at every corner all the way up, and we burn a large quantity of gas in the room without the slightest effect on the most delicate plants; if they are quite close they get mouldy.—A DENTIST.

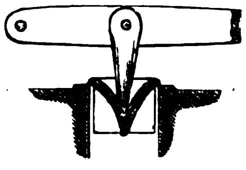
[3779.]—BOILER.—"One in Need," should give the effective weight of his lever, and the weight of the valve; if he is unacquainted with any method of finding the same, he may get it as follows:—Place the lever at the fulcrum on a three-sided file, and fix the short end, at the centre of motion, hang weight sufficient to balance the long end, thus the effective weight is the weight required to balance, and the weight of lever, to which he must add weight of valve.—JONATH.

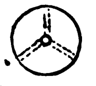


[3779.]—BOILER SAFETY VALVES.—According to "One in Need's" figures, the weight required on end of lever would be 67lb. 10oz., but I am afraid the 7lb. 14oz. weight of lever and valve does not include the *effective* weight of lever, in which case he is altogether wrong.—MUTUAL IMPROVEMENT.

[3779.]—BOILER.—A weight of 58·184lb. placed on the end of the lever will give the required pressure. This weight is not exactly correct, but it is as correct as can be calculated from his description of the valve. If he requires the exact weight, he must give the weight of the valve and lever separately; if the lever be of the same breadth and thickness through out, its effective pressure can easily be calculated, but if tapered he must disconnect it, and try what weight will balance it, making the point in a line with the centre of the valve, the fulcrum.—THOMAS J. O'CONNOR.

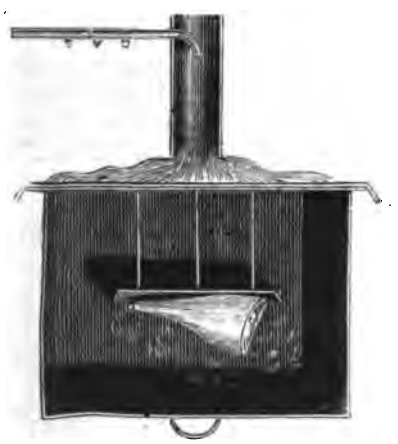
[3780.]—AREA OF SAFETY-VALVES.—The area of the valves for pressure is not at all affected by the difference of form shown in the two sketches. They are, however, not good forms of valve, as when the steam is blowing off strongly the current is considerably impeded by meeting the flat or concave surface of the valve before escaping. The form of valve ordinarily used on locomotive engines is, perhaps, the best of be simple valves, and is somewhat thus, the seating being a very small mitre, or sometimes a narrow flat ring of bearing surface.—Q. Q. R.





[3786.]—AREA OF SAFETY VALVES.—I think "Flat and Concave Valves" will find on a little consideration that there is no difference between the two, because if there seems to be more surface in the concave, the column of steam is only 4in. dia. in the pipe's neck. Did he ever hear of the man who made a corrugated piston bottom, so as to work the steam on a greater area?—MUTUAL IMPROVEMENT.

[3793.]—COOKING BY GAS.—If the gas is not under the meat inside the oven, the meat is quite as nice as that done before the fire. We find the best way is to put a Bunsen burner under an iron plate and cover this with a large tin cover, which is cased in flannel to prevent loss of heat. The meat must be supported on a stand in the centre of this, with the gravy tin under it. By this arrangement the meat is cooked as before the fire by hot air, and the most critical person cannot tell how it has been cooked. The same burners may be used for boiling vegetables, &c., and plates may be warmed by setting them on edge round the oven, or putting them on the top. We have used this plan for 6 years exclusively, and as near as we can tell, it costs about 5d. or 6d. per week to cook for 3 people. During 6 months of the year we have no fires at all, and [illegible] cooking cannot be kept with coal at 28s. per ton, for less than 2s. per week. At present we have four cooking burners and cook for seven people never using the fire for any purpose, and I estimate the cost for cooking to be about 1s. per week; this, of course, includes boiling water for children's baths, washing floors, &c.—A DENTIST.



[3793.]—COOKING BY GAS.—I beg to inform "J. M. D." that I cooked by gas for several years for a large school. The flavour of the meat, &c., were not only preserved, but the process was cleaner and cheaper than the usual mode. There should be a pipe on the top of the oven for the escape of the carbonic acid gas, &c., which should pass into a chimney or the open air.—J. DYER.

[3794.]—POLISHING STEEL.—"Cylinder" must be sure this clock is good metal, that his stuff is good, and that his steel was properly hardened before it was tempered, and not empered too much. He must have everything clean, and not dust flying about. The block must be refiled before each attempt, the least quantity of red stuff used, and the polishing moved very little during the process. Anything more is difficult to describe, as it is by the feel he will know when he has rubbed enough. It all depends on leaving off at the right moment.—NOBODY.

[3797.]—TELESCOPE STAND.—If Mr. Turton will call at Brunswick House, Tanner's-hill, New-cross, he shall see the stand and mounting of my 9in. reflector.—J. DYER.

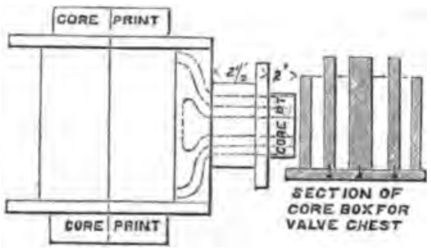
[3798.]—TUBE FOR 9IN. REFLECTOR.—The thickness of the sheet iron of which the tube of my telescope is made, is rather over the 20th of an inch. The tube is 7ft. 5in. long, and the focal length of the speculum is 6ft. 6in.—J. DYER.

[3799.]—BRASS COIN.—Is a Nurnberg counter. As many of those legends have no meaning, and some of the devices fanciful, it is next to impossible to give further information about them than what has been given. A friend of mine laughingly said to me the other day, "I think the Nurnbergs have been pretty well worked or used up in the ENGLISH MECHANIC." I quite agreed with him, and I am pretty sure, Mr. Editor, that when you see one again you will be able to say in your "Answers to Correspondents" what it is without giving us a woodcut.—D. T. BATTY, 9, Fennell-street, Manchester.

[3801.]—LEVER ESCAPEMENT.—"Gracchus" asks for plain instructions to plant a lever escapement. This implies that all the pieces are ready made, and all he wants to know is how to plant or pitch them off into connection with one another. But as he adds, "proper dimensions," &c., he evidently wants to be shown how to make a suit of clothes to fit anybody, "proper dimensions," of course. I must remind him that a knowledge of the escapements is acquired studiously and with great application by all who wish to know anything of their business. The subject will bear no trifling with, and "Gracchus" must not think to get off less easily. I could do nothing to help him without an accurate plan of what he wants, or at least the half containing the escapement; and then if he knows nothing on the subject, all my explanations will be double Dutch to him.—NOBODY.

[3803.]—CHANGING COLOUR OF PRIMROSES.—I have about half a dozen differing in colour from yellow to a very dark purple. This change was caused by being yearly transplanted into richer soil. They first come an orange colour, then a light red, and eventually purple. The following recipe will show "J. D. M." how to change other flowers:—The colours of flowers may be changed by certain additions to the soil in which they grow. Powdered charcoal deepens and intensifies. The flowers of the dahlia, rose, petunia, &c. Carbonate of soda reddens hyacinths; and superphosphate of soda alters in various ways the hue and bloom of other plants.—W. F. HAIGH.

[3810.]—CYLINDER PATTERN.—Let amateur make his cylinder model similar to sketch, the main feature of which is the valve box and thoroughfare cores. In the first place, put a good core print on valve box, then make a core box to suit the print, and inside this and from bottom side screw on three pieces of wood exactly where the ports want to be, and let them come through the top, and by making the core box for ports long enough to come through the valve box core, it all goes in together and prevents the moulder having to put studs in to carry the cores of the port. By putting a thick print on valve box it gets a good bearing surface for the cores. —JOHN W. BEDFORD.



[3813.]—POROUS CASTINGS.—This short query would admit of a very long answer; but I will try and make it as plain as I can. 1st. The sand is a very important thing; if it contains too much clay it is a great difficulty to make castings free from airholes. Clayey sand is only fit for light castings, where good impressions are of value, likewise avoid everything that will generate gas, such as coaldust, charcoal, and like substances. Ram your mould regular, and vent or pierce it with innumerable airholes; cast or pour it with as hot metal as you can get, not forgetting to run it in the mould as quick as it will go in. The sullage must be kept back with a skimmer during the pouring of the metal in the mould, and the head or git must be made so as it will be kept up or kept full during the casting operation.—N. L.

[3819.]—CHEAP GAS.—A great saving in the consumption of gas can be effected by regulating the pressure of gas on the burners. When more gas flows to the burners then they can properly combust, the illuminating power of the gas is deteriorated, and, of course, the gas bill is increased. One of the best ways to prevent this waste of gas, is to have a good regulator fixed near to the meter, which would regulate the flow of gas to all the burners. Another plan I have also adopted, that of placing a disc, with a small hole in the centre for the gas to pass through, in the elbow or brass socket in which the burner is screwed. The whole in the disc must be made according to the size of flame required at the burner. I have been able to save 25 to 30 per cent. in the consumption of gas by adopting the above. With regard to the carburisation of gas by causing it to pass through a vessel filled with some hydrocarbon, this plan has been tried under two or three patents for the last 30 years, but nearly in all cases where it has been adopted, after a long trial it has been abandoned on account of the difficulties, and the absence of the economy anticipated. A word respecting gas regulators, and regulating burners:—The best regulators for fixing near the meter that I know of (and I have tested several) are those made by W. Tices, 65, Bartholomew-close, E.C., and by W. Sugg, Vincent-street, Westminster; Sugg has also a good regulating burner. Nearly all the regulating burners offered to the public are worthless after they have been in use for a short time.—L. M.

[3820.]—AQUATIC BOTANY.—*Stratiodes Aloides*, or Soldier plant. There is no plant so beautiful and interesting as this for the above purpose. Tie it to a stone and sink to the bottom; it will soon send up young plants on long stems reaching to the top of the water like so many juvenile palm trees. After a time the stems decay and the young plant floats free, of a lovely transparent green. They will soon require thinning out; for this purpose a tank should be kept out of doors, in full sunshine, where those not wanted should be placed, when they will get strong and change to a mahogany brown. Returned to the aquarium they will gradually go through all the intermediate shades till they regain their green hue, A constant interchange of tint may thus be kept up. The plant may be grown of any size, according to that of the vessel, and increase abundantly.—AMATEUR.

[3824.]—GOVERNORS.—I can recommend Porter's patent governors as being very sensitive and powerful. They revolve very quickly—usually from 300 to 400 revolutions per minute—and when properly proportioned will not allow a variation of more than perhaps 3 per cent; so that a shaft running at 60 revolutions per minute would not vary more than 2 revolutions per minute. These governors are made by the Whitworth Company, in Manchester.—Q. Q. R.

[3827.]—NITRATE OF SILVER STAINS.—To remove the nitrate of silver stains, pour on solution of potassic iodide, then nitric acid twice diluted, and then wash with hyposulphite of soda. I have found this succeed in removing stains from the hands, but care is required.—OMIO.

[3829.]—SOLDERING.—Perhaps the following may be of use:—A lute for the joints of iron vessels may be composed of 60 parts of finely sifted iron filings and 2 of sal ammoniac in fine powder, well mixed with 1 part of flowers of sulphur. This powder is made into a paste with water, and immediately applied; in a few seconds it becomes hot, swells, disengages ammonia and hydric sulphide, and soon sets as hard as the iron itself.—OMIO.

[3834.]—DUMB BELLS.—See "Physical Education," by A. Maclaren of the Gymnasium, Oxford. Clarendon Press Series, 5s.—OMIO.

[3836.]—PITCH OF PROPELLER.—The first thing "T. J. O'C." must do is to bore out the eye of the propeller in the lathe, and fence up the outside end of the eye for the nut to bear properly that secures the propeller on the shaft; then take it out and lay it down on the ground with that side up that is faced for the nut, and level it up all the four ways of that part that is faced; then put a centre into the eye of the propeller, and from the centre of the eye draw a circle with any radius on that part of the eye that is faced for the nut, and divide that circle into 12 equal parts, and also divide the blade from the centre of the eye to the point into feet, and draw the lines across the blade with a radius from the centre; then take a straight-edge that will reach from the point of the blade to over the centre, and lay the edge of the straight-edge on the point where one of the divisions cuts the circumference of the circle and makes it run into the centre, and keeps it in that position by laying a block of iron on it; then plume down from the edge of the straight-edge with a centre plummet to the divisions on the blade, and mark them with a centre punch; then measure the distance from the edge of the straight-edge to the plume point on the blade—presume that it is 6in.; then turn the straight-edge to the next divisions, still keep it running into the centre, and likewise level, and plume down with the plummet again to the blade, and mark it, and then measure the distance down again from the edge of the straight-edge to the plume point—presume it is 20in. Now the difference between 20in. and 6in. is 14in.; then as every inch of the perpendicular distance gives 1-12th of the pitch in feet, therefore 14in. would be a 14ft. pitch to the blade of the propeller; and if the blade is not broad enough to take in a twelfth part, divide the circle into 24 parts and the blade into 6in., and every ½in. in the perpendicular distance, in the same way, will give a twenty-fourth part of the pitch, and so on. The most convenient way to divide the blade is to divide the straight-edge into feet or half-feet, as it is required, and square lines across the edge; then make one of the lines coincide with the centre of the propeller, and the edge with one of the points on the circle, and then plume down from these points to the blade and mark them; then measure the distance down.—G. B. D.

[3845.]—BOEHM FLUTE.—In answer to "Another Flautist's" inquiries respecting the Boehm flute, I may state that the use of the rings is to stop holes which are beyond the reach of the fingers. On the old flute the holes are altered from their true position from the inability of the fingers to reach them; hence its notes are unequal in power, and are "out of tune." The latter defect is partially lessened by altering the size of the holes, but at the expense of adding to the former. Boehm overcame these difficulties by placing the holes in their natural places, and by making them of equal proportions throughout (the holes being made gradually smaller and smaller through a regular progression upwards), by which means he obtained uniformity of force and tune, and great increase of power in the whole scale of the instrument. But these advantages were met by a great drawback, for he found it necessary to alter the fingering of many notes; and this involved to those who already knew the old flute the unlearning of one system of fingering and the learning of a new. From this cause many, seeing the superiority of the Boehm flute, became dissatisfied with their old flutes; but finding the difficulties of the new fingering too much for their patience, gave up flute-playing entirely. Some few years ago Mr. Clinton, the celebrated flautist, invented a flute called the "equisonant flute," which not only had all the advantages of the Boehm flute, but retained the old fingering, and with increased beauty and brillancy of tone to the instrument itself. The writer of this has had practical experience of all these flutes, and much prefers his "equisonant" to any other. What I have said about flutes will equally apply to B clarionets. It would take too much space to describe flute machinery thoroughly.—H. T. LEFTWICH.

[If Mr. Leftwich desires to treat the subject more fully, space is at his disposal.—ED. E. M.]

[3846.]—NICKEL.—The following extract may perhaps be of interest to "Another Flautist":—"Nickel (Ni 29·57), a

FIG. 1

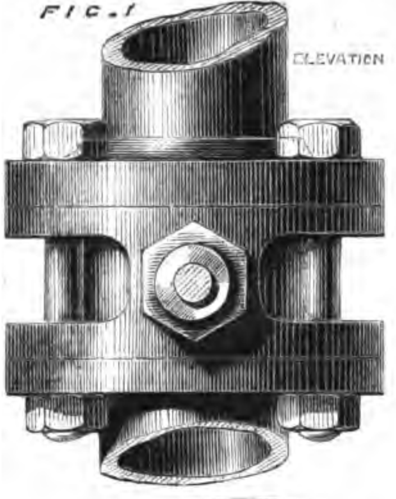
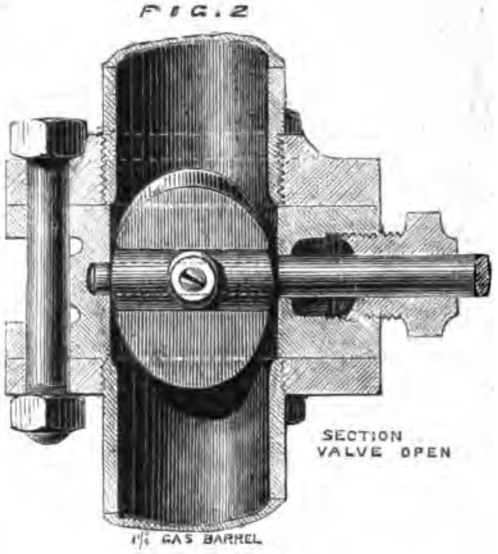


FIG. 2



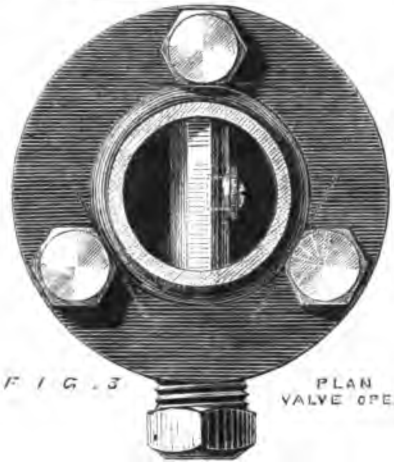
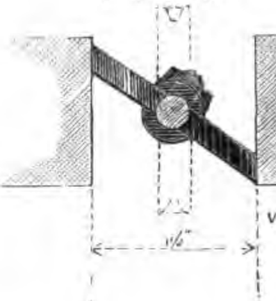


FIG. 3

FIG. 4



metal of a greyish-white colour, with remarkable magnetic properties, which it loses on being heated to 660°. It is ductile and malleable. A Bavarian coin has been struck in this metal, and the impression of the die is said to be very perfect. The sp. gr. of nickel varies from 8·27 to 8·40 when fused, and after being hammered, from 8·69 to 9·0, it has a high melting point, and is but little acted on by dilute acids. Native nickel is found in the Erzgebirge in small quantities. Kupfernickel, or copper nickel is an arseniuret, and is also tolerably abundant. The nickel of commerce is obtained chiefly from kupfernickel, nickeliferous pyrites, and from the spiess obtained as a secondary product in the treatment of the nickeliferous ores of cobalt. As there has been a great demand for nickel in the manufacture of German silver, some improved methods of obtaining the metal have been introduced. They are, however, kept secret; but Mr. Phillips, in his *Manual of Mineralogy* suggests the following as the process likely to be followed:—"The roasted ore or spiess, after being dissolved either in sulphuric or hydrochloric acid, to which either nitric acid or nitrate of soda has been added to peroxidise the metals, is placed in large vessels, in which the insoluble matters are allowed to subside. The clear liquor, after it has cooled, and the copper and lead which have been precipitated by sulphuretted hydrogen, may be decanted off and treated by carbonate of lime in the form of common chalk, by which the iron and traces of cobalt will be precipitated, whilst the greater portion of the cobalt and the whole of the nickel will remain in solution. After the oxide of iron thus precipitated has subsided, and the liquor has been again syphoned off, the cobalt may be thrown down by saturating the solution with chlorine gas, by the addition of hypochlorite of lime, and then adding carbonate of lime. The liquor syphoned from this solution contains the whole of the nickel, which may now be precipitated by ebullition with hydrate of lime, and dried and reduced in the usual manner —HARRY G. NEWTON.

[3850.]—THERMOMETER.—"Thermo" had better place his thermometer against a piece of ice, which will have the effect of causing the mercury to recede towards the bulb; but if the bulb is not broken much, it will soon settle of itself. —SEMPER PARATUS.

[3851.]—HARNESS.—"Equestrian" will find the best way to clean his harness is to well wash it in warm soap and water, (soapsuds would be better), dry it thoroughly, and then rub neat'sfoot oil on it; let it stand till next day, and if it absorbs the oil readily, give it another coat. This treatment is suitable for any kind of harness or leather: but if the bridle is a black one, he will find a great preservative in Harris's harness composition.—SEMPER PARATUS.

[3852.]—BRASS INSTRUMENTS.—They fill the tubes with melted resin, and twist them about when cold with apparently as much ease as they would use in bending a piece of cord. No doubt a sharp look out is kept for puckers, which they hammer in directly they appear on the inside of a bend of course with a small round-faced hammer. Copper tubes may be filled with lead, but it is dangerous with brass ones, as, to get the lead out, a good heat must be used, which makes brass brittle, and very likely to give way with the weight of the lead. I saw Distin's factory once, and was quite struck with the tube bending, which I had supposed such a delicate operation. I believe it is very difficult to get bruises out of tubes, and that they have a sort of jointed metal mould to put inside a bell which has a bent tube to it, and which has received any injury.—J. K. P.

[3852.]—BRASS INSTRUMENTS.—The bends of brass instruments are made by first filling them with lead, and then bending them; after that the lead is melted out. The reason they require filling with lead is to keep them from bulging out at the sides. The lead would, however, be inadmissible in the case of zinc tubes, as they would melt when the lead was run out. I am told resin would do instead, but this I have not tried. I should advise "Clutha" to try it, and report progress.—SEMPER PARATUS.

[3860.]—COPPER COIN.—Is of Catherine II., Empress of Russia; no value.—BERNARDIN.

[3863.]—PASTILLES.—Take 8drm. of cascarilla bark, 4drm. of gum benzoin, 2drm. of styrax, 2drm. of olibanum, 6oz. of charcoal, 1½drm. of nitric, and a sufficient quantity of mucilage of tragacanth. Powder the substances and form into a thick paste with the mucilage, and divide into small cones; dry them until quite hard in a slow oven.—MINNEHAHA.

[3863.]—PASTILLES.—"W. R. C." asks for some recipes for fumigating pastilles; I send the following, copied from a book which I believe can be relied on, but not proven on account of the difficulty of obtaining one or more of the components:—Pastiles á la rose. Essence of roses 1 part, nitre 9 parts, gum 12, tears of olibanum 12, tears of storax 12, powder of roses 16, charcoal 60; powder the solids very fine, and make a paste with gum tragacanth, 2 parts dissolved in rosewater 35.—Pastilles à la-Vanille: Gum galbanum 25 parts, tears of olibanum 25, tears of storax 25, nitre 25, cloves 25, vanilla 35, charcoal 115—make paste as above.—Orange Flower Pastilles: Neroli 1 part, nitre 9, galibanum 13, tears of olibanum 12, tears of storax 11, pure orange powder 12, charcoal 70, reduce to fine powder, and make paste with gum tragacanth 2, dissolved in orange-flower water 15, and rose water 17 parts.—Lastly, but hardly fit for a sick room, Explosive Pastilles: Make a hole at base of pastille and fill with gunpowder. I am afraid the queer names of these fragrant resins will almost frighten the querist; but I believe all except tears of storax and neroli can be bought in pennyworths at the druggist's; if one shop does not keep them, try another. They say that tears of storax have not been in the English market for years, but I believe the liquid storax will answer the purpose. By the word "tears" is meant the drops of resin in that shape, but of course the lumps will do as well. Orange and rose powder I take to mean powdered orange and rose flowers. Neroli is the essential oil of orange flowers. I will now give a simpler way for fumigating, but which has this objection, that everybody does not like the perfume. Dip brown paper till quite soaked in a strong solution of nitre; then, when perfectly dry, rub over it a varnish made by dissolving either or both gum olibanum (frankincense), and gum benzoin this soon dries and is ready for use; this last I have done myself, and succeeded in getting a strong fumigant.—H W. BISHOP.

[3871.]—THROTTLE VALVE.—I send for "Grocer's" benefit a full size drawing above of one I put to an engine of 4½" cylinder. The same thing reduced to ¾ gas barrel which measures say ⅞ inside and the casting bored to 1" would do for a 1 h.p. engine. The lower section of pipe is screwed and brazed into wrought iron flange and faced off in the lathe being a short length altogether, the upper flange cast iron tapped for barrel, which is screwed, in with white lead. The intermediate piece is like a pulley with large hole through, and very deep groove with a piece stuck in the pattern at one side to be bored out to make stuffing box, and a small boss opposite side to prevent spindle hole coming through, all bolted together with 3 bolts. These are prevented from turning by three flats filed on edge of moulding on casting as shown on plan, Fig. 3. The valve is cast with two tails for centering in the lathe, and a finishing cut taken with the slide rest to exact diameter of valve case. See Fig. 4. To get it out in case of wanting repair, slack nuts ½ turn, and let a little steam on, then take out bolts, and all comes asunder. You need not cut off the tails from valve if they are not long enough to gain when valve is full open, which it would be by moving 30°.—J. K. P.

[3866.]—LATHE AND ITS USES.—For the information of G. Flackburn, the universal cutter spindle of which he speaks works or rotates in two internal hardened steel cones, the two ends of the spindle being external. The square bar which fits into the receptacle of slide rest of a 5-in. centre lathe Holtzapffel's standard is 9 1-6th square and 4½ long. Perhaps I might add that I have arranged and now make a far superior instrument for simplicity, effectiveness, and durability than the one represented in Vol. V., p. 203, Fig. 256, and do hope before long to give the ENGLISH MECHANIC a representation and description of it.—EDWIN BAKER.

[3867.]—LATHE DIVIDING PLATE.—If "R." requires a ready reckoner to assist in working the above, I shall be happy to make him a present of one for that purpose, if he will let me know his address.—EDWIN BAKER, 13 and 14, Mount-street, Grosvenor-square, W.

[3867.]—LATHE DIVIDING PLATE.—If you look at p. 12 of present volume, you will see a counting index figured and described in connection with the wheel cutting engine. It is not very troublesome to fit up, and need not be self acting.—J. K. P.

[3868.]—WATERPROOFING CLOTH.—Make a solution of india rubber in naphtha, and apply it to the cloth; this is the article used for waterproof coats; add a little linseed oil to it. If this is not suitable to "A. S. A." I can send a few other recipes.—SEMPER PARATUS.

[3869.]—WEIGHT OF WATER.—The reply to "Countryman's" query is very simple. By a rule in hydrostatics, any body immersed in water is pressed by the weight of a column of water the height of a perpendicular drawn from the centre of gravity of the body to the surface of the liquid, and in breadth equal to the cross section of the body. A rule to calculate the pressure on the bucket may be stated thus: for every 7ft. of depth allow 3lb. pressure per square inch.—A BOUGHEY.

[3869.]—WEIGHT OF WATER.—It is said that any heavy body 20lb. in weight, taken to the top of a mountain 3 miles high, loses but ¼oz. in weight; therefore the difference in weight of a bucket of water at the top and bottom of a well 90ft. deep, must be indeed slight. The apparent difference is, I think, due to the weight of the rope when the bucket is at the bottom.—HARRY G. NEWTON.

[3873.]—BOOKBINDERS' GLUE.—Bookbinders use the same glue as carpenters and joiners, but break up the cakes into small pieces, and soak them in water for 8 or 10 hours, then thoroughly melt them in an iron or earthenware pot before using in the glue pot; some add treacle when using it for cloth work; some add paste. There is a work called "Bibliopegia," I think it is by Arnott. I do not know the publisher, but if "Aristotle" will insert his queries in "our" MECHANIC, they will receive prompt attention from—AB INITIO.

[3874.]—CONSTELLATION.—The group "Aristotle" sketched is the Pleiades, as he will at once perceive on a closer look at the group on page 63 of "F.R.A.S.'s" maps. He wants a sketch of the Pleiades; I refer him to his own on page 238 of present vol.—H. W. BISHOP.

[3876.]—TOOL FOR TURNING PIVOTS.—The latest tool for turning pivots is the French turnbench, with 8 centres and a small slide rest. They are from 10s. 6d. each and upwards.—S. TANENBERG, Leeds.

[3878.]—DAILY TEN O'CLOCK TIME SIGNAL.—Yes; all wires from 1min. to 10 o'clock to 1min. after 10 are in connection with Greenwich clock, when all working is suspended for that time.—A TELEGRAPH CLERK.

[3879.]—GINGER BEER.—White sugar 10lb., lemon juice 9oz., honey ½lb., bruised ginger 11oz., water 9gal. Boil the ginger in 1½gal. of water for half an hour, then add the sugar, juice, and honey, with the remainder of the water, and strain through a cloth. When *cold* add the white of one egg and ½oz. of essence of lemon; after standing 4 days bottle. —(Extracted.)—MINNEHAHA.

[3897.]—NAPOLEON,—I beg to inform "H. B.", p. 231, that his coin of the French Republic, 1848, is not worth much more than its weight in gold. If it is, as I suppose, a 20 franc piece, its intrinsic value is 15s. 10½d. in our money.—HENRY W. HENFREY, M.N.S., &c., &c.

[3900.]—ASPHALTE FOR ROOFING, &c.—I would advise "Dublin Printer" to try the following; he will find it useful in stopping many a crack besides those in his roof:—Take 2 parts by weight of common pitch with 1 part of gutta percha, melt together in an iron pot; it forms a homogeneous fluid much more manageable than gutta percha alone. Now to repair his gutters, carefully clean out of the cracks all earthy matters, slightly warm the edges with a plumber's soldering iron, then pour the cement in a fluid state upon the cracks while hot, finishing up by going over the cement with a moderately hot iron, so as to make a good connection and a smooth joint. The above will repair zinc, lead, or iron gutters, and is a good cement for aquariums.—PATIENCE AND PERSEVERANCE.

[3907.]—UNIVERSITY EXAMINATIONS.—London, 1871. Special subjects:—1st B.A., Latin, Tacitus, "Annals," Book I.; Virgil, "Æneid," Books VII. and VIII. English, History of English Literature during 17th Century; Bacon, "Essays;" Shakespeare, "Julius Cæsar;" Dryden, "Annus Mirabilis;" and "Absalon and Achitophel;" French, English, past and present. If "Xanthos" will write to me, I will give him any information he may require upon this subject. C. H. W. B.

[3908.]—OLD COPPER COIN.—In answer to Mr. Nash, p. 239, the inscription on his coin is FAVSTINA AVGVSTA (Faustina Empress). I cannot say without seeing the coin whether it was struck by the elder Faustina, wife of Antoninus Pius, born A.D. 105, died A.D. 141, or by the younger Faustina, wife of Marcus Aurelius, died A.D. 175. The bronze coins of both are common, and worth very little.—HENRY W. HENFREY, M.N.S., &c.

CHINESE VACCINATION.—It may be news to some that the Chinese commenced to practise vaccination for the small-pox at Canton forty years ago. There are now public vaccinators at Pekin with regular days and hours for scarifying infants brought to them, just as in London. When their supply of vaccine lymph falls short, it is renewed from the English missionary hospital.

NOTES AND QUERIES.

◆

[3910.]—CONICAL WINDING DRUMS.—Will some brother reader kindly give some particulars respecting the construction and working of conical or spiral drums, as applied at collieries for drawing coals, and state what conditions are to be observed in order to ensure their safe working?—W. M., Junr.

[3911.]—GALVANIC CELL.—I have a galvanic cell, composed of a stick of what I suppose to be carbon (it is black, about 5in. long, and 1in. square) in a porous cylinder surrounded by a zinc cylinder about 3in. in diameter, all in a glass vessel. Will any of your readers kindly inform me what liquid or solution I should use to excite it; also the name of the combination, and whether it is best adapted for strength or constancy?—HERMIT.

[3912.]—REVOLVING FRAME FOR SHOP WINDOWS.—I wish to construct a revolving frame to show pictures in a shop window, and find the ordinary meat-jack clumsy; it revolves too rapidly at times, and requires winding up during the day; I should like also to avoid the return motion. Can any of your correspondents help me?—PITMAN.

[3913.]—TO A. STRINGER.—In No. 269 A. Stringer writes on velocipede construction; will he kindly, for my own and the information of others, insert a plan with the details of the three-wheeler he speaks of steered like a boat; will he also say where I can purchase an "English" velocipede?—CONSTANT SUBSCRIBER.

[3914.]—WOOD ENGRAVING.—I should feel greatly obliged if any brother subscriber can tell me where to obtain the best book of instruction in the above art, and the price?—K. T. Z.

[3915.]—NAIL BAGS.—I have a large quantity of nail bags which are worn out, for what purpose will they serve; will they do for making paper, or must I consign them to the rubbish heap?—W. CATTELL.

[3916.]—PAINTING BOILER.—How can I mix a good green paint to paint the boiler of an engine so as the heat may not effect it?—A. W.

[3917.]—ICE CHEST.—ICES.—Perhaps some of my fellow subscribers will tell me the best plan for making an ice chest (a few sketches would be a great assistance); also a few instructions for making ices?—BRIGHTON SUB.

[3918.—ENAMEL.—Can any of my numerous brother readers inform me how to make white English glass, or the tin enamel, as made in France, that given a few weeks back was not white or good: also where I could obtain a brush for painting figures and letters on clock and timpiece dials?—ANXIOUS INQUIRER.

[3919.]—GALVANIC BAND.—TO "SUFFOLK AMATEUR."—I have very carefully made a galvanic band after the plan of "Suffolk Amateur," p. 11, last vol., I have tested it with a small galvanometer, but cannot get the slightest current from it. I have made it as follows:—A strip of copper and one of zinc, 18in. long, 1in. broad, and 1-32th in. thick, are united at the ends by small copper rivets, I have lapped over these rivets with thread, and varnished over the thread with shellac in alchohol, the ends are left bare 1½in., the copper and zinc are lapped spirally round with a piece of cotton list 1in. broad, and covered in a bag of oil skin; I tried all strengths of vinegar, but to no purpose. Would "Suffolk Amateur" kindly say where I have failed?—W. A.

[3920.]—MEASURING LIVE STOCK.—Will some of your learned correspondents inform me if their is a book published on measuring live stock, say an ox; or give a rule, through the medium of our MECHANIC, to measure a living four-footed animal so as to find its weight?—A COUNTRYMAN.

[3921.]—BRASS COIN.—I have a brass coin the size of a penny, on the obverse the bust of a man, on the reverse a female in chariot drawn by four elephants with LIE over them, there is an inscription round the bust, but the only letters I can make out are ALT—PAIANC. I should like to know of what coin it is, and of what value?—TOM C. HOLLOWAY.

[3922.]—REMOVING PAINT.—Although some answers have appeared in reply to inquiries for a good alkali or such method for removing paint, still not one effectual mode has been suggested. If any brother reader could advice a ready and effectual method of softening the old paint on dorrs, &c., when it becomes thick and hard, so as to remove it speedily (without the use of charcoal fire), and enable the operator to clean off mouldings with credit, it would be a very useful enlightenment?—HOUSE PAINTER.

[3923.]—GEOMETRICAL DRAWING.—A method of drawing the ellipses that represent circles—N.B.—When the dimensions are not reduced to geometrical proportion; if one can also recommend a good cheap work on the above?—CARL J. H. COTTHESSON.

[3924.]—SILENT FANS.—Can any of our readers tell me the diameter of the blade of one of Messrs. C. Schiele and Co.'s 50in. Excelsior silent fans, patented 1863?—ONE WHO WANTS TO KNOW.

[3925.]—POSITION OF MAGNETIC POLE.—Can any of our readers inform me whether, as the declination of a needle is the angle made by the magnetic and geographical meridians of any place, and the magnetic meridian passes through the magnetic poles, when the declination alters does the position of the magnet pole change with it?—VIBRATOR.

[3926.]—FORCING WATER.—An engine forces water through a 9in. pipe, perpendicular, to a height of 30ft., will it require the same power to force it to the same height through a 9in. pipe, but such height being 180ft. away, with a gradual ascent of 1ft. in 6ft.?—B. S. M. G. H.

[3927.]—WINDOW PAINTING.—I shall be very grateful to any of your readers who will tell me of a rich transparent permanent crimson; also a pure bright yellow? Crimson lake is such a varnishing colour it will not bear continued exposure to daylight, the colours are to be used with oil and varnish for glass painting. Amongst all the varied and valuable information contained in your journal, I have never noticed any on the old act of window painting, I do not mean the modern process of staining, I have been a painter of dissolving views for years, but I should be most thankful if you could assist me in the former matter.—SABLE.

[3928.]—RE-MANUFACTURING INDIA RUBBER.—Will some reader kindly tell me if india rubber of first-class quality, in sheets of ¼in. thick and under, could be re-manufactured, and what it would be worth per pound?—J. T.

[3929.]—EMIGRATION.—I should be pleased to get all the information I could respecting New Zealand and Tasmania, as places suitable to make a home in, particularly as to peculiarities of climate, soil, productions, reptiles, insects, &c., if any insects to give much annoyance like the mosquitoes or gallinippers of the Southern States, U.S., which I have suffered considerably from, I reckon. I do not wish to go where it is very hot, but a little milder winter than our own, with its cold dull weather and piercing easterly winds. Perhaps our kind friend "F.R.G.S." would oblige.—TASMANIA.

[3930.]—WINES, JAMS, PICKLES AND PRESERVES.—Can any of your readers inform me if there is any practical work on making wines, and also a book on manufacturing jams and pickles. I have one, but it is of little use for a new beginner.—FRANCES BROWN.

[3931.]—INDIA RUBBER SOLUTION.—Will any of your obliging correspondents, "Sigma," for instance, tell me of what the india rubber solution for mending waterproof clothing is composed, and the proportions of each material. Also whether there is any solvent for silk, which on evaporation leaves the thread without decomposition?—ALECIA BROWNING.

[3932.]—BICYCLE RUBBER TIERS.—I intend fitting an india rubber tier to the driving wheel of my bicycle, could any brother subscriber kindly assist me in the fixing? I do not want to remove the iron tier; should also like a practical opinion of the merits of the rubber tiers, best shape, depth, &c.?—C. MORTIMER.

[3933.]—HYPOPHOSPHITE OF IRON AND QUININE.—Will any brother reader kindly inform me of the medicinal properties, doses, and cost of the above preparation of iron and quinine?—MAY.

[3934.]—ORGAN ACCORDION STAND.—Will any fellow subscriber furnish me with a diagram for the construction of the above, so that it may be played with both hands—the feet, by means of a pedal, giving necessary action to the bellows?—SIGMATAU.

[3935.]—DISSOLVING SHEEP'S HORNS.—Could any of your numerous readers inform me how, or in what way, I could dissolve sheep's horns to make them into glue, size, &c., or for any manufacturing purposes?—VERY OLD SUBSCRIBER.

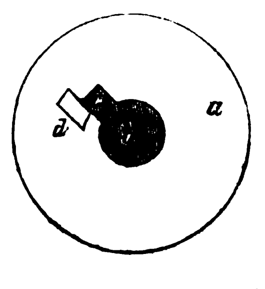
[3936.]—FAST COLOUR FOR SHEEPSKINS.—Will one of your readers kindly inform me how to dye the wool of sheepskins (fast colour) without injury to the pelts?—W. C. S.

[3937.]—CHEMICAL QUERY.—200grms of liquid nitrous oxide are gradually warmed to a temperature of 0°C., the barometer standing at 760mm. What volume will the gas occupy? Will E. G. Davis, "Urban," or some other friend kindly answer the above, and also show the way in which the answer is got?—ZETA.

[3938.]—AMERICAN CLOTH BAG.—Having to use in the course of my business a large light tight bag, made of American cloth (being light and cheap) I find it answer when the weather is warm, but when cold the enamel chips or peels off, and is soon useless, will any reader tell me how I can prevent this?—PETERBORO.

[3939.]—ELECTROTYPING.—Will any one please inform me how to take electrotype impressions in brass or in any other inexpensive metal harder than copper?—HERBERT.

[3940.]—THREE-WHEELED VELOCE.—I am making a three-wheeled veloce for two to ride, and to drive off the front wheel as in bicycles, and of hind axle with levers. I am at a loss to know how to make the hind wheels loose on the axle in turning a corner, as I am afraid if both fast on one axle it would be very bad to turn. Will any reader give an opinion on the following method, or suggest a better one? *a* if the back end of the nave, *b* is the axle, a section of, *c* is a projection on that axle, *d* is a projection on the end of the nave, so that the projection on the axle will drive the wheel by it on going round a corner. I think *d* on the outside wheel would leave *c* on the axle going at the speed of the inside wheel. It is on the principle of a lathe driver.—T. T. M.



[3941.]—MARKING INK.—Can any one tell me how best to use printers' type and press with marking ink, for marking linen, clothes, &c. My difficulty is how to get the marking ink on the type neither too much nor too little.—DAISY.

[3942.]—MAKING BUTTER.—Will "Scorpio," or some other reader be good enough to explain more fully the method on p. 213. Does it not involve the digging of a pit, then filling and then re-digging? Has any condition of ground to be attended to. What materials are the sacks made of?—OMIO.

[3943.]—BEES.—I have a hive of comb in which a swarm died last winter. Can any of your readers tell me is I may safely hive a coming swarm into it this summer, I may mention the hive is a common straw one with a wooden box under it quite full of comb, and is 3 years old. I feel doubtful in consequence of the comb being apparently dirty; it appears on the outside quite black, though I see no appearance of mould. Would it do to remove any of the comb to make room for the new swarm, as it is quite full. Some hints on the general management of bees by a practical bee keeper might prove interesting to many of your readers, as they would to me.—S. W.

[3944.]—ARITHMETICAL QUESTION.—Will Mr. J. Sharp, who answered query No. 3710, p. 213, kindly show how it can be proved that a circle is equal to a parallelogram whose length is equal to half the circumference, and breadth equal to half the diameter. If he can prove it by geometry, will he kindly do so?—T. J. O. C.

[3945.]—PAINT FOR BOATS.—Would any reader inform me how to mix a bronze or copper-coloured paint for the bottom of a small model boat?—A MODEL BOAT MAKER.

[3946.]—SYRUP OF HYPOPHOSPHITE.—If any medical correspondent will inform me of the medical uses and cost of syrup of hypophosphite of iron and quinine, together with the dose for ailments in which it is beneficial, I shall feel greatly obliged?—G. THICK.

[3947.]—REMELTING HARD WHITE PAINT.—How shall I remelt hard white paint, shelled off, composed probably of white lead boiled oil, and litharge.—T. S. U.

[3948.]—INDIA-RUBBER TYRES.—If some correspondent, who has had experience with india-rubber tires, on velocipede wheels, would answer a few questions respecting them, they would oblige a number of readers who are interested in velocipedes Where they can be obtained, and price? The best way of fastening them on, and should they be used with iron tires? How long they last? How are they astened on the "Phantom" wheels?—G. K.

[3949.]—GUYANA.—Where is situated the Republic of Guyana? A few particulars will oblige.—JOHN D.

[3950.]—GOMUTUB FIBRE.—I find in a Dublin paper that the bristles imported for the purpose of making brooms for sweeping the streets, come from the Arenga or Gomuto palm. Is this not an error?—GOMUTO.

[3951.]—BAMBOO NUTS.—I wish to know what kind of nuts are the "Bamboo nuts," I find mentioned in the circular of Messrs. Mundy, Horley and Co., last number of our MECHANIC, and what is the use of those nuts?—GEORGES.

[3952.]—LOAM PANS.—Having some of these to make occasionally, and much annoyed with them veining inside, I shall feel obliged if any of our brother readers, having practical experience in moulding the same, will inform me the cause and remedy.—INQUIRER.

[3953.]—COIL.—As I am afraid I have annoyed Mr. A. E. Tucker more than I ought, perhaps "Sigma" would kindly answer me one or two queries. I quite forgot to state formerly that I intended making my coil in four sections. What would be the best way to connect them at the discs. I can almost fancy from "Sigma's" note in the last number of the MECHANIC that there is a possibility of doing without so much gutta percha paper, as I see recommended by everyone. I only hope he may show me how to begin, I'll be a willing pupil. I have taken Mr. Tucker's advice, and intend putting 8lb. No. 36 wire instead of 4lb; will "Sigma" also say if I should get the new double mercury break instead of Mr. Ladd's spring break. I may state here that my old coil had a core ¾ instead of ½in., as put in my note. (This is in reference to Mr. E. Tucker's reply to my last query, which I have to thank him for.)—D. FORBES.

[3954.]—SCREW AND WHEEL CUTTING LATHE.—Would "J. K. P." or any of your numerous correspondents kindly give me their opinion on the following:—I am going to have a 4½in. back-geared self-acting screw and wheel-cutting lathe made expressly for me, and I want it to be as near to perfection as possible without being too complicated. 1. Would a 8ft. 6in. bed 4in. across be the size (please give all the other dimensions)? I should like it that length. 2. What size and rate should the screw be which goes inside the bed? it *must* be inside. 3. What size should the mandrel be, and what length; is a ½ thread the right size to be as strong as necessary? 4. What size and number of teeth should the back gear wheels and pinions be? 5. The slide rest must have self-acting surfacing motion, what length should the bottom slide be, what length the top one, and what is the best form of tool holder for the slide rest? 6. What is the best wheel-cutting apparatus to fit in the slide rest to cut wheels up to 3½in. in diameter? The most approved plan, I believe, for dividing the head is a tangent wheel fixed to the mandrel, and the screw which turns it to have a hand and dial; or is the rows of holes the best after all.—P. N. HASLUCK.

[3955.]—SCALE PARAFFIN.—Can any of your readers inform me how many tons of scale paraffin are produced in Scotland in one year?—S. P.

[3956.]—CHEMICAL.—Will Mr. G. E. Davis be so kind as to show how I could calculate the weight in grammes of 1 litre of methyl gas at 20°C. and 760mm. pressure; and also how to prepare acetic acid from the following: C_2H_5I, H_2O, CaO, H_2SO_4, K_2CrO_4, Na_2CO_3?—R. TERRET.

[3957.]—POWERS OF NUMBERS.—Will Mr. Biggs, or some other contributor to our valuable paper, be kind enough to inform me how numbers are raised to their 3·6th and to their 1·7th powers. Take No. 10 for instance, to the 3·6th power = 3982. how is it done?—ECONOMY.

[3958.]—NAMES OF PARTS OF BELLOWS.—Would any maker of Reverte's bellows and hearths, be kind enough to give me the names, separately, of all parts of bellows, such as is used in a ship building yard?—E. FOWLER.

[3959.]—THE "EDINBURGH" VELOCIPEDE.—Will any brother subscriber give the address of the maker of the "Edinburgh" velocipede?—C. T.

[3960.]—THE BLOOD.—I beg to ask through your valuable journal, if some kind reader would give me a recipe (cheap) for purifying the blood?—J. G. JACKSON.

[3961.]—BISULPHIDE OF CARBON PRISM.—Will any brother reader state what cement will resist the action of bisulphide of carbon? I have made a prism, but the bisulphide dissolves all the cements I have tried?—E. C. MURRAY.

[3962.]—WHITE LEAD.—I bought some stuff for "white lead genuine," but find it has all dried up. like old putty, although at first it looked like ordinary white lead, and has been kept covered up in water; how is this?—H.

[3963.]—OAK, WALNUT, AND MAHOGANY STAINS.—Would some reader supply me with recipes for making oak, walnut, and mahogany stains?—ZEMBLA.

[3964.]—CAST IRON FOR TURNING.—I should be much obliged to "J. K. P." if he would give me a few hints about preparing cast iron for turning and filing, whether by chipping or pickling it. If the former, I should like to know the shape of chisel, and mode of using. If pickling be the better way, I wish to know the strength of acid, and time of duration of using it. I should also be much obliged by advice as to rebronzing a medal. It is one of a case of Napoleon medals, and the colour has been taken off by my attempting a cast in wax for electrotyping, leaving it a dull leaden colour. I should like to know how to get a cast from it for electrotyping, as wax sticks to the metal and breaks. Plaster of Paris makes a pretty good one, but I do not know how to make it conducting, as the plumbago will not adhere.—FABER.

[3965.]—ORGANS.—Will the "Harmonious Blacksmith," "Adept," or any of your *organised* body of contributors give me some information on the following subject:—When my organ was built some years since, funds being rather low, about six or seven of the bottom keys in the swell were left minus any pipes. A few months ago I consulted a first-class organ builder on the subject of having pipes attached He examined it, and informed me that the swell box had just been made to encase what pipes there is in, and no more; and that if I wanted pipes attaching they would have to be placed *outside* the case,—a piece of business my *swellish* pride objects to. Will any brother reader (or sister either) give me their kind suggestion?—THE HARMONIOUS COTTON SPINNER.

[3966.]—TABLES WITHOUT DECIMALS.—I am of opinion that for certain practical and common purposes all tables which can admit of figures—without minute decimals—would be a boon to numbers of working mechanics and others not having the power of making calculations; and I know of no medium equal to the ENGLISH MECHANIC to start the system. Will any brother reader kindly arrange a table—free from decimals—giving the quantities of water, in pounds, ounces, and parts of ounces (of course avoirdupois), required to condense a cubic foot of steam, so as to produce a practical working vacuum, the steam to increase from common atmospheric pressure to 1lb. per square inch, up to 10lb., or upwards, with size of condenser?—R.W.

[3967.]—MAGNETIC NEEDLE.—Will any of your subscribers answer me this question:—Supposing I have two magnetic needles centered, one strongly magnetised and the other only faintly so, from which ought I to get greatest deflection, placing each in succession in the same coil?—Θηρα

[3968.]—KILN.—Will one of your correspondents oblige me with a description of a good kiln for burning lime, and state the proportion of coal used to lime burnt, also the quantity burned per day? A sketch would be useful. Is there any good practical book on the subject?—L. M.

[3969.]—COPPER BOILER.—Can any of my brother readers kindly inform me of the most efficient design of copper boiler to drive an iron boat 66 inches long by 6½ inches beam, the engines of which are two cylinders, each 1¼ inch bore and 1⅝ inch stroke; and what would be the best form of apparatus and fuel for firing same. The boat is 6 inches deep?—O. G.

[3970.]—FOOD FOR COWS.—Will any reader tell me how to steam food for cows; to do fifty bushels at once. Would it be cheaper to have an iron tank or brick and cement tank?—R.R.

[3971.]—DISPLACEMENT OF SHIPS.—Will any of our correspondents be so kind as to give me a proper way to find the displacement of a ship? I have not given any dimensions, but those that can do it, can take a length, breadth, and depth for themselves. I know that it is a difficult problem, but surely there is one amongst our talented brothers that can assist me.—G. B. D.

USEFUL AND SCIENTIFIC NOTES.

HACKNEY SCIENTIFIC ASSOCIATION.—Mr. H. W. Emon, the Hon. Sec. of this Institution has sent us a report of its third annual meeting just held, from which we gather that the institution is flourishing. The number of members was actually twice as great as at the commencement; the papers, &c., read had been more interesting and numerous than on any previous occasion, and the library, which had only been commenced this year, already comprised many valuable works. The conversazione, held at the commencement of the session, was attended by a much larger number than was expected. It was announced that during the summer months excursions would be organised to places of scientific interest, also to the various public museums.

A NEW PROJECTILE.—Captain Ericsson announces, in a communication to the American *Army and Navy Journal*, that he has perfected a system of submarine attack by which he can destroy the largest ironclads ever built. The resistance of the water is so great that explosive projectiles have always proved failures hitherto when designed to strike below the water-line. Captain Ericsson is confident that he has devised a projectile which will overcome the difficulty caused by this resistance. It is an elongated shell, charged with 300lb. of dynamite, and shot from a 15in. gun, at such an elevation as to enter the water near the hostile vessel, and strike the hull anywhere below the water-line. It is fitted with a percussion cap, which explodes upon very slight impact against the hull, so that the velocity of the shell when it reaches its destination need not be high. The gun is carried on a swift armoured boat, protected by a turret. Captain Ericsson intends to make a formal offer to test this invention. He is ready to fit out, at his own cost and risk, a fast screw vessel, with two 15in. guns of the kind described, if somebody else will furnish the ironclads to be experimented upon. In the politest terms he does this country the honour to single out the new British ' aclad Devastation as one of the most splendid pecimens of an armoured war-vessel which can be produced, and challenges her to come out and encounter his torpedo.

BRADAWLS.—It is stated, remarks the *Scientific Review*, that there are but three bradawl makers in London, and a bradawl seems to offer such a small field for improvement that a patent would appear to be scarcely worth applying for; yet this is not the case. An improvement has been invented, which consists in making the busk in two pieces, one secured to the handle, and having thereon a tapped or otherwise formed upper part, made to fit in and correspond with the second piece, such second piece being a tapped or otherwise formed cap, furnished with an internal projecting collar or shoulder, both pieces being constructed to receive the blade of the bradawl in such a manner that, when the blade is inserted in the busk, the nozzle or screwed cap may be passed over such blade, and may, when screwed up or home on the busk, abut against a corresponding projection-collar on the blade of the bradawl formed for the purpose, and made to fit in such a nozzle or cap.

WARMING CARRIAGES.—A new method of warming first-class carriages in express trains has been adopted in Bavaria. A special van is attached to the train, and contains a powerful "calorifere," and the heated air is conveyed to all the carriages of the train by means of india-rubber tubes. The experiment with first-class carriages is reported upon so favourably that the authorities have determined to apply it to all the carriages on the Bavarian lines, and it is expected that it will soon be adopted on all the German railways.

METHOD FOR RENDERING WOOD DIFFICULTLY COMBUSTIBLE, AND FOR PRESERVING IT WHEN UNDERGROUND.—Dr. Reinsch recommends the following:—The wood, which must not be planed, is placed for 24 hours in a liquid composed of 1 part of concentrated silicate of potassa and 3 of pure water. After having been removed from this liquid, and dried for several days, the wood is again soaked in this liquid, and, after having been again dried, painted over with a mixture of 1 part of cement and 4 parts of the liquid above alluded to. After the first coat of this paint is dry, the painting is repeated twice. Of the paint-mixture alluded to, large quantities should not be made up at once, because it rapidly becomes very dry and hard. Wood thus treated is rendered uninflammable, and does not decay underground.

SOME HINTS ABOUT SCREWS.—Where screws are driven into soft wood and subjected to considerable strain, they are very likely to work loose; and it is often difficult to make them hold. In such cases, says the Canadian *Builder*, we have always found the use of glue profitable. Prepare the glue thick; immerse a stick about half the size of the screw and put it into the hole; then immerse the screw, and drive it home as quickly as possible. When there is an article of furniture to be hastily repaired, and no glue is to be had handily, insert the stick, fill the rest of the cavity with pulverised resin, then heat the screw sufficient to melt the resin as it is driven in. Chairs, tables, lounges, &c., are continually getting out of order in every house; and the proper time to prepare them is when first noticed. If neglected the matter grows still worse, and finally results in laying by the article of furniture as worthless. Where screws are driven into wood for temporary purposes they can be removed much easier by dipping them in oil before inserting. When buying screws notice what you are getting; for there are poor as well as good kinds. See that the heads are sound and well cut; that there are no flaws in the body or thread part, and that they have gimlet points. A screw of good make will drive into oak as easy as others into pine, and will endure having twice the force brought against it.

CHANGES IN FISHES.—In the *American Naturalist*, Charles C. Abbott, M.D., gives some account of the changes in the fishes of New Jersey within a few years. A slight local disturbance quite alters the fauna. Thus in 1867 a small, never-failing brook, emptying into the Assumpink, was populated by chubs, dace, and minnows. In July a heavy, sudden fall of rain caused a rise of water' but did not alter the brook enough to attract the attention of those who lived near it. After the subsidence of the water not one of these fish could be found there, while their place was taken by roach, mullets, and red-fins, which are now abundant, while not a chub can be found. Dr. Abbott mentions several fishes that were not inhabitants of the New Jersey streams twenty-five years ago, which are now quite abundant; and he is greatly at a loss to imagine how they can have reached these streams. He mentions the interesting case of the gizard shad, which is sometimes carried by freshets into inland streams or ponds. A pond near Trenton was stocked with them in 1857, and is now full of specimens, weighing sometimes five pounds. They have become so different in colour from the same fish as found in the Delaware and on the cost, that Dr. Abbott at first thought them quito distinct: and he says they have changed considerably, but only in colour, during the last ten years.

DEEP-SEA DREDGING.—The Admiralty have acceded to the request of the Royal Society by again placing Her Majesty's surveying steam-vessel the Porcupine at their disposal for another deep-sea exploration, to commence in the latter part of June. Mr. J. Gwyn Jeffreys will take charge of the first cruise, which is intended to be across the Bay of Biscay, along the coasts of Spain and Portugal, to Gibraltar. Dr. Carpenter will there succeed him in the beginning of August, and proceed into the Mediterranean, after endeavouring to trace the direction and nature of the currents at the Straits. Professor Wyville Thomson will probably join Mr. Jeffreys. A photometric apparatus has been contrived by Mr. Siemens for the purpose of ascertaining the depth to which solar light penetrates the sea; and other questions of considerable interest will be investigated in this expedition. But we regret to find that the time is so limited for such an important object.

THE GREASE TREE.—In China there grows a tree known as the Grease Tree. It is said that large forests of this vegetable lubricant are to be found there, and they form the source of a considerable local traffic, This tree not very long ago was imported into India, and it is said that the experiment of cultivating it there has proved quite successful. In the Punjaub, and North-western provinces generally, it grows as rapidly and as vigorously as in its native soil, and there are already thousands of trees on the government plantations yielding tons of seed, admirably adapted to a variety of commercial purposes. Dr. Jameson, a chemist in the Punjaub, has prepared hundredweights of grease from this particular tree, and has forwarded on trial a portion of it to the Punjaub Railway to have its qualities tested in a practical manner as lubricating material for those parts of machinery constantly exposed to friction. The grease thus obtained forms an excellent tallow, burning with a clear, brilliant, and what is infinitely more to the purpose, a white light, and at the same time emitting not a trace of any unpleasant odour, or of the ordinary disagreeable accompaniment of combustion—smoke.—"Notes and Queries on China and Japan."

EXHIBITION OF FANS.—At the South Kensington Museum there has been opened to the public an exhibition of fans. The exhibition is a part of the scheme of the Department of Science and Art for the art instruction of women. To promote this object, the Deparment offered prizes in competition for fans painted by the students in the female schools of art in 1868, and again in 1869. The fan-mount to which in the first of these years the chief prize was awarded, is included in this exhibition, and it is intended to continue the competition. Her Majesty also purposes to offer a fan prize for competition at the International Exhibition of 1871. The Society of Arts has also offered its gold medal (of the value of 21 guineas) for the second-best fan exhibited. The Lady Cornelia Guest and Baroness Meyer de Rothschild have each offered a prize of £10 for the two next best fans. A sum of £50 will be awarded and spent in various amounts by the Science and Art Department, for fans produced by female students of the schools of art in the United Kingdom. Among the more curious of the fans exhibited is one dated 1650, the mount of which is a landscape and figures embroidered in silk. Some of the carving of the mounts is exceedingly delicate. A fan, one of the wedding presents of the Empress of the French, is especially noticeable for its display of fine open cutting in so brittle a material as mother-o'-pearl. Some of the fans possess historic interest, two or three being associated with the unfortunate Marie Antoinette. The Queen contributes sixteen examples; the Empress of the French, thirty-five; and the Princess of Wales, Princess Christian, and Madame la Comtesse de Paris, are among the contributors.

SCRAPING SLIDE VALVES.—Mr. W. P Cowan, of Brooklyn, New York, writes to the "Scientific American" to the effect that few workmen know how to scrape properly. He says:—I have always found the scraper works best after a smooth file; everything should be finished with the smooth file previous to the scraper being used. I have seen many workmen leave too much to be done by the scraper. Now that is a gross mistake; every article ought to be fitted as well as possible before being touched by a scraper; otherwise a bad job is almost certain to be the result. The scraper should always be used obliquely to the file marks, never across, at any rate. Nothing makes a better scraper for wrought and cast iron than a taper saw file, and for brass a flat scraper must be used if good work is wanted; say about 1in. broad and 3-32in. thick. A saw file scraper is too keen for brass. In all railway shops in the north of England scraping is much used, and with the best results. We always scraped slide valves, motion bars and blocks, and axle boxes. It is certainly a very unworkmanlike way of turning out a slide valve and leaving it to work itself tight. It is tantamount to saying it can't be made tight. Most of the first-class marine engine builders in Great Britain scrape valves, &c. In one case last year it was tried to do away with the scraper on a pair of large valves; but on the trial trip the valves got cut up awfully, so scraping is considered a necessity.

GRAFTING IN CHINA.—A very peculiar method of grafting is practised in China. In spring the young shoots of the chrysanthemum are inserted into the stalk of the *ai* plant (wormwood?), by making an incision, cross shaped, in the stem of the latter, and binding the two tightly together with a piece of bast or hemp. After the incision has been properly bandaged; a flower-pot is put over it, bottom downwards, the plant passing through the hole in the pot, which does not rest on the ground, but upon four bricks placed under it, about six inches high. Earth is then put into the pot, and the plants gradually unite, taking root at the same time in the pot. As soon as the chrysanthemum flowers, the stem of the *ai* is severed immediately under the pot, and the whole is removed from the nursery to the garden or verandah. The grafting "strengthens" the chrysanthemum, which would otherwise produce but a very poor flower. The method is most ingenious, and the plants seem to unite very readily.—*Notes and Queries on China and Japan.*

REFLECTED LIGHT.—A series of experiments with a novel form of apparatus for determining the amount of light reflected from metallic surfaces at different angles has shown Professor Rood that a mirror silvered by Liebig's process, using the silver side at an angle of 45 deg., reflects 91 per cent. of the light emitted by a flame, and from the glass side 78 per cent., while an amalgam mirror at the same angle reflects only 45·5 per cent. The apparatus and method employed will be found described in the "Journal of Gas Lighting, &c." It would be interesting to know the reflecting power of the beautiful platinised mirrors now coming into use.

MILK.—It may be worth mentioning, for the sake of people employed in white lead works, and other occupations which expose them to the same risk, that milk taken as a drink has been found as useful as the dilute sulphuric acid in preventing colic.

GLUE.—The value of glue, that is, the amount of pure gelatine it may contain, may be determined by precipitating this body with pernitrate of mercury, a standard solution of which tested with a known weight of pure gelatine may be employed.

THE ENGLISH MECHANIC LIFEBOAT FUND.

Subscriptions to be forwarded to the Editor, at the office, 31, Tavistock-street, Covent Garden, W.C.

Amount previously acknowledged	£180	10	10
Vibrator	0	1	0
Zeta	0	1	0
J. Liller	0	1	0
C. Forrest, jun.	0	2	6
Frank Fairleigh	0	2	6
	£180	18	10

ANSWERS TO CORRESPONDENTS.

*** All communications should be addressed to the EDITOR of the ENGLISH MECHANIC, 31, Tavistock-street, Covent Garden, W.C.

ADVERTISERS' TESTIMONIALS.

Messrs. **ASHWORTH**, of Ashley-lane, Manchester, after advertising their patent "looped" portfolios in the ENGLISH MECHANIC a few times, say :—"Several hundred of these binders for the ENGLISH MECHANIC have already been sent out."

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CAUTION.

Messrs. **MOTTERSHEAD**, Market-place, Manchester, say :—

"Having noticed in a recent number of the ENGLISH MECHANIC a caution about certain members of the long firm calling themselves "Claud & Co., Cheltenham," we send a line to say that we have been favoured with an order from these individuals, but, thanks to your notice, were on our guard. We sent them, as we usually do to strangers, an invoice, requesting a remittance before we sent the goods. Of course we have received no reply (since the 2nd April). We have since had an order from Parks & Co., Manchester Warehousemen, Alvington, Glo'ster, which we treated as above, with exactly the same result. We should judge from the writing that they are the same people. Perhaps another caution about them might be useful."

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THE following are initials, &c., of letters to hand up to Friday morning, May 27, and unacknowledged elsewhere :—

Rev. E. Kernan, Veritas, J. F. B. (Chelmsford), R. Marrison, F. F., E. W. F., Ashworth Bros., T. W. R., R. J. B., R. G. B., C. B. V., Edwin Baker, W. T. T., Col. J. H., Rev. E. R. T., R. A. Proctor, F.R.G.S., New Subscriber, Jas. Merritt, J. B. James, W. B., Live and Let Live, C. H. M., J. L., Orme Bros., E. J. M., Thos. Westlake, P. P. & Co., G. T. F., F. M. B., J. Hooper, R. L., Aviatæ, L. M., O. G., A Practical Man, Leicester Mechanic, R. R., Sable, J. S. T., W. A., A. Tolhausen, J. B. M., J. Thomas, A Stoneman, Mutual Improvement, Jas. Bell, F. H. Linton, W. H. A., Tannic Acid, G. G. B., Andrew Johnson, Grocer, A Lover of Birds, E. H. C., H. G. Newton, Harmonious Cotton Spinner, Geo. Luff, J. Heilbrom, W. R. T., J. R. T., W. W. B., J. A. M., E. Slater, J. Rumford, Jas. Anderson, Corn Factor.

A. W. **MARSHALL** would oblige by sending the information for "Xanthos" and "Cotton Clerk" to our pages for the benefit of others as well.

Rev. E. **KERNAN**, with MS. complete to folio 173.

E. **SLATER**, on Cotton Spinning, next week.

PETER FIELDING,—We cannot forward trade circulars.

"Hints to Astronomical Students" next week

A. **TOLHAUSEN**, with MS. on Materials, &c.

"Health-helps for Self-helpers" next week.

THOS. J. O'CONNOR.—See "Extracts from Correspondence," page 212. We hope none of our correspondents skip this interesting column.

POLSON.—Advertisements must be paid for.

FRED. BALDWIN.—We know nothing about the pedespeed beyond what appeared on page 61. We do not answer by letter.

FIGURE OF THE EARTH.—Mr. Jas. Beardsley has written us a long letter, which may be summarised in a few sentences. He disclaims any connection with "Parallax," Mr. Hampden, or Mr. Carpenter, as he knows nothing of them, and and has not read anything they have written. Mr. Beardsley thinks that as he is honest and independent in the utterance of his opinions, he is entitled to a fair answer, and not misrepresentation or abuse. He considered it a pleasure to hold communion with such a correspondent as Mr. Tydeman, "who calls in question my sentiments in a charitable and concise manner, without rancour and without abuse."

T. J. O'CONNOR.—The *Philosophical Magazine* is published by Taylor & Francis, of Red Lion-court, Fleet-street, E.C. Price 2s. monthly.

J. S. W.—We cannot give the addresses. You might put yourself in communication with such manufacturers by an announcement in the Sixpenny Sale Column.

KATE DOUGLAS.—Too much like an advertisement.

E. HATCHIN.—We know nothing of the party you mention. We should prefer consulting a regular medical man.

REEDS.—The ENGLISH MECHANIC is not a medium for advertising quacks.

A COUNTRYMAN.—We cannot supply them; but they are sometimes offered for sale in our advertising pages.

ALBERT MEGTON.—Persuade your sister to think of something less foolish. We never attempt to help or advise in such cases.

THE Sixpenny Sale Column is the only place in which can appear queries sent by Staem, S. D. T., E. G., W. R., A. O. S., Beta.

G. C.—It results from several causes—bad teeth, disordered stomach, consumption, &c., and can only be cured by consulting a medical man

A PRESSMAN.—See Reply 3907, in this number.

CANTO.—Your advertisement is repeated, but the fault is due in great measure to your own indistinct handwriting.

HENRY COTTON.—Both ends of an ellipse are equal. An oval *is* egg-shaped; hence its name, from ova, an egg.

ANTI-EGYPTIAN.—We cannot. A query appears in this number on the subject, and will probably bring answers to suit you.

JEUNE HOMME.—Information on the subject appeared in last volume.

SAMUEL COBURN.—All advertisements in the Exchange or Sixpenny Sale Column are payable in advance.

PAWNBROKER.—See back numbers. You don't entrap us into another discussion on the "wheel question," if we know it.

TOPSY TURVY.—An exceedingly silly question.

A. G. PERRING.—See reply to Canto.

H. S. SAVORY.—Thanks for patterns.

WM. CARPENTER.—We really cannot afford space.

J. R. T.—In due time.

J. T. B. (Chelmsford).—Thanks. As we have refused Mr. Beardsley any more space, we think the controversy on the rotundity of the earth should cease.

J. H. D.—Arrangements are being made to publish the ENGLISH MECHANIC early on Thursday morning, and consequently not so much in advance of the day of publication as at present.

J. B. W.—We cannot act as arbitrators.

J. BARRY.—The fault is with the Post Office.

W. T. J.—We can only express our sorrow that the ENGLISH MECHANIC Lifeboat Fund accumulates so slowly.

SEMPER PARATUS.—We hope to be able to produce an index of Notes and Queries without extra charge. We cannot recommend anyone's goods.

ARTISAN will see it is an American invention.

W. A.—Send us a thoughtful and condensed letter on "Galvanism as a Medical Agent," not theoretically considered, and we will insert it.

J. B. asks what he can do in return for the assistance he has received from the ENGLISH MECHANIC. Introduce the publication to others who may be in want of similar assistance.

R. W.—*Anyone* may ask for or communicate information through our columns. We are no respecter of persons. No charge is made.

COTTON SPINNING.—Several letters on this subject are postponed.

"SCIENCE FOR THE YOUNG" next week.

THE INVENTOR.

IN obedience to the suggestions of a number of readers, we have decided on appropriating a portion of our space to a condensed list of patents as nearly as possible up to the date of our issue.

APPLICATIONS FOR LETTERS PATENT DURING THE WEEK ENDING MAY 23, 1870.

1408 J. L. Montefiore, 53, Kensington Gardens-square, improvements in the manufacture of bronze.—A communication

1409 E. F. Jones, Middlesborough-on-Tees, improvements in the manufacture of iron

1410 C. Hunt, Nine Elms, engineer, improvements in retorts and retort settings

1411 J. H. Player, Birmingham, apparatus for the manufacture of phosphorus

1412 H. B. Greenwood, Welwyn, Hertfordshire, apparatus for holding window sashes or shutters.—A communication

1413 M. Benson, 9, Southampton-buildings, improvements in steam pumping or blowing engines.—A communication

1414 J. Agnew, Liverpool, a new and improved medicinal preparation of cod-liver oil

1415 B. Hunt, 1, Serle-street, Lincoln's-inn, improvements in the manufacture of certain pigments or paints.—A communication

1416 E. Green, Phœnix Works, Wakefield, improvements in the construction and arrangement of steam boilers

1417 B. Birnbaum, New Broad-street, London, an improved fastening for leggings, gaiters, stays, and corsets

1418 F. J. Cleaver, Red Lion-street, improvements in apparatus for moulding and stamping soap

1419 B. Lawrence, Basinghall-street, an improved ink, or improved inks for printing and other purposes.—A communication

1420 T. G. Webb, Manchester, improvements in the manufacture and ornamentation of articles of glass

1421 G. Nelson, Liverpool, improvements in apparatus for raising, lowering, and detaching ships' boats

1422 H. van Laethem, Berlin, dial universal

1423 T. P. Young, Bury, Lancaster, and J. Thomasson, Radcliffe, improvements in looms for weaving

1424 G. Hodgkinson, Manchester, improvements in the manufacture of toilet quilts, toilet or table covers, quiltings, and the like articles

1425 J. Casthelaz, 19, Rue Saint Croix, Paris, improvements in the manufacture of artificial alkaloids

1426 J. G. Charlick, 4, Park-street, Dorset-square, improvements in holding frames or brackets

1427 W. Waller, 34, Grey-street, Newcastle-on-Tyne, improvements in furnaces

1428 D. McColley Weston, Boston, Massachusetts, U.S.A., improvements in the machines for and the manufacture of knitted goods

1429 W. E. Newton, 66, Chancery-lane, an improved automatic barrel-filling apparatus.—A communication

1430 J. Starley, Coventry, an improvement in sewing machines

1431 W. R. Lake, Southampton-buildings, London, improvements in looms for weaving.—A communication

1432 W. Brodie, Edinburgh, improvements in the construction of vehicles used on railways

1433 G. R. Turner, The Woods, Charmouth, improvements in winnowing or dressing machines

1434 F. Edwards, Nottingham, improvements in the manufacture or production of lace

1435 E. Peyton, Birmingham, improvements in the manufacture of welded iron or steel tubes

1436 E. Peyton, Birmingham, improvements in the manufacture of metallic bedsteads

1437 G. T. Bousfield, Loughborough-park, Brixton, improvements in looms for weaving.—A communication

1438 A. M. Clark, 53, Chancery-lane, improvements in machines for manufacturing cigars.—A communication

1439 J. Steart, 61, Saint James-road, Bermondsey, improvements in cleansing ships' bottoms

1440 J. Diggle, Radcliffe, Lancaster, and H. Booth, Pilkington improvements in looms

1441 B. C. Muzzall, Windsor, improvements in the construction of school furniture

1442 S. Baerlein, Manchester, improvements in doubling cotton

1443 J. Smithies and J. Smithies, improvements in the manufacture of woven fabrics

1444 W. E. Gedge, 11, Wellington-street, Strand, improvements in steam engines.—A communication

1445 G. Zanni, Sidmouth-street, Gray's-inn-road, improvements in magneto-electric telegraphic apparatus

1446 J. A. Hopkinson, and J. Hopkinson, Jun., Huddersfield improved means or apparatus for admitting and regulating the supply of air to steam boiler and other furnaces

1447 R. Oxland, Compton Gifford, Plymouth, improvements in the manufacture of sulphuric acid

1448 G. W. Rendel, Elswick Works, Newcastle-on-Tyne, improvements in cartridges for ordnance

1449 R. Pitt, Newark Foundry, Bath, improvements in valves for drawing off water and other fluids

1450 J. Schloss, 46, Cannon-street, London, improvements in fastenings applicable to purses and such like articles.—A communication

1451 W. R. Lake, Southampton-buildings, London improvements in machines for lapping cotton and other fibrous materials.—A communication

1452 J. Baird, Glasgow, improvements in treating oils

1453 W. L. Mitchell, Kirkcaldy, Fife, improvements in looms for weaving

1454 J. P. Blake, Massachusetts, U.S.A., improvements in rolling metallic rods or wire

1455 J. Breeden, Birmingham, improvements in lift and force pumps

1456 A. M. Clark, 53, Chancery-lane, improvements in apparatus for the production of gases for lighting and heating purposes.—A communication

1457 M. Giraud, Rue Sauzay, No. 22, Constantine, Algeria, improvements in machinery for tilling or digging land

1458 J. H. Johnson, 47, Lincoln's-inn-fields, apparatus for preserving butter and other similar substances.—A communication

1459 G. G. M. Hardingham, 28, Great George-street, Westminster, improvements in tobacco pipes and cigar holders

1460 A. Taylor, Lydbury, Salop, improvements in rocket projectiles for purposes of war

1461 T. Hodson, Manchester, improvements in the manufacture of piled fabrics

1462 T. J. Smith, 166, Fleet-street, an improved arrangement of apparatus for diminishing the friction of spindles, axles, and other similar rotating bodies.—A communication

1463 J. J. Denoual, New Cross, improvements in enveloping medicinal and other liquids

1464 D. O. Lowber, Church-street, Warrington, improvements in wire ties for securing bales of hay, cotton, and other merchandise

1465 W. Barwell and G. B. Smith, Birmingham, improvements in securing the nuts of the screw bolts used in fish jointing the rails of railways

1466 H. Osterkamp, Eschweilerpumpe, near Aix la Chapelle, Prussia, improved rock-drilling machine

1467 A. M. Silber, Wood-street, Cheapside, and F. White, Camberwell, improvements in apparatus for lighting and heating purposes

1468 G. Fischer, Brandenbourg, Prussia, a new steam boiler firing with complete smoke combustion, &c.

1469 R. Harte, 42, Argyle-road, Kensington, improvements in means and apparatus for effecting aerial locomotion

1470 J. A. Ryke Van Den Bergh, Southsea, an improved sea messenger or receptacle to be used for receiving papers, parcels, and such like

1471 G. Simpson, Glasgow, improvements in machinery and arrangements for cutting or getting minerals

1472 T. H. Lloyd, Stockport, improvements in the construction and arrangement of valves

1473 W. Avery, Redditch, improvements in cases or receptacles for needles, pins, matches, pens, cards, stamps, photographs, cotton, and other similar articles

1474 P. Webley and T. W. Webley, Birmingham, improvements in breech-loading fire-arms

1475 E. B. Allen, 33, Pelham-place, Brompton, improvements in the construction of tramways and in engines and carriages employed thereon

1476 F. J. Tellier, Paris, improvements in machinery for the manufacture of strings and cords

1477 H. Hind, and G. Wells, Nottingham, improvements in steam and other valves

1478 B. Perowne, Great Snoring, Norfolk, improvements in machinery for cutting turnips and other roots

1479 F. Milnes, Camden Town, improvements in apparatus for healthily exercising the human frame

1480 J. Macqueen, Manchester, certain improvements in carding engines

1481 W. E. Heath, 23, Camden-road, improvements in cooling or refrigerating beer, liquors, or beverages

1482 H. A. Bonneville, 18, Chaussee d'Antin, Paris, a new and improved mode of manufacturing wooden floors and wainscots.—A communication

1483 H. A. Bonneville, 18, Chausee d'Antin, Paris, improvements in sewing machines.—A communication

1484 P. C. Evans, Brimscombe Mills, Gloucester, and H. J. H. King, Glasgow, improvements in apparatus for feeding wool, cotton, or other fibrous materials

1485 M. Benson, Southampton-buildings, improvements in the mode of supplying lamps or lanterns with atmospheric air. —A communication

1486 A. Long, 22, Aylesbury-street, Walworth, improvements in means for regulating the flow or controlling the supply of water or other fluids

1487 W. E. Newton, 66, Chancery-lane, improved machinery for grinding hand saws.—A communication

1488 A. Browne, 85, Gracechurch-street, improvements in screw propellers.—A communication

1489 J. Head, Middlesborough, improvements in setting horizontal stationary boilers

1490 W. R. Lake, Southampton-buildings, London, improvements in machinery for scouring, glossing, and otherwise treating leather.—A communication

1491 W. R. Lake, Southampton-buildings, London, improvements in machinery for sewing boots and shoes.—A communication

1492 T. A. de Carvalho, 1, Park-villas, High-road, Lee, improvements in ships and vessels

1493 M. Henry, 68, Fleet-street, an improved case holder or receptacle for matches.—A communication

PATENTS SEALED.

3368 J. Bottomley, and S. Emsley, improvements in spinning fibrous substances

3376 H. A. Bonneville, a new and improved steam boiler supply cock.—A communication

3377 H. A. Bonneville, electro-metallurgy.—A communication

3378 H. A. Bonneville, improvements in electric batteries.—A communication

3380 J. E. Croce-Spinelli, improvements in means and apparatus for propelling and steering vessels

3381 E. Hound, an improved indicator for marking games of skill or chance

3384 A. Nairn, improvements in steam carriages for common roads

3388 A. McNeill, a safe for ships and other navigable vessels carrying mails, specie, and other valuables

3391 J. Fogg, improvements in machinery for dressing flags and stone and other hard materials

3392 S. Cotton, improvements in machinery for preparing flax

3398 S. Chatwood and T. Sturgeon, improvements in apparatus for forcing and drawing fluids and liquids

3401 W. C. Mann, improvements in the manufacture of hats

3414 W. Pollitt, and W. J. Knowles, improvements in machinery for washing, wringing, mangling, churning, and mixing fluids

3443 S. Perry, J. J. Perry, and L. H. Perry, improvements in boxes for holding various articles

3460 J. Wood, J. Wood, and W. H. Wood, improvements in ventilating hats or other coverings for the head

3748 W. Bennett, and J. Currall improvements in kitchen ranges and fire-places or stoves

3569 G. F. Logan, a new or improved means for utilising waste heat

3779 G. Hamilton, improvements in the construction of steam boilers

151 T. Whitehead, improvements in wool combing and drawing machinery

194 J. M. Plessner, improvements in apparatus for and in the treatment of liquid fuel

306 C. Kinsler and A. Keppler, improvements in propellers

630 J. O. Morrell, improvements in apparatus applicable to the treatment of refuse for sanitary purposes

744 J. J. Stevens, J. J. F. Stevens, and W. A. Stevens, an improved apparatus for working points and signals on railways

918 C. Cotton, improvements in machinery for the manufacture of knitted fabrics

3406 J. Goddard and W. Finley, machinery for pill mass mixing and pill making

3414 G. M. Felton, improvements in collars and cuffs

3417 D. Barker, improvements in the manufacture of varnish and varnish paints

3418 J. Denis, improvements in the means of and machinery for producing pulp from wood

3422 E. H. Burke, improvements in metallic barrels

3424 W. Perkins, improvements in fusees, matches, or other analogous articles

3425 J. Combe, improvements in machinery for hackling flax and other fibrous substances

3427 J. Brunton, improvements in working and locking railway points and signals

3434 J. Pitt, J. Pitt, E. Pitt, and W. Pitt, improvements in machinery or apparatus for drilling, turning, or cutting and shaping metals or other materials

3435 L. Pochet, an improved apparatus for cutting or dressing stone

3439 W. Cross, an improved manufacture of shawls

3444 S. Fox and J. Reffitt, improvements in machinery or apparatus for boring, turning, and polishing treenails and bobbins

3455 J. Edwards and J. Quin, improved means for preventing roller laps on roller ends of machines for carding cotton, woollen, flax, or any other fibrous material

3469 R. Milburn and T. Browning, improvements in drying machines suitable for drying ears of corn, grain, seeds, and other materials

The English Mechanic
AND
MIRROR OF SCIENCE AND ART.
FRIDAY, JUNE 10, 1870.

NOTICE.

FOR years past the ENGLISH MECHANIC, though professing to be published on each Friday morning, has in reality been published on the preceding Monday. We have, therefore, been obliged to go to press on Friday evenings, or a week before the nominal day of publication. As this arrangement has occasioned no end of inconvenience to correspondents and advertisers, it has been determined in future to go to press on Tuesday evenings, and publish early on Friday mornings; in other words, on and after the 8th of July next, the ENGLISH MECHANIC AND MIRROR OF SCIENCE will be published at the same time as the widely-circulated London weekly papers. In order that no inconvenience or disappointment may arise, our readers will oblige us by informing their respective booksellers or newsagents of the contemplated alteration in the day of publication.

We beg also to inform our Subscribers that we have purchased the copyright of *Scientific Opinion*, and that on the day mentioned—the 8th proximo, that well known and high-class scientific publication will be incorporated with the ENGLISH MECHANIC. *Scientific Opinion* has a good staff of contributors and correspondents; these, added to our own, will no doubt materially enhance the value of the ENGLISH MECHANIC.

HINTS TO ASTRONOMICAL STUDENTS.

BY T. W. WEBB.

(*Continued from page* 74.)

IN a previous paper we discussed at some length the nature of the images formed from luminous points by refraction on reflection, and the representation of stars by spurious discs, with their attendant rings. We will now proceed to extend our remarks to the consideration of the telescopic definition of lines and surfaces. The character of this, after what has been said, it will not be difficult to understand. As the real discs of the stars, from their extreme remoteness, approximate, so far as our sight is concerned, to mathematical points, so, for the same reason, the natural outlines and boundaries of heavenly bodies become sensibly mathematical lines. But the mathematical line may be considered as composed of an infinite number of mathematical points; and its telescopic representation will therefore be equivalent to an infinite number of spurious discs, each with its attendant series of rings. The resulting image, instead of being indefinitely and almost imperceptibly narrow, must have a sensible breadth equal to that of the spurious disc; and the edges of the infinitely overlapping rings wi produce as many narrow luminous borders on both sides of it as there are visible rings, each parallel to the bright band which forms the image of the line. Such is the natural result of what we have already attempted to explain; we have, however, no opportunity of exemplifying it in practice, there being no instance of a luminous object in the sky, at once, long enough, narrow enough, and bright enough to form such a telescopic image. We have, however, in the limbs of the celestial bodies, the external boundaries of luminous surfaces which answer the description as far as one side of them is concerned. The surface itself mathematically represented by an infinite number of points, will produce a luminous image composed of an infinite number of overlapping spurious discs; and the outer boundary which terminates that surface will consist of the half of such an image of a line as has been described; the other half being of course merged in the general illumination of the disc. Every line being referable to an infinite number of points, and every surface to an infinite number of lines, and the image of a luminous point being strictly ascertainable as to character by the laws of optics, and determined as to magnitude by the experience of the best opticians, we have at length a clue which will guide us through all the details of telescopic definition. There are, however, collateral considerations which must be carefully borne in mind. The phenomenon is not only objective but subjective—that is, it depends not merely on the existence of certain undulations, but in the capacity of the retina to appreciate them. Below a certain intensity, varying considerably in different individuals, the vibrations constituting light fail to produce any perceptible effect upon the organs of vision; and the office of the telescope in many cases is, by collecting a greater number of these vibrations, to produce the requisite intensity, and to strengthen the latent image till it excites the retina to a sufficient degree. Thus, though the optical image of every star is theroretically surrounded with a considerable number of rings, in practice our eyes can only distinguish a few of them, even around the brightest stars, from the rapid degradation of their light; and as the stars diminish in magnitude, so the outer rings go successively out of sight. By the use of a larger aperture we counteract this degradation, and restore some of the lost rings; but as we call up, so to speak, the rings of the inferior magnitudes, so we bring into sight the central discs of innumerable fainter stars, which were before imperceptible, and whose rings are still too feeble for our sight. And the same of course holds good with the external portions of the spurious discs which are in a similar way lost sight of, or brought into view, according to the visible telescopic brightness of the star. In every case, therefore, of a luminous telescopic image, the theoretical result is modified by the receptive power of the eye, and the aperture of the instrument enters materially into the result, not merely as giving a larger or smaller spurious disc, but as making visible a greater or less number of rings, or, in the case of a line, the luminous border which they produce by their superposition.

We are now in a position to understand why the outlines of every telescopic image, the limbs, for instance, of the moon and planets, though remaining perfectly distinct, in a good instrument, up to a certain degree of magnifying, become progressively less hard and cleanly-defined with every subsequent increase of power. In their own nature they are throughout only approximately sharp, being composed of an infinite number of overlapping external halves of spurious discs, whose light decreases rapidly towards their edges. As long, however, as the power employed is insufficient to give a sensible magnitude to the radius of the disc, or at any rate to the portion of it where the light sensibly fades, so long the sharpness of outline continues apparently perfect, whatever eyepiece may be employed; but under the same conditions of magnifying which render the spurious disc large enough to affect the eye with the idea of size, we shall find the hard definition of outlines begin to fail. Theoretically considered, the latter as composed only of semi-discs, should bear twice the amount of power with equal distinctness; but these are niceties into which we need not enter. We may however remark, what is fully borne out in practice, that the sharpness of planetary definition always is in proportion to the size of the telescope, the diameters of the spurious discs on which it depends varying inversely with the aperture. At first sight it might appear strange that we do not see the limbs of the moon and planets attended by a border resulting from the presence of, at least, the first interference-ring, and that the details of their surfaces are not rendered indistinct from the same cause, but a little consideration will show that such an effect is imperceptible for the same reason that rings are not noticed round the smaller stars—namely, the want of intensity of light, the reflected lunar and planetary beams being incalculably more feeble than the intrinsic splendour of stars of any considerable magnitude. I have, however, noticed a border round the limb of Venus, undoubtedly due to such a cause, and in all probability it would be very conspicuous round the sun, were it possible to view him without such a darkening apparatus as must extinguish all such appendages. The knowledge of these facts serves to explain why the details of planetary surfaces are frequently not so well made out with the largest apertures as we might have beforehand expected. The amount of light may be sufficient to render the interference-rings visible, which, overlapping each other throughout the luminous area, must produce a certain amount of hazy indistinctness, or what is commonly termed a "glare." Hence there is often a gain in the definition of minute details by the reduction of light through moonlight, twilight, or haze, and this may probably be the reason why every telescope usually shows such details best with a certain amount of power—namely, that which without expanding the light to too great feebleness, reduces it so far as to render these rings, and the resulting irradiation or glare, insensible.

We have thus pursued the subject of definition to a considerable extent. The different modes, however, in which telescopic vision may be effected will render a little further investigation necessary at a future opportunity.

ELECTRICITY—ITS THEORY, SOURCES, AND APPLICATION.

BY J. T. SPRAGUE.*

(*Continued from page* 218.)

130. The next great class of electric generators includes nearly all the other forms of battery. The principle is the employment at the negative plate of some substance containing oxygen in such a condition as to be readily parted with; thus the hydrogen instead of being set free, decomposes this substance, forming water; he ingenuity of inventors has been largely exercised in varying—1st, the negative plate; 2nd, the oxidising agent, this latter being either liquid or solid. By keeping this classification in view, the principles and qualities of the different forms are rendered much more comprehensible than by a mere description of successive inventions.

131. **GROVES'S CELL.**—This was the first devised of this class, and in most respects is the best, platinum being the negative metal, and nitric acid the oxidising agent. The form is not essential, but it is usually made with flat plates; the platinum in a flat and narrow porous vessel to reduce the quantity of acid to the least, the zinc being either in two plates connected together, or one plate bent so as to surround the porous vessel at a distance of about three-eighths of an inch. Fig. 40 shows this arrangement, and will serve for many of its modifications. It is not generally known that the force of this arrangement is increased by platinising the platinum, as with the silver in the Smee.

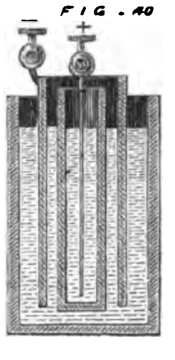
FIG. 40

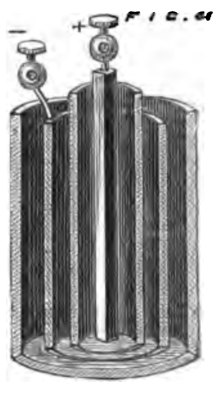
FIG. 41

132. **BUNSEN'S CELL** is the same, with graphite or gas carbon substituted for the platinum. It may be made with a flat plate of this material, but s more usually made of a solid block in a

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* "Sigma.

cylindrical porous jar, as in Fig. 41, which will serve as the type of this form.

133. CARBONS.—The employment of carbon is attended with some difficulties which call for attention here. Carbon is one of the most remarkable of the elements, possessing what is called "allotropic" forms, in which, though chemically the same thing, its physical properties are different, with different relations to heat, electricity, and light; such varieties are the diamond, charcoal, and graphite. It is this latter which is useful in electricity, either in its natural form of plumbago or black lead, or the artificial deposit of gas carbon. It must be clearly understood that this substance is *not coke;* coke is the solid residue left after distilling coal; the graphite comes from the *gas*, the rich hydrocarbons of which are decomposed by contact with the heated retort, on which they form a shell; it is, in fact, a great nuisance to the gas maker, as it arises from the destruction of the richest gas, injures the retorts, and wastes the heat; in the gasworks it is called "scurfing." The densest and hardest is the best for electrical use, and some which comes from abroad is far superior to anything our English coals produce; it should be almost non-absorbent, and ring like a metal when struck, and have a clear gray colour, not black. It is rather costly when good, simply because of the great difficulty of working it. Other substances will answer, such as the material of black lead crucibles, which is indeed made up for the purpose,

The chief difficulty with carbon is making the connection with it; this is commonly done by simply fixing a clamp on it, in which case a piece of platinum ought to be interposed between the two surfaces. A better plan is to deposit copper on the upper part, and then solder the connection to it, as this gives continuous circuit; the copper takes on it just as it would on a metal. There is one drawback to this, the same in fact which requires the platinum interposed in the first plan; the acid both creeps up the surface and soaks into the substance, and then acts on the copper and destroys the connection. I have devised a perfect remedy for this which I do not think has ever yet been published. Before use I thoroughly dry the carbon and mark on it the point to which the liquid will reach, and then moisten with water this part, and also the extreme top where the copper is to go; the intermediate part is then heated by a Bunsen's gas burner, and touched carefully with a piece of paraffin as long as it will absorb any, taking care none runs over the surfaces to be used; with care this intermediate portion may be thus thoroughly saturated with paraffin, which resists contact of liquids, and on which acids have no action; the copper is now deposited, and the connection fixed, and then the copper surface and top of the carbon is covered with a thick coat of paraffin, which serves as a complete protection.

134. Other materials have been employed, as lead or iron, platinised. Cast iron has been strongly advocated under the name of Callan's, or the Maynooth cell; a very few words will sum up their qualities. They are worthless. If any one wishes to lose his temper and his money he can use a cast iron battery, with some certainty of success. They waste the acid frightfully, they boil over suddenly, in fact they do everything we should wish not done, without having one redeeming quality to atone for their evils.

135. The relative merits of platinum and carbon depend on circumstances; the first is most expensive at first (especially as it is bad economy to use very thin sheet, which is a bad conductor, and soon becomes brittle and breaks up), but it gives a slightly higher force, and is preferable if the battery is to be much used. Still, for ordinary use the carbon answers every purpose, and is much more commonly employed. The actual conditions and expenses of working are the same with both, and the following remarks apply to both, though the experiments were actually made with a carbon plate.

It is impossible to give an exact statement of the reactions which take place in the nitric acid cell, as they are continually varying with the strength of the acid. HNO_3 may lose 1 atom of oxygen, becoming HNO_2 nitrous acid, under one equivalent of action, which provides H_2 to from H_2O water; but one atom of hydrogen is equally able to take up one of oxygen together with the hydrogen of the acid; thus $HNO_3 + H$ becomes $H_2O + NO_2$; or the same reaction taking place with the residue (nitrous acid) of the first case $HNO_2 + H$ becomes $H_2O + NO$. In each of these cases the work done electrically by one atom of acid would be different. The principal action which really occurs is the first and third combined, $HNO_3 + H_3$ becoming $2H_2O + NO$, and according to this, one atom of nitric acid is effective for one and a half equivalents of electrical action; or to express it practically, though not in the true chemical language, two-thirds of an atom is the equivalent. This action is however complicated with others, for the acid is even totally deoxidised and converted into ammonia to some slight extent. Owing to this and to the loss by evaporation or carrying away of acid by the escaping gases, and by leakage through the porous cell, the working equivalent or value of the acid can only be settled by actual experiment, and in addition to this, when we buy nitric acid we only get a solution of it varying very much in actual strengh. I therefore have calculated a table showing the properties of the acid at the various strengths; it is not prepared for analytical, but for practical use, and is based on Ure's tables. Column I. is the specific gravity as given by him; Column II. is the percentage of true acid HNO_3 Ure's tables are based on the anhydride N_2O_5 formerly regarded as the acid, but I have calculated the true acid from his figures. Column III. is the number of atoms of 63 grains weight contained in one lb weight; and Column IV. the number of those atoms in 1000 grains fluid measure; these two I have calculated from the percentage, and they will furnish every required information as to the work which acid of any strength is equal to.

	I.	II.	III.	IV.
	Specific Gravity.	Percentage HNO_3	Atoms per lb.	Atom. in 1000 liquid gr.
1	1·5210	100·	111·11	21·4
2	1·5000	92·978	103·31	21·5
3	1·4980	92·048	102·28	21·89
4	1·4960	91·115	101·12	21·63
5	1·4940	90·189	100·21	21·88
6	1·4910	89·259	99·17	21·12
7	1·4880	88·329	98·14	20·86
8	1·4850	87·399	97·11	20·60
9	1·4820	86·470	96·07	20·34
10	1·4790	85·540	95·04	20·08
11	1·4760	84·610	94·01	19·82
12	1·4730	83·680	92·98	19·57
13	1·4700	82·750	91·94	19·31
14	1·4670	81·820	90·91	19·05
15	1·4640	80·890	89·88	18·79
16	1·4600	79·961	88·84	18·53
17	1·4570	79·031	87·81	18·27
18	1·4530	78·101	86·77	18·10
19	1·4518	77·777	86·42	17·90
20	1·4500	77·176	85·40	17·82
21	1·4460	76·242	84·71	17·54
22	1·4424	75·313	83·67	17·27
23	1·4385	74·382	82·64	16·98
24	1·4346	73·453	81·61	16·69
25	1·4306	72·523	80·57	16·39
26	1·4269	71·593	79·54	16·10
27	1·4228	70·663	78·50	15·80
28	1·4200	70·009	77·78	15·78
29	1·4189	69·734	77·47	15·50
30	1·4147	68·804	76·44	15·29
31	1·4107	67·874	75·40	15·08
32	1·4065	66·294	74·37	14·87
33	1·4023	66·014	73·34	14·65
34	1·3978	65·085	72·31	14·44
35	1·3945	64·156	71·28	14·19
36	1·3882	63·226	70·24	13·93
37	1·3833	62·296	69·21	13·68
38	1·3783	61·367	68·18	13·43
39	1·3732	60·437	67·15	13·17
40	1·3681	59·507	66·11	12·93
41	1·3630	58·577	65·08	12·67
42	1·3579	57·648	64·05	12·43
43	1·3529	56·718	63·02	12·18
44	1·3477	55·788	61·98	11·93
45	1·3427	54·858	60·95	11·69
46	1·3370	53·928	59·92	11·45
47	1·3323	52·998	58·88	11·21
48	1·3270	52·068	57·85	10·97
49	1·3216	51·139	56·82	10·73
50	1·3163	50·209	55·79	10·49
51	1·3110	49·279	54·75	10·26
52	1·3056	48·349	53·72	10·03
53	1·3001	47·419	52·69	9·71
54	1·2947	46·489	51·65	9·56
55	1·2887	45·559	50·62	9·33
56	1·2826	44·629	49·59	9·09
57	1·2765	43·700	48·56	8·86
58	1·2705	42·769	47·52	8·63
59	1·2644	41·840	46·49	8·40
60	1·2583	40·911	45·46	8·18
61	1·2523	39·981	44·42	7·95
62	1·2462	39·051	43·39	7·73
63	1·2402	38·121	42·36	7·51
64	1·2341	37·191	41·32	7·28
65	1·2271	36·262	40·29	7·07
66	1·2212	35·332	39·26	6·83
67	1·2148	34·402	38·22	6·64
68	1·2084	33·472	37·19	6·43
69	1·2019	32·542	36·16	6·23
70	1·1958	31·613	35·13	6·00

1, is the absolute theoretical acid, called the 1st hydrate formerly.

19, is $2HNO_3 + 2H_2O$, formerly the 2nd hydrate.

28, is $2HNO_3 + 3H_2O$. This is the strength to which boiling brings both stronger and weaker acids and distils unchanged at 248° Fah., but is not, as sometimes stated, a definite hydrate, as it varies according to the pressure.

39 and thereabouts, is *double aquafortis,* and about 63 is *single aquafortis.*

136. The following experiments will bo illustrate the uses of the table and the actions the battery. The acid used was pure, inten for analytical purposes, its specific gr 1·3175 giving, by averages between No. 49 and 50 in the table, a value of 10·58 atoms per 1000 grains, or 5·29 for 500, the quantity used in the porous cell, which on the above theoretical considerations should furnish at two-thirds 7·93 equivalents; 3000 grains measure of sulphuric acid solution were used in the outer cell equivalent to the consumption of 12 units of zinc, and a sheet of copper was arranged to receive a deposit of copper. The cell continued in action for nearly 7 hours, giving a deflection ranging between 67° to 55° and at last falling rapidly to 20°. There were deposited 8·64 units of copper, while 10·21 units of zinc were dissolved, showing a loss, by local action, of 1·57 units. I afterwards allowed the action to go on as long as any took place, but only 1·28 more of copper was deposited, and 3 of zinc dissolved, showing how much the local action increases towards the end; it was more than 14 per cent. beyond the 5 allowed in calculations for the simple cell: as to the nitric acid, 8·64 the true work is so near 7·93 that calculated as to show that the reaction described is the chief one and that the more perfect deoxidisation which may occur compensates for losses; however as it is not possible to work to near exhaustion as in this experiment, for practical purposes the atom should be taken as the equivalent instead of two-thirds.

137. It has been recommended to use salt instead of sulphuric acid, and the following trial was made under exactly the same conditions as the first; the current went up to 64° lasted 3½ hours instead of 7 gave a deposit of copper 4·13 units and use of zinc 4·72 being a loss of one-eighth by local action. This proves, as might be expected, that the use of salt is bad economy, it takes no part in the reaction (so far as cost is concerned), except as a conductor, but the zinc is dissolved by the nitric acid transferred *to it* by electrolysis.

138. For practical use a much cheaper nitric acid may be obtained. Thus I use one of sp. gr. 1·4146 containing 76·4 atoms per lb., and costing threepence per lb., or ·0393 of a penny per atom. Applying the results of the experiment to this value we have the cost of working nitric acid batteries thus:—

Cost of simple cell per unit		·0471
Extra local action 14 per cent. =	·0066	
Nitric acid — ⅔ atom	·0262	·0328
Per unit		·0799

Working with salt we have—

Cost of salt, say		·0020	
Zinc equivalent	32·6		
Loss 15 per cent.	4·9		
37½lb. at 7d. ÷ 7000		·0375	
Nitric acid — 1 atom	0393		
30 per cent	0118	·0511	
Cost per unit			·0906

This shows an excess of cost of one-eighth by using salt, and this excess would increase according as the cost of nitric acid per lb. or per unit exceeded the figure given. Adding to the first figures enough to bring the cost up to practical working, or 1 atom of acid per unit ·0799 + ·0131 = ·0930 as the cost per unit as compared with the other forms of battery. This is somewhat under that of Daniells, but that is capable of reduction by causing the copper to be deposited in useful forms, while this is at its lowest; the real drawback, however, to nitric acid batteries is the escape of nitrous gases, which are unwholesome and very injurious to all metallic substances; where these can be avoided, and the trouble attending its use is of little moment, the nitric acid cell is undoubtedly the most powerful and most advantageous source at present known from which to obtain a steady and powerful current.

(*To be continued.*)

ON STAR-GROUPING, STAR-DRIFT, AND STAR-MIST.[*]

(Concluded from page 247.)

TURNING to the subject of star-mist, under which head I include all orders of nebulæ, I propose to deal but with a small proportion of the evidence I have collected to prove that none of the nebulæ are external galaxies. That evidence has indeed become exceedingly voluminous.

I shall dwell, therefore, on three points only.

First, as to the distribution of the nebulæ:—They are not spread with any approach to uniformity over the heavens, but are gathered into streams and clusters. The one great law which characterises their distribution is an avoidance of the Milky Way and its neighbourhood. This peculiarity has strangely enough been regarded by astronomers as showing that there is no association between the nebulæ and the sidereal system. They have forgotton that marked contrast is as clear a sign of association as marked resemblance, and has always been so regarded by logicians.

Secondly, there are in the southern heavens two well-marked streams of nebulæ. Each of these streams is associated with an equally well-marked stream of stars. Each intermixed stream directs its course towards a Magellanic Cloud, one towards the Nubecula Minor, the other towards the Nubecula Major. To these great clusters they flow, like rivers towards some mighty lake. And within these clusters, which are doubtless roughly spherical in form, there are found intermixed in wonderful profusion, stars, star clusters, and all the orders of nebulæ. Can these coincidences be regarded as accidental? And if not accidental, is not the lesson they clearly teach us this, that nebulæ form but portions of the sidereal system, associating themselves with stars on terms of equality (if one may so speak), even if single stars be not more important objects in the scale of creation, than these nebulous masses, which have been so long regarded as equalling, if not outvying, the sidereal system itself in extent?

The third point to which I wish to invite attention is the way in which in many nebulæ stars of considerable relative brightness, and belonging obviously to the sidereal system, are so associated with nebulous masses as to leave no doubt whatever that these masses really cling around them. The association is in many instances far too marked to be regarded as the effect of accident.

Amongst other instances[†] may be cited the nebula round the stars c^1 and c^2 in Orion. In this object two remarkable nebulous nodules centrally surround two double stars. Admitting the association here to be real (and no other explanation can reasonably be admitted), we are led to interesting conclusions respecting the whole of that wonderful nebulous region which surrounds the sword of Orion. We are led to believe that the other nebulæ in that region are really associated with the fixed stars there; that it is not a mere coincidence, for instance, that the middle star in the belt of Orion is involved in nebula, or that the lowest star of the sword is similarly circumstanced. It is a legitimate inference from the evidence that all the nebulæ in this region belong to one great nebulous group, which extends its branches to these stars. As a mighty hand this nebulous region seems to gather the stars here into close association, showing us in a way there is no misinterpreting, that these stars form one system.

The nebula round the strange variable star, Eta Argus, is another remarkable instance of this sort. More than two years ago I ventured to make two predictions about this object. The first was a tolerably safe one. I expressed my belief that the nebula would be found to be gaseous. After Mr. Huggins' discovery that the great Orion nebula is gaseous, it was not difficult to see that the Argo nebula must also be so. At any rate, this has been established by Captain Herschel's spectroscopic researches. The other prediction was more venturesome. Sir John Herschel, whose opinion on such points one would always prefer to share, had expressed his belief that the nebula lies far out in space beyond the stars seen in the same field of view. I ventured to express the opinion that those stars are involved in the nebula. Lately there came news from Australia that Mr. Le Sueur, with the great reflector erected at Melbourne, has found that the nebula has changed largely in shape since Sir John Herschel observed it. Mr. Le Sueur accordingly expressed his belief that the nebula lies *nearer* to us than the fixed stars seen in the same field of view. More lately, however, he has found that the star Eta Argus is shining with the light of burning hydrogen, and he expresses his belief that the star has consumed the nebulous matter near it. Without agreeing with this view, I recognise in it a proof that Mr. Le Sueur now considers the nebula to be really associated with the stars around it. My belief is that as the star recovers its brilliancy, observation will show that the nebula in its immediate neighbourhood becomes brighter (*not* fainter through being consumed as fuel). Infact, I am disposed to regard the variations of the nebula as systematic, and due to orbital motions among its various portions around neighbouring stars.

As indicative of other laws of association bearing on the relations I have been dealing with, I may mention the circumstance that red stars and variable stars affect the neighbourhood of the Milky Way or of well-marked star-streams. The constellation Orion is singularly rich in objects of this class. It is here that the strange "variable" Betelgeux lies. At present this star shows no sign of variation, but a few years ago it exhibited remarkable changes. One is invited to believe that the star may have been carried by its proper motion into regions where there is a more uniform distribution of the material whence this orb recruits its fires. It may be that in the consideration of such causes of variation affecting our sun in long past ages a more satisfactory explanation than any yet obtained may be found of the problem geologists find so perplexing—the former existence of a tropical climate in places within the temperate zone, or even near the Arctic regions.[*]

It remains that I should exhibit the general results to which I have been led. It has seemed to many that my views tend largely to diminish our estimate of the extent of the sidereal system. The exact reverse is the case. According to accepted views there lie within the range of our most powerful telescopes, millions of millions of suns. According to mine, the primary suns within the range of our telescopes must be counted by tens of thousands, or by hundreds of thousands at the outside. What does this diminution of numbers imply but that the space separating sun from sun is enormously greater than accepted theories would permit? And this increase implies an enormous increase in the estimate we are to form of the vital energies of individual suns. For the vitality of a sun, if one may be permitted the expression, is measured not merely by the amount of matter over which it exercises control, but by the extent of space within which that matter is distributed. Take an orb a thousand times vaster than our sun, and spread over its surface an amount of matter exceeding a thousandfold the combined mass of all the planets of the solar system:—So far as living force is concerned, the result is—*nil.* But distribute that matter throughout a vast space all round the orb—that orb becomes at once fit to be the centre of a host of dependent worlds. Again, according to accepted theories, when the astronomer has succeeded in resolving the milky light of a portion of the galaxy into stars, he has in that direction, at any rate, reached the limits of the sidereal system. According to my views, what he has really done has been but to analyse a definite aggregation of stars—a mere corner of the great system. Yet once more. According to accepted views, thousands and thousands of galaxies, external to the sidereal system, can be seen with powerful telescopes. If I am right, the external star-systems lie far beyond the reach of the most powerful telescope man has yet been able to construct, insomuch that perchance the nearest of the outlying galaxies may lie a million times beyond the range even of the mighty mirror of the great Rosse telescope.

But this is little. Wonderful as is the extent of the sidereal system as thus viewed, even more wonderful is its infinite variety. We know how largely modern discoveries have increased our estimate of the complexity of the planetary system. Where the ancients recognised but a few planets, we now see, besides the planets, the families of satellites; we see the rings of Saturn, in which minute satellites must be as the sands on the sea-shore for multitude; the wonderful zone of asteroids; myriads on myriads of comets; millions on millions of meteor systems, gathering more and more richly around the sun, until in his neighbourhood they form the crown of glory which bursts into view when he is totally eclipsed. But wonderful as is the variety seen within the planetary system, the variety within the sidereal system is infinitely more amazing. Besides the single suns, there are groups and systems and streams of primary suns; there are whole galaxies of minor orbs; there are clustering stellar aggregations, showing every variety of richness, of figure, and of distribution; there are all the various forms of nebulæ, resolvable and irresolvable, circular, elliptical, and spiral; and lastly, there are irregular masses of luminous gas, clinging in fantastic convolutions around stars and star-systems. Nor is it unsafe to assert that other forms and varieties of structure will yet be discovered, or that hundreds more exist which we may never hope to recognise.

But lastly, even more wonderful than the infinite variety of the sidereal system, is its amazing vitality. Instead of millions of inert masses, we see the whole heavens instinct with energy,—astir with busy life. The great masses of luminous vapour, though occupying countless millions of cubic miles of space, are moved by unknown forces like clouds before the summer breeze; star-mist is condensing into clusters; star-clusters are forming into suns; streams and clusters of minor orbs are swayed by unknown attractive energies; and primary suns singly or in systems are pursuing their stately path through space, rejoicing as giants to run their course, extending on all sides the mighty arm of their attraction, gathering from ever new regions of space supplies of motive energy, to be transformed into the various forms of force,—light, and heat, and electricity,—and distributed in lavish abundance to the worlds which circle round them.

Truly may I say, in conclusion, that whether we regard its vast extent, or its infinite variety, or the amazing vitality which pervades its every portion, the sidereal system is of all the subjects man can study, the most imposing and the most stupendous. It is as a book full of mighty problems,—of problems which are as yet almost untouched by man, of problems which it might seem hopeless for him to attempt to solve. But those problems are given to him for solution, and he *will* solve them, whenever he dares attempt to decipher aright the records of that wondrous volume.

SCIENCE FOR THE YOUNG.[*]

BY THE REV. E. KERNAN, CLONGOWES COLLEGE.

(Continued from page 223.)

§ II.—FLEXIBILITY.

FLEXIBILITY is the capability of bending without any permanent separation of the particles in a body. This is an important property, in consequence of practical questions which it involves.

No. I.—Laws.—A body in which the dimension of length is considerably greater than the other two dimensions, may be viewed as constituted by three sets of particles—the upper, the lower, and the middle. The conditions of these in a flexed body are the subject of the few but important laws of flexibility. A rod with wires passed through it, shows well, in an enlarged form, the meaning of the laws. When the wires carry white beads the action is made still more evident, Fig. 37. Lead or some body that keeps the bent form, is the best material for the rod.

Law I. The upper particles of a flexed body are separated without destroying their molecular attraction. Hold the wired rod, the wires perpendicular, bend the ends down, the wires diverge, forming an angle between each pair. The beads, as Fig. 38, represent the particles as separated by the action of bending.

N.B.—The terms *upper* and *under*, are not to be taken in their ordinary sense only. For then the laws would refer to but one sort of flexion—centre raised *up*, ends bent *down*. Every flexed body has a *convex* and *concave* side. And in this sense are used the terms upper and under.

Law II. The lower particles of a flexed body are compressed. Look at the beads below (*a*), they are close up, or perhaps overlapped.

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[*] The substance of a Lecture delivered by R. A. PROCTOR, B.A., at the Royal Institution on May 6.

[†] Eight pictures of nebulæ were exhibited in illustration of this peculiarity.

[*] Sir John Herschel long since pointed to the variation of our sun as a possible cause of such changes of terrestrial climate.

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Law III. The central particles are neither separated or compressed. This law is not to be taken in a very strict sense, which would be that only *one single file* of particles was in the unaffected condition. But so small is the greatest separation, that a considerable portion of the body may be looked upon as practically unaffected.

FIG. 37

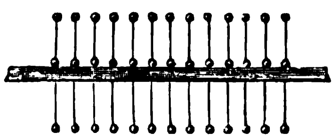
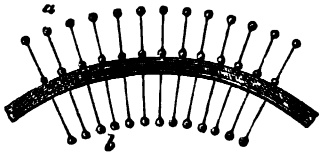


FIG. 38



Law IV. The separation of the upper and compression of the lower particles diminishes to the centre. The angles of the wires show the diminution.

No. II.—Proofs. The rod with the wires contains a simple proof of all four laws. The wires are acted upon by the lines of particles only. When, therefore, the wires are displaced, the particles too must be displaced, and in a similar manner.

Therefore, where the rods indicate separation, compression greater or less, similar action must have been effected (on a very reduced scale) in the flexed body.

No. II.—APPLICATIONS.

App. I.—Neutral Axis is that part of the body which is neither dilated nor compressed. And this neutral axis, practically extends to some depth at either side of the strict, absolute centre line.

App. II.—Hollow Beam. Under certain conditions a hollow beam is stronger than a solid one of the same dimensions. This question occurs again, just now, only what flexibility contributes to the explanation ? 1. In the hollow beam the real effective part is retained, that is : the upper set of particles, which resist by their molecular attraction, and the lower set, which resist by their opposition to compression. The beam, then, has in certain dimensions, all that contributes to its strength, although much diminished in quantity of matter.

2. The weight of all the matter in the neutral axis is removed ; so much bending force is thus avoided.

3. No crushing force is directly conveyed from the upper to the lower set of particles —the bottom of the beam—except at the sides ; the rest of the bottom of the beam is only acted upon through its cohesion to its edges, or sides. There is, therefore, introduced a resistance to flexure, represented by the whole length of the bottom of the beam, inside its perpendicular walls. On the contrary, in the solid beam each vertical layer transmits a portion of the force, directly crushing the lower particles.

App. III.—Girders. The great horizontal beams of iron now so common, have a form, the section of which is like the letter H laid flat, ⊢⊣, Fig. 39. Their resistance depends in part on the same principles as those just explained for the hollow beam. The centre rib takes the place of the two sides, and is strengthened as required by angle pieces, Fig 39, *a a*. The girder is not of necessity solid throughout. Thus lightness and elegance of design can be combined with strength, Fig. 40.

FIG. 39

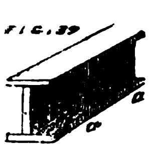
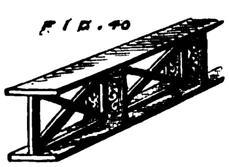


FIG. 40



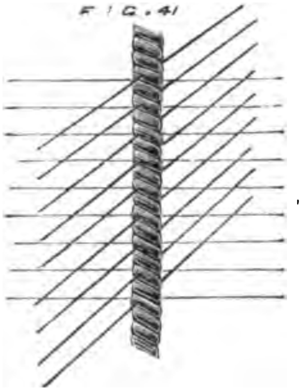
§ III.—ELASTICITY

Elasticity is, to a certain point, the same as flexibility, but it has something additional, by which it differs essentially. When drawn away from their position of rest, elasticity gives to the particles the power of returning to that position. This power is called "restitution." Almost all bodies are elastic, more or less ; some very little, others very much so.

Elasticity is a subject of great consequence, which has been investigated by deep mathematical study and much experimental research Here, of course, but the great general principles

There are four sorts of elasticity—elasticity of *compression*, of *traction*, of *flexion*, and of *torsion*. The two first are familiar in balls, strings of india-rubber ; the third, in rods of wood, steel, &c. ; the fourth, is that observed in cords of every sort, when twisted. Torsion-elasticity is well shown to the eye by an elastic rod with wires, or a thick cord. Holding the rod or cord perpendicular, the wires show the changed position of the particles when the rod or cord is twisted, Fig. 41. In all, the disturbed particles return to their position of rest, whether forced from it by compression, by drawing asunder, by bending, or by twisting. All four belong to the solid state, the first only to the liquid and gaseous.

FIG. 41

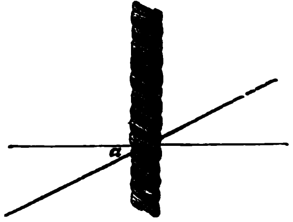


No. I.—Laws. These regard particularly the fourth sort of elasticity.

Law I. The laws of flexibility are true of elasticity, inasmuch as the sort of elasticity will permit. There is separation, compression, and neutral axis, where the source, cause, mode of action of the elasticity, can produce these effects.

Laws II. In torsions elasticity the force of torsion is proportional to the angle of torsion. When the cord is twisted, the particles move horizontally, forming an angle with their original position. The wires represent *each* a line of particles from the centre to the circumference of the cord. The angle with the position of rest is called the angle of torsion, *a*, Fig. 42.

FIG. 42



Law III. In torsion elasticity the oscillations are isochronous. No matter how great or small, the distance (within certain limits) at either side of the point of rest, to which the particles move, the swing is effected in equal times.

No. II.—Proofs. Experimental only.

Law I. Compression-elasticity, does not admit the separation of particles. The existence of this source is usually shown by dropping an ivory ball upon a block of marble, damped with some dark thick fluid. The spot upon the ball will be found to be much larger than the point on which the ball would stand if laid gently down. The ivory must, then, have been compressed. Its form remains still true ; it must, therefore, have been *restored*. In traction-elasticity there can be no compression. The particles are all drawn away. A strip of india-rubber under traction is interesting. By marking some one spot its changes can be observed. It grows thinner, as the force increases, and if the strip be flat, and of equal breadth throughout its length, the sides move in, more or less parallel, except just near where the ends are held. Flection-elasticity shows exactly as the flexibility laws, adding the restitution. An elastic rod with wires, Fig. 43, *a*, returns, when relieved from action, to its first form, *b*. In torsion, elasticity, the compression which takes place is not in the same direction as in flexibility. This is made evident by the wires, Fig. 41 ; at both sides the wires stand out.

FIG. 43

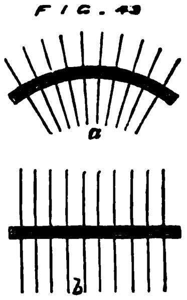
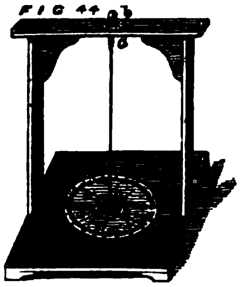


FIG 44



The compression begins at the axis of the cord, decreasing horizontally to the circumference This compression makes itself felt by the resistance to further twisting, which a cord soon offers. There is, too, a certain spiral motion which adds to the compression. To have been mentioned, must be enough for this spiral winding.

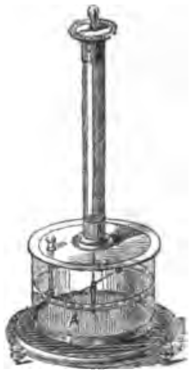
Law II. Found to be experimentally true ; a known force 2, 3, *n* times greater, was found equal to the torsion of an angle 2, 3, *n* times larger. Some idea of the apparatus in the Applications.

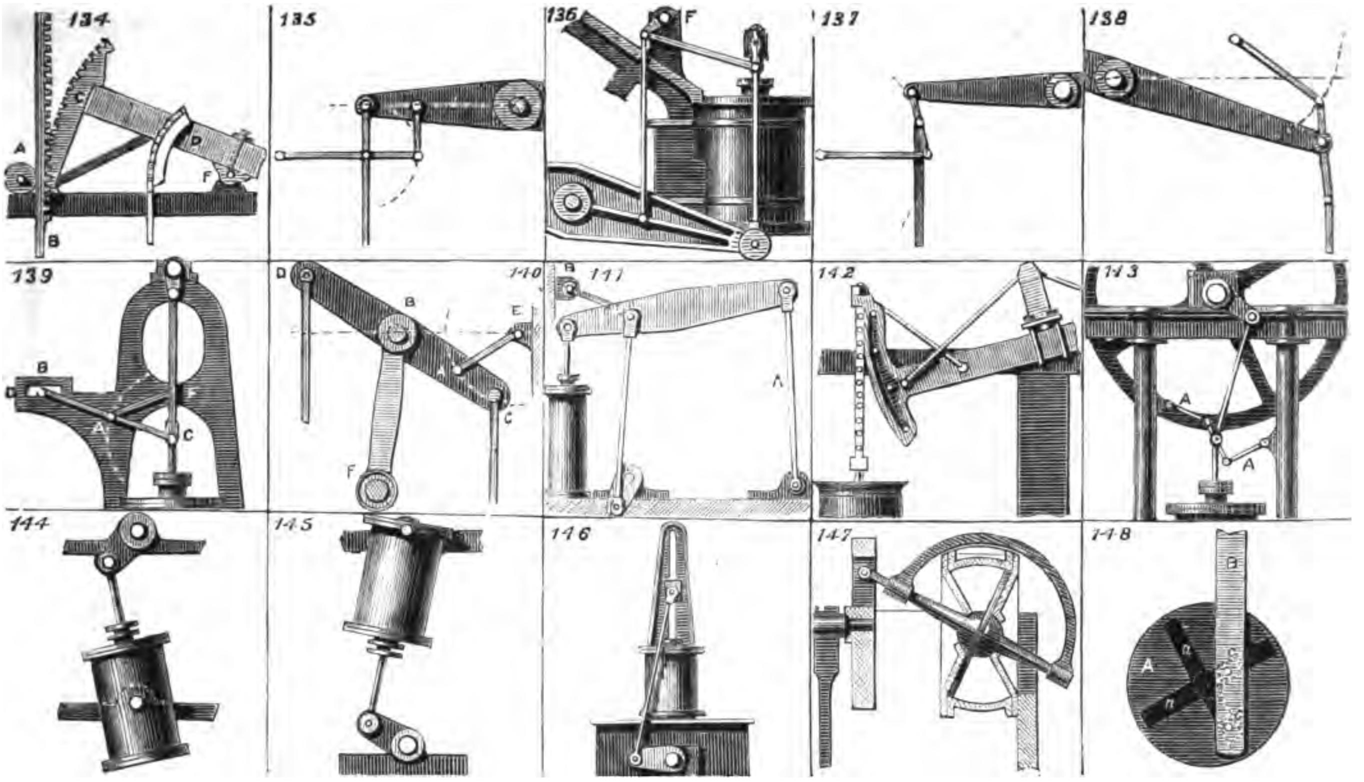
Law III. Shown by Coulomb to be the ca The experiments do not belong to mechanics, least, the forces brought into action.

No. III.—Applications.—From amongst these the principal one is, the explanation of Coulomb's instrument, in its *mechanical* essentials. These well understood now there is so much done and out of the way for electrical study later.

App. I.—Torsion Balance.—An index A is delicately suspended by a thread free from all torsion, Fig. 44. Under the index is a graduated circle, the degrees of which show the angles of torsion. In some experiments it is required to make the index stand at a certain angle. This is effected by turning the handle *b* of the axis *a* above, from which the thread hangs. The handle of that axis carries an index over a small graduated circle. When the upper torsion is used, it must enter into the calculations of the force under examination. It may sometimes be more than one turn, one complete revolution of the handle. The divided circle serves for any number of turns. At first sight the torsion balance here shown may seem to differ very much from the Coulomb instrument, Fig. 45. Still there is not the smallest *essential* difference, in as much as they are torsion balances. A cage of glass A, protects the index from the air currents. From the cage rises the tube which supports the upper torsion scale, the axis, and nippers to hold the silver wire. The lower torsion scale is usually on the cage. All other details are dependent upon electrical principles. And here occurs the first occasion of warning the student against over-attention to the unimportant details of instruments. See, make sure of all the essentials required by the principles. These, well understood, and retained, the explanation of the instrument is fixed in the mind. The details may or may not be remembered ; this will not affect true knowledge, the instruments under new forms can still be recognised and examined. Besides, in too much attention to details, there is sometimes this danger, that the memory is over-burdened with them ; in the confusion the mind does not see where the essentials are, and after a most careful setting forth of even the smallest points of height, position, material, and general action &c., the explanation of an apparatus may

FIG. 45





MECHANICAL MOVEMENTS.

conclude without one of the main principles having been touched.

Examiners in mathematics will sometimes present a proposition with the figure reversed from its usual position. How many candidates has not this *immaterial* change completely puzzled? So in scientific apparatus, change the position, form, &c., leaving the essentials; many who have stored up pages of details, will no longer recognise the instrument, to acquire the explanation of which may have cost them much labour.

App. II.—Inelastic Bodies.—It is impossible to have a body hard, and perfectly free from elasticity. Of this remarkable proofs later in experiments, which for their perfection require such bodies. Perfect elasticity is equally impossible. Full restitution takes place, but its external effect is not fully produced; more strictly the "external action" of even the most perfect elasticity is never complete—proved experimentally in Dynamics.

App. III. Torsion shock.—Under this title, a French engineer explained, some time ago, the cause of the occasional breaking of railway carriage axles, which may have appeared to be quite sound. At the curves of the "line," the *inside* wheel produces a torsion in the axle, which little by little disintegrates the metal, and so insidiously, that none of the ordinary methods of examinations, indicate the flaw which has extended from the outside to the centre. Close scrutiny and experiments have confirmed the theory of Mr. Lucas. The chief remedy he proposes, is to have the axles made of welded bars. Any flaw will thus show at once. Another safeguard is to have the wheels so hung that they can move with different velocities. The experiments of Mr. Lucas are very interesting and instructive, but are too long to be produced here.*

App. IV. Cork springs.—Cork would seem to possess a remarkable power of endurance, in bearing compression, elasticity; so much so that it has been substituted for indian rubber in railway springs. The cork prepared for this use, under a pressure of 20000lb., exhibited an elasticity which recalled that of compressed air.

(*To be continued.*)

MECHANICAL MOVEMENTS.†

(*Continued from page* 248.)

133. A parallel motion used only in particular cases.

134. Shows a parallel motion used in some of the old single-acting beam-engines. The piston-rod is formed with a straight rack gearing with a toothed segment on the beam. The back of the rack works against a roller A.

135. A parallel motion commonly used for stationary beam engines.

136. An arrangement of parallel motion for side lever marine engines. The parallel rods connected with the side rods from the beams or side levers are also connected with short radius arms on a rock-shaft working in fixed bearings.

137. Parallel motion, in which the radius rod is connected with the lower end of a short vibrating rod, the upper end of which is connected with the beam, and to the centre of which the piston-rod is connected.

138. Another modification, in which the radius bar is placed above the beam.

139. Parallel motion for direct action engines. In this, the end of the bar B C is connected with the piston-rod, and the end B slides in a fixed slot D. The radius bar F A is connected at F with a fixed pivot, and at A midway between the ends of B C.

140. Another parallel motion. Beam D C with joggling pillar-support B F which vibrates from the centre F. The piston-rod is connected at C. The radius-bar E A produces the parallel motion.

141. "Grasshopper" beam engine. The beam is attached at one end to a rocking pillar A, and the shaft arranged as near to the cylinder as the crank will work. B is the radius bar of the parallel motion.

142. Old-fashioned single-acting beam pumping engine on the atmospheric principle, with chain connection between piston-rod and a segment at end of beam. The cylinder is open at top. Very low pressure steam is admitted below piston, and the weight of pump-rod, &c., at the other end of beam, helps to raise piston. Steam is then condensed by injection, and a vacuum thus produced below piston, which is then forced down by atmospheric pressure thereby drawing up pump-rod.

143. Parallel motion for upright engine. A A are radius-rods connected at one end with the framing and at the other with a vibrating piece on top of piston-rod.

144. Oscillating engine. The cylinder has trunnions at the middle of its length working in fixed bearings, and the piston-rod is connected directly with the crank, and no guides are used.

145. Inverted oscillating or pendulum engine. The cylinder has trunnions at its upper end and swings like a pendulum. The crank-shaft is below, and the piston-rod connected directly with crank.

146. Table engine. The cylinder is fixed on a table-like base. The piston-rod has a cross-head working in straight slotted guides fixed on top of cylinder, and is connected by two side connecting rods with two parallel cranks on shaft under the table.

147. Section of disc engine. Disc piston, seen edgewise, has a motion substantially like a coin when it first falls after being spun in the air. The cylinder-heads are cones. The piston-rod is made with a ball to which the disc is attached, said ball working in concentric seats in cylinder-heads, and the left-hand end is attached to the crank-arm or fly-wheel on end of shaft at left. Steam is admitted alternately on either side of piston.

148. Mode of obtaining two reciprocating movements of a rod by one revolution of a shaft, patented in 1836 by B. F. Snyder, has been used for operating the needle of a sewing machine, by J. S. McCurdy, also for driving a gang of saws. The disc A on the central rotating shaft has two slots *a a* crossing each other at a right angle in the centre, and the connecting rod B has attached to it two pivoted slides *c c*, one working in each slot.

(*To be continued.*)

ON THE RELATIVE SAFETY OF DIFFERENT MODES OF WORKING COAL.

THE following is the substance of a paper read before the Institution of Civil Engineers on May 3rd by Mr. G. Fowler, on the above subject.

It was maintained by the author, that whilst there was no possibility of freeing the workmen engaged in coal mining from accident, there was reason to hope for a considerable diminution in the proportion of those killed to the number employed. It was the purport of this communication to show that the mode of getting coal had considerable effect on the safety of the workmen. The accidents incidental to mining were classified by Her Majesty's Inspectors of Coal Mines under five heads, as arising from explosions, from falls of roof or of coal, in shafts, from miscellaneous causes underground, and on the surface. It appeared that in the years 1866, 1867, and 1868, out of a total of 3686 casualties, 1091 were the result of explosions, and 1255 of falls, or respectively 29 per cent. and 34 per cent. of the whole; the remaining 37 per cent. being attributable to the other causes, which were not influenced by the mode of working. The different methods of getting coal, which were described in detail, were the practical application of two distinct principles. One idea was to remove the coal at two operations, and this was practised in the board and pillar work of the North of England, in the bank work of Yorkshire, and in the stall work of South Wales. The other idea was to remove the whole of the mineral at one operation, as exemplified in the longwall system of the Midland Counties. In the latter case, as the faces advanced, packwalls of roof rock, or bind, were built at regular intervals, and whenever a sufficient width of opening was obtained, the roof settled down, with or without fracture, upon these packs. Accidents by falls might fairly be brought to the test of figures; for although the roofs of various seams might differ much, the averages of large districts were likely to be uniform. Of a gross tonnage of 198,636,043 tons obtained by pillar work in 1866, 1867, and 1868, the casualties by falls were 814, or 231,739 tons of coal for each life. Of a gross tonnage of 22,899,000 tons extracted by the longwall plan, the casualties were 75, or one life for every 305,320 tons. If the latter ratio existed in pillar work, the casualties would have been reduced from 814 to 614, or a saving of 200 lives. In these calculations certain coal fields, which yielded about three-tenths of the produce of the whole kingdom, has been excluded; as in North Staffordshire, Cheshire, and Shropshire, both modes of working coal were adopted, and the same was the case in Scotland. The mortality from falls was greatest in South Staffordshire, where the lofty cavernous openings killed off 1 man for every 214,517 tons of coal raised, or an excess over the ratio of 35 per annum. There, too, the coal was obtained by both methods, but the greatest number of accidents took place in the thick seam, which was worked in pillars. The greater safety of longwall mines from falls was owing to the narrow width of the working places, to the constant change to a new roof, so that there was not time for atmospheric action, which greatly weakened the roofs of many mines, and to the small extent of open mines, which permitted a more thorough examination. It might be thought that in longwall work, the constant settlement or bending down of the roof would be attended with danger, but practically that was not the case. If a fracture occurred, it was not by the running down of a number of loose fragments, but a general settlement took place gradually, accompanied with so much noise that warning was given, when the workmen retired. The excessive mortality of some pillar districts was owing to the weak undersized pillars, which were crushed and sank into the floor, and induced a weak jointy state of the roof. The goodness of a roof as often depended upon the way in which it was managed, as upon the character of the material of which it was composed.

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* "Les Mondes," Vol. I., p. 290, III. p. 243.

† Extracted from a compilation by Mr. H. T. BROWN, Editor of the "American Artisan."

With respect to explosions, the author contended that the mode of getting coal had more influence on this question than was usually allowed: and whilst fans, safety lamps, the absence of gunpowder, and all sorts of precautionary expedients were proposed, and were more or less adopted, the effect of the mode of working, perhaps the most important of all, had been lost sight of. It might be safely laid down, that that mode of working was the safest from explosion which admitted of the most perfect ventilation, which was the least subject to a local failure of ventilation, in which the discharge of gas was best regulated, in which large accumulations of gas were prevented, and in which the superintendence of the workmen could be most thorough. In an unbroken coalfield, the free hydrogen might be assumed to be distribute evenly over small areas, and each ton of coal would have a certain proportion diffused through it. If this were liberated only in the coal actually cut, and when it was cut, the amount of ventilation could be exactly regulated to the production of the mine; and the mode of work, so long as ventilation was possible at all, would be immaterial. The firedamp lying in coal seams possessed considerable mobility amongst the particles of coal, and as it was often at a pressure in excess of the atmosphere, it travelled through the coal for some distance towards a point of discharge. The rapidity with which a given area was so drained, no doubt varied in some proportion to the difference between the initial pressure of the gas and that of the atmosphere, and the amount of resistance which the gas met in permeating the coal. It also varied according as the openings were broadways or endways of the seam. In all probability it was three or four times the greatest on the end of the coal, as the clevage planes were to a certain extent channels for the passage of the gas. Thus, in a headway on the end of the coal, the discharge of gas was most abundant at the back of the heading; while in boardways it was most perceptible at the sides of the heading, and in such a heading a large part of the gas would probably be let off for some yards on each side. When the excess of pressure was relieved, the discharge might be supposed to vary with the changes in the barometrical pressure. It was suggested that experiments should be made in different localities. to ascertain (1) the quantity of gas given off per square yard of freshly cut surface, (2) to what extent this varied on the face or end, (3) in what ratio this discharge diminished with time of exposure, (4) to what extent barometrical changes effected the discharge of the gas, and (5) by what amount the pressure of gas increased, as measured from the exposed surface inwards to the solid seam. It was believed such experiments would show that from 50 per cent. to 75 per cent. of the gas contained in the coal lying 10, 20 and 30 yards on each side of a boardways heading, was liberated when and after this was driven.

As the free hydrogen gas came not only from the hewn coal, but also from the solid seam, it was important that the surface exposed to the air should be as small as possible. It was argued that every mode of pillar work liberated three, five, or ten times the amount of gas per ton hewn in the solid than was liberated by a system of longwall work. If, therefore, the diluting power of the air current was the same in both cases, three, five, or ten times more would be necessary in pillar mines than in longwall mines. In a mine under the author's charge, this excessive discharge of gas in pillar roads was very noticeable. Long after a headway was driven, the gas oozed out of the sides of the headway, and might be heard at a considerable distance. In the longwall faces this was not perceptible, as the gas given off there was that due merely to the coal hewn.

Again, in pillar mines from six to twenty times as much surface coal was exposed as in longwall mines, and therefore such mines were from six to twenty times more subject to the effect of changes in the atmospherical pressure.

On inspecting the maps of mines worked by different pillar methods, and comparing them with the diagram showing a like extraction of coal by longwall, it was clear how large a proportion the gas discharged in the former must bear to that in the latter. It was frequently argued that this gas drainage was desirable, but it was submitted that before such a course could be with propriety recommended, it was necessary to show that the ventilating current would be proportional to the discharge.

The ease with which a mine could be ventilated, and the freedom from local derangement, would depend much upon the cubic contents of open mine, upon the freedom from stoppings, doors, &c., and upon the general simplicity of the arrangements. For a like extraction of coal, the cubic contents of pillar mines were from ten to twenty times the amount of properly designed longwall mines, and the drawings showed clearly the relative simplicity of each. In every pillar mine the workings were driven in advance of the ventilating channels, and constant brattices were essential. It would be seen, by examining the reports, how numerous were the accidents from defective brattices.

In South Wales the working places were driven into the solid coal, and when finished had no channel left for a steady through current, and thus the chance of their harbouring firedamp was very great. In the North of England there were none of these dumb points, but the cubic contents of boards, in which there was no sensible current, was often very large. Whatever might be the difference of opinion with regard to barometrical changes in mines, it was reasonable to suppose that they would exert the least influence where the surface of coal which might exude gas was the least. The proportion which the surface exposed in pillar mines bore to that in longwall mines was from 10-20 to 1. The goaf of a longwall mine became approximately solid as the coal was extracted over large areas, and thus permitted of a general settlement. In pillar mines the tendency was towards the formation of many small goaves, where there could be no surface settlement. These goaves thus became so many gas holders. The longwall mode of work also admitted of the nearest approximation to goaf ventilation. The only open parts were the edges, and as these were cut through with roads, a constant current could be maintained along them. It was possible, in a properly laid out longwall mine, to keep the goaf clear of gas as far back as it was open. In pillar workings there was no possibility of sending air into the goaf, and it thus became charged with gas. It was therefore submitted, that the safety of mining operations might be increased by the extension of longwall working. It was satisfactory to be able to add that, on economical grounds, it was daily gaining in favour, and that simplicity, compactness, small cubic contents of open mine, small exposure of coal surface, regular gas discharge and thorough ventilation could be best attained in longwall mines.

Another paper on "coal mining." an abstract of which we shall give next week, was read at the same meeting by Mr. Emerson Bainbridge.

THE SCENERY AND GEOLOGICAL STRUCTURE OF A COUNTRY. *

(*Continued from page 220.*)

AND all that is necessary to understand what I am putting before you to-night is, not so much technical knowledge, as that you should make good use of your eyes. This explanation which I have offered to you of the carving out of the earth's surface was, for some time, vehemently opposed, on the ground that the forces were not equal to the task, and that they must have been helped very much by the action of the sea. This objection was very satisfactorily met by a reference to the country of Auvergne, in the south of France. That country was a long time ago the scene of volcanic action, and it is still studded over by volcanic cones, which may be roughly described as heaps of ashes, which have accumulated in piles all round. These cones were so friable that if they had been submerged beneath the sea they must have been worn away to sand and mud. Therefore, if we can point out there any valleys hollowed out since the period of volcanic action, our case will be pretty clear. In the valley, then, a volcanic eruption has taken place, and through that valley lava has poured and completely filled it. Subsequently a fresh channel has been cut in it, at first partially, and afterwards quite as far down as the old rock. Now, we are quite sure that the new channel must have been cut out since the time of the eruption, and that the sea has never flown over it. That which these forces did at Auvergne, they are competent to do elsewhere.

From this short sketch of the manner in which the shape of the ground has been produced, you will have gathered that one important element is the relative hardness of the rocks. The harder rocks are best able to hold out against denudation. That is the reason why Wales and Scotland remain hilly and mountainous, and parts of England are flat and comparatively tame. Again, wherever we find a different degree of hardness in the rocks, we always find a striking variety of land contour. Take the country about Bath, or the moorland tracts of the north of England, or the high land of Derbyshire and Yorkshire. There we find the characteristic features of the country to be a number of long, straight, terraced lines of hill, running roughly parallel to each other, with deep valleys between them, and when we come to look a little into the structure of the country, we find that wherever a river runs across a ridge, it flows in, narrow gorge, and wherever it leaves such ridges, and enters a valley, it widens. These ridges, from the fact of their being formed of a hard substance, have been able to defy the impress of the water. A large portion of the rocks, as you are aware, are composed of beds, or layers of strata lying above one another. In some cases these layers lie flat or horizontally, in others they lie at angles. It is quite clear that if the beds lie very nearly flat, any single bed will reach over a large portion of country; and if the rocks are soft, we shall have, in addition, an undulating and feeble-looking country; but if the rocks are hard, the valleys will tend more or less to be steep-sided, and approach the form of gorges. Again, if the beds, instead of being flat, are tilted, we shall cross a greater variety of rocks, and also more varied features of country; and, as I quoted just now, we find ridges with valleys lying between them.

I will now lay before you one or two instances in which beautiful scenery is associated with geological structure, and endeavour to point out the connection between the two. I once had the good luck to get a view at Buxton, Derbyshire, so far that I could actually see the sea at Liverpool. I stood on a wild, rugged hill country, overspread with heather, and tenanted only by grouse and mountain sheep. This hilly country ended off sharply and abruptly in a bold line of hills to the west. Looking over these hills I saw another range, the Peckforton Hills, and far away I caught a glimpse of the sea. There was a rough, rugged, wildness around me which contrasted strongly with the peaceful stillness of the broad plain. I enjoyed it all the more because every one of these elements of beauty conveyed to my mind a history of the way in which these particular features had been produced. I knew that the foreground stood up high because it was made of hard rocks; I knew that it was rugged because its rocks were of unequal hardness; and I knew that the broad plain before me was low-lying because the strata of which it was composed was more easily and largely swept away than the hard rocks I was standing on. The keen mountain air had quickened my appetite, and the sheep I saw around me reminded me of the excellence of the moorland mutton: I recollected that Wales, the Lake country, and other hilly districts, were similarly distinguished. The superiority arises probably from several causes, the nature of the food, the pure air, and the active habits rendered necessary by the rugged ground; and all these in the end depended on the fact that the rocks of the district were hard. By contrast, the great plain called up pleasant remembrances of Cheshire dairies and Cheshire cheese, and the existence of these is due to the luxuriant pasturage afforded by the rich, marly subsoil. The main physical and geological features of the view I have just described are shown in a somewhat exaggerated form in the sketch section Fig. 1.

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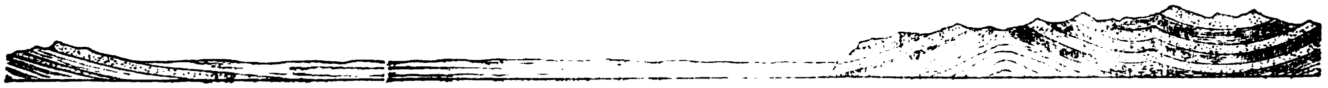
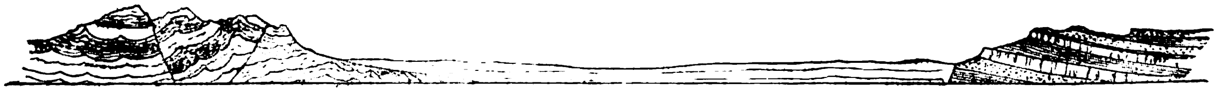
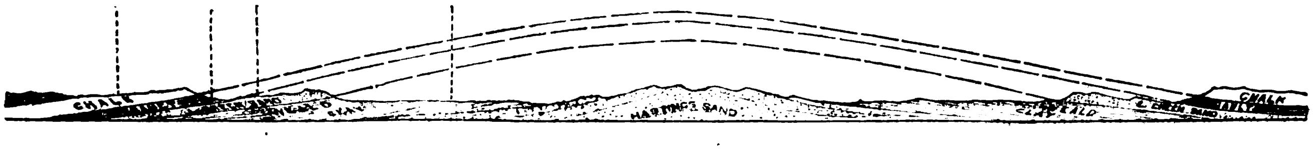
* A lecture delivered at St. George's Hall, by A. H. GREEN, Esq., M.A., Cambridge, F.G.S. (of her Majesty's Geological Surveys), March 20, 1870.



A similar prospect is seen from the top of Mickle Fell in the extreme north-west of Yorkshire. The hill is situated on the western edge of a wild and rugged moorland district formed of the same rocks as are found in the neighbourhood of Buxton, and from it the ground falls away rapidly to the west, along a steep hillside, which from a distance seems to rise almost like a vertical wall from the broad vale of Eden which lies beneath. On the far side of this valley the Lake Mountains rise in sight, clustered apparently on a small space, but with each peak and each broad-backed hill clearly and distinctly marked. Here again we have the wild and rugged foreground contrasted with the broad, peaceful valley, out of which the lovely little group of the Lake Mountains stands up with charming distinctness. You will at once see the reason for each feature in the view, and I need only mention that the bold, wall-like, eastern flank of the Eden valley is a fault by which the hard rocks of the hill country have been thrown side by side with the softer beds of the low ground, and that while on one side the latter have been largely denuded, the solid strata on the opposite side have been left standing in a bold face, the steepness of which sub-aërial action has somewhat lessened but not entirely removed. Fig. 2 shows the shape of this country.



Let us now turn to another district, not quite so strongly featured as the last, but where the outlines of the surface give rise to a charming variety in the scenery, and are in the most unmistakeable way dependent on geological structure. The district I mean is the Weald of Kent and Sussex, and we may easily note all its main features in a railway journey across it, say from London to Brighton.



As far as Croydon there is nothing very marked, but after passing that station the traveller enters a country whose general form is that of a broad plain sloping up gently to the south, and cuttings and other openings show him that it is made up of chalk. The general smoothness of this incline is broken by many deep valleys, but looked at on a large scale it has the shape I have just mentioned. As we journey on, the general rise of the ground is shown by the increased depth of the cuttings, and at last we shoot into a tunnel. On coming again into daylight, and looking back, we find the outlet of the tunnel to be situated on a steep hill side, which runs away in a well-marked bank or escarpment, east and west, as far as the eye can reach. We next cross a strip of nearly flat ground, whose shape shows that it is formed of a soft and uniform bed: it is indeed occupied by a clay, known as the Gault, which comes out from below the chalk. From the plain the ground again begins to slope up in a gentle incline, terminated on the south by a steep escarpment; this land, we know from these features, must be formed by a band of harder rock coming out from below the Gault: the beds are known as the Lower Green sand. The strips of country occupied by the chalk and Lower Green sand resemble one another in having a long gentle slope to the north and a steep descent to the south, but the incline of the Lower Green sand is traversed by a number of east and west ridges with valleys or flats between, while that of the chalk has a far more even surface. Beyond the escarpment of the Lower Green sand we run over a broad flat formed of the soft clay known as the Weald clay, and note that to the south of this flat the ground again begins to rise with a gentle slope in such a way that we infer that another hard bed is coming out from beneath the Weald clay, and on reaching the higher country we find our suspicion correct, for we observe in the cuttings, sandstones and shales, known as the Hastings sands, dipping so as to pass below the plain we have just left behind. So far we have found the dip to be steadily to the south, and have passed continually on to lower and lower beds. After passing through another tunnel we find that the country beyond possesses just the same gentle incline southwards as the chalk country near Croydon had to the north. In fact we have no doubt that in the latter part of our journey we have had exactly the same succession of strata as we passed over in the first half, only that the order has been reversed.

We now see the whole geological history of the district. The different beds, Chalk, Gault, Lower Green sand, Weald clay, and Hastings sand, once stretched in level sheets one above another over the whole area; they were then bent up into the shape of an arch, and as they rose into that form the higher portions were stripped off by denudation, and beds lower and lower in the series were laid bare towards the centre of the area.

This is the way in which I passed my time during a journey from London to Brighton a few days ago. I found it very pleasant, and I shall be still more pleased if what I have said enables any of my hearers to while away unavoidably idle hours in an equally agreeable manner.

Passing to the consideration of the second class of denuding agents—viz., sub-aerial forces, we shall find it convenient to begin with rivers. If a river is left to itself it will inevitably cut a narrow steep-sided trench. To test the truth of this we must try to find a district in which rivers are free from interference—that is from rain. Such a district is the country drained by the great Colorado river of the West in North America. The whole of this vast territory is a desolate plateau, traversed in every direction by profound gorges called canons, in which all the drainage of the country runs off. It is hardly possible to convey to the mind an adequate idea of the enormous sizes of these gorges. The Great Canon is 238 miles long, and from 2500 to 4000ft. in vertical depth. I think I speak correctly when I say that in some places they are only 200 or 300ft. across. The arrangement of the whole so exactly resembles that which we see when water rolls off a flat country, where we see little streamlets running down into brooks, that we cannot resist the conclusion that the whole of this extraordinary assemblage of precipitous ravines is a river system. Some persons have conjectured that these vast chasms were owing to earthquakes, but there is no trace whatever of them.

I must say something of the action of another denuding force—viz., rain. The effect of rain falling in any large quantity is to wash in and reduce this steepness caused by the action of rivers. Springs will burst out at different depths of the steep sides of the river, and break off great masses of the groundwork; and so we see that though a river channel, if left to itself, must inevitably cut a trench-like form, yet it is impossible that it can keep this shape for any length of time. The trench must spread out before long into a wide valley. The country where those canons occur is a district of very little rain. During six months of the American exploring expedition, rain fell on only six days. The result is that the action of the rivers being uninterfered with, they have in process of time cut down these extremely deep gorges. But in countries like our own, where other agencies are at work, as fast as the trench is cut down by the river, it is widened again by these other actions. The rate of this widening process must depend very much on the nature of the rocks of which its sides are composed. If they are soft, they will be easily worked off, but if the river should cut across hard strata, the sides will be able to stand better. For example, a railway cutting in hard rock can have nearly vertical sides. The case of the river Derwent, north of Matlock, in Derbyshire, shows that when we come to look at in the great wall of hills there is an opening—a gap, which was so excessively narrow that when they wished to carry a turnpike road through it, they found there was not room, and they were obliged to blast the rock. If we examine the structure of the country, the explanation of this is extremely simple. The broad valleys are in soft shale, and the impediment to the river is formed of hard limestone. There is no doubt that originally the river flowed along this flat track, where it cut a deep, narrow, trench. Where the clays were easily worn away, the valley was widened out, but along the harder rocks it kept its narrow form. The contrast between the valley and the hills rising boldly across it is very beautiful indeed; and, to my mind, it was increased by the knowledge I possessed on this subject.

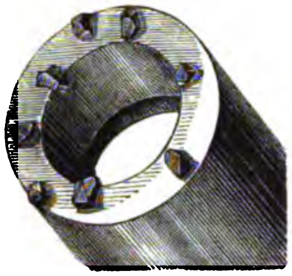
(To be concluded.)

MORTAR-JOINTS IN BRICKWORK.—The quantity of mortar which may safely and with advantage be used with bricks must in a great degree depend upon the quality of the mortar and the purpose to be served by the brickwork. Some mortars swell (expand) in use; others shrink. The best samples of mortar in setting become hard and tough: poor samples remain soft, and crumble on exposure. A thin bed of the best mortar for such a work as a tall chimney would not be so strong as a thick bed, because in a thin bed there will be parts where the best bricks will be in contact, even where ¼in. thickness of bed may have been specified for, and this thickness of bed and joint may show on the face of the work. With common bricks, a bed of ¼in. of mortar will leave rough projecting portions of the bricks in contact. Good mortar, when set, is, as we have just said, hard and tough; and to secure the whole strength it is capable of giving, the entire bed and joint must be full, so that the whole area of beds and joints of bricks shall be cemented by intervening mortar.

THE GREASE TREE OF CHINA, mentioned p. 263, last number, is the *Stillingia sebifera*, Michx., belonging to the Spurge order, or Euphorbiaceæ. Particulars vide *Technologist*, vol. iv., p. 33.—BERNARDIN.

DIAMOND-POINTED STEAM DRILLS.

FIG. 1



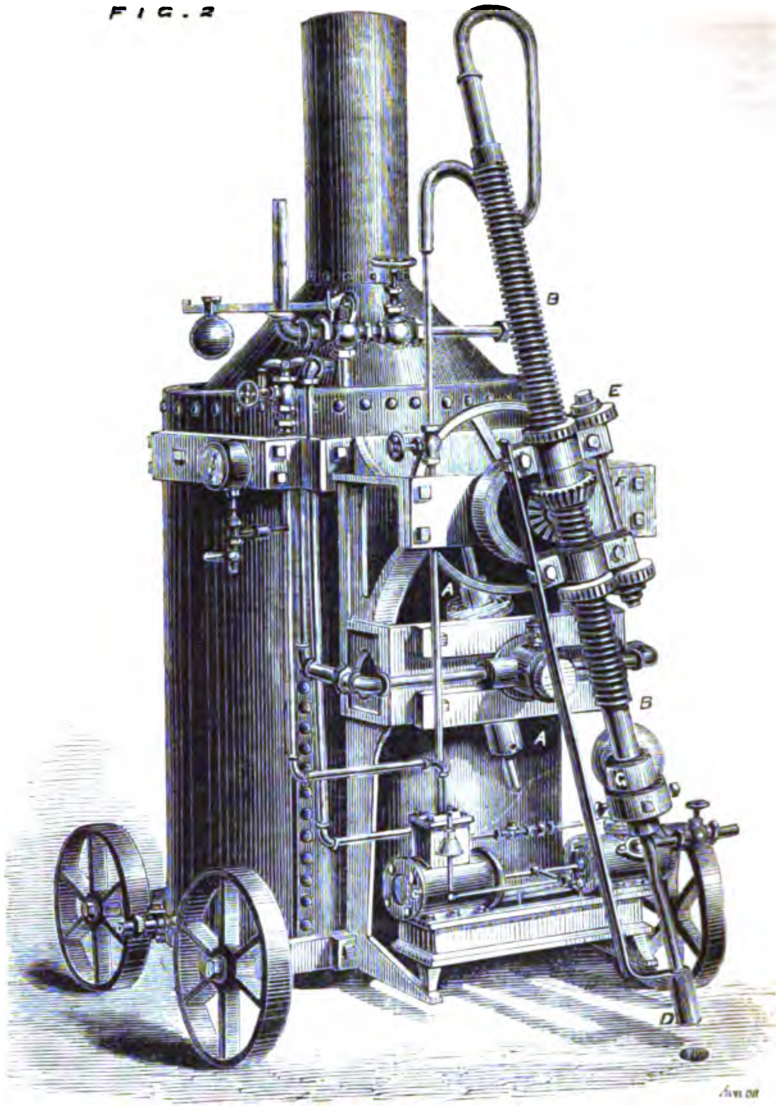
THE following affords our readers an interesting description of Leschot's patent rock-drilling machine, which, from its unequalled efficiency and economy, is receiving some attention in the United States. The small engraving, Fig 1, represents a plan of setting diamonds in an annular cutter, and will be easily understood. Fig. 2 represents what is termed a "No. 1 prospecting drill," so called because of its general use in testing the character and value of mines and quarries It consists of a small, upright boiler, to one side of which is firmly bolted the cast-iron frame which supports the engine and swivel drill-head, gears and screw shaft, as shown in the engraving. The engine—an oscillator of from five to seven horse-power—is shown at A. B is the screw-shaft with drill passing through it. This shaft is made of hydraulic pipe from 5ft. to 7ft. in length, with a coarse thread cut on the outside. This thread, a portion of which is shown in the cut, runs the entire length of the shaft, which also carries a spline by which it is feathered to its upper sleeve-gear. This gear is double and connects by its lower teeth with the bevelled driving-gear, and by its upper teeth with the release-gear E. This release-gear is feathered to the feed shaft F, at the bottom of which is a fractional gear fitting the lower gear on the screw-shaft, which has one or more teeth less than the fractional gear, whereby a different feed is produced. This fractional gear is attached to bottom of feed-shaft F by a friction-nut, thus producing a combined differential and fractional feed, which renders the drill perfectly sensitive to the character of the rock through which it is passing, and maintains an uniform pressure upon the same. The severe and sudden strain upon the cutting-points incidental to drilling through soft into hard rock with a positive feed is thus avoided. The drill proper (passing through the screw-shaft B) consists of a tubular boring bar, made of lap-weld pipe, with a steel bit or boring-head D, screwed on to one end. This bit is a steel thimble about 4in. in length, having three rows of black diamonds in their natural rough state firmly imbedded therein, so that the edges of those in one row project forward from its face, while the edges of those in the other two rows project from the outer and inner peripheries respectively. The diamonds of the first mentioned row cut the path of the drill in its forward progress, while those upon the outer and inner periphery of the tool enlarge the cavity around the same, and admit the free ingress and egress of the water as hereafter described. As the drill passes into the rock, cutting an annular channel, that portion of stone encircled by this channel is of course undisturbed, and passes up into the drill in the form of a solid cylinder. This core is drawn out with the drill in sections of from 8 to 12ft. in length.

The sides of the hollow bit are one-fourth of an inch thick, and the diamonds of the inner row project about one-eighth of an inch, so that the core or cylinder produced by a two-inch drill (the ordinary size for testing), is one and a quarter inches in diameter.

Inside the bit D is placed a self-adjusting wedge which allows the core to pass up into the drill without hindrance, but which impinges upon and holds it fast when the action of the drill is reversed—thus breaking it off at the bottom and bringing it to the surface when the drill is withdrawn.

In order to withdraw the drill it is only necessary to throw out the release gear E by sliding it up the feed-shaft F to which it is feathered, when the drill runs up with the same motion of the engine which carried it down, but with a velocity sixty times greater—that is, the speed with which the drill leaves the rock, bringing the core with it, is to the speed with which it penetrates it as sixty to one—the revolving velocity in both cases being the same.

FIG. 2



ROCK DRILLING MACHINE.

The drill-rod may be extended to any desirable length by simply adding fresh pieces of pipe. Common gas pipe is found to serve admirably for this purpose, the successive lengths being quickly coupled together by an inside coupling four inches long, with a hole through the centre of each to admit the water. The drill is held firmly in its place by the chuck G at bottom of screw shaft.

The small steam pump C C is connected by a rubber hose with any convenient stream or reservoir of water, and also with the outer end of the drill-pipe by a similar hose having a swivel joint, as shown in the cut. Through this hose a ¾in. stream of water is forced by a pump into the drill from which it escapes between the diamond teeth at the bottom of the bit D, and passes rapidly out of the hole at the surface of the rock carrying away all the grit and borings as fast as produced. Where water is scarce or difficult of access, a spout is laid from the mouth of the hole to the tank or reservoir, and a strainer attached to the connecting hose, so the same water may be used over and over again with but little loss.

Messrs. Severance and Holt, of New York, are the manufacturers of Leschot's patent diamond pointed steam drills.

A THEORY OF NEBULÆ AND COMETS.*

WILL you allow me to lay before your readers a theory regarding nebulæ and comets which I believe is in a great degree new, and which appears to me to afford a satisfactory explanation of the phenomena observed in those remarkable bodies?

The theory may be stated as follows:—There exist in space large masses of matter in a gaseous, non-luminous, and therefore invisible state. This matter is necessarily very rare, because there is no solid nucleus to condense it by its attraction.

As long as a mass of such matter remains by itself, it continues gaseous, non-luminous, and invisible. It will, however, sometimes happen that two masses of gas having a chemical affinity for each other rush together under the influence of their mutual gravitation. When this occurs, chemical combination will take place, with a consequent evolution of light and heat, and a nebula will begin to be formed. Chemical action will only take place where the gases become mixed—that is, about their common bounding surfaces; and the greater part of the matter will remain invisible. The apparent shape, then, of a nebula will by no means indicate the real shape of all the matter composing it, but will rather reveal the form of the common bounding surfaces of the different masses of gas.

The gases, so long as they remain separate, cannot condense into a liquid or solid state; but the compound formed by the chemical union may only be able to exist as a gas so long as it remains at a great heat. After the compound has formed, it will cool down, and may ultimately assume the liquid or solid state.

When liquid or solid matter is formed, it will gradually aggregate and gravitate towards the centre of the nebula, and will form into a nucleus there. It is probable that chemical action will not be the only source of light and heat, but that they will also be produced by the loss of motion of the solid and liquid parts moving through the gases.

This theory attempts to explain how nebulæ originally came into existence and assumed the shapes they actually have. And in this it differs from that of Sir William Herschel, who only speculated on what would be the subsequent motions and behaviour of nebulous matter after it had once been formed.

I will now proceed to examine what account this theory renders of the phenomena observed in nebulæ.

And first, I think, if we admit that a great part of the matter forming a nebula is invisible, we remove the immense difficulty which we otherwise experience in attempting to conceive how nebulæ have assumed or can retain their extraordinary shapes and yet be subject to the law of gravitation.

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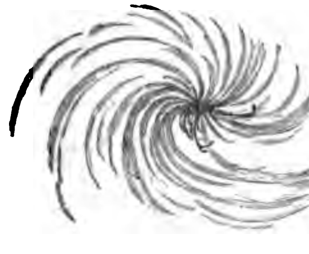
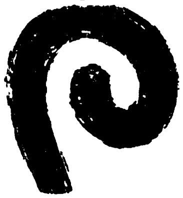
* By A. S. DAVIS, B.A., Mathematical Master, Leeds School, in the *Philosophical Magazine*.

The researches of Huggins prove that many of the nebulæ are gaseous self-luminous masses, whilst the spectra of others prove the existence of solid or liquid matter. These last being generally those which are most easily resolved, would be those which have been longest in existence, and which, therefore, should contain most liquid and solid matter.

The curious shapes of the nebulæ are well explained on this theory.

Thus the spiral nebulæ would be produced by two masses of gas rushing together and forming an eddy in which they become mingled with each other. If any detached portion of one gas got mixed up with the other gas, it would be drawn out by the eddy into an elongated spiral form, the surface of which would become visible by the light produced by the chemical action. This would be the kind of nebula which would be produced when the two masses of gas did not differ greatly in size, and rushed together in a line not very oblique to the line joining their centres of gravity.





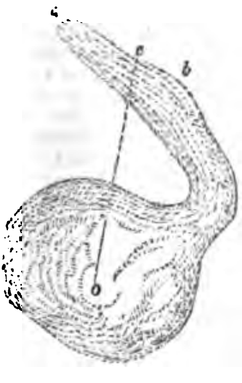
Lassell, pl., 1. fig. 3.†

Some spiral nebulæ consist only of a single whirl. A nebula of this kind might be produced by a small mass of comparatively dense gas rushing obliquely into a large mass of rarer gas.* Such a mass would tend to the centre of gravity of the larger mass; and since those parts which are nearest the centre of gravity would be most accelerated, it would become drawn out into an elongated spiral form.

Lassell, pl. 7. fig. 30.

After a time the whole of the smaller mass of gas will have collected about the centre, and a globular or planetary nebula will be formed.

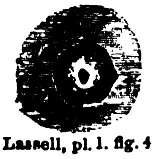
In the annexed diagram, copied from a drawing by Lassell, we appear to have a globular nebula in the process of formation. That the smaller mass of gas has entered obliquely is shown by the fact that the ending *a b* of the tubular portion is oblique to the axis of the tube; for the line *a b* will indicate the boundary of the larger mass. That the gas is collecting about the centre of the larger mass is indicated by the fact that the line *o c* joining the centre of the globe with the end of the tube is perpendicular to *a b*—as it should be, supposing the larger mass of a spherical form.



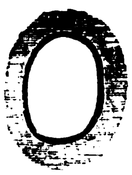
Lassell, pl. 2. fig. 9.

Planetary nebulæ, consisting of more than one envelope might also be formed in the same way as those having only one envelope, the envelopes being formed in succession at different periods of time.

Annular nebulæ might be formed in the following manner. If a small mass of gas were attracted to a larger mass so as just to graze its surface on passing it, its path (previously parabolic) would become elliptic, and its motion would be changed into a periodical revolution round the larger mass. At each revolution it would graze the surface of the larger mass, and the elliptic orbit would gradually be changed into a circular one. It would at length come to revolve about the larger mass in such a manner as continually to graze the surface, and an annular nebula would be the result.



Lassell, pl. 1. fig. 4.



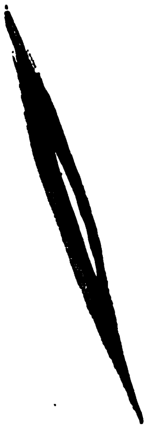
Nebula in Lyra.

Those nebulæ, like the larger one in Andromeda, in which streaks of darkness cross the bright parts, offer the greatest difficulty in their explanation.

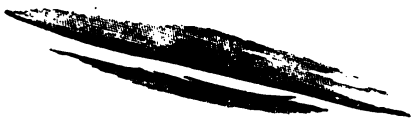
We might imagine that a mass of rare gas has become entangled between two masses of dense gas, and that the masses of dense gas being attracted to one another, crush out the rare gas into a thin sheet, which, looked at edgewise, presents the appearance of a dark streak.

Some of the nebulæ of this kind have nuclei; and it may be remarked that the position of the nucleus, which will be the centre of gravity of the nebulæ, is in the position in which we should expect to see it if the apparent vacuous streaks were in reality filled with matter.

Many of the nebulæ are very much diffused, and in shape very irregular; but even these show certain characteristics which seem to indicate their mode of formation. The extreme faintness of their light favours the hypothesis that they are not luminous throughout, but that their luminosity occurs only here and there in comparatively thin shells.



Lassell, pl. 5. fig. 21 A



Lassell, pl. 5. fig. 21.

Again, if these nebulæ were luminous throughout, the intensity of their light should be greatest where the thickness of matter looked through is greatest. and should fade away at the boundaries, whereas, if the visible parts occurred in shells, the boundaries should appear brighter than other parts; for at the boundaries the line of sight would be very oblique to the shell, and a greater thickness of luminous matter would be looked through. Now if we examine any of the irregular nebulae, we see some parts of it ending abruptly with a clearly-defined outline, whilst in other parts the light gradually fades away into darkness. We may suppose that in the one case we are looking edgewise at a shell, so that the line of sight is tangential to its surface, whilst in the other case we are looking at a part where the luminous shell gradually thins out. Now in the first case we find that the light increases towards the border, consistently with the supposition that the visible parts are in thin shells.

This peculiarity is, I apprehend, what Professor Bond and Mr. Lassell refer to when they speak of the scroll-like appearance of the nebula in Orion.

In those nebulæ which appear to have assumed a more stable form, as in the elliptic and circular nebulæ, the light diminishes from the centre to the circumference.

These nebulæ may be in a later stage of formation; they may have become more condensed, and a more intimate mixture of the gases may have taken place, and in consequence they may be more or less luminous throughout. Their shape, and the fact that they are generally resolvable in the telescope, point to the conclusion that they have been a long time in existence.

Before turning to the subject of comets, I may remark that the theory that there are large masses of invisible gas traversing space, affords an explanation of the sudden temporary outbursts in the intensity of certain stars. Such an outburst might occur if a star became enveloped with a mass of gas with which it could chemically combine.

It also explains the phenomena of periodical stars. Mr. Huggins has found that the diminution in the intensity of the light of these stars is due to an increase in the number and size of the absorption bands in their spectra.

It has already been suggested that large opaque bodies may be revolving in orbits round such stars, and periodically obscuring their light. We have only to suppose that large masses of invisible gas instead of opaque bodies revolve about them, to explain the phenomenon in accordance with spectroscopic observation.

(*To be concluded next week.*)

FRICTION IN STEAM CYLINDERS.*

BY MR. P. JENSEN.

SO few data exist on the subject of friction in steam cylinders, that the author approaches it with some diffidence, more especially as he has not had time to make direct and comprehensive trials which would furnish particulars for exhaustive treatment of the subject. He, therefore, can only offer such remarks and make such deductions from the experience of others and of himself that have a bearing on the subject, without assuming to settle questions relating thereto. Of the importance of the subject there can be no question, as engineers are aware of the great percentage of power that may be consumed in piston friction. Hence it is well to define this loss under various circumstances, and then to apply remedies for diminishing the loss. Friction in the steam cylinder may be classed under three heads; piston friction, slide valve friction, and stuffing box friction. As regards piston friction it ought to depend upon the working pressure, the packing material employed for keeping the piston tight, the extent of the rubbing surface of the packing, and the means of lubrication. It is evident that a piston should not be made to stand a higher pressure than that it is intended to work with, otherwise a great amount of power may be lost by unnecessary friction, and wear and tear both of piston and cylinder will ensue. It also appears evident that engines expanding the steam to any great extent in one cylinder should have piston packing, the tension of which is dependent upon and constantly varying with the pressure of the steam at any part of the stroke. There is not, it is believed, any difficulty in this, and all are doubtless familiar with one or more constructions of pistons of this sort which answer the purpose in a greater or less degree.

The common rough and ready way of calculating piston friction by assuming a certain constant pressure per square inch of piston as being the measure for the piston friction (which, as will be seen presently, constitutes by far the greater portion of the total friction) of the engine itself is erroneous, or at any rate should be used with discrimination. Although it has been found in a few instances that the friction of a piston for instance in an engine working with 2½ atmospheres may be expressed by (say) 2lb. per square inch of the piston, which may or may not mean that the piston packing has had just the requisite amount of tension, and not perhaps 50 per cent. more than requisite, we have no right to infer that the same rule holds good with 5 or 10 atmospheres pressure. If the piston packing has just the right tension, the friction must amount to a certain percentage of the pressure. But we must not lose sight of another circumstance—namely, that the circumference of a piston increases as the diameter simply, while the area increases as the square of the diameter.

The question is, has a piston of 24in. diameter double the amount of friction, or has it four times the amount of that of a 12in. piston, other circumstances being alike, that is, with the same material, same depth of packing, state of lubrication, pressure, &c. We must not forget either that the proportionate depth of packing varies with the diameter of the cylinder. Whether it is supposed to give less wear on the piston rings (an opinion considered incorrect by the author) or not, we need not stop to discuss; the practice is, however, not to increase the depth in direct proportion as the diameter of the piston increases in size, and thus it is that the piston friction does not in practice decrease in the ratio otherwise anticipated, though it is believed that it does decrease. In other words, it is propounded that piston friction as percentage of power decreases as diameter increases, but increases as pressure and depth of packing increase, the packing material being the same. In practice the following rule holds good:—Depth of packing = $\frac{3}{4}\sqrt{d}$ in inches: for instance, for a 19in. cylinder, depth of packing = $\frac{3}{4} \times 7 = 5\frac{1}{4}$; for smaller engines, $\frac{2}{3}\sqrt{\sqrt{d}}$ (say) 16in. cylinder, depth of packing = $\frac{2}{3} \times 4 = 2\frac{2}{3}$in. This is for cast-iron packing rings. With Ramsbottom's steel rings a much smaller depth is found quite sufficient. Hence if it is found that 2lb. per square inch is the measure of the piston friction in a 12in. cylinder, it would seem that the friction of a 24in. cylinder (having four times the area but only double the diameter), would only be double, but as the depth of packing is as 2·3 to 3·89 it would become $\frac{3{\cdot}89}{2{\cdot}3} \times 2 = 3{\cdot}38$, so that the pressure per square inch absorbed by piston friction would become $2 \times \frac{3{\cdot}38}{4} = 1{\cdot}69$lb. per square inch in a 24in. cylinder, and 2lb. in a 16in. This is of course assuming the ordinary theory of piston friction to be correct, namely, that it is to be calculated by the superficial area of the piston packing × the pressure of the steam × the friction, co-efficient. If, then, the above be correct, it is clear that we must avoid taking a certain fixed percentage of the pressure on the piston area as the measure of the piston friction, except we take the size of the cylinder into account.

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* When I speak of one gas as being rarer than another, I mean that, when subject to equal pressures, the one gas is specifically lighter than the other.

† See Memoirs of the Royal Astronomical Society, vol. xxxvi.

* Read before the Society of Engineers, March 7, 1869.

The packing material has considerable influnece on the friction. Hemp packing for moderate and for high pressure causes more friction than metallic packing, which is now almost universally adopted. Cast-iron rings or Ramsbottom's steel rings, though not giving so little friction as gun metal, are generally preferred, because they wear well and are not so much affected by grit. The author's experience is that Ramsbottom's rings are tight, wear well, and do not require excessive tension. For great expansion in a single cylinder the tension of the packing should be dependent upon the varying pressure in the cylinder, as before stated.

In considering the question of stuffing box friction, the author would first observe that the amount of loss caused by it is only trifling if the packing is in proper condition and the gland has been properly fitted; but otherwise this loss may become enormous. The author is not aware of any comparative experiments showing the friction caused by the employment of various kinds of stuffing-box packing, although that, doubtless, has also a great influence. But what all are aware of is the great wear on the piston rod through having the packing too hard. A careful engine driver avoid this, but every engine driver is not careful, and if he has many other things to look to, as is often the case, then the plain question arises whether it is not better either to use a packing that requires but little lubrication, or else to provide means for keeping the packing continuously supplied with a very slight amount of grease, which, as experience has shown, can be effected by greasing the steam before entering the cylinder. No other means are then found necessary for lubricating the slide rod or piston rod, and hard packings become an impossibility.

It is not intended to describe the various kinds of packing; suffice it to say that there are some which answer their purpose very well, some of them requiring little or no lubrication. The self-lubricating mineral packing has under some circumstances answered very well. Metallic stuffing box packing has been proposed and used. On account, however, of the great depths required and the expense and trouble attending its manufacture, it has never come into extensive use. Metallic stuffing-box packing would be a great boon, provided it answered its purpose. Mr. John Penn used to have one of his small shop engines fitted with metallic stuffing box packing, and the author believes he has so now.

(*To be continued.*)

The Vielle-Montague Zinc Mines and Foundries Company increased its production of zinc last year to 48,036 tons, as compared with 40,216 tons in 1868, 36,260 tons in 1867, 31,722 tons in 1866, and 30,592 tons in 1865.

HINTS ON THE SELECTION AND USE OF A MICROSCOPE.

THE quality of a microscope, says the *Technologist*, of course depends entirely upon the perfection with which it shows objects as they really are. Some microscopes distort objects so as to give views that are anything but correct. Others colour whatever they show with all the brilliant hues of the rainbow. We have often admired the magnificent colours displayed by natural objects under the microscope, such, for example, as the petal of the geranium, whose cells are filled with the most brilliant scarlet colouring matter; or the crystals of the ruby oxide of copper, which are gorgeous beyond expression; or various objects seen by polarised light, which gives to some of the most colourless and transparent crystals colours that far excel the tints of the ruby or the sapphire; but we have often smiled when asked to view the splendid colour shown by hair, or a fly's eye, or a section of wood seen by ordinary transmitted light, for we well knew that these objects have no colour of their own, or at least only dull, neutral tints, and that all the gorgeous hues so lavishly displayed were merely the result of defects in the microscope.

It is unquestionably true that one of the fine large achromatic microscopes, furnished with objectives of low as well as high power, would be the best for all purposes of *examination*. But such microscopes are very expensive. A tolerable one cannot be had for less than one or two hundred dollars, while a first-class one will cost four or five times that amount. Such a microscope, although desirable, is not absolutely necessary, and therefore we will turn our attention to the less costly kinds.

The first that presents itself is the simple lens mounted in a metal or horn frame. In the hands of a skilful observer, this instrument will do good service. Opticians frequently arrange several lenses in one frame, and suggest the idea of combining them so as to obtain an increase of power. In general, however, this idea is fallacious, and the instruments are not properly arranged for the purpose. In the first place, there is no diaphragm (or thin plate with a small hole in it) between the lenses to cut off the extra light; and, in the second place, the lenses are placed as close to each other as possible, so as to occupy but little room, and this prevents us from obtaining a good effect. Moreover, it is unfortunately true that opticians (somebody once called them in derision *shopticians*) rarely give us the best selection of powers. There is too much sameness in them. The best arrangement we could find in a large collection consisted of three lenses, whose magnifying powers were respectively 25, 20, and 16 diameters. Now, this is not variety enough, and the reason for not making a greater difference between the powers of the lenses is the fact that high powers are so much smaller than the lower powers that to combine them in the same frame makes a clumsy instrument. We confess, however, that we would much prefer efficiency to elegance.

A frame containing three plano-convex lenses, 1in., ½in., and ¼in. focus, we have found altogether the most convenient arrangement. The magnifying powers are 10, 20, and 40 diameters; and whether we desire to examine a mineral, a flower, or an insect, whether we wish to look at the mildew on a grape-leaf or the beetle which preys upon the buds, such a series of powers will enable us to do so thoroughly.

In selecting single lenses to be used as microscopes, procure, if possible, those of which one side is perfectly flat, that is to say, plano-convex. The view obtained by such lenses is always better than that given by double convex lenses of the same power. Such simple microscopes are undoubtedly the best *cheap* instruments. But at a very slightly higher cost we may obtain that best of all simple microscopes—Wollaston's doublet. This microscope is formed of two plano-convex lenses adjusted together in the same tube. It is rarely that we can find a good one in the opticians' stores, but they are so easily mounted that any working optician could put one together at short notice. One of our friends made a remarkably efficient instrument of this kind, having formed the lenses of plate glass (a piece of broken store window), which consequently did not require the plane side to be ground, and arranged the lenses in a tube made of stout writing-paper, pasted. Suitable lenses could, no doubt, be procured by mail from most opticians, and it would no doubt require no great manual dexterity to mount them.

ON THE RELATIONS BETWEEN BODY AND MIND.*

LECTURE II.

(*Continued from page* 243.)

IT is a natural question, Whence come these animal traits and instincts in man? Whence was derived the instinct which taught the idiot woman to gnaw through the umbilical cord? Was it really the reappearance of a primitive instinct of animal nature—a faint echo from a far distant past testifying to a kinship which man has almost outgrown, or has grown too proud to acknowledge? No doubt such animal traits are marks of extreme human degeneracy, but it is no explanation to call them so; degenerations come by law, and are as natural as natural law can make them. Instead of passing them by as abnormal, or, worse still, stigmatising them as unnatural, it behoves us to seek for the scientific interpretation which they must certainly have. When we reflect that every human brain does, in the course of its development, pass through the same stages as the brains of other vertebrate animals, and that its transitional states resemble the permanent forms of their brains; and when we reflect further, that the stages of its development in the womb may be considered the abstract and brief chronicle of a series of developments that have gone on through countless ages in nature, it does not seem so wonderful, as at the first blush it might do, that it should, when in a condition of arrested development, sometimes display animal instincts. Summing up, as it were, in itself the leading forms of the vertebrate type, there is truly a brute brain within the man's; and when the latter stops short of its characteristic developement as *human*—when it remains arrested at or below the level of an orang's brain, it may be presumed that it will manifest its most primitive functions, and no higher functions.

I am not aware of any other considerations than those just adduced which offer even the glimpse of an explanation of the origin of these animal traits in man. We need not, however, confine our attention to idiots only. Whence come the savage snarl, the destructive disposition, the obscene language, the wild howl, the offensive habits, displayed by some of the insane? Why should a human being deprived of his reason ever become so brutal in character as some do, unless he has the brute nature within him? In most large asylums there is one, or more than one, example of a demented person who truly ruminates: bolting his food rapidly, he retires afterwards to a corner, where at his leisure he quietly brings it up again into the mouth and masticates it as the cow does. I should take up a long time if I were to enumerate the various brute-like characteristics that are at times witnessed among the insane; enough to say that some very strong facts and arguments in support of Mr. Darwin's views might be drawn from the field of morbid psychology. We may, without much difficulty, trace savagery in civilisation, as we can trace animalism in savagery; and in the degeneration of insanity, in the *unkinding*, so to say, of the human kind, there are exhibited marks denoting the elementary instincts of its composition.

It behoves us, as scientific inquirers, to realise distinctly the physical meaning of the progress of human intelligence from generation to generation. What structural differences in the brain are implied by it? That an increasing purpose runs through the ages, and that "the thoughts of men are widening with the process of the suns," no one will call in question; and that this process has been accompanied by a progressive development of the cerebral hemispheres, the convolutions of which have increased in size, number, and complexity, will hardly now be disputed. Whether the fragments of ancient human crania which have been discovered in Europe do or do not testify to the existence of a barbarous race that disappeared before historical time, they certainly mark a race not higher than the lowest surviving human variety. Dr. Prichard's comparison of the skulls of the same nation at different periods of its history led him to the conclusion that the present inhabitants of Britain, "either as the result of many ages of great intellectual cultivation, or from some other cause, have much more capacious brain-cases than their forefathers." Yet stronger evidence of a growth of brain with the growth of intelligence is furnished by an examination of the brains of existing savages. Gratiolet has figured and described the brains of the Hottentot Venus, who was nowise an idiot. He found a striking simplicity and a regular arrangement of the convolutions of the frontal lobes, which presented an almost perfect symmetry in the two hemispheres, "involuntarily recalling the regularity and symmetry of the cerebral convolutions in the lower animals. The brain was palpably inferior to that of a normally developed white woman, and could only be compared with the brain of a white idiotic from arrest of cerebral development. Mr. Marshall has also recently examined the brain of a Bushwoman, and has discovered like evidence of structural inferiority: the primary convolutions, although all present, were smaller and much less complicated than in the European; external connecting convolutions were still more remarkably defective; the secondary sulci and convolutions were everywhere decidedly less developed; there was a deficiency of transverse commissural fibres; and in size, and every one of the signs of comparitive inferiority, "it leaned, as it were, to the higher quadrumanous forms." The developmental differences between this brain and the brain of a European were in fact of the same kind as, though less in degree than, those between the brain of an ape and that of man. Among Europeans the average weight of the brain is greater in educated than in uneducated persons; its size—other circumstances being equal—bearing a general relation to the mental power of the individual. Dr. Thurnam concludes, from a series of carefully-compiled tables, that while the average weight of the brain in ordinary Europeans is 49 ounces, it is 54·6 ounces in distinguished men; and Professor Wagner found a remarkably complex arrangement of the convolutions in the brains of five very eminent men which he examined. Thus, then, while we take it to be well established that the convolutions of the human brain have undergone a considerable development through the ages, we may no less justly conclude that its larger, more numerous, and complex convolutions reproduce the higher and more varied mental activity to the progressive evolution of which their progressive increase has answered—that they manifest the kind of function which has determined the structure. The vesicular neurine has increased in quantity and in quality, and the function of the increased and more highly-endowed structure is to display that intelligence which it unconsciously embodies. The native Australian, who is one of the lowest existing savages, has no words in his language to express such exalted ideas as justice, love, virtue mercy; he has no such ideas in his mind, and cannot comprehend them. The vesicular neurine which should embody them in its constitution and manifest them in all its function, has not been developed in his convolutions; he is as incapable, therefore, of the higher mental displays of abstract reasoning and moral feeling as an idiot is, and for a like reason. Indeed, were we to imagine a person born in this country, at this time, with a brain of no higher development than the brain of an Australian savage or a Bushman, it is perfectly certain that he would be more or less of an imbecile. And the only way, I suppose, in which beings of so low an order of development could be raised to a civilised level of feeling and thought would be by cultivation continued through several generations; they would have to undergo a gradual process of humanisation before they could attain to the capacity of civilisation.

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* Two lectures delivered at the Royal College of Physicians in 1870. By HENRY MAUDSLEY, M.D., F.R.C.P., Professor of Medical Jurisprudence in University College, London.

Some who one moment own freely the broad truth that all mental manifestations take place through the brain, go on, nevertheless, to straightway deny that the conscience or moral sensibility can be a function of organisation. But if all mental operations are not in this world equally functions of organisation, I know not what warrant we have for declaring any to be so. The solution of the much-vexed question concerning the origin of the moral sense seems to lie in the considerations just adduced. Are not, indeed, our moral intuitions results of the operation of the fundamental law of nervous organisation by which that which is consciously acquired becomes an unconscious endowment, and is then transmitted as more or less of an instinct to the next generation? They are examples of knowledge which has been hardly gained through the suffering and experience of the race being now inherited as a natural or instinctive sensibility of the well-constituted brain of the individual. In the matter of our moral feelings we are most truly the heirs of the ages. Take the moral sense, and examine the actions which it sanctions and those which it forbids, and thus analyse, or, as it were, decompose, its nature, and it will be found that the actions which it sanctions are those which may be proved by sober reason to be conducive to the well-being and the progress of the race, and that its prohibitions fall upon the actions which, if freely indulged in, would lead to the degeneration, if not extinction, of mankind. And if we could imagine the human race to live back again to its earliest infancy—to go backwards through all the scenes and experiences through which it has gone forward to its present height—and to give back from its mind and character at each time and circumstance, as it passed it, exactly that which it gained when it was there before,—should we not find the fragments and exuviæ of the moral sense lying here and there along the retrograde path, and a condition at the beginning which, whether simian or human, was bare of all true moral feeling?

We are daily witnesses of, and our daily actions testify to, the operation of that plastic law of nervous organisation by which separate and successive acquisitions are combined and so intimately blended as to constitute apparently a single and undecomposable faculty: we observe it in the formation of our volitions; and we observe it, in a more simple and less disputable form, in the way in which combinations of movements that have been slowly formed by practice are effected finally as easily as if they were a single and simple movement. If the moral sense —which is derived, then, insomuch as it has been acquired in the process of human development through the ages—were not more or less innate in the well-born individual of this age, if he were obliged to go, as the generations of his forefathers have gone, through the elementary process of acquiring it, he would be very much in the position of a person who, on each occasion of writing his name, had to go through the elementary steps of learning to do so. The progressive evolution of the human brain is a proof that we do inherit as a natural endowment the laboured acquisitions of our ancestors; the added structure represents, as it were, the embodied experience and memories of the race; and there is no greater difficulty in believing that the moral sense may have been so formed, that in believing, what has long been known and is admitted on all hands, that the young fox or young dog inherits as an instinct the special cunning which the foxes and the dogs that have gone before it have had to win by hard experience.

These remarks are not an unnecessary digression. Nor will they have been made in vain if they serve to fix in our minds the conviction that the law of progressive evolution and specialisation of nerve-centres, which may be traced generally from the first appearance of nerve-tissue in the lowest animals to the complex structure of the nervous system of man, and specially from the rudimentary appearance of cerebral convolutions to the numerous and complex convolutions of the human brain, does not abruptly cease its action at the vesicular neurine of the hemispheres, but continues in force within the intimate recesses of the mental organisation. Moreover, they are specially to the purpose, seeing that they enable us to understand in some sort how it is that a perversion or destruction of the moral sense is often one of the earliest symptoms of mental derangement: as the latest and most exquisite product of mental organisation, the highest bloom of culture, it is the first to testify to disorder of the mind-centres. Not that we can detect any structural change in such case; it is far too delicate for that. The wonder would, indeed, be if we could discover such more than microscopical changes with the instruments of research which we yet possess. We might almost as well look to discover the anatomy of a gnat with a telescope.

(*To be continued.*)

GRINDING EDGE TOOLS.

EDGE tools are fitted up by grinding, very much as a plank would be reduced in thickness were a large plane employed, in which were set a hundred or more very small gouges, each cutting a narrow groove. The sharp grit of the grindstone being harder than the iron or steel, cuts very small channels in the surface of the metal, and the revolving disc carries away all the minute particles that are detached by the grit. If we were to examine the surface of a tool that has just been removed from a grindstone, under the lenses of a powerful microscope, it would appear, as it were, like the rough surface of a field which has recently been scarified with some implement which formed alternate ridges and furrows. Hence, as these ridges and furrows run together from both sides, at the cutting edge, the newly-ground edge seems to be formed of a system of minute teeth, rather than to consist of a smooth edge. For this reason, a tool is first ground on a coarse stone, so as to wear the surface of the steel away rapidly; then it is polished on a wheel of much finer grit; and finally, in order to reduce the serrature as much as possible, a whetstone of the finest grit must be employed. This gives a cutting edge having the smallest possible serration. A razor, for example, does not have a perfect cutting edge, as one may perceive by viewing it through a microscope. And yet the serrations are actually so much smaller than a human hair that the minute teeth cut the hair in twain; but when the serrations on the edge of the razor becomes so battered up and dull that they will not sever a hair, or cut a man's beard off, the edge must be honed and strapped until the system of minute teeth will be so much smaller than a hair that several of them will take hold of the smallest hair at once. These suggestions will furnish something of an idea of the operation in grinding and whetting edge tools.

Beginners are sometimes instructed, when grinding edge tools, to have the stone revolve towards the cutting edge, and sometimes from it. When the first grinding is being done it is a matter of indifference whether this is done or not; but when the finishing touches are applied near and at the very edge, a grinder can always comptete his task with more accuracy if the periphery of the grindstone revolves towards the cutting edge, as the steel that is worn away will be removed more easily; whereas, when a stone runs in the opposite direction, the grinder cannot always tell exactly when the side of the tool is fully ground up to the edge. This is more especially true when the steel has a rather low or soft temper. The stone, when running from the edge, will not sweep away every particle of the metal that hangs as a "feather;" but when the stone revolves towards the edge there will be no "feather edge" to deceive the eye of the grinder.

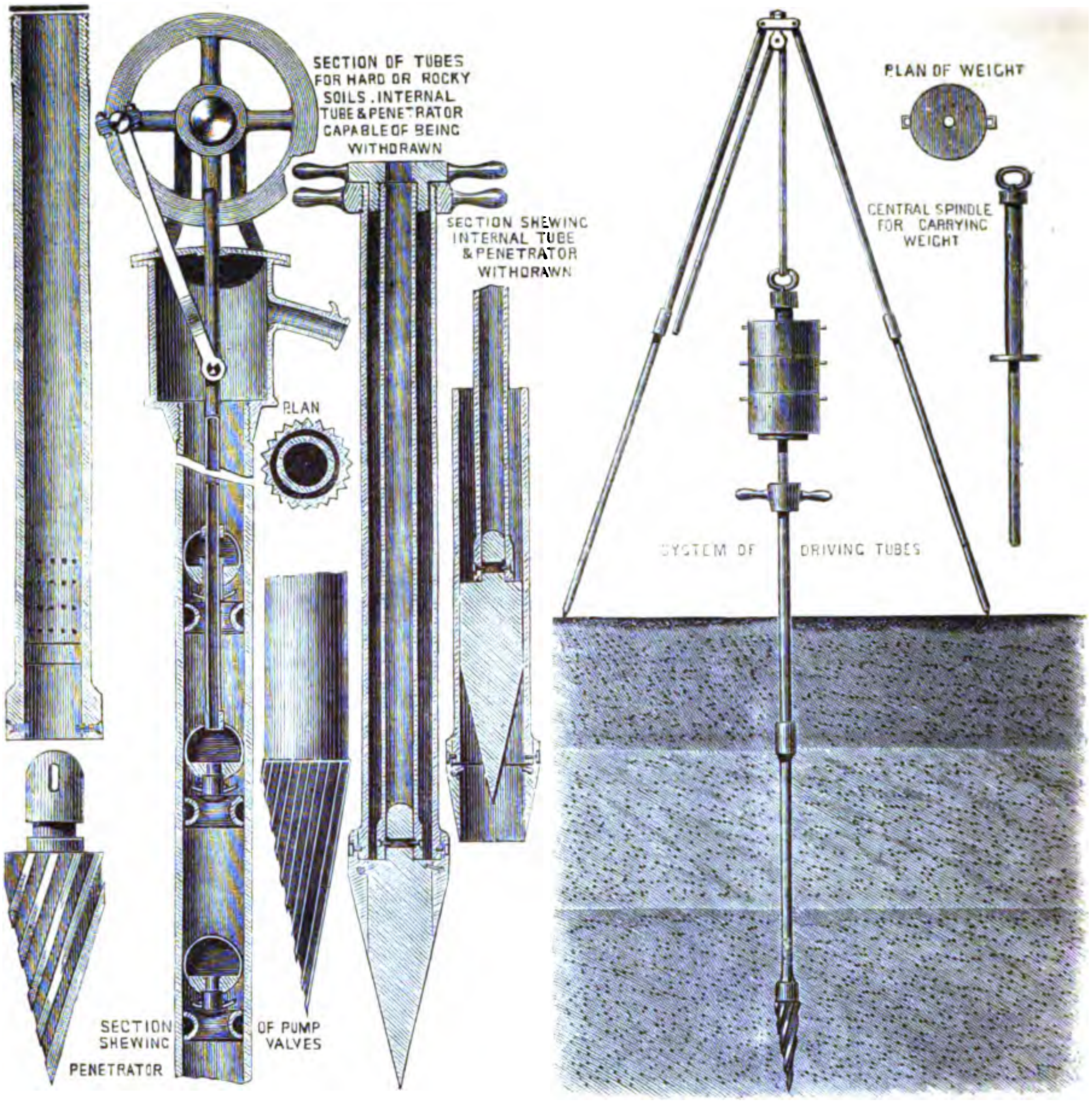
WATSON'S DEEP TUBULAR WELLS.

(*Illustrated on next page.*)

THE advantages claimed for Mr. Watson's system of obtaining water or other fluids from any depth, over any other method, will be easily understood by our scientific readers from the accompanying cuts, with but little explanation of the details; its utility in boring through a hard or rocky soil being more particularly prominent.

In sinking or boring by this method, in ordinary cases, the first length of tubing is provided with a fluted steel penetrator, having a groove cut in the part fitting into the tube, so as to allow it to revolve on the screws in the lower end of the pipe, which is made stronger for the purpose. The spindle for carrying the weights used in driving down is provided with a collar, the lower side of which forms a fair surface to fall on to the brass hand nut, which is screwed on to the upper end of the tube, so that it is not injured by the blow, and when down to the surface of the soil this nut is removed and another length of tube connected with an ordinary socket joint, as shown i nthe cut, the process being continued as before, and tubes added as required. In boring through a rocky soil a double tube is used; the outer tube at its lower end has a steel collar fluted on the outside, and also revolving at each blow of the weights in a similar manner to that in the foregoing.

The inner ube is provided with a steel point likewise constructed to revolve, as in the first instance of the single penetrator, but has, in addition, two recesses to suit the two catches or tumblers fitted in the revolving collar of the outer tube, which keep it in its proper position, without impeding its withdrawal when necessary. The two tubes are of equal lengths, fitted with brass hand-nuts at the upper ends, similar to that on the single tube, thus insuring their being driven equally together. The inner tube can be drawn to the surface at any time, either for the purpose of being sharpened, or of ascertaining the nature of the soil, &c., and replaced with perfect ease; but in tubes of 3in. or more in diameter, provisioncan


SECTION OF TUBES FOR HARD OR ROCKY SOILS. INTERNAL TUBE & PENETRATOR CAPABLE OF BEING WITHDRAWN
SECTION SHEWING INTERNAL TUBE & PENETRATOR WITHDRAWN
PLAN OF WEIGHT
CENTRAL SPINDLE FOR CARRYING WEIGHT
PLAN
SYSTEM OF DRIVING TUBES
SECTION SHEWING PENETRATOR
OF PUMP VALVES

WATSON'S DEEP TUBULAR WELLS.—(See previous page.)

be made for ascertaining the nature of the various strata the tube is passing through without removing the inner tube at all. Where the outer tube is found to be at a sufficient depth to insure a good supply of water, the inner tube is withdrawn. The valves, pump, bucket, and gear are then placed in position—usually about 20ft. from the surface of the water—the pump rod being made hollow, so that in the event of grit or sand interfering with the proper working of the valves water can be passed down it on to them, and the obstruction cleared away—though this will be but seldom required, the pump being provided with a head valve, which always retains a column of water after it is discharged by the pump bucket. The whole of this arrangement will be clearly understood from the engraving, it being a very compact and serviceable job.

These wells are well adapted for the colonies, tropical climates, farms, gold and other mines, also in testing for mineral and other substances, and ~~can be~~ used to advantage as boring tools in Artesian well making.

For mansions situate at any distance from the water the tube wells are found useful.

These pumps are now being constructed for the patentee, Mr. G. Watson, of Plaistow, by Messrs. T. Blundell and Sons, of West India-road, Limehouse.

THE "PHANTOM" BICYCLE.

(*For Illustration see page* 277).

The machine represented in the accompanying sketch has been the subject of no little controversy among some of our readers, and in placing this cut before them we would recommend those who may desire to have further particulars than we can afford space enough to convey to consult the pages of the interesting pamphlet, "The Bicycle; or, the Wheel and the Way," from which we make the following extracts:—

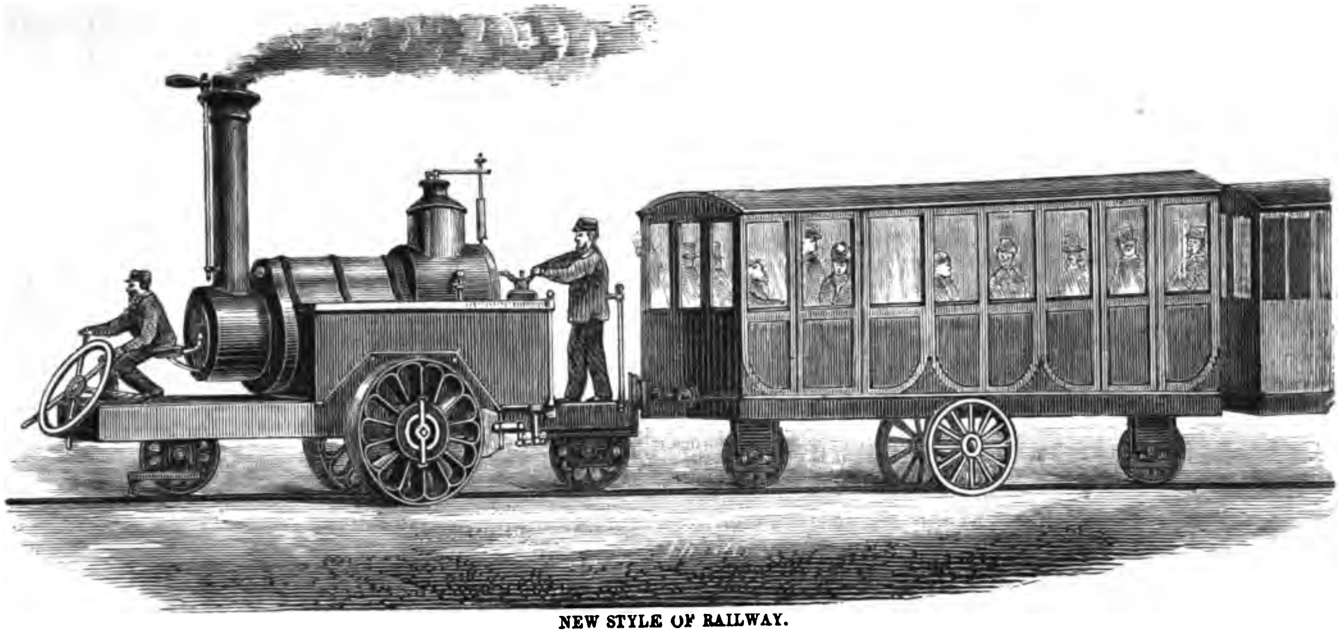
"The machine is steered from the middle of the frame, or from *both* wheels, and not from the front wheel alone, as in the ordinary bicycle, and as the front wheel only turns half as much as usual, it is never brought into proximity even with the rider's thighs. It is completely railed off too by the frame within which it is enclosed. In turning a corner, or on a curve, each of the wheels are put upon the same arc of a circle; the back wheel, therefore, always *follows* the line of the leading wheel; it passes over exactly the same ground, in fact; there is in consequence no 'drag.' In the event of a fall the rider does not get hurt by the machine—that is, he cannot get 'mixed up' or entangled in a painful way between the front wheel and the backbone, as in the ordinary bicycle. The shape of the framework ensures greater speed being obtained than does that of the ordinary pattern. There are very convenient 'steps' for mounting and dismounting, and the same contrivances are serviceable as safe and comfortable rests for the feet. A spring concealed in the steering-socket destroys the vibratory concussions usually conveyed to the hands. The cranks are readily adjustable to any length of throw, and when 'adjusted' they do not work loose. Both the wheels have fixed axles, and run in gun-metal bearings provided with separate oil cups which do not leak. Lastly, the wheels are a grand improvement in themselves, being made upon the suspended principle in such a way that they act as springs, and assist in dispelling the concussions caused by rough roads. The general result is that a bicycle is produced which is of a decidedly improved appearance, which is much safer to ride, easier to steer, far less dangerous to fall from, and which is much easier to mount and dismount. Finally, the *speed*, and consequently the ease of driving are improved by at least a third."

The remarks as to india-rubber tires are of general interest:—

"A rubber tire is usually made up smaller than the rim of the wheel it is intended for, and is held in its place by being stretched into a groove, formed in the wheel by putting flanges on each side of the rim. The defects of this plan are that when the wheel is pivoted upon its base, as when the machine is turning a corner, the rubber tire is wrung or twisted by the screwing motion of the wheel upon the ground, and directly a part of it is raised a little above the edge of the flange, the whole of the tire instantly springs out of the groove. To get it back is a job of some difficulty, especially if the accident happens when on a journey, as it takes at least two or three pairs of hands, and some little skill to stretch it in again. The stretching on of the tire is intended to prevent it from being twisted out by making it impossible to stretch it further. This plan not only frequently fails to effect its object in that respect, however, but it exposes the tire to a constant danger of, if possible, a worse kind in another way. Stretched rubber *gapes* wherever it is cut, and as a very few weeks' wear, especially in districts where the roads are macadamised, produces a good many cuts in the tire, the result is that it is disfigured by a number of ugly gaps, and is drawn up into thick and thin places, instead of being of an even thickness throughout its circumference. It then makes the machine bump and down, and becomes more of a nuisance than an advantage, and by-and-bye the contractile tendency is strong enough in the thick parts to tear the tire completely asunder at one or other of the thin places.

"The rubber tire of the 'Phantom' is a different thing, however, and it is not liable to any of these disadvantages. The principle upon which the wheel is constructed 'dispenses altogether with the necessity for an iron tire to keep it together, as the rim is held in by the suspending rods; that leaves a wood surface upon which to fix the rubber tire. The latter is made half round, and has a canvas base made up with it in the vulcanising process. The canvas base serves two purposes; it prevents the tire from stretching in the direction of its length, and it forms a bed for holding the heads of short iron pins, which are driven through the rubber and into the wood rim at intervals of about every inch of the circumference. The heads of these pins are buried in the rubber, which closes over the hole made in driving them in, so that they are not seen or felt in any way. They keep the rubber tire from being shoved off. Then, as the rubber is not, and in fact cannot be, stretched in the direction of its length, it does not gape and stretch wherever it happens to get cut by sharp stones. Consequently there is practically no end to the wear of the tire, as, in spite of the cuts it may have across it, it retains its uniformity of thickness, and there is never any defect in its action. Of course the cutting of the rubber tire cannot be prevented, but by this plan of fixing it on, the practical usefulness and luxurious effect is not diminished by the cutting, the *gaping* of the cuts being entirely prevented."

TO CLEAN PAINT.—There is a very simple method to clean paint that has become dirty, and if our housewives should adopt it, it would save them a great deal of trouble. Provide a plate with some of the best whiting to be had, and have ready some clean warm water and a piece of flannel, which dip into the water and squeeze nearly dry; then take as much whiting as will adhere to it, apply it to the painted surface, when a little rubbing will instantly remove any dirt or grease. After which, wash the part well with clean water, rubbing it dry with a soft chamois. Paint thus cleaned looks as well as when first laid on, without any injury to the most delicate colours. It is far better than using soap, and does not require more than half the time and labour.



NEW STYLE OF RAILWAY.

LETTERS TO THE EDITOR.

[We do not hold ourselves responsible for the opinions of our correspondents. The **Editor** respectfully requests that all communications should be drawn up as briefly as possible.]

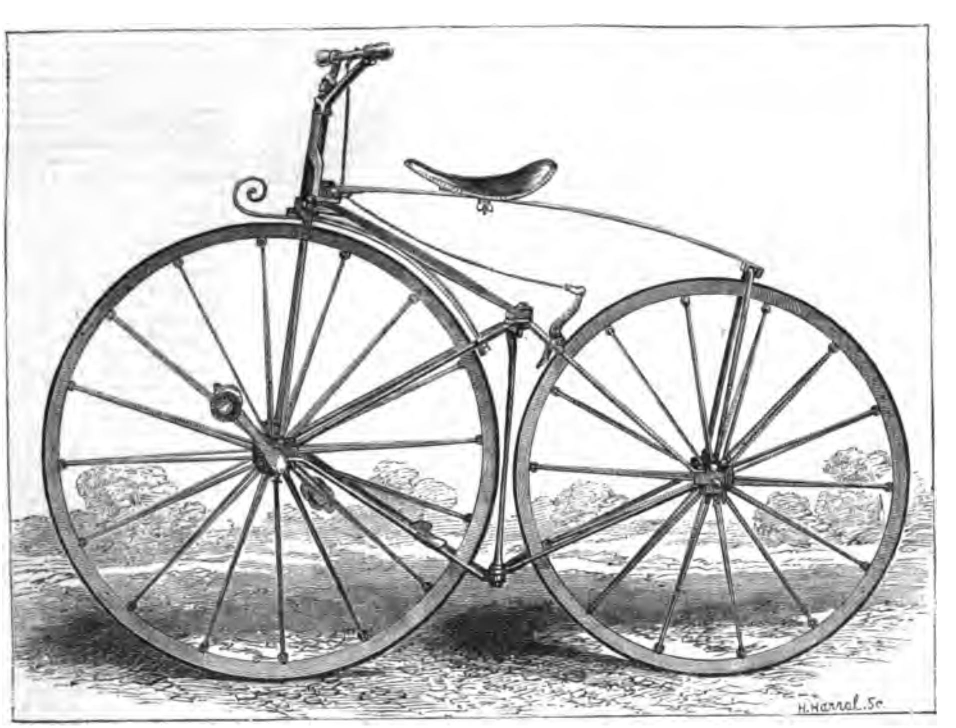
*** All communications should be addressed to the **Editor** of the **English Mechanic**, 31, Tavistock-street, Covent Garden, W.C.

All cheques and Post Office Orders to be made payable to J. **Passmore Edwards**.

ASTRONOMICAL, OPTICAL, AND GENERAL.

Sir,—Let me, *imprimis*, congratulate my fellow subscribers upon the advent into your columns of our Great Solar Spectroscopist, Mr. J. Norman Lockyer. Let us hope that after the appearance of so convincing a reply from *the* man, perhaps of all living the best qualified to speak *ex cathedrâ* on this special subject, we shall have no more vague guesses and expressions of doubt from people who are confessedly ignorant of the very elements of the problem which they undertake to discuss.

Lower on the same page (256), I find two or three queries by Mr. H. W. Bishop, to which I will reply in order. First, then, just as twilight is fading, is the most favourable time to examine the colour of a star. In the case of a star like Sirius, Mr. B. must remember that from its relative proximity to the horizon, atmospheric dispersion operates in tinging it very perceptibly with colour; and this is exaggerated by its projection on the black background of the midnight sky. Of course, I am supposing the star to be one of a tolerably low magnitude. Some of the minute red stars require the darkest sky you can get, and some little attention to boot, to discern their colour fairly. On the other hand, that lovely pair α Herculis is never seen to such advantage as in full twilight. I must confess my inability to "give the comparative brightness of the chief nebulæ visible in a 3in. achromatic," because I am unaware of any photometric process which is applicable to such a measurement: but if a rough eye estimation of relative visibility be of any use to your correspondent, I may tell him that of the nebulæ now favourably situated for observation, he ought to see 79 Hersch. I. Virginis, and will have some difficulty with 99 Hersch. I Boötis; while 418 Hersch. II. Boötis, and 756 Hersch. II. Boötis will be beyond his power altogether. 13 Messier Herculis he will either *barely* resolve, or see as a bright nebula, according to the excellence of his instrument. 57 Messier, the Ring Nebula in Lyra, will, in a first-rate instrument, show traces of luminosity inside of the ring proper. This is all vague enough, but I do not see well how to frame my response differently. Before dismissing this branch of my subject, I may say that June is, as my querist probably knows, the worst month of all the twelve for the examination of nebulæ.



THE "PHANTOM" BICYCLE.—(Described on page 276.)

I may tell "Investigator" (also on p. 256) that the method now universally employed, where practicable, for the determination of longitude, is that by the Electric Telegraph. As he appears to possess "Loomis's Practical Astronomy," I can refer him to pp. 305, *et seq.*, of that work for full details of the method adopted in practice. It may, however, serve to show with what extraordinary accuracy longitude can be obtained by the transport of chronometers, if I mention that of Mr. Airy, in 1844, superintended the transmission of thirty pocket chronometers ten times backwards and forward between Greenwich and Feagh Main, at Valencia, in the extreme West of Ireland; and that when the difference of longitude between these two places was redetermined galvanically in the summer of 1862, the result was almost precisely identical with that obtained by the older method. Moon Culminating Stars, unless observations be very much multiplied and great care be taken to observe both limbs of the moon, give but indifferent results, and Lunar distances, even in the hands of skilled observers, are only pretty good; but Occultations of Fixed Stars by the Moon when carefully observed, and rigidly reduced, are very much better still. Secondly, every visible Occultation is observed at Greenwich, as are the phenomena of Jupiter's Satellites &c. These are published at intervals in the "Monthly Notices of the Royal Astronomical Society"; and this answers your correspondent's third query as well. Next, all the observations at Greenwich of the Moon, both with the transit circle on the Meridian, and with the altazimuth off it, are "for the purpose of detecting errors of the lunar tables." The Greenwich observations are published by John Murray, of Albemarle-street, London. With regard to the immediately following question, he may take the length of the Polar semi-axis of the Earth at 20853768ft., and that of the equatorial semi-axis he may deduce from it by conceiving with the Astronomer Royal that the ellipticity amounts to ·003352. I must, however, add that a most elaborate series of investigations, undertaken by Colonel Clarke, of the Engineers, tends to show that the ellipsoid which best represents existing measurements has its major axis (Equatorial) in Longitude 13° 58′ 5″ E, and that the greatest and least values of the meridian compression are $\frac{1}{286\cdot779}$ in longitude 13° 58′ 5″ E., and $\frac{1}{309\cdot364}$ in longitude 103° 58′ 5″ E. The difference of the Equatorial semi-axes is 5308ft. or, roughly, about a mile. It will hence be seen that the figure of the Earth is by no means absolutely symmetrical, nor even that of any solid of revolution. Finally, "Investigator's" references to page 130, &c. are presumably to those of some volume of the "Nautical Almanac," but, in the absence of the name of the work to which they pertain, they are just a little vague.

"The Welsh Shepherd," p. 256, like numberless other people, severely exercises himself about a question upon which as much nonsense, physical and metaphysical, has been talked, as has been uttered, about most things. The whole matter seems to lie in a nutshell. If, from the way our eyes are placed in the head, we have to raise them to look at a part of an object, we say that that is the top; if we have to depress them to see another part, we call that the bottom. Our whole notion of up and down is derived from *motion*; and if the image fell upon the stomach instead of the retina, and we had to raise our body to perceive it, we should say that that part was the highest; if, on the other hand, the body had to be lowered, we should call the part of the image which necessitated such lowering for its perception the lowest. The so-called "inverted image" on the retina, is treated by most people as though, so to speak, we saw *that*; albeit to do so, we should have to have another eye behind it!

What, in the name of fortune, does "F. W. M." (p. 257), imagine he is adding to a controversy which has been carried on *usque ad nauseam*, by reiterating what has been said over and over again about the Earth and Moon forming parts of one solid globe?

Fellow of the Royal Astronomical Society.

NEW STYLE OF RAILWAY.

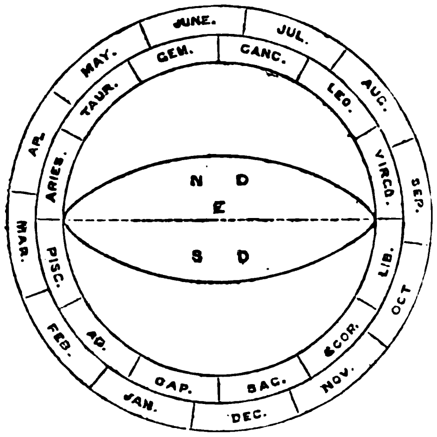
Sir,—I send you a drawing of a new style of railway just introduced into Lisbon. It runs on one rail along the common thoroughfare. In the illustration you see that the engine and carriages have small wheels, which run on the rail, and large ones on the road. The cylinders are under the boiler, just like any other engine. The wheel which the man in front is holding is an extra brake, by means of which the engine can be stopped at 10 yards' notice. Its greatest speed on the high road is 20 miles an hour, and in town 10. The coal and water are kept on either side of the boiler. The carriages in construction are just the same as any other railway carriage, with the exception of the wheels, which are as already described. It is the invention of a gentleman named Lormargot.

H. GARLAND.

READINGS FROM THE GLOBES.—III.

SIR,—Frequent allusions are made to the different constellations of the heavens both by ancient and modern poets, and this arose not only from the custom amongst all nations of making use of figurative language, but because the sowing and reaping of corn and agricultural productions depended upon a right observation of the rising and setting of particular stars. When, for instance, the sun had reached the Tropics, or turning points, it was necessary to reckon so many days before it was advisable to undertake particular work, but in these times of accurate computations and astronomical observations, the calendar is employed, which is much simpler. Thus, the poet Hesiod in his "Works and Days" makes mention of the Tropics, and the Roman poet has constant allusions to the signs of the Zodiac.

In order, therefore, to enter into the beauties of these writers we should have accurate notions of the course of the sun through the Zodiac, and it will be our business in this letter to show by the globes the longitude and declination of that bright luminary as he proceeds in his round. It is not our purpose now to enter into any argument either for or against the Copernican system, as this has been amply discussed, but merely to illustrate certain pheunomena which can be explained on either supposition—namely, that the earth moves round the sun, or that the sun moves round the earth, and to illustrate the better, we will make the latter supposition. The figure is a representation of the two outer circles on the wooden horizon of the globe, and the eclipse may represent the ecliptic on its surface. The sun's longitude, then, and indeed of any other celestial body, is its distance from the point Aries eastward. It is from this point that the reckoning begin, and it will be found from an inspection of the figure, that he is at this point on March 20, he then passes through the signs of the Zodiac as they are marked in the circle, and reaches them on the months immediately above them. Thus the sun enters Cancer, June 21, and generally speaking he enters a new sign on the 20th of each month; that is, apparently enters, for the stars being millions of miles distant from both the earth and the sun, his entrance into them is obvious to the eye only. Concerning the origin of the names assigned to the signs of the Zodiac, there seems to be some uncertainty, but it is generally supposed that they are intended to denote the peculiarities of the season at these particular times. Thus he entered the signs of the Ram and the Bull, when farmers were busy in rearing domestic animals, and at his greatest height, he begins to recede, or, like a crab, to walk backwards. The Lion being a native of the Torrid Zone denotes the heat of the season, the Balances when the days and nights are again equal, the Archer, the hunting season, the Waterbearer, the watery aspect of the clouds, and the Fishes that the seas were open for mans supply when the ground was hard from frost, and uncultivated. The declination of the sun means his distance north or south of the equator, his greatest declination being 23½°, when he has reached the meridian line on which the angle is measured, which the ecliptic makes with the equator, and he then shines over the North Pole, and 23½° beyond it. But to this subject we shall have afterwards to advert. If, then, we wish to know the sun's longitude by the globe, we have only to look on the wooden horizon for the month, and the corresponding circle beneath will show the sign, and if we wish to know the declination we have only to bring the sun's place to the brazen meridian, just as we find the latitude of a place, and immediately over it is the declination. We may remark that the orbit which the sun makes, or the earth, for it is immaterial for our purpose, is not circular, but elliptical, and those who wish to pursue the subject will do well to study Mr. Proctor's Maps, published by Messrs. Longmans, where they will find not only the orbit of the earth, but the orbit of all the planets round the sun accurately described according to scale. By a study of these maps it will be seen that the sun is in perigee or nearest to the earth in winter, ten days after he has entered Capricorn, December 31, when, according to Mr. Proctor's scale of measurement, he is 91 millions of miles from the earth, and that he is in apogee, or at his greatest distance from us, in Midsummer, July 2, when his distance by the same scale is 95 millions of miles. Thus we find that we are nearer to the sun by 4 millions of miles in winter than we are in summer, and, consequently the warmth of our summer arises not from our proximity to the sun, but from the fact of his being longer above the horizon and his rays, owing to his altitude, darting less obliquely upon the inhabitants of the North Temperate Zone. These maps show the situation of the earth in his orbit for every ten days, as well as what sign of the Zodiac he is in, and should be possessed by those desirous of accurate notions upon this subject. Thus it appears that the sun's longitude is really the distance which the earth travels in her course round the sun, which, computed in miles, will be found to be more than 65,000 miles per hour.



T. S. H.

P.S.—Mr. Dyer states the following sentence in Letter I. to need correction: "As the globe turns on it's axis from west to east, those who live in west longitude, must have their time earlier than those living in east longitude, because they will not come in to the enlightened hemisphere so soon." He says the word "earlier" should be "later." I submit the sentence must stand without correction. Turn the globe on its axis from west to east, England will come into the enlightened hemisphere *sooner* than America, which is in west longitude; but the time in America is earlier than in England, for when it is 12 o'clock at London noon, it is 7 o'clock in the morning at New York; so that we come into the enlightened hemisphere *sooner* than the Americans, and yet their time is *earlier* than ours. *They* in the latter part of the sentence must be connected with the *nominative* of the sentence.

TO MILLERS.

SIR,—I am glad to find an improvement in the letters respecting mills and millering. The remarks of "C. M.," on the balancing of stones with Clark and Dunham's patent, I consider good sound reasoning, and I hope we shall hear again from him. Also J. Botting's remarks on the swish in stones, are interesting and true. I having tried the same remedy for similar evil and corresponding results. R. R. Smith gives us some useful hints betimes. I hope all our dusty brethren, who have a little useful information, will please send it to our MECHANIC for the common benefit. I will just ask the above, or any other, if they can give me a good remedy for filling up broken joints in millstones; I have tried alum and borax, but cannot make a good job of it.

E. O.

SIR,—I cannot say I am prepared to dispute Mr. Evans' theory that the cause of a stone's standing and running balances differing is "The balance weight does not coincide with its counteracting object in its radial distance from the centre," but in my blindness I cannot conceive why it should not. He asks me if I cannot alter a stone's standing balance by raising or lowering the weights when running. I have already said I have found when a stone's standing and running balance do not coincide, something was wrong, independent of the balance; but whether it would alter or not if both balances coincided, I am not prepared to say, but to my unenlightened intellect it seems improbable. But in spite of Mr. Evans' scientific reasons why, and my inability to dispute them, some very ugly facts (to the contrary) stare me in the face. And as Mr. E. says "Facts are stubborn things," I ask both him and Mr. Smith how we managed to balance our stones so that they "hummed like a hive of bees," made bran "like a bee's wing," and as good a per centage before we had the patent balance as we do now with it, and why every serious fault that occurred then will now, in spite of balance. And as to despising the standing balance as "virtually of no use, and practically non-effective," that idea has recently done serious damage. If it be of no use, it is mysterious how we managed to make our stones work as well without the patent balance as with it. I repeat the fault of a stone's dragging lies either in empty cogs or their pitch circles not meeting, or irons not working parallel with the face, or unlevel bedstone, or faulty face. Of course the running balance will keep a stone from vibrating (?). I know of stones that have received a good running balance, but went empty, and on being freed by the spoutsman, commenced kicking violently, and before the mill could be stopped knocked off 12 months' wear of skirt. Where was the running balance that it did not keep them steady? What was the cause of it? And why did it not occur when being balanced? The more untrue the face, irons, &c., are, the greater difference there is in the two balances—so great as to drag off the skirts when starting and stopping if the running stone has a running instead of a standing balance. If, as Mr. Evans asserts, the cause of the difference in the two balances is owing to the unequal specific gravity of the burrs, or because the balance weight does not coincide with its counteracting object in its radial distance from the centre, how is it we often see parties try the running balance of their stones every three or four dressings, and find it differ each time? To me it looks very much like a different face to the running stone.

A STONEMAN.

[Will some miller, or any one else who may know, tell us how we can get the names and addresses of the millers of Great Britain and Ireland?—ED. E. M.]

SIR,—Having in my letter in this week's issue of the ENGLISH MECHANIC endeavoured to show that a silk bolter must make a better or finer sample of flour than a wire machine, so that, after showing the advantages of said bolters, I will now describe some of their disadvantages. In the first place, owing to the great length they have to be made to dress from, say, even four pairs of stones is very much against their adoption in many mills because of their taking up so much room. 2nd. As they will not, generally speaking, dress more than from three to five sacks per hour on an average, or about one-fourth the quantity a good wire machine will dress, causes them to be worked continuously as the mill grinds, and there is often fixed over the head of the machine a hopper boy or cooler, to cool the meal before it enters the bolter; it will be seen by this that a miller cannot keep his ground meal by him for two or three days to cool, unless indeed he has extra silks to dress it up with. 3rd. There is another matter that is against them, namely—not being able to change any number of the silk and put another on in a few minutes, according to the stuff that wants dressing and the time of year, as of course for damp wheat meal the silk should be coarser than for dry foreign wheat meal. To obviate this I have, in conjunction with some parties in Manchester, brought out a silk machine that occupies a great deal less space than the present silks, and any sheet may be taken and another put in in a few minutes. 4th. In dressing with a silk bolter it is impossible to get the bran as clean and bright as by dressing it with a wire machine. Consequently I generally put a small machine to take the bran out before it enters the silk or after it leaves it, as by that means everything is cleaned up as well as possible. 5th. By dressing with the present silk bolters there is not more than one-third of the silk that actually dresses, as the rails or ribs inside the reel as it revolves carries the head up and drops it on to the silk near the bottom at the opposite side of the reel. It is this that forces most of the flour through the silk, but it at the same time gives the silk a sudden twitch, which of course is injurious to it.

E. DAVIES.

COMMERCE AND TRADE.

SIR,—As this subject has been opened, and is one which, directly or indirectly, is of vast importance to us all, it may be as well to say a little more about it, especially because its very vastness involves the consequence of very partial views being caught of it by most minds; hence it is, that so many, even intelligent people, are captivated by that delusion, "protection to native industry," which is now set forth under the disguised, but equally delusive, form of "reciprocity," or in other words, refusing to buy cheap what we want, because those from whom we buy have not sense enough to buy of us, what we offer them cheaper than they can otherwise obtain it. This is the very delusion by which "F. W. M.," page 257, is somewhat afflicted. He does not see the whole bearing of what he says. Let us accept at its worst the result he sets forth. "Our men are compelled to emigrate in large numbers." What of that? A temporary suffering to them and others—a resulting unmixed good to them and all—they leave a country overstocked with labour, where, if they cannot produce, they are a burden on the producers; they go away, and at once become producers to their own great benefit, and large customers to those who remain behind.

Rightly considered, the necessity for emigration is a great proof our prosperity, for it means excess of population, but an excess not due to diminished work (for any intelligent man knows that the total work of the country is vastly increased every year), but to the rapid ratio of increase of population, and to temporary changes in the nature of work, which at times throw out whole classes of workmen, who are then unable readily to find fresh work, not from its deficiency so much, as from the competition that involves with those already engaged in it. Now nothing is much more certain in political economy than that a rapid increase of population is a consequence of prosperity. Stagnant nations never increase—they very commonly decrease in number, and this is only one form of Nature's universal law, that creatures only multiply where there is food for them. Even one year's bad trade, or disaster, is marked by diminished birth rates in the next, as well as increased death rates.

Of course it is hard to look beyond the immediate personal action of these laws, and hence it is that so intelligent a race as the Americans violate them. Instead of recognising the unlimited advantages Nature gives them, as producers of raw material, they wish to do everything themselves, and seek to be manufacturers, which those very advantages forbid, by their effect on the labour market. The consequence is, that while a few years ago they were dangerous competitors in every market, since they adopted their tariff system, we are beating them everywhere, and literally driving their flag off the seas. I quote the following from the "New York shipping and Commercial List":—"No better commentary upon the decay of American navigation interests can be had, than is afforded in the fact that the Novelty Iron Works have sold off most of the machinery and tools; the Allaire works are now occupied as a stable; the Etna Iron Works have ceased to make marine engines; the Fulton Iron Works are for sale; W. H. Webb's shipyard is to let; Henry Steer's yard is empty; the Continental Iron Works are almost deserted; and grass is growing in nearly all of the shipyards which a few years ago were filled with workmen."

It may be said, that something similar applies to London, but that is only because other English ports are taking the trade. English shipping is superseding American, and there is no other reason than this—America tries to make her own iron, &c., which she cannot, except at high price, instead of buying ours cheap with the corn and other things she can really produce well, and thereby indirectly throws away the friendly union with us which would result from being mutually necessary to, and benefactors of, each other.

SIGMA.

SIR,—"F. W. M.," on page 257, seems to have fallen into the trap that "Saul Rymea" laid. He believes that England is getting drained of her wealth, by an outflow of money sufficient to make our exports balance our imports—a very common error. It is necessary to remember that, with the most insignificant exceptions, trade is barter; the fluctuation in the amount of gold held by England from year to year, may be entirely disregarded in examining her trade with the whole world, and this one fact should be steadily kept in sight, that one year with another, the goods we send out to the foreigner, are considered by him equal in value to what he sends us in return. Take the case that I gave, and which "F. W. M." holds up to ridicule. I send out a cargo, which costs me here £18,000, but when it reaches the foreigner, it is worth

£24,000 to him there; and in return he ships to me a cargo, for which he charges me there £24,000; by doing so, he balances my account, I owe him nothing, he owes me nothing; but his cargo, when it reaches me, is worth £29,000 here. I do a good trade, and can afford to pay freight, insurance, &c., out of the difference of the English values of the two cargoes. Where the goods are, makes the difference in value.

HERBERT.

INDUCTION COIL.

SIR,—I do not quite apprehend Mr. Cunningham's question, p. 258. Covered wire is used simply for convenience of manufacture, but any mode of keeping the wires out of contact answers. When I first took up the study of electricity, I could get neither books nor materials, and had to study out things for myself, and discover them afresh, guided only by the knowledge that certain things had been done. That was in Australia, before the days of gold; it was also before the days of Rhumkorff's coil, and I made to all intents an induction coil (only without the condenser) without knowing that I had done something new, for my coil gave violent shocks by holding one conductor only. The reason was that I had no covered wire, and invented a substitute, and my wire was exceedingly fine; in fact, I laid it very closely and evenly, separating the turns by a cotton thread, saturating very carefully with an insulating varnish, and dividing the layers by silk saturated with the same. But such a coil, though very well for an amateur experimentalist, would be very troublesome to make, and almost incapable of repair if injured, and consequently would not have been made in any but such exceptional conditions.

No doubt Mr. Cunningham's coil acts as he says; the only point is, whether, with the same battery power, much greater effects would not be obtained from the same wire if the interposed material were absent, for the true point to be aimed at is to keep the wire as close as possible to the magnetic core, as distance has so great effect in diminishing action; the only limit to this approximation being the necessity for insulation. The moment this insulation exceeds what is necessary, it is injurious, by weakening the effect; hence the importance of using the very best insulators, and applying them on the best principles. Taking, for illustration, a coil 6in. long by 3in. diameter, the secondary of which is an inch in depth, if we use the common process of working the layers from end to end, the points of extreme tension are separated only by that inch, and it being occupied with a succession of stages of wire, there is great facility offered for the spark to leap across this space, and we must resist this by extreme care in insulation; but if, beginning at one end, we work our layers in sections instead of strata, and complete the coil as we go towards the other end, the points of extreme tension are separated by 6in. instead of one, and much less perfect insulation is needed. There is, however, a great practical difficulty in the way, and at present a compromise is effected by the process of dividing the secondary into a series of short independent coils, each complete in itself, and connected to its neighbours.

This will reply to Mr. Forbes, No. 3953. The connections are made alternately by passing an end under the disc to form the commencement of next section, and soldering the outer end. The Mercury Break is only needed for very powerful coils.

SIGMA.

DRY PLATE PHOTOGRAPHY.

SIR,—I have lately been making some experiments in dry plate photography, and I think it will not be out of place to give the readers of our journal a few hints on this subject, which I consider one of the most beautiful and interesting branches of the above art. Within the last two months I have tried three processes, tannin, Ryley's modified Fothergill, and collodio-albumen, but, taking everything into consideration, I prefer the tannin process, as the plates can be prepared very quickly—in fact, I usually prepare two dozen in one night, and allow them to dry in the dark room until morning, when I find them quite dry without the application of artificial heat. I have used Mawson's ordinary wet plate collodion, which I find an excellent one for the tannin process. I coat the plate and sensitise it in the usual manner, and on removing the plate from the bath I wash it with about a quart of water (I have tried distilled water, but I find plain water to answer quite as well). I then immerse it in a 15 grain solution of tannin, and let it remain while another plate is being prepared. It is then taken out of the tannin, and placed to dry in racks, or reared against the wall. When it is quite dry it is varnished about ⅛in. all round with ordinary black varnish, laid on with a soft camel hair brush. It is then ready for exposure, which should be about 12 times as long as for wet plates. I develope with pyro, 2 grains; citric acid, 1 grain; water, 1oz. The picture should be brought out with the least possible quantity of silver in the developer, and when all the detail is out it can be intensified in the usual manner. With Ryley's process I had very little success, but with the collodio-albumen process I have obtained some very beautiful results; but it is a very troublesome process, and very liable to blisters, &c.; so on the whole I prefer the tannin. I usually develope the same evening I take the pictures. I beg to ask "Mus," or some other of your photographic correspondents, if they will be kind enough to describe to me the coffee and gum gallic processes, and let me know if they have had any success in them, as I believe they are both very good processes; but I have not the formulæ. I have also got an old wedding ring; it weighs just 25 grains. I shall be glad if any of our subscribers can inform me how to convert it into chloride of gold solution for toning purposes. I have tried "Mus.'s" toning bath, and find it an excellent one, and should like to have a few more hints from him.

TANNIC ACID.

RE CAPT. PETERSEN'S STEAM LIFEBOAT.

SIR,—After reading in your journal of the 20th ult. an appeal, on behalf of Capt. Petersen, for subscriptions to build a trial steam lifeboat, and among the list of subscribers such corporations and institutions as Lloyd's, the Salvage Institution, the Shipwrecked Mariners' Society, and the Royal National Lifeboat Institution, &c., I was much surprised to see in your impression of the 27th ult. the letter from Mr. Lewis, secretary to the last-named institution, raising such objections, many of them ridiculous on the face of them. Surely the several institutions here named, and more particularly the Royal National Lifeboat Institution, thoroughly examined the plans, models, and drawings, and fully satisfied themselves that Capt. Petersen's invention was not only practicable, but had every chance of success. I doubt not Mr. Lewis raised the same objections at the time his committee was inspecting the invention; and the explanations given by Capt. Pesersen were such that they were perfectly satisfied it could be carried out, and expressed themselves as such by granting £100 (about one-sixth of the amount required) towards building a trial boat.

In order to show the absurdity of these objections, I will just quote one, in which he says—"That the motion of boats, under such circumstances, is so great and violent, they sometimes standing perpendicular, with either the bow or stern uppermost, that the propeller would work at a great disadvantage, and the machinery be perhaps liable to disarrangement."

Now, it is self-evident that when this happens, the same objection would apply to the lifeboat now in use, inasmuch as the men in the boats would, under such circumstances, be placed in an horizontal position; but Capt. Petersen's steam lifeboat would have the advantage, for I see by his plans that he carries two more sets of oars than the present boats, in addition to which he has the steam propellers. This advantage is obtained by the difference in the formation and arrangement of the air-chambers, &c.

Mr. Lewis must be wrong in saying that "most of the plans merely aim at putting an engine in one of our lifeboats," for from what I have seen and heard of the drawings and plans of Capt. Petersen's self-righting steam lifeboat, I am under the impression that it is of a very different form, construction, &c., giving as much, if not more, room than those in present use.

I will not trespass further upon your valuable paper, as I have no doubt Capt. Petersen will fully answer all the objections, to the complete satisfaction of the subscribers to the ENGLISH MECHANIC Lifeboat Fund; which fund I hope may be a success, and that their boat will be built in accordance with Capt. Petersen's plans, which I believe are the very best extant.

R. S.

REBUILDING A CHURCH ORGAN.

SIR,—I am thinking of rebuilding our church organ: adding a swell and independent pedal organ: and I should like to know what the dimensions of the bellows should be for a liberal supply of wind, and yet no larger than can be helped.

I should have three 8ft. stops, two 4ft., one 2ft. in great organ; two 8ft., two 4ft. in small organ; one 16ft. tone (8ft. stopped) in pedal organ. I have most of the pipes by me: and the pedal pipes are gedact, with a foot of 3in. diameter in the aperture for the CCC. If any correspondent would give me dimensions for bellows and reservoir I shall be extremely obliged: also, is there any real practical advantage in having three feeders worked by a three-throw crank, over the usual two feeders worked by a lever? Theoretically it seems best; but is it?

COUNTRY PARSON.

DARK LINES IN THE SOLAR SPECTRUM.

SIR,—I could hardly believe that Mr. Lockyer had not misread my letter at p. 211; but on referring to it I found I really had by a *lapsus calami* spoken of *density* instead of *quantity*. You know how much I have been overtaxed with work lately, and will therefore understand how easily such a slip would occur. Fortunately, however, the text exhibits my real meaning very clearly; and I have written too often and too recently (see *Pop. Sc. Review* for October, 1869, in which I have introduced even a *picture* of the widened line of hydrogen, as also my "Other Worlds," at p. 46) to a contrary effect for any question to exist as to my knowledge of the fact pointed out by Mr. Lockyer. In the letter he quotes, I was showing that the atmospheric dark lines could not change in thickness as the sun neared the horizon, notwithstanding the greater range of atmosphere through which the solar rays then pass. No one knows better than Mr. Lockyer that this is the case. A ray from the sun might pass tangentially through the earth's atmosphere fifty times and yet the atmospheric dark lines would be no wider than in the spectrum of the sun in the zenith.

If "T. A.'s" view required further demolition, evidence might be urged which is even clearer than that adduced by Mr. Lockyer. I refer to the existence of dark lines in the spectra of the stars.

I take far too much interest in Mr. Lockyer's work to overlook any of the results he has obtained. Though I do not by any means accept all his conclusions, and indeed consider some of them to be beyond all question erroneous, I none the less appreciate most thoroughly his skill in observation, his ingenuity in devising new modes of research (witness his suggestion in 1866 about the prominence spectrum) and the perseverance and energy with which he carries out his purposes. If my haste in writing should ever again lead to a *lapsus calami* let Mr. Lockyer believe the cause of the mistake to be anything rather than forgetfulness of his work, or of any that is being done by our fellow-workers in astronomy.

May I venture, however, to point out that the discovery of the influence of density on the thickness of spectral lines belongs to an earlier date than Mr. Lockyer's alliance with Dr. Frankland. I think Plücker would have something to say on this point as well as on the influence of temperature. I have a paper before me in which Mr. Huggins says incidentally "it seemed of importance to have proof from experiment that this line of hydrogen, when it becomes broad, expands equally in both directions. I made the comparison of the narrow line of the vacuum tube with the more expanded band which appears when denser hydrogen is employed." This paper is dated April 13, 1868, and I think it was after the eclipse of 1868 that the alliance referred to above was formed. But the discovery is older yet. We must not overlook the work of Miller, Huggins, Plücker, Angström, Gladstone, and the host of other eminent men who have advanced the cause of spectroscopic science.

RICHARD A. PROCTOR.

STARTLING THEORY ABOUT JUPITER AND SATURN.

SIR,—The reviewer of my work has treated me so kindly that I hardly like putting in a word in favour of the view to which he feels compelled to "demur at once." I object, myself, to startling theories unless put forward to explain even more startling facts. This is the case as regards my theory about Jupiter and Saturn.

Any theory which accounts for the apparent advance of a satellite on the disc of Jupiter and its apparent return presently outside the disc (an observation made independently by three such astronomers as Smyth, Pearson, and Maclear) must, I apprehend, be rather striking. I think mine the only available one. In fact, I cannot imagine any other. I by no means assert that the surface of Jupiter was necessarily changed in shape on this occasion. Clouds suspended at a great height in his atmosphere may have suddenly been dissipated. Again, Saturn's assumption of the square-shouldered aspect seems to me wholly inexplicable on any other hypothesis than mine.

Sir John Herschell writes to me of this theory, "Strange as it seemed to me at first, I cannot but admit that the reasons you adduce are not to be lightly set aside."

R. A. PROCTOR.

AMALGAMATION AS A PREVENTIVE OF RUST.

SIR,—Some time since I sent a query to our paper on preventing rust. It was not, I believe, answered. I now send a clipping on this subject, which may be interesting to others as well as myself:—"Reinsch, of Germany, proposes the amalgamation of the surface of the iron as the best protection against rust, the only difficulty being to make the mercury adhere to the iron. It is well known that iron has no affinity for mercury, and even a perfectly clean surface, when rubbed with metallic mercury, will absorb none of it. On the other hand, gold, tin, lead, and several other metals will take it very readily, and almost all metals quickly become coated with mercury when plunged into a solution of a mercurial salt; but iron and steel resist even this treatment, and it is only here and there that some traces of the mercury adhere. Fortunately a method of causing the mercury to adhere to the iron has at last been discovered. The iron is first well cleaned with hydrochloric acid, and then plunged into a very dilute solution of sulphate of copper, mixed with a little hydrochloric acid. It immediately becomes thinly coated with metallic copper, which copper must be removed by means of a brush, friction with paper, and washing. The iron is then placed in a very dilute solution of bichloride of mercury, also mixed with a little free hydrochloric acid. It becomes perfectly coated with a layer of mercury, which cannot be removed by friction with rough bodies. This mercurial covering protects the iron very well against rusting, especially if after the amalgamation it has been washed with liquid ammonia. The inventor has compared the action of the air of the laboratory, continually charged, as it is, with acid vapours, on iron objects, some of which were amalgamated and some not, and found that, while the latter were rapidly eaten up, as it were, the amalgamated objects did not show a trace of rust; and he recommends the process highly for the working parts of all kinds of machinery, clocks, engines, &c. He also proposes to amalgamate the iron parts of suspension and other bridges before covering them with paint, in order to ensure a more perfect protection; but, as we know that mercury diminishes considerably the strength of those metals, with which it easily amalgamates, we think it would be well to test its action in this respect on iron wire before risking the amalgamation of the wires forming the cables of a suspension bridge."

I may say that I have not practically tested the application of mercury to iron, but I see no reason why this method should not be successful.

J. H. W.

THE SAFETY VALVE.

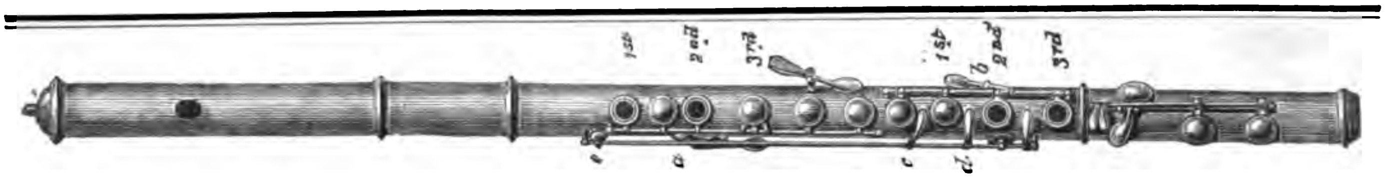
SIR,—Having noticed many queries in our ENGLISH MECHANIC relative to the lever safety valve, I now offer, for the benefit of my brother readers, the following calculations thereon. Fig. 1 is a diagram of a lever safety valve of the ordinary construction in which L represents the lever, V the valve, and W the weight.

As the words *effective pressure* will be frequently met with in the following examples, I shall explain the meaning of this phrase before entering into the calculations.

Suppose the lever of a safety valve of uniform depth and thickness to be 24in. long, 3in. from the fulcrum to the centre of the valve, and weighing 3lb. Now it is the opinion of many that a lever of this dimensions would only exert a pressure of 3lb. on the valve. This, I must say, is a great mistake, for such a lever instead of exerting a pressure equal to its own weight, would exert a pressure as great as three times its own weight, or 12lb. on the valve, and this is what is called the *effective pressure*.

RULE.—If the lever be of uniform depth and thickness the effect of its weight on the valve is the same as if it were collected at its middle, but if the lever is tapered, then its effective pressure can only be found by disconnecting it and ascertaining what weight is required to balance it, making the point in a line with the centre of the valve the fulcrum. The result will be the effective pressure of such a lever.

All the examples will be worked out by two methods,

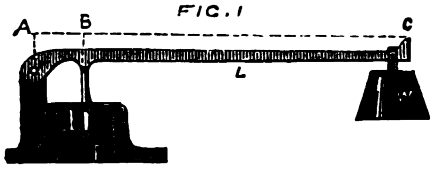


THE BOEHM FLUTE.

first, in the form of an algebraical equation, and, secondly, by the aid of an ordinary arithmetic. I have done this in order that those who are unacquainted with algebra may be enabled to understand the calculations.

Ex. 1. A safety valve is 2in. in diameter, length of the lever 29in., distance from the fulcrum to the centre of the valve 3in., and a weight equal to 24lb. placed on the extremity of the lever. Required the pressure per square inch. In this example the lever is supposed to be parallel, and to weigh 2lb., and the valve ·5lb.

FIG. I



Let *d* represent the distance from A to B, C the distance from A to C, *d* the diameter of the valve, *w* the weight, *p* the effective pressure of the valve and lever, *e* the decimal ·7854, and *x* the pressure per square inch. Then

$$\frac{\frac{c}{d} \times w + p}{d^2 \times e} = x$$

29in. ÷ 3in. = 9·6′, the ratio of A C to A B.

$2^2 \times {\cdot}7854 = 3{\cdot}1416$ sq. in., the area of valve.

9·666
24

38664
19332

231·984lb. effective pressure of weight.
9·660 " " lever.
·500 " weight of valve.

3·1416)242 1440(77·07
219 912

222320
219912

240800
219912

Ans. 77·07lb. per. sq. in.

Ex. 2. The diameter of a safety valve is 2·5in., pressure per square inch 20lb., distance from the fulcrum to the centre of the valve 3in., weight on the end of the lever 40lb., effective pressure of the lever and valve 8lb. Required the length of the lever.

Let *d* represent the diameter of the valve, *e*, the decimal ·7854, *p* the effective pressure of the lever and valve, *w* the weight, *s* the pressure per square inch, *t* the distance from A to B, and *x* the unknown part A to C.

Then

$$\frac{d^2 \times e \times s - p \times t}{w} = x$$

$2{\cdot}5^2 \times {\cdot}7854 = 4{\cdot}908$ area of valve.
20 pressure per sq. in.

98·160
8 weight of lever and valve.

90·160
3

40)270·48

6·762

Ans. 6·762in.

Ex. 3. The diameter of a safety valve is 3in. distance from the fulcrum to the valve 3in., effective pressure of the lever and valve 6·25lb. Required the weight to be placed 24in. from the fulcrum to be equal to 80lb. per square inch.

Let *d* represent the diameter of the valve, *e* the decimal 7·854, *r* the ratio of A C to A B, *p* the effective pressure of the lever and valve, *s* the pressure per square inch, and *x* the weight required. Then

$$\frac{d^2 \times e \times s - p}{r} = x$$

$3^2 \times {\cdot}7854 = 7{\cdot}0686$ area of valve.
80 pressure per sq. in.

565·4880
6·25

8)559 238

69·90475

Ans. 69·90475lb.

The divisor 8 is the ratio of A C to A B because 3 : 24 : : 1 : 8.

Ex. 4. A safety valve has a lever 6·762in. long, a weight equal to 40lb. on its extremity, the pressure per square inch 20lb., effective pressure of the lever and valve 8lb., and the diameter of the valve 2·5in. Required the distance from A to B. Let *d* represent the diameter of the valve, *w* the weight, *l* the length of lever, *p* the pressure per square inch, *e* the decimal ·7854, *f* the effective pressure of the valve and lever, and *x* the distance required.

Then

$$\frac{l\,w}{d^2 \times e \times p - f} = x$$

$2{\cdot}5^2 \times {\cdot}7854 = 4{\cdot}906$ area of valve.
20 pressure per sq. in.

98·160

6·762 length of lever.
40 weight on "

90·160)270·480(3
270·480

Ans. 3in.

The divisor 90·160 is obtained by deducting the weight of the valve and lever from the direct pressure 98·16lb.

Ex. 5. The lever of a safety-valve is 24in. long, 3in. from the fulcrum to the centre of the valve, effective weight of the valve and lever 6·25lb., pressure per sq. in. 80lb., weight on the end of lever 69·90475lb. Required the diameter of the valve.

Let *r* represent the ratio of A C to A B, *w* the weight, *p* the effective pressure of the valve and lever, S the pressure per sq. in. *e* the decimal ·7854, and *x* the required diameter.

Then

$$\frac{w \times r + p}{S} = \text{the area of the valve represented by } a \;\therefore \sqrt{\frac{a}{e}} = x$$

69·90475 weight on lever
8 ratio of A C to A B

559·23800
6·25 weight of lever and valve.

80)565·488

·7854)7·0686(9
7·0686

$\sqrt{9} = 3.$ Ans. 3in.

Ex. 6. What is the area of an annular valve whose greater and lesser diameters are 12 and 4in.?

Let *d* represent the diameter of the greater, and *l* the diameter of the lesser, *e* the decimal ·7854, and *x* the required area.

Then

$$(d^2 \times e) - (l^2 \times e) = x$$

		sq. in.
Area of whole circle	$12^2 \times {\cdot}7854 =$	113·0976
" lesser "	$4^2 \times {\cdot}7854 =$	12·5664
		100·5312

Ans. 100·5312 sq. in.

Ex. 7. To what height must a safety valve 3in. in diameter be lifted to allow a free escape of steam equal to the area of the valve?

Rule.—Divide the diameter by 4, the quotient will give the height. Let *d* represent the diameter of the valve, *c* the number 4, and *x* the required height.

Then

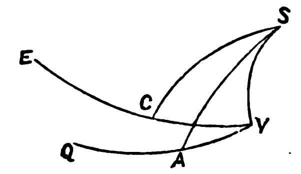
$$\frac{d}{c} = x$$

3in. ÷ 4 = 0·75 Ans. ¾in.

Thos. J. O'Connor.

TO G. FIRTH.

Sir,—I am afraid G. Firth has attempted to study practical astronomy before making himself master of a little spherical trigonometry, or he would have no difficulty in converting longitude and latitude into right ascension and declination, and *vice versa*.



In the accompanying figure, γ is the first point of Aries, and E γ and Q γ the ecliptic and equator respectively. Consequently

A γ is the right ascension $= \alpha$

And

C γ is the longitude $= l$
S A is the declination $= \delta$

And

S C is the latitude $= \lambda$
E γ Q is the obliquity of the ecliptic $= \omega$
S γ A $= \varphi$
S is the place of the star.

And we will suppose that α, δ and ω are given to determine l and λ. Of course the reverse problem is precisely similar. Join S γ = P with the arc of a great circle, then

$$\cos. P = \cos. \alpha, \cos. \delta, \text{ and } \tan. S\gamma A = \frac{\tan. \delta}{\sin. \alpha}.$$

Then

$$\sin. \lambda = \sin. P. \sin. (\varphi - \omega)$$

And

$$\tan. l = \tan. P \cos. (\phi - \omega)$$

S γ A and P can be eliminated and the formula written in the form of

$$\sin. \lambda = \cos. \omega \sin. \delta - \sin \omega \sin. \alpha \cos. \varrho$$

$$\tan. l = \cos. \omega \tan. \alpha + \frac{\sin. \omega \tan. \delta}{\cos. \alpha}.$$

This is not the same formula as was given on the page alluded to by G. Firth, but the one can be deduced from the other. I will give him the formulæ properly corrected, and which I think is as easy a method as any other of altering co-ordinates.

$$\frac{\tan. \delta}{\sin. \alpha} = \tan. B$$

$$B - \omega = A$$

$$\frac{\tan. \alpha \cos. A}{\text{Cos. } B} = \tan. l$$

$$\tan. A \sin. l = \tan. \lambda.$$

If G. Firth wishes an example worked out in figures I shall be most happy to send it, or to give him any assistance.

Omicron.

THE BÖEHM FLUTE.

(Illustrated above.)

Sir,—The ring principle on all instruments of the flute genus, is the same, it gives the power of closing two or more holes by the action of one finger only. The invention of this system belongs to a Captain Gordon, who conceived the idea in Paris, about thirty years ago; the application of it, however, is Böehm's a professor of Munich. I think a little work "The Flute in its Transition State," by the Hon. and Rev. H. Skeffington, would interest "Another Flautist." Hatchard, or Skeffington Piccadilly, are the publishers. As a soloist I am acquainted with nearly every form of flute. For the Böehm flute I cannot say much; it is an expensive instrument; the faults I find with are, the constantly-recurring difficulties in executing rapid and continuous passages, especially in the third octave, arising from the cross and back fingerings. To illustrate this, the B flat, which is produced naturally and easily on the Nicholson flute, is fingered on the Böehm by placing the third finger of the left hand on the ring of the G hole, and F sharp is fingered by pressing down the ring of the E hole; these are very awkward and unnatural fingerings, added to which, the quality of tone in the third octave is thin, weak, and the notes bear very *sharp* (in the old flute they bear *flat*), and it is almost impossible for an amateur to blow them in tune. This arises from the fundamental holes being made too large, and without due attention to the part they are required to take as *vent holes* in the production of the notes in the third octave. But should "Another Flautist" desire still to hear more of the Böehm, I shall be happy to give him information. Tune, tone, and facility, are the things sought for by flute players of all classes, and with your permission I will now describe as briefly as I can, a flute in which these qualities are combined to the fullest possible extent As a professor of the flute, having no pecuniary interest in flute manufacture, I continued to use the Böhm because its powers and capabilities were so great, notwithstanding the toil it imposed upon the performer, especially with the open G sharp key. Nearly eight years ago, the late Mr. John Clinton showed me his flute, called the "Equisonant," a vast improvement on the Böhm, which I have used ever since. I subjoin a sketch of it, with an explanation. In the Böehm the thumb key makes C natural, in this flute that key makes both B flat and C natural. There is a small open key at *a* (the C natural key), which is kept *shut* by the thumb key, and when the latter is opened for B flat in the usual manner of fingering this note, the C natural key is kept closed by the second finger of the left hand pressing down the ring surrounding the A hole. There is also an open F sharp key at *b*, which is shut by the second finger of the right hand pressing on the F natural hole ring, the third finger of the same hand closes it in making D and F natural, for which latter note the "fork fingering" is used in all rugged and difficult passages. The F natural key (short) remains. At *c* there is a lever for acting rapidly upon either the B flat or C natural keys. At *d* is a lever for the D shake key *e*. Your correspondent knows not what he asks; the mechanism of flutes has been a vexed and most intricate question.

Sable.

POST-OFFICE TELEGRAPHS.

Sir,—I shall be glad if you will allow me, through the medium of your pages, to ask some of your able correspondents, the following questions, which are important to many in the same circumstances as myself. It is well known that the Post-Office has lately acquired the telegraphs, and a great many postmasters have to waste hours daily in watching the instruments, and therefore I wish to know whether it is possible to fix a bell, or other apparatus, to the existing single needle instrument, in such a manner, that we shall have warning without the watching now tedious to

A Poor Postmaster.

SEWING MACHINES.

Lock Stitch.

(Continued from page 232.)

Sir,—Spools, or metallic bobbins, require illustration to show what has been attempted in the way of improvement. The Wheeler and Wilson spool is $1\frac{3}{16}$in. diam., and $\frac{5}{32}$in. thick outside, and holds 18¼ yards of No. 24 cotton, and the Elliptic holds 14¾ yards, the diam. being $1\frac{1}{16}$in., and the outside thickness $\frac{7}{32}$in. Wheeler and Wilson's spool is represented at Fig. 1, a front view, and Fig. 2 a section. It is formed of a pair of thin steel discs, *a b*, fixed on a brass axis C, with a hole through it, which fits on the shaft of the machine to receive a rotary motion for winding on the thread, and in the space between the double convex spool. A very slight variation of tension may be given by winding on the thread more or less tightly, but it is too limited to be of much use. To provide a tension on a spool, the following plan has been adopted. A pair of flat discs, with the thread wound on the axis, which also has a hole through it, is placed within a case or shell, having an axis to retain the spool in place, and to allow it to unwind freely. In the rim of the case or shell, holes were made for the thread from the spool to pass through, to give tension in the same manner as in Thomas's shuttle. There are machines of different makers working this kind of spool, but they are not successful compared with other machines, although it may be wrong to trace the failure to the spool only. In some machines, the spool was applied horizontally, as illustrated in Fig. 3, a plan, and Fig. 4 a sectional elevation; *a* is the spool, composed of two flat discs on an axis, with a hole through it. The shell or case *b*, has a centre pin, on which the spool *a* revolves. The thread passes from it to the holes C, and is passed through one or more to obtain the tension required. The frame *d d* of the machine, is bored large enough to contain the spool, and a rotating hook *e* secured to the pinion *f*; an axis, *g*, passes through the pinion. The top end of the axis forms the bed on which the spool and case rests, and the lower end is secured to the frame of the machine. The pinion *f* is driven by a rack motion in some machines, in others the hook receives a direct circular movement. The action is as follows:—the ascent of the needle in the needle slot, throws off the loop, the hook takes it in its rotation, or its vibratory movement, and opens it, when on the back end of the hook, then carries it more than halfway around the spool case; here the needle pulls the thread off the hook, which returns ready for the next stroke or stitch. In machines which make a complete rotation of the hook, the needle thread is less liable to break, and more easily slips off the hook. When the needle thread has been passed around the spool case and released, it has to be pulled up through the needle plate at a great velocity—for every stitch from 2in. to 3in of thread must so pass. This is usually done by a spring above the needle, and the least accident to so delicate an instrument, puts the machine out of order. A thin fabric, stitched by a shuttle, compared with one stitched by a spool machine, shows in practice what may be expected from theory—viz., the less quantity of thread passed through the fabric, the better the stitch, and the longer the loop passed through the fabric, the more uneven it must appear, laying below the surface on the upper side, or drawn too deeply into it, and forming too thick a ridge on the lower side. The spool machines are not made or sold because of this quality, but because of certain other merits they possess. All the best qualities in the various machines have not been combined in any machine yet made, ner are they likely to be. This thought should humble some of the members of the sewing machine family, who are given to overmuch boasting. Little remains to be noticed about the various instruments employed in the formation of the lock stitch, until the machines are described and compared.

Other contrivances have been patented, or proposed, but not of sufficient practical value to describe them; and some of these here noticed, serve to show the many ways proposed to do the same thing, and to point out that the impracticable may become the stepping stone to the useful; or to show inventors what has been already done, or attempted, and to save them the trouble of *re*-inventing and *re*-patenting. This has been done to a large extent, and many years' experience in searching the patents, and making new machines, and experiments for inventors, leads me, as a matter of duty, to warn those who are fond of new ideas to be careful. One of the most unsuccessful attempts to form the lock stitch, and one often attempted, is to use a large reel of thread below in a spool, shuttle, or its equivalent, so that it will last as long as the needle thread, and require no re-winding. One of the most likely plans to do this, was to place the reel in a large spool case, having an external screw, which, by rotating, carried the needle thread from its front to its back end, the holder and driver being arranged to let the thread pass over it without obstruction. The arrangement was so far practical, but it involved long needle loops. More time is lost in pulling up long needle loops than in rewinding spools or shuttle reels. The spool, laying on its flat bed, and having a horizontal moving hook, is not so well adapted to work as one vertically placed. In the former the hook in taking the thread from the needle pulls it out of its slot horizontally, and thus bends or breaks it. The vertical pull of the hook is a far better arrangement, the needle being less liable to strain or breaking; and the thread pulled more in one direction only, or chiefly downward instead of across the needle: A vertically oscillating hook has been applied to carry the thread around the spool, the hook being curved to nearly match the circumference of the spool or holder. All such contrivances are more complicated than direct circular motion, and the complicated in mechanism is nearly always leading to failure; the simple, giving less trouble to learn, or keep in order, leads to success.

It is not advisable to do more than allude to other inventions for making the lock stitch. Shuttle machines are made to work with waxed thread, kept heated by gas; in some the loop of the needle thread is kept open by a hook, so that the shuttle passes through without dragging on the thread. In one machine working leather the shuttle is made to work above, instead of under it. Leather machine bands, ship sails, heavy carpets, and every kind of sewing, from the heaviest to the lightest, is done by the shuttle. One of the earliest attempts at a lock stitch machine was to use a double-pointed needle with its eye in the middle, arranged to go through the fabric, and back; being pulled by mechanical fingers, and using one thread, and pulling it tight at each stitch, as in hand sewing was once thought the best way. Another inventor proposed using a long needle, and to gather the fabric on it, then pull it through, and draw out the gathers until the thread was tightened; this simple but limited appliance is often revived and sold.

FIG. 1

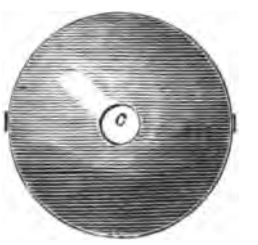


FIG. 2

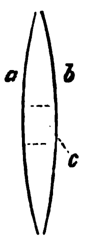


FIG. 3

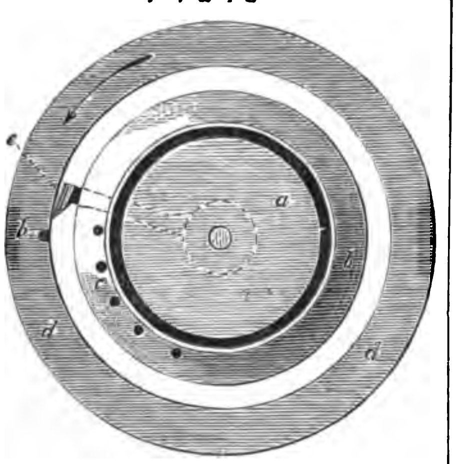
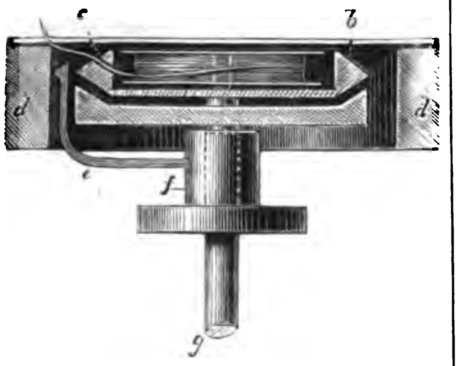


FIG. 4



The revival, and abandonment of inventions and imitations is abundantly illustrated in the history of the sewing machine. A museum containing one machine made to work from each invention, would be very interesting to the mechanic; it would be a very large collection, and show each link which connects together the extremes of difference. How unlike, at first sight, appears the Howe, and the Wheeler and Wilson machines! If they were taken to pieces, and then mixed together, we should only find a resemblance in their needles, all the other parts being dissimilar, yet adapted in a different manner to make the lock stitch. The instruments for making the lock stitch, already described in these pages, connect link by link, with slight shades of difference, the extremes of form and action. Some of these contrivances never came in, or soon went out of use, and only served to teach what could not be done, or to suggest ideas for better inventions. It is strange to find in "*the development of species*," and *the development of invention*, there is a resemblance. The sewing machine was not a perfect and complete invention at the commencement, but was developed by successive stages of improvement; the strong and useful predominate, the weak and useless die out. Selection of the right stitch is the first thing to do by those who desire to make a sewing machine, then to copy the best mechanical contrivance to produce the stitch, to study in detail the formation of the stitch, and working of the thread. The workmanship should be good, but it is of less importance than correct principle and proportion. There should be harmony of movement; needle and shuttle must be in time, and work smoothly. Further particulars will be given when the machines are completely illustrated, and at this stage many may be tempted to make sewing machines without having first paid sufficient attention to the formation of the stitch. Let such be warned in time, "a stitch in time saves nine."

A Practical Man.

P.S.—"Jacquard," 3848, Notes and Queries, is advised not to be in a hurry to begin making a sewing machine. His questions show great discernment, but involve too many considerations to be answered in a brief reply to do him service. What he requires is partly explained at page 232, and the rest will be fully dealt with when the subject is sufficiently advanced. Machines of different classes will be fully illustrated and their qualities compared, so that "Jacquard" and others may know how to proceed. No. 1. Some machines drive the shuttle by a crank, others by a cam with a pause. The form of cam depends on the other parts of the machines. 2. Buy a shuttle the size you wish. The shell is stamped to shape, and the ends brazed in. 3. The stroke is longer than shuttle from $\frac{1}{16}$ to ¼in., according to the machine and size employed. 4. The needle to raise about ¼in. and then pause while the shuttle passes through the loop.

SHORTHAND.

Sir,—The best system of shorthand is, I believe, Mr. Pitman's (of Bath); it is not hard to learn, and any one with an hour's daily practice, should be able to write at the end of twelvemonths, sixty words per minute.

G. Gregory.

Sir,—In answer to "Hermit," p. 255, Pitman's system is decidedly the most popular, and I think the simplest and most comprehensive. At one time I learnt Odell's, but did not somehow think very much of it. It is of course very difficult to say which is preferable from actual experience, as to learn one system thoroughly is not an easy task, while to mix that with others would lead to a glorious confusion. The ease with which Pitman's system is attained speaks well for it. I received from Mr. Pitman two courses of lessons, which, of course, greatly facilitates the acquirement of the art, and can only say I was much pleased with the simplicity upon which the system is based. I would by all means recommend "Hermit" to join a class taken by the above gentleman, when he would see for himself how surprisingly easy it is to learn. It is perhaps scarcely necessary to add that all depends upon the time devoted, and the regularity when practising.

Harry G. Newton.

MEDICAL GALVANISM.

Sir,—Much as has been written in this valuable journal on electricity, chiefly in relation to experiments, or to the science itself as a recreation, very little has been advanced on galvanism as a medical agent.

This subject appears to me of such vital importance, compared with many subjects discussed in your paper, such as electrical bells, magnetic engines, &c., &c., that I think it is high time that the subject of medical galvanism should be better understood, and more frequently discussed than it has yet been.

I have been induced to address you because I believe there is no other journal in this country which is better fitted to deal with this branch of electricity than the English Mechanic, both in its practical and theoretical bearings. Some of your correspondents have, I believe, objected to medical subjects being discussed, and so far as physic itself is concerned, I should say that the inquirers themselves are not likely to suffer much in constitution by remaining in ignorance of some of the irrational prescriptions which are often suggested to them. But when a subject like the present falls within the domain of physical science, and when it is remembered that electricity is both an external and an internal remedy, which can alleviate pain and arrest disease, and this, too, in the most rational inexpensive, and simple manner, and when the patient himself may administer the remedy without fear of adulteration or empiricism, its importance becomes secondary to no other branch of electrical or experimental science, and its generation and application demands the attention of any journal which is competent to deal with the subject, and professing the advancement and well-being of its readers. It is true that electricity as a remedial agent has worked its way but very slowly, but it would not be difficult to show, did space permit, how this has happened. I believe there are still many intelligent physicians who regard galvanism in disease as empirical simply, as I take it, because they do not see or understand why or wherefore it, being a thing intangible, and as immaterial as a shadow, should have any effect upon the nervous economy. On the other hand, others have gone so far as to believe this mysterious fluid to be the nervous influence itself. But whatever doctrine is right, it is sufficient for our purpose to know that electricity is a surprising stimulant to the nervous system; and, moreover, that it would appear to have the power of preparing, repairing, and replenishing the shattered telegraph wires of the body wit hpermanent additional energy.

Before I close allow me to state more particularly my object. It is to ask your correspondents to take this subject up. Amongst the many thousands of subscribers to the English Mechanic there will ever be a vast percentage who receive these pages every week, sufferers from some bodily derangement or disease, and who might receive incalculable benefit from a proper application of galvanism. Many, doubtless, are poor and unable to purchase the costly and often worthless apparatus, as sold at the instrument makers. Many do not understand the *modus operandi* of the same. It would not be necessary to plunge into the theory of the nervous effects of electricity, but to point out the most desirable, easy, cheap, and efficient way of constructing apparatus suitable for medical use. What is wanted, then, are plain drawings and directions with advice as to the proper administration of the current. An ordinary coil, I believe, is not suitable, the objections being that where there is more than one continued wire the current is completed in one, while in the secondary wire another current is induced which completely destroys the power as a remedial agent.

Since writing the above I have received so many answers respecting Medical Coil ("Wanted") as per advertisement in No. 270, that I am more strongly convinced than ever that the apparatus and application generally are totally unsuited to the purpose. The chief error seems to be in using intense battery power as though the living economy were to be relieved of pain by additional torture. Most of the coils are primary and secondary wires, and most likely have no guide to the uninitiated as to which is the negative and which the positive pole. It is manifest that this latter is of the greatest importance, since in many diseases the current from the positive element should flow with the natural stream through the system, whilst in others the current is reversed.

W. A.

LIGHT OF HEAVENLY BODIES.

SIR,—In a letter addressed to the astronomical readers of the journal in general, H. W. Bishop states that I said "that the light of D'Arrest's comet was to be 0·126." I think I may venture to say that I never said anything of the kind. What I said was, probably, that the *intensity* of the light of the comet would be represented by that fraction.

The intensity of light of a heavenly body not self-luminous is proportioned to $\frac{1}{R^2 D^2}$, R and D representing respectively the radius vector and the distance from the earth. At the time mentioned this fraction $\frac{1}{R^2 D^2}$ was equal to 0·126. At the time that the comet became invisible to Maclear, at the Cape of Good Hope, at the last apparition, the intensity was equal to 0·190, the probability was therefore that at the date I mentioned, the comet would be slightly fainter than when lost sight of by Maclear. So far as I know at present, the comet has not been discovered.

OMICRON.

THE LATHE.

SIR,—Since the appearance in the ENGLISH MECHANIC of the description of the Saltaire Lathe, I have been troubled with a wish which I have had many a time during the last two or three years; and that is to improve the lathe in my possession, or make a new one; I have been a subscriber from the first number, and have carefully read all the articles on the lathe, but I am undecided on many of the different points of a perfect amateur's lathe. Could Mr. Smith be induced to give us working drawings of an amateurs lathe, drawings to scale, say the gantry, so as to give height from floor, and a section of do., length he would recommend gantry to be, drawings of the two heads, and height of centres, together with the form and diameter of spindle of fast head—in fact, all drawings and dimensions to enable an intelligent workman to construct one, always bearing in mind all to be made so that the other tools, chucks, slides, and the different cutting apparatus belonging to a complete lathe could be added to at the inclination or convenience of the workman; I think it would be a very interesting subject, and one very popular. If the height of the centres given did not suit every one, they could enlarge or reduce the dimensions to their own. That the subject is of interest I see by the inquiries of No. 3866 and 3867 in this week's number. Some time since we had two or three promises from different parties to give us specimens, &c., which I am sure would give pleasure to more than myself, and also Mr. Plant promised drawings of his chucks. I am sure they will excuse me reminding them—the reason is, I am anxiously expecting them.

H.

ACHROMATIC OBJECT GLASSES.

SIR,—If any of your contributors would kindly afford information upon the following points in connection with achromatic telescope object glasses, it would be highly esteemed. In Brewster's and other works upon optics, the secondary spectrum is described as being of a wine, claret, purple, or lilac colour, on one side, and of a green colour on the other side of the focus. Now, I have had opportunities of examining object glasses by some of our best makers, and the outstanding colours in all of them, were (to my eyes) blue and yellow. Am I to infer from this difference, that the tint of such oustanding colours is chiefly influenced by the colours of the two rays selected for correction, and that the extreme red and violet ones (as mentioned in the works alluded to), are no longer (as a rule) adopted for that purpose; or is such difference attributable to the irrationality of the glass now employed? It has struck me, upon comparing one or two glasses which have come under my notice, giving a dark outstanding colour, resembling the claret, or other colour referred to, with one in the blue state of correction, that the former was incomparably superior in defining fine black lines, which I attributed to the contrast between black and white being much better preserved under the influence of a dark colour, than a pale bright one. The dark colour also appeared to be much less in quantity than the blue, which latter seemed to form a cloud before the object, and a wide fringe around it, while no such obstruction was perceptible or appreciable in the case of the claret or deeper-toned colour. I should like some of your readers to make the experiment upon a white enamelled watch face, at a distance not exceeding thirty or forty yards, in full sunshine, under a high power. Other states of achromatism may, by uniting more luminous rays, appear, theoretically, to offer an advantage in the shape of increased intensity, but is it not probable that a paramount disadvantage may accrue from the uncorrected colour being both paler and thicker, or of greater breadth, whereby the advantage which would otherwise necessarily follow the increased amount of light, would be counterbalanced? If the experiment suggested be made, it will be observed that under the blue correction, black letters will appear absolutely blue, whereas in the other case, the black will remain unimpaired. I should also be glad to know what effect over and under correction have upon the definition, and whether object glasses, in which the extreme red and violet rays are united, can now be procured, and of whom?

O. G.

GEOLOGY OF IRELAND.—WHEEL-STONES.

SIR,—The deposits of limestone passed over by your correspondent "F. Harwood," p. 257, is that known to geologists as the Mountain Limestone, and occurs as the middle group in the Carboniferous system immediately underlying the true coal measures. This formation and the carboniferous slates are widely developed in Ireland, and give to the scenery of that country some of its peculiar and special features. The characteristic fossils of the mountain limestone are corals, and encrmites, especially the latter, which very often make up the entire mass of the stone; from this circumstance it is aptly termed "encrmital limestone." The encrmite, or "stone lily," so called from its elegant shape, is an animal, and belongs to the class Radiata; it is, in fact, a star-fish set upon a flexible and jointed stalk. It is of marine habitat, and wherever found as fossils indicates the strata to be of marine origin. Until recently the race of Crinoideæ were thought to be extinct, and only a dozen kinds are now known to exist, one of the dozen being dredged up by Professor Forbes in Dublin Bay. The separated discs of which the stems of these creatures were composed being naturally perforated, were thus easily strung upon strings and used as rosaries; they were likewise called wheel-stones, and St. Cuthbert's beads, by the English peasantry, St. Cuthbert being credited with their production. Sir Walter Scott refers to this circumstance in Marmion:—

> "On a rock by Lindisfarn
> St. Cuthbert sits and toils to frame
> The sea-born beads that bear his name."

H. H.

THE SOLAR SPECTRUM.

SIR,—I am pleased to find so good an authority as J. Norman Lockyer endeavouring to remove my difficulties regarding the origin of the dark lines in the solar spectrum. In returning thanks, may I assure him the evidence afforded by the phenomenon referred to had been duly considered before I ventured to write the letter on p. 114; but I arrived at the conclusion that the want of chemical power in the light of the solar prominences was the cause of some of the lines changing from dark to bright.

I cannot agree with Mr. Proctor in considering Kirchhoff right in ignoring crepuscular evidence. Neither, in my opinion, are the conditions wanting in the upper atmosphere for the chemical combination with oxygen of iron, magnesium, &c. He is, however, undoubtedly correct in considering that employing one's-self about photographic manipulations does not necessarily teach anything concerning the nature of light. That depends upon the character of the operator. He may be an excellent photographer, although a poor philosopher.

In dismissing this subject, I wish to add a few words respecting the motive for its introduction. In the hands of the astronomer the spectroscope has proved of great service. In the hands of the meteorologist it would be equally as useful. I hope this hint will not be disregarded.

T. A.

TESTING BOILERS.

SIR,—As a rule, I do not care to call in question the replies given in good faith by your correspondents, but in your present number I find "Anti-Egyptian" gives a reply which is very likely, from its vagueness, to mislead many of our fellow-readers. His first remark, that it is useless to test a boiler unless the plates and seams are visible, is quite correct; but after that he states that a single rivetted boiler cannot be worked at a higher pressure than 15lb. on the square inch. Now, from old age or imperfect construction, it may be that his engineer forbids him to work his own boilers at a higher pressure, yet the statement that no boiler can be worked beyond 15lb. unless it is double rivetted, is certainly a long way from the truth. I can assure him that we have three Cornish boilers constantly at work, from year's end to year's end, at a pressure varying between 35lb. and 40lb., and yet they are all single rivetted. How can the two statements be reconciled?

T. S. CONISBEE.

EXAM.—QUESTION.

SIR,—"Zeta's" query (No. 3937) is very simple. The weight of one litre of nitrous oxide at 0°C. and ·760 metre of mercury is 1·9712 grammes. 200 grammes, then, must measure 101·461 litres, and as one litre equals 61·028 cubic inches, that is equivalent to a volume of 6191·965 cubic inches. He can readily obtain the weight in grammes of one litre of any gas at 0°C. and ·76 metres of mercury, by multiplying ·0896 by the atomic weight of the gas, and divide by its volume: as for nitrous acids

$$\frac{\cdot 0896 \times 44}{2} = 1{\cdot}9712 \text{ grammes.}$$

Mr. Murray (No. 3961) should use gelatine as a cement for bisulphide prisms. It is the easiest, if not the best, as I can personally testify.

URBAN.

ANSWERS FROM GEORGE E. DAVIS.

SIR,—A correspondent, "Another Flautist," requires the composition of German silver. I offer the following:—1st, copper, 40pts.; zinc, 26, and nickel, 31pts. 2nd, copper, 10pts.; zinc, 6, and nickel, 4pts. The first is a good metal, which takes a high polish, and the second is the white copper of the Chinese.

Query 3850.—"Thermo" may perhaps unite the mercury in his thermometer by giving it a series of sharp jerks. See also other correspondents' answers to "Gitche Manito," some time since.

Query 3875 ("Gratus").—Bleaching powder is made by placing lime (moist) in a chamber, upon perforated shelves, and submitting it to the action of chlorine, evolved by the action of hydrochloric acid upon the black oxide of manganese. Refer to correspondents' answers on the subject in a recent volume.

MANUFACTURE OF OXYGEN (3883.—"M. P. C. S.")—Oxygen may be prepared from manganate of soda by heating it to a certain temperature in a retort which is connected with a steam boiler, and a pump which supplies air. The retort containing the manganate is first heated, and the tap from the steam boiler turned on, when the following change takes place:—

$$(Na_2\,MnO_4)_2 + (H_2O)_2 = (NaHO)_4 + Mn_2O_3 + O_2$$

The oxygen being liberated, is passed on to the holder. When this part of the operation is over, the steam is shut off, and superheated air pumped over the mixture in the retort for about a quarter of an hour, when it is again ready to undergo the first operation. The air must be freed from carbonic acid by passing it through caustic soda solution before being pumped over the spent manganate. The manganate may be made in large quantities by heating to redness a mixture of black oxide of manganese, carbonate and nitrate of soda, the heat being continued for some time, in order to decompose the sodium nitrate, which is at first formed.

Query 3887.—THE UTILISATION OF SEWAGE.—See "On the Utilisation of Sewage by Irrigation and Filtration," by C. E. Austin, Mem. Inst. C.E.; Baldwin Latham's "Inaugural Address," published by Spon, and Baron Liebig's letter on the utilisation of the metropolitan sewage, published by Allnutt. There is plenty of information on the subject to be found scattered through the *Engineer*, *Building News*, and *Gardener's Chronicle*.

WATER ANALYSIS.—("Aqua" 3886).—If "Aqua" is not accustomed to make analyses of different articles, and water more particularly, he should use Nicholson's process, which is admirably described in the *Quarterly Journal of the Chemical Society* for December, 1862. The apparatus required would be 2 burettes, 50 cbc., divided into 500 parts, with an Erdmann's float. The burettes must be provided with a glass stopcock in lieu of the indiarubber tube, and Mohr's clip; several small stoppered flasks, to hold about 100 cbc.; porcelain and glass evaporating basins, a few beakers, and a litre measuring flask. Solutions required are:—Standard lime solution: Dissolve 0·172 grm. of selenite in a litre of water. Soap solution: The sapo mollis of the Pharmacopœia is to be dissolved in a mixture of equal volumes of distilled water and methylated spirit, to be of such a strength that 22 divisions of the burette are required to produce a permanent lather with 50 cbc. of the standard lime solution. Barium nitrate solution: 0·26 grm. in a litre of distilled water. Silver nitrate solution: 8·5 grms. in a litre of water. Ammonium oxalate, 0·355 grm. in a litre of distilled water. Chameleon solution: Dissolve 0·159 grm. of potassium permanganate in a litre of water. These are the standard solutions required; but for the analytical process I must refer "Aqua" to Nicholson's paper, the December part of the *Journal of the Chemical Society* for 1862, as it would occupy too much time and space to give it in detail.

VOLUME OF GAS (Query 3937).—"Zeta" can calculate the volume of gas thus:—11·16 litres of hydrogen weigh 1 gramme; and as the density of nitrous oxide is 22, that is half the molecular weight, 11·16 litres of that gas measured at 0°C. and 760mm. would weigh 22 grammes. Now, as we know that 22 grammes occupy 11·16 litres, we can easily find the volume occupied by 200 grammes:—

$$\frac{11{\cdot}16 \times 200}{22} = 101{\cdot}454 \text{ litres at } 0^\circ\text{C. and 760mm.}$$

WEIGHT OF GAS (3956).—R. Terset can, by following the method here detailed, find the weight of any volume of gas. First, methyl gas is known by the formula $\left\{ \begin{matrix} CH_3 \\ CH_3, \end{matrix} \right.$ therefore, the density would be 15. Now, a litre of hydrogen at 0°C. and 760mm. weighs 0·0896 grm.; consequently, a litre of methyl would weigh 1·344 grms. at the same temperature and pressure. But the temperature is 20°C., whilst the pressure remains unaltered. A litre at 0°C. would become 1·0733 at 20°C. by the equation 1 + at or 1 + (0·003665 × 20). We can now easily get the weight of 1 litre, for we have found that 1.0733 litres of methyl at 20°C. weigh 1·344 grammes; what will a litre weigh? By the equation:—$\frac{1{\cdot}344}{1{\cdot}0733} = 1{\cdot}252$ grms., or the weight of a litre of methyl gas 20°C. and 760mm. As regards the second part of the question, how to prepare acetic acid from the substances mentioned, he may prepare it thus:—First slack the lime with water, and boil it with sodium carbonate to form sodium hydrate. This must be obtained in the solid state by evaporation.

$$Na_2CO_3 + Ca(HO)_2 = (NaHO)_2 + CaCO_3.$$

The ethyl iodide is then acted upon by the caustic soda, and the resulting alcohol distilled off:—

$$C_2H^5I + NaHO = C_2H_6O + NaI$$

The alcohol is then heated with sulphuric acid and potassium chromate, when aldehyde is formed:—

$$C_2H_6O + O = C_2H_4O + H_2O$$

and this aldehyde, when fused with caustic soda, forms the sodium salt of the acid, from which salt the acid is liberated by sulphuric acid:—

$$C_2H_4O + NaHO = C_2H_3NaO_2 + H_2$$

$$\text{and } (C_2H_3NaO_2)_2 + H_2SO_4 = (C_2H_4O_2)_2 + Na_2SO_4.$$

I hope I have made the process plain enough for R. Terset, and shall be most happy to help him on the road to knowledge whenever he chooses to ask.

GEORGE E. DAVIS.

FLIGHT.—FIGURE OF 8 WAVE THEORY OF WING MOVEMENTS.

SIR,—Would you kindly insert the enclosed in your valuable journal; it will, I think, interest a large number of your readers.

AVIATOR.

In the proceedings of the Royal Institution of [illegible] Britain for March, 1867, Dr. J. Bell Pettigrew, [illegible], the distinguished Curator of the Museum of the Royal College of Surgeons of Edinburgh, announced the startling discovery that all wings—whether those of the insect, bat, or bird—were twisted upon themselves structurally, and that they twisted and untwisted during their action—that in short they formed *mobile helices or screws.* In June of the same year (1867), Dr. Pettigrew, following up his admirable researches, read an elaborate memoir "On the Mechanism of Flight,"* before the Linnean Society of London,* in which he conclusively proves, by a large number of dissections and experiments, in which he greatly exhibits, that not only is the wing a screw structurally and physiologically, but further that it is a reciprocating screw. He shows, in fact, that the wing, during its oscillations, describes *a figure of* 8 *track*, similar in some respects to that described by an oar in sculling. This holds true of the vibrating wing of the insect, bat, and bird, when the bodies of these animals are artificially fixed.

When, however, the creatures are liberated, and flying at a high horizontal speed, the figure of 8, as he points out, is curiously enough converted into a *wave track*, from the wing being carried forward by the body, and from its consequently never being permitted to complete more than a single curve of the 8.

This is an entirely new view of the structure and functions of the wing, and one fraught with the deepest possible interest to the aëronautical world. It promises to solve everything. Dr. Pettigrew's remarkable discovery has received an unlooked for confirmation within the last few months at the hands of Professor Marey, of the College of France, Paris. This gentleman, who has acquired great celebrity for his improvements and dexterity in the use of the sphymograph, has succeeded in causing the wing of the insect and bird to register their own movements, and has established by an actual *experimentum crucis.* the absolute correctness of Dr. Pettigrew's views. Professor Marey's mode of registering displays much ingenuity, and is briefly as follows:—A cylinder revolving at a given speed is enveloped by a sheet of thin paper smeared with lampblack, and to this the tip of the rapidly-vibrating wing of the insect is applied in such a manner as to cause it to brush out its track on the blackened paper, which it readily does. A similar result is obtained in the bird by fixing a registering apparatus to the wing, and causing the bird to fly in a chamber. In this case the registering apparatus is connected with the cylinder by means of delicate wires, and the registering is effected by means of electricity. In both cases the figure of 8 and wave movements, originally described and figured by Dr. Pettigrew, are faithfully reproduced. It is difficult to forsee what next. The way of a wing in the air has hitherto been regarded as a physiological puzzle of great magnitude; and well it might be, since some insects (the common fly for example) vibrate their wings at the almost inconceivable speed of 300 strokes per second, that is, 18,000 times in a minute!

SCIENCE FOR THE YOUNG.

SIR,—The uncourteous tone of Mr. O'Connor's letter, p. 257, ENGLISH MECHANIC, imperatively forbids my taking any notice of its contents. Nothing would induce me to help on, even ever so little, that spirit of incivility between correspondents in the ENGLISH MECHANIC, which has done so much mischief in 'times' now fortunately passed, to the real, the best interests of the journal. Were this obstacle not in the way, it would be easy to show Mr. O'Connor that a better acquaintance with "Science for the Young" would probably more than reconcile him to the divisions of the subject, and would certainly convince him that there was no reason for his letter.

E. KERNAN, Clongowes.

EMIGRATION.—TO "COTTON CLERK" AND OTHERS.

SIR,—Divert your attention for a moment from Canada and the other British colonies, and direct your thoughts also for a moment to other States, whether as regards Republics, or under other Governments—for example, South America. Not countries which lie within the Tropics, but in those broad, healthy climates which lie to the south of, say, Rio de Janeiro. From this point, lying southward, you come first to Santo Paulo, a district where lately, I believe, there has been introduced a railway, through English capital, and gas works, and a region of great beauty and fertility. Then you come to Paranagua and San Francisco; then to San Catherina and Portalegre, all offering some splendid sites for emigrants, but some, of course, preferable to others. Then you come to the Banda Oriental, the Entre Rios (district lying between the two rivers Uruguay and Parana), and lastly the unsettled but magnificent district of Paraguay, which grows everything almost in the world. All these countries are either Republics, enjoying their own privileges, or are under the Brazilian Government. To these regions resort, every year, hundreds of Germans, thrifty and wise, who congregate together and make their own peaceful settlements there, become farmers, and make their little fortunes. The exact settlements where these honest Germans live I do not precisely know; but they have this advantage, they have the country to themselves, and live in peace. I should say to this good and industrious "Cotton Clerk," place yourself at once in correspondence with any house you may know at Liverpool who trades with the Brazils—he will give you all information; or, secondly, with any merchant trading with Buenos Ayres or Monte Video; or, thirdly, if you know any German at Liverpool, Manchester, or London, he could tell you what his countrymen are doing. Recollect, when you go to a British settlement, you must *pay for the fancied security.* In the other countries on the Southern Main you may get quantities of land all but given to you—that is, in *some* of the above countries. You can ascertain for yourself what population there is. I rather think it is somewhat scant, and that everyone is his own workman; and, of course, in a foreign country, where there are *none* but Germans, it may be somewhat dull and dreary. But the Anglo-Saxon blood abounds everywhere, and facts you can get for yourself. I believe the safety and security of these lands are everything you can desire. The world is growing, through the influence of science and education, somewhat tired of war, and all peoples and all languages are finding out that riches, well-being, and comfort are to be found in the pursuit of the peaceful arts of manufacture and agriculture, rather than in the barbarous pastime of war.

E. W. J.

COTTON SPINNING.

SIR,—Your correspondent, "B. W. R.," page 230, seems very much disposed to carry out the old adage—viz., to "pick a fellah up before he's down"—with respect to my letter on draughts. When will ye have wisdom, and hearken to the voice of reason, O ye cotton lords! Surely "B. W. R." must have penetrated very deep into the mysteries of the fibrous art to find out that a lap will bag if there is no draught between feed and lap rollers. Let me inform him, for his edification, that we have at the present time about 140 carding engines at work, and if he can find the slightest draught in any one of them, or the least sign of a slack lap, I dare forfeit the engine he finds it in. The same may be said with respect to the lap rollers of our combing machines. It may not be out of place here to remark that I flatter myself with having penetrated so far in the art of cotton spinning to know that if the lap rollers move at the same surface speed as the feed rollers, it is impossible for the lap to bag. The following is the draught (!) of our engines between lap and feed rollers:—Diam. feed rollers, 1¾in.; lap rollers, 6in.; a 14 wheel on end of feed roller drives a 48 on end of lap roller. The result of the above, when well reckoned, will amount to about as much as "B. W. R.'s" penetration does. I want to know what use a draught would be if the lap is delivered just as the feed rollers take it? How can it bag? You just may as well say that the break van at the rear end of a train will get into the station before the engine that is pulling it. "B. W. R." also refers me to a letter of E. Slater, on the same page as my own, to convince me that there is a draught. Certainly E. Slater may have a draught in *his* engines; but if E. Slater has a failing (which it certainly is), it does not follow that it must be crammed into every person's noddle, whether they agree with it or not. By-the-bye, if all E. Slater's contributions are to be judged from his distribution of "Factory Lad's" draughts, and his "penny wise and pound foolish" ideas about draw-boxes; if we are to infer that these are "the truth, and nothing but the truth," then I must say that "B. W. R.'s" "penetration" has not been of much use to himself, or he would never have referred me to E. Slater to be convinced of my error (?). "B. W. R." also loses his extraordinary "penetrating" powers when he states that the draw-box of a carding-engine is between the doffer and delivery rollers. He must mean between the doffer and *coiler* rollers, as the draw-box and the delivery rollers are the same thing—at least they are so called in this quarter of the globe. What I said then I say now, that there is not any draught between doffer and delivery rollers—*i. e.*, the draw-box.

THE HARMONIOUS COTTON SPINNER.

[Some of our cotton correspondents are somewhat inclined to "chaff" each other. This is no doubt amusing to them, but they should remember it occupies valuable space which might be better appropriated. They and all others would oblige by telling us what they have to say in the fewest number of words, so that we may be enabled to give the largest amount of information for the largest number of readers.—ED. E. M.]

SIR,—CONTRIVANCES FOR TESTING THE STRENGTH OF YARNS, &c.—I shall be very much obliged if any of the Cotton Spinning Company will give me some information about the above. The reason of me troubling you is this: I have an idea of making a simple machine by which you can tell the strength of yarns in lbs. and oz. without the aid of springs, or any complicated mechanism at all about it. What I require is this—a brief explanation (accompanied by diagrams if found needful) of the most complete and simple contrivances now in use, that will give the strength of yarns from 80s single, down to 40s 12 fold heald yarn. If I find that there are more simple and correct ones than mine (which I am not so self confident as to doubt at all), then of course I shall not go on with mine; but if I see that mine will have any advantage over the others in use, then I shall get one finished, and trouble you to give a description of it with a sketch, so that I can submit it to the penetration of your now numerous body of cotton spinning subscribers. I shall be glad when anybody replies to the above, if they will give the names of the makers, and where I can obtain one. I beg to return my thanks to Joseph B. Crossley (p. 254) for his recipe for size for cop bottoms, which I find to act very well, especially with a bit of fish glue added to it. He is right in saying that the difference in the make of frames will make the results of experiments very considerably, but I cannot understand (except from that cause) how he can run his frames faster with the bobbins leading than with the flyers leading. Of course there is not much difference when the bobbins are full, and they are leading, and you are making about a 12 bank roving, but when the frames are just starting a fresh set, and the bobbins are empty, and you are making say ¾ hank slubbing, then is the time the poor tubes "get it hot." I have not very much spare time at present (and probably you have not much spare room) or I would go into this much-neglected subject more fully. Early information on the yarn testing subject will greatly oblige.

THE HARMONIOUS COTTON SPINNER.

SIR,—DRAUGHT OF DRAWING FRAME.—On page 136 "Factory Lad" asks: "Suppose a drawing frame to have 4 lines of rollers, with a total draught of 7, what draught ought there to be between the 1st and 2nd, 2nd and 3rd, and 3rd and 4th rollers?"

On page 183 E. Slater, Burnley, replies thus: "Let 'Factory Lad,' page 136, divide his 7 by 3, and make the draughts of each line of rollers in the drawing boxes equal, as 2⅓ + 2⅓ + 2⅓ = 7, or 2¼ + 2½ + 2¼ = 7."

On page 231 Mr. Slater corrects himself in the following words: "My meaning was (from front to back), between front and 2nd roller, 2·5; between 2nd and 3rd, 1·69; between 3rd and 4th, 1·67. Or, reversing their order, 1·67 × 1·69 × 2·5 = 7·05575, or something as near this order as he should find convenient. I was once rarely puzzled by a similar answer, given to me by a very intelligent old man; however, I learnt something from it, and if you *think* you will do the same."

Now, I submit that if Mr. Slater will *think*, he must think that it would tend more to the improvement of our contributors if he would kindly write what he *means at once*; for I dare be bound he is the only person who reads his two replies who will find the least possible resemblance between them. He says his object in writing is to set us thinking. It certainly will; but it leads me to think he ought to be a little more consistent, "especially when, as in this case, the subject is a very important one."

MUTUAL IMPROVEMENT,

SIR,—Edward Habergham, p. 204, says he is wishful to understand the backing off motion, and the operation of the cam shaft. The term "backing off" is applied to the reversed motion of mule spindles at the finish of a "spinning stretch," by which the coil of yarn that the spinning action has thrown upon the bare portion of them is unwound down to the point of the cop, so that the action of winding may commence on the body of the cop. Now, observe, this backing off action must take place at the same time, and correspond in its speed to the downward motion of the faller; for if the spindles back off quicker than the faller goes down, the yarn will be thrown off into "snarles;" or, if slower, it will be overstretched, and the bottom coils pushed down in a slovenly manner to the cop shoulder. And, moreover, as the cop is continually increasing in length, the backing off must be diminished in the same proportion. From this, then, it is clear that the two distinct operations, the locking of the faller and the backing off of the yarn, must by some means be made to depend upon each other. This has been ingeniously accomplished by many different arrangements of levers and cams, &c.; so I will now try to explain their action and principle. See the sketch, which, I may observe, is not intended to be a correct representation of any working mule, but to illustrate the actions, and help to convey some idea of the cam shaft and backing off motion. 1 is the backing off disc or cup, to which a retarded motion is given from the pulley 3 by the wheels 4, 5, 6, 7, and 8, and this in an opposite direction to that of the pulley 2 and rim. The pulley 3 is loose upon the rim shaft, and connected to the wheel 4 by a long boss. 10 is the ordinary loose pulley. Fast upon the rim shaft is the friction cone 11. The surface of this corresponds to the inside of the cup 1. Let us now suppose that a stretch has been spun, and that there is some kind of a bracket fixed to the carriage, which comes in contact with the long lever, and causes it to fall a certain distance at the front end. This action of the lever will cause a corresponding rise of the connecting rod *a*, which in its turn will lift up an escape lever, *b*, that has been holding against one of the pallets, *c*, on the end of the cam shaft, A. As soon as this takes place, the cam shaft having power given to it either by a friction bowl, a strap, or other means, turns round until another of the pallets comes in contact with the escape lever. But suppose this first movement of it has, by means of cams that are attached to it, caused the strap to be thrown on to the pulley 3, and the disc 1 to be pressed against the cone 11 by the lever *b*, it is evident that the disc will not only act as a brake to the rim shaft and spindles, but when it has stopped their motion in one direction it will then turn them in its own, or reverse their first direction, and that this action will go on as long as the cam D presses the disc against the cone, or so long as the cam shaft keeps this condition. However, as soon as the rim begins to move in a backward direction, the catch *x* comes in contact with the teeth of the ratchet wheel *y*, which is fixed upon the same shaft as the pulley 12, or spindle shaft. The ratchet then causes the ring *z* to turn round along with the shaft and spindles; and as the chain 13 is attached to this ring, the motion is communicated by this means to the "faller sector" 14, which is pulled down at a speed corresponding to that at which the yarn is being unwound, until the latch 15 falls at the end of the sector, and locks the faller. The falling of the latch 15 allows the lever 16 to fall also, and this, through the rod 17, allows the long lever to fall another distance, which in its turn again liberates the cam shaft from the contact of escape lever and pallet. The cam shaft now turns a distance further, and throws back the disc to its loose position upon rim shaft, and, at the same time, by other cams and levers, throws the putting up wheels into gear, and the carriage runs up until the long lever is pressed down again at the back end, and the cam again is allowed to complete its revolution, throwing spindles, rollers, and carriage into gear all at once for another stretch.

I may observe that the first motion of the cam shaft at the finish of the out stretch of the carriage is often made to throw the rollers and carriage out of gear, whilst the strap is still allowed to drive on the rim pulley for the purpose of putting extra twist in the yarn. When this is the case, the cam shaft will be held stationary by some such arrangement as a worm and bell wheel would give. It is well to observe also, that the less the cops are, the higher is the builder, which causes the latch 15 to be thrown farther back on the surface of the sector 14; and the farther back this is thrown, the longer will the spindles back off before the cam shaft is liberated by the falling of the latch. The arrangement of wheels, cams, levers, &c., that have been contrived to produce these various conditions and motions to such a degree of perfection as we now find them, has required a great amount of ingenuity; and to understand their working thoroughly will be well worth the trouble Edward Habergham may devote to the purpose. In fact, the self-acting

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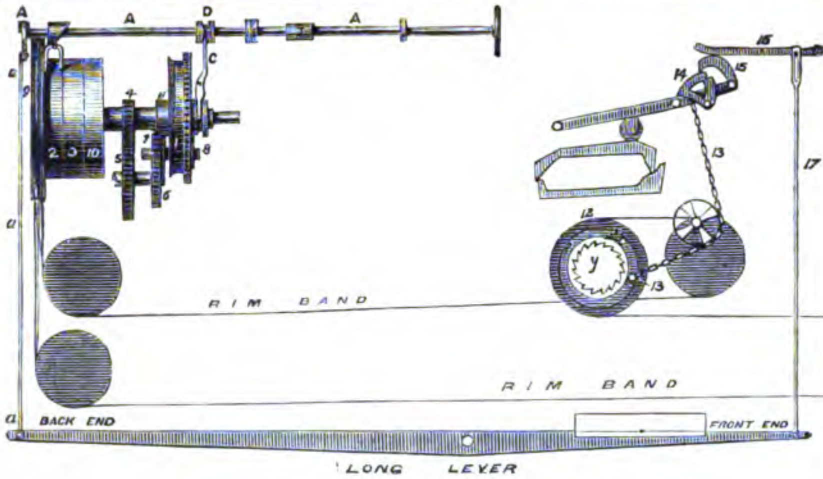
* This memoir, which is illustrated by nearly 100 original figures, is published *in extenso* in the 126th volume of the Transactions of the Society.



mule is a wonder in itself, and a credit to English ingenuity. I have perhaps said enough now to put him on the proper track when he watches the mule in operation; if not, I shall be glad to render further help. I beg to thank him for his kind words; and if I have been of service to him, I am by that fact repaid for my trouble.

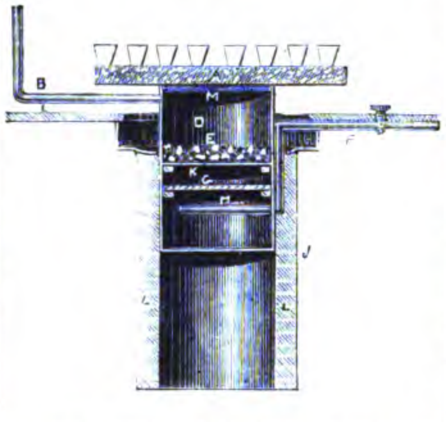
I see in this week's Mechanic that my answer to "Factory Lad" has brought a "cart-load of bricks" on the top of me, "I beg to tinder my grate thankfulness for that same intirely." However, I had no idea whatever that he would receive so many answers in return; but I have an idea that some mischief might be done by him or others acting from insufficient information, and was quite willing and prepared to give both further explanation and "reasons" for what I have said. Look at the circumstance of C. Halmshaw, of Gomersal, having begun to alter some jack-frames —roving or slubbing frames—before he had looked properly *through* the job, and this, too, from an *idea* that he had gathered from a communication by "B. R. W.," which I am positive that gentleman never intended to convey; and I think your conclusions will be like my own, that no one ought to act upon the information contained in a short, isolated answer from any one. An important machine like a drawing box, one single bad roller in which will spoil the work of 1000 mule or throstle spindles, should not be altered without a thorough knowledge of the "why" and "wherefore." It is said of Arkwright, the inventor of the frame, that when anything was wrong with his yarns he told his men to see to the drawing boxes. "The fault," he would say, "is sure to be there." I do not say so myself; but this showed that he fully understood the importance of them. As I stated in my last, an answer similar to the one I gave him caused me to *think*, and *made* me learn. I asked an old manager how he would distribute a total draught of six in four lines of drawing rollers. His answer was, "Have a last draught of two, and add the other four by the first and the intermediate ones." However, I will return to these same drawing boxes again, and I think I shall be able to lift a few of the bricks on to some other of the answers that have so far been given to "Factory Lad." But as my object would not be served by "banging them about," I will try not to get in a temper, and "dust" both myself and those who differ from me, like some of the millers have done.

I should like to call the attention of "Mutual Improvement" to these two extracts from his letters: —"I quite agree with 'B. W. R.' the rule I quoted does not give the draught sufficiently accurate. The draught should be the difference between the surface speeds of the first or feed rollers and the last or delivery rollers." "Harmonious Cotton Spinner" seems to understand his business. He is perfectly right: "Let the rollers take up properly, and there will not be any material draught between doffer and rollers." Did he not ask if the rule quoted was "strictly correct?" And now, when he has got answers to what was, as I at once supposed, an ambiguous question, he makes it appear that both sides are perfectly right, though one says "yes" and the other "no." I have no doubt whatever but that "B. W. R." and "H. C. S." are both of one mind about the subject of a draught between lap roller and feed rollers—*the less that can be made to do and the better*, just enough to keep the sheet of cotton straight, is all-sufficient. How would "Mutual Improvement" manage to get the gossamer-like web from the deffer to the calenders without some slight gaining motion of the latter, when even a breath of wind will stretch it out and make it slack? I will give my reasons for condemning draw-boxes shortly, but I may here say that though "some of our most successful spinners work them," it does not at all follow that their success is due to the draw-boxes; possibly it may be in spite of them. With respect to the question raised about bobbins or flies leading, I am in favour of the bobbins leading, because it makes a more equally pressed bobbin with less waste. And, bear in mind, the waste that flies off the broken end, when the fly leads, is not only waste, but very mischievous waste, as it gets entangled with the other ends that are running upon the bobbins, and causes thick, slovenly places in the yarn, that are a perfect—if I may use the word—eyesore when the printed cloth is examined. "H. C. S." says, page 204, "Let any one try to start a frame with the bobbins leading and the spindles running 900 per minute." My answer is, that ours run, with no inconvenience, at about 1280, or between that and 1300 per minute, making about a six hanks roving. But, by the way, what will "H. C. S." think when I tell him, as I do now, that he must by some means or other put his cart before his herse if he intends it to go?

E. Slater, Burnley.

HEATING GRRENHOUSES.

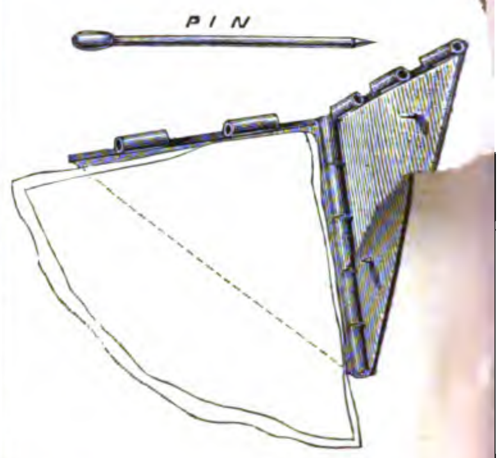
Sir,—There have been many ideas and plans discussed in your columns for the heating of greenhouses, but not one, as far as I see, suitable for a window conservatory. Now, I, in common with many others, have erected one of these miniature affairs against the window of my sitting-room, and there, during the whole of last summer and autumn, even up to Christmas Day, my geraniums and fuschias grew and blossomed in abundance; but the first sharp frost converted my little fairy scene into one of woe-begone desolation. Then, and not till then, did I set about discovering some cheap and simple means for excluding that merciless fellow, Jack Frost; and having studied the pages of the English Mechanic for some time past without getting any suitable hints, I have invented a simple apparatus, which I think would do what I require, though I should like the opinion of your *practical* readers as to the feasibility of the plan before going to the expense and trouble of making. I therefore beg to enclose you a rough sketch, and should be glad if you think it of sufficient general interest to engrave. The apparatus I will describe thus:—A rather large glazed earthenware pipe (J), with a collar, is suspended from the floor of the conservatory C, in which a hole is cut the same size as the inside measure of collar of pipe. Within this pipe is a second D, of about half the length, and a little smaller, made of iron, say sheet iron, into the top of which is fitted a lid like a saucepan lid M, on which rests a shallow iron pan containing sand A, upon which to stand pots for striking cuttings. The heat is got from a gas coil H, above which, resting on three studs or pins fixed in the sides, is an iron ring with iron or copper gauze stretched over it, so as to fit the iron pipe or drum, and above this still is another iron ring K, with copper wire stretched across at intervals, so as to form a kind of net work. Upon this net, work are placed very small pieces of pumice stone E to the depth of about 2in., or less. The gas then ascends through the gauze and pumice stone, and is lit on the surface of the latter, which I believe would get red hot, and so hold the heat. A pipe B is inserted in the iron drum, near to the top, to carry off the fumes; and this pipe can be carried round the greenhouse, so that the heat it contained could be used. The end of it must, of course, be carried outside the house. F is the gas supply pipe for supporting the iron drum within the glazed pipe. Pieces of iron could be rivetted on to the sides, and bent out so as to rest on the collar of the pipe, or the bottom of the pipe could be stopped up all but a little hole for draught, and stones or bricks placed inside, upon which the drum could stand. To light the gas, the tray and saucepan lid would have to be lifted off, a match put to the pumice stone, and the lid and tray replaced, or, when not striking cuttings, the tray could be put away altogether. I think very little gas would suffice to keep up sufficient heat, and any smith or tinman could make the apparatus. I should like to know if the pumice stone would last long, or if there is anything better that could be substituted. Would asbestos be better?



Hortus.

A CLIP FOR HOLDING PAPERS.

Sir,—I beg to send a drawing of a simple contrivance for holding blotting paper, or letters, or manuscripts, which has recently been int duced by Mr. C. D. Singer, of Ingram-court, F church-street. The papers are placed between the



flaps, which have little points to insure a firm hold, and a pin passed through the interlocking loops at their edges. If necessary, the end of the pin may be shaped as a hook or ring, so that the clip, and the papers held by it, may be hung up on a nail. The clip is so simple and so clearly shown in the engraving that it requires no further description.

J. C.

SPECULUM GRINDING.

Sir,—For more than two years I have read with deep interest our Mechanic, especially those letters on speculum grinding, polishing, figuring, &c., and telescope construction in general. I now wish to add my mite to the great mass of information already given. Soon after "Arcturus" gave instructions for grinding and polishing a 12in. mirror, I set to work a 7 5 16in. mirror, using an iron tool proportionately larger, and succeeded so far as to be able to get some pleasing views of the moon, likewise of Jupiter and his moons, with very slight traces of his belts; but with high powers my mirror was useless. Yet, not liking the idea of being beaten, I did as I was once taught by a music master—viz., "Try, try, try again," but still with no better success. I now abandoned this process to try that of the Rev. Mr. Cooper Key. I accordingly reduced my iron tool to the size of my mirror, and again set to work, when in steps Mr. Purkiss with his valuable instructions. These, combined with my past practical experience, helped me greatly. I have now ground and polished two mirrors, the first being but a poor specimen. Nevertheless, I silvered it and kept it for use, intending to go over it again when I had made a better one, which I believe I have now accomplished. I have not as yet tried it on the heavenly bodies, but have tried it on a piece of paper cut from the English Mechanic, containing an engraving of Cameron's steam punch and 10 or 12 lines of letter press, the smallest but one to be found therein. This piece of paper is pasted to a tree 100 yards distant. I have examined it with three different powers—viz., 160, 213, and 359. With the two first powers I can read distinctly the contents of the paper and see the finest lines in the engraving; but the last-named power is almost too high for want of light, as my mirror is yet unsilvered; but still, with sustained attention I can read it. In the case of the two first powers the lines in the engraving, with the large and small letters, are well defined, clear and black, without any appearance of mist. I invite the opinion of Mr. Purkiss and our kind "F.R.A.S." as my own experience is rather limited in these matters. The eyepieces I used were only double convex lenses, and no sun shining during the test.

Optical Bricklayer.

INDUCTION COIL INSULATION.

Sir,—Perhaps it might be interesting to some of our amateur electricians of the Mechanic to inform them of a mode of insulation that I have tried, and which I think is very successful. I think it is equally as good as gutta percha tissue, or shellac varnish, and very much cheaper. It is made in the following way—viz., 2oz. resin, add ½oz. raw linseed oil, and melt them in an old earthenware pot, near the fire, frequently stirring. When the resin is thoroughly dissolved, add 2oz. spirits of turpentine, it is then ready (while warm), for painting on newspaper, or other thin paper, with a camel-hair brush (or an ordinary paint brush will do): when gone over (evenly) hang up to dry, which will take three or four days, in a cool place. When dry, cut into narrow shreds the full width of the reel or bobbin inside. When I got the primary on, I filled each lateral layer with warm paraffin wax, so as to make an even surface. I then wrapped two thicknesses of the above paper on, before beginning the secondary, which I built in the following manner—viz., one layer of wire, rubbed with paraffin, then one thickness of the above paper, and so throughout the whole of the secondary.

D. F. Ashton.

SIMULTANEOUS EQUATIONS.

Sir,—I venture to hope I did not in the least way hurt the feelings of my dear brother correspondent

"C. H. W. B." I beg to assure him this was not at all my intention. Of course, if Mr. Todhunter gives these problems only as exercise of the 2nd degree two solutions are sufficient. I believe that several author give the problems of the form $x^{2n} + px^{n} + q = o$, in which the exponent of x in the first term is double of that in the second, and which can be solved by the 2nd degree only to exercise the pupils in algebraical practice. The valuable German treatise of E. Heis, just lying before me, gives also a collection of them. Several problems of Mr. E. H. have been translated into English in the "1000 Algebraical Tests," by Mr. T. H. Cayzer, London, 1864.

Bernardin.

EXTRACTS FROM CORRESPONDENCE.

AN ENGLISH MECHANICS' SOCIETY FOR LONDON.—"G. G. B." writes:—"How is it that the metropolis is behind the provinces in the establishment of a mechanical association? Certainly there must be numbers of suitable men in and about London to form a first-class society. Will a few favourably-disposed gentlemen, with scientific and mechanical inclination and ability, send me their names and addresses, with a view to holding a preliminary meeting? I should like to invite, by their noms de plume, many of your able correspondents, but it would be invidious to do so; besides, unless the desire is mutual and spontaneous, the affair would be weak and insipid. I shall be happy to receive any response to this, either through our Mechanic or by post, addressed to G. G. B., Ripon Lodge, Grove Park, Camberwell."

VELOCIPEDES.—"Isle of Ely" says:—"I think my brother readers are rather hard on Mr. H. W. Reveley. The 30 miles per hour I cannot believe in, but still he has hit the right nail on the head, for a slow motion of the legs, and a quick motion of the wheels, are just the things required in a veloce. We have another tempting bait in 'Leo's' veloce, now this has been tried, and he states it will run at the rate of 15 miles per hour. If this be true (but I am inclined to doubt it), no crank velocipede can come up to it. He would greatly oblige us by giving a clearer description. Has any other reader seen this machine? I have tried many different kinds of velocipedes, but never one of a swinging motion. It seems to me you cannot get the power with them you can with others. What is the width between the swinging bars of the back wheel bicycle? I cannot see how the steering wheel is kept from coming against them in turning a corner."

CLAIRVOYANCE.—"Solicitor" says:—"Perhaps the following case may interest our friends 'Sigma' and 'Harmonious Blacksmith.' Some years ago a relative of mine arrived at home unexpectedly one evening from Buenos Ayres, the door was opened to him by one of his brothers, and almost one of the first questions asked by the absentee was, 'Is your wife living?' The reply was in the negative, calling forth the exclamation, 'Ah, I feared as much, I saw her on board our ship on the evening of —— (I forget the exact date). I may say the date was the day of the lady's death.'"

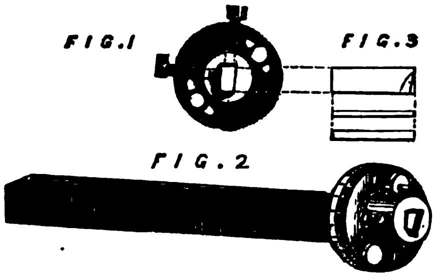
DISTANCE OF THE SUN, &c.—"Hugo" writes:—"Allow me to tell 'Veritas' that angles are not proportional to their tangents, as he seems to think; and, therefore, it is not true that 'the mean distance of the sun is to the mean distance of Venus from the earth as the mean horizontal parallax of Venus is to the mean horizontal parallax of the sun.'"

"AB INITIO" CORRECTED.—"J. Dyer" says:—"I am at a loss to understand 'Ab Initio.' He says, 'Philadelphia, for instance, has its time 5 hours earlier than London, it being only 7 a.m. there when it is noon here.' If the rotation of the earth was from east to west this would be the case, but as it turns in the opposite direction, looking south, any place west of London, as Philadelphia, must have its time later, or after London time. How noon can be after 7 in the morning of the same day, or how the time of a place with the sun on its meridian can be later than another 75 deg., or 5 hours to the west of it, I know not. If the time of Philadelphia in 5 hours earlier than London time, then the time at London is 2 hours earlier than the time at St. Petersburg, and so. When Wednesday of the same week is, in point of time, earlier than Tuesday, then will this be, but not before."

POTATO REFORM.—In a little tract called "Potato Culture," Mr. F. W. Wilkins points out to us a method of generally increasing our potato yield, which is worthy of the most careful trial; for, if his experiments are correct, he has put us in the way of quadrupling the crop of this most useful vegetable. At present, potatoes are planted in rows, about 2ft. apart, and 10 or 12in. from each other, the average produce being 240 bushels to the acre, or 6 tons, worth (say, at 3s. per bushel) about £36 per acre. By the new method, large whole potatoes are selected, and the eyes, all but one or two, scooped out. They are then planted 4in. deep, in rows 4ft., or, if very large, 5ft. apart. The result is, that each plant produces from half a bushel to one bushel, the potatoes themselves weighing 2lbs., 3lbs., 4lbs., or even 6lbs. The yield of the acre therefore is 1360 bushels, instead of 240, and the acre will bring in to the fortunate owner £204 instead of £36. The *rationale* of the proceedings seems to be, that we dwarf and stunt our potatoes by overcrowding, like we do our children in towns, and that the proper mode of treatment is to give to each potato sufficient room to expand, regarding it, in fact, like a young tree. The plants, indeed, grow to such a size that they are obliged to be supported by pea-sticks, to which they must be tied like hops to poles. We most strongly recommend a trial of this new form of potato culture to our gardening readers.

REPLIES TO QUERIES.

HOLTZAPFFEL'S CUTTER BAR.—"C. W. A." asks for a sketch of above, which I send copied from Vol. II. I don't quite agree with him about soft wood turning, at least I never could drive too fast for a good result. Fig. 1 is a front view; Fig. 2 perspective view; Fig. 3 shows elevation of a cutter for threads of high pitch ground away to clear under the cutting edge. Also plan view of a thin and a thick cutter for 2 different pitches. This tool is more expensive, and not so good as mine.—J. K. P.



[2538.]—**INCRUSTATION IN POROUS CELLS.**—The querist asks a means for preventing the incrustation of the cells of his battery; the following arrangement may, I believe, suit him. I imagined this battery some weeks ago, and one is working now since 16 days with the greatest regularity, serving several clocks, and having nearly no incrustation at all. I put in the jar ordinary water and a zinc plate, and in the cell a mixture of water and 1-25th part of sulphuric acid and a small plate of copper; and am, as far as yet, quite satisfied with the results.—D. N. Omiar, Belgium.

[2558.]—**SUN DIAL.**—I was much struck by the very *simple* method described by your correspondent "Anon," in your impression of May 6, 1870, of obtaining a true meridian line—viz., by the "ordnance maps" and "railway time," and began to doubt the old-fashioned method, which I have always adopted when I desired to ascertain my meridian, as determined by equal altitudes on a horizontal plane by a perpendicular style in the centre of concentric circles, which requires neither ordnance maps, railway time, nor setting a watch by a dial, involving equation of time, &c., but only a clear, sunshiny day, or intervals of sunshine, at periods of equal altitudes. This method is so simple, so often quoted, and is found in so large a number of works that I should imagine that every reader of the English Mechanic would be acquainted with it. When once a true meridian line is obtained, and permanently marked, it is very useful for a variety of purposes, setting a sun dial included. I have one in my garden consisting of a stretched wire about 10ft. long, which is attached to a tall stake truly upright, and which passes to the centre of the south pier of my telescope. When the shadow of the west edge of the stake coincides with the shadow of the wire, both being received upon a stone povement, the sun transits the meridian. I find this exceedingly useful for obtaining apparent time at noon.—W. R. Birt, Cynthia Villa Observatory, Walthamstow.

[3675.]—**NAVAL ARCHITECTURE.**—In answer to some correspondent who asked a question on this subject about two weeks ago, I am able to state that there are not, and never have been, any evening classes at South Kensington, for the purpose of teaching the above. There is in the South Kensington Museum the "Royal School of Naval Architecture and Marine Engineering," in which both these subjects are taught. Very full information concerning it may be obtained by writing to the Secretary, Science and Art Department, South Kensington Museum.—F. W. G.

[3707.]—**TWISTING POWER OF METAL.**—Molesworth's "Pocket Book" gives the following table of the "relative powers of metals to resist torsion":—Wrought iron, 1·00; cast do., ·90; cast steel, 1·93.—Steersman.

[3746.]—**TESTING BOILER.**—Having opened the flues so that a thorough inspection of the outside of the boiler may be easily made, run the boiler full of water, and get an ordinary boiler maker's force-pump, which may generally be obtained on hire from any boiler maker or dealer in machinery. Having connected the pump to the boiler by means of the feed-pipe or otherwise, close all other orifices except the one leading to the pressure gauge. When the finger (if a Bourdon) or mercury points to the required pressure, let your man make a careful examination of the whole boiler. It were best that a boiler-maker or engineer should perform this duty, as he would be able to remedy any defect; and if there be no sign of leakage you might work safely under steam to one-fourth the indicated cold pressure. Thus, supposing the boiler so found to be in good condition, and you prove it to 120lb., you might work up to 30lb. under steam, but do not trust to your own idea of its state, as there might be some defect which would escape your attention, but catch the eye of an experienced man at once.—T. S. Conisbee.

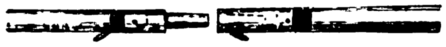
[3755.]—**TURBINE WHEEL.**—"A. B," will by this reply see the *rationale* of my request to be supplied with some data. A 1-horse power turbine with a 20ft. head of water would require 35 cubic feet per minute. His ½in. pipe would supply only 0·304 cubic feet, the loss in friction with such a small feed being enormous and quite useless for any practical purpose. There is no special line of demarcation between that which is a high or low pressure turbine. I should call any turbine with a head of water of from 7 to 14ft. low pressure. The writer knows of a very powerful turbine working with only 9in. of head, and he has erected several up to 14ft., and one with a head of 260ft., with a supply of only 200 cubic feet per minute, which gave an indicated power of over 60 h. p.—Senex.

[3786.]—**AREA OF SAFETY VALVES AND PISTONS.**—I note a remark by "Mutual Improvement," p. 260, as to corrugated pistons. Perhaps he is not aware that not only has that very thing been done, but it is patented. I once had a hot argument with a somewhat eminent engineer who believed in the notion, while I contended, of course, that though the surface was increased, and with it the pressure, still, as the increased pressure was not in the direction of the motion, there was no gain, and the effective work is only due to the plane area or section of the moving surface—*i.e.*, the piston or valve. As to the latter, the figure given by "Q. Q. R." is the best, as giving the least resistance to the escape of the steam.—Sigma.

[3835.]—**CLEANING COINS.**—The best way to clean silver coins is to immerse them in spirits of ammonia, which will thoroughly clean them without injuring them. For copper coins a *weak* solution of nitric acid.—J. H. D.

[3839.]—**COLOURING TRACING PAPER.**—A little ox-gall mixed with the pigments will make them flow readily on the cloth or paper, and "Tracing" should paint on the under side of his drawings so as to show through the cloth.—Solicitor.

[3843.]—**FLY ROD.**—In reply to "Regular Subscriber," the joints of my rods are all tongue and socket joints, being in my opinion the best. The ferrule is fitted upon the joint for ⅜ of its length, let in the thickness of the brass. The socket is bored with a slight taper first with a spoon bit, and finished with a taper round file. The tongue is made to fit tight ¼ of its length, allowing ⅛ for slackness, occasioned by wear. The ferrule should not be made fast until the boring and fitting are satisfactorily done, as it has to be taken off now and then to see if the hole is straight and smooth; always keep it on, however, when boring or fitting the tongue in, else the wood will split. Next, paint the joint with white-lead, drive the ferrule well home, and fasten with two brass pins at right angles to each other, one ½ from the base of brass, and one an inch from the same. The ash I get on my own property—it is better to be cut from a tree, and not more than 9" diameter. The outside is the best, and it must be reedy, and free from gnarls or cross grains, and very well seasoned before using. The hickory, or lancewood, I pick up where I can, generally getting what I want in a coach factory or scantling yard. I stain my rods with logwood and alum which gives a dark plum colour; never stain with an acid, as it generally destroys the wood, burning all the juices of the timber right out, and rendering it what is technically called "frush." The lapping is done with strong saddlers' twist silk, well waxed, and the whole varnished with coachmakers' varnish. The butt end of rod may have either a spike attached, or finished off with a piece of horn or brass ferrule. Any further information will be given cheerfully, free, gratis, for nothing. I send a sketch of joint.—Vivis Sperandum.



[3851.]—**TO CLEAN SADDLES.**—Wash with yellow soap, and dress with the smallest possible quantity of neatsfoot oil. When the oil is dried in, use beeswax dissolved in turpentine, apply with a brush, and polish with a soft cloth.—A New Subscriber.

[3852.]—**BRASS INSTRUMENTS.**—The bends in brass musical instruments are made by filling the straight tube with lead or pitch, and after the correct curve is obtained the substance is melted out.—Solicitor.

[3856.]—**TRICYCLE.**—"W. B." will find 4ft. 6in. wheels worse than useless for any kind of velocipede whatever. Velocipede wheels should never exceed 3ft for ordinary roads. Never forget small wheels and long cranks for ease. The following, I think, would be the best tricycle for two on a long journey; although bad to turn round, it will easily turn out of the way. The front wheel just the same as a bicycle front wheel; the two hind wheels, of course, with a two-crank axle; all the cranks one size—say 8in.; all the cranks connected by two ash treadles. Both men would step alike; the treadles would have long eyes on the front cranks, to allow for a little turning out of the way. The foot is not required to press flat on the treadles, but the same as if in a stirrup, so that the foot is always in a straight and easy position. The hind man would require a hand hold on each side, so that he could press well with his feet. Hand levers would not be required. A better velocipede for two on a long journey cannot be made; two hind wheels 28in. apart—not more.—Andrew Johnson.

[3864.]—**EXTRACT OF DANDELION.**—"Sable" sends a "Poor Blacksmith" what he asks for from the Pharmacopœia, it is the article of commerce:—Take of fresh dandelion root (bruised) 2½lb., boiling distilled water 2 galls.; macerate for 24 hours, then boil down to 1 gal., strain while hot, and evaporate to a proper consistence.—Sable.

[3868.]—**WATERPROOFING CLOTH.**—"A. S. A." asks for a recipe for waterproofing cloth. Though my answer is probably not quite what he wants, yet it may help others. I tried it as an experiment, and found it to be a waterproof, though that was not my design in doing it. I wanted to fasten two thicknesses of black calico together for a photographic tent, so I laid a sheet of thin gutta percha, procurable at any chemist's, between the two pieces of calico, and then ironed it with a flat-iron as hot as I dare use. The cohesion was perfect; it was a waterproof and light-proof too, and very easily made.—Country Parson.

[3869.]—**WATERPROOFING CLOTH.**—1lb. of sugar of lead, 1lb. of alum, pound separately, and mix in a basin, and then pour 2qts. of boiling water on the mixture; let it stand 6 hours, and then bottle off for use. Apply to the cloth with a sponge or soft brush on a table till well saturated, and then iron it over and hang up to dry.—(From the *Field*.)—A New Subscriber.

[3882.]—**STEAM AND WATER.**—The two motive powers of steam and water can be applied to the same shaft. As water is the cheapest mode of driving, of course it is used to its fullest extent first, and what is wanted to be gained in speed or power is added by the engine, a competent engineer being always able to tell whether the wheel is driving the engine, or *vice versa*. In all cases where a wheel and engine are in connection, they should both be started at one time, the wheel driving and the engine gradually brought up to the required speed by the engineer at the valve.—Vivis Sperandum.

[3883.]—**MANUFACTURE OF OXYGEN.**—See G. E. Davis's letter.

[3886.]—**WATER ANALYSIS.**—See G. E. Davis's letter.

[3894.]—**IRISH RING MONEY.**—I beg to refer "Dankosen" to a paper read before the Royal Academy by Sir William Betham, M.R.I.A., Ulster, King of Arms, printed at Dublin, in 1836. I would give the quotations, but they are too long. He attributes the date of them to be several centuries before the Christian Era, and used by the Phœnicians in barter, to whom he assigns the invention. He says, "Cæsar tells us that the Gauls *use for money gold and iron* *rings, by certain weight.*" The latter have perished by oxidation, but the two former are found in great abundance in the fields and bogs in every part of Ireland." There are many varieties engraved illustrating the paper above alluded to, but none like the one in the ENGLISH MECHANIC. Perhaps the usual *flat* or cup terminations may be seen broken off.—D. T. BATTY, 9, Fennell-street, Manchester.

[3891.]—SLIDE VALVE.—I should not think that "Slide Valve" would succeed with an engine having a cylinder less than 3in. stroke, or 1¾in bore. The flywheel would require to be about 10in. diameter. I shall be happy to give him any further particulars.—IXION.

[3894.]—IRISH RING MONEY.—In answer to "Daukosen," I beg to inform him that it was used by the ancient Celtic inhabitants of Ireland. They are usually in the shape of a crescent, sometimes with and sometimes without pointed ends. The weights of some are 53gr., 1dwt. 2gr., and 4dwt. One, in the shape of a horse-shoe, weighed as much as 15dwt. "Daukosen" is mistaken in supposing that they may have formed links of gold chains; they are always alone, and complete in themselves. They must have been current money, and not ornaments, because they exhibit no signs of attrition in places where they could have been worn. They are, I believe, always made of the purest gold. Very little is known of these curious articles, but there is a short paper on them, with three illustrations, in the *Numismatic Chronicle*, old series, vol. vii. It is by Edward Hoare, Esq., of Cork. From it I quote the following:—"A friend has suggested to me, and I think with great probability of truth, that it is possible that the crescentic form has been given to these Celtic rings with a religious protective view. The worship of the moon is an idolatry of the most ancient date, and the crescent form may have been adopted to preserve by its sacred character, the circulating medium from spoliation or debasement, in like manner as the ancient Greeks impressed the images of their gods upon their coins, as it is believed by many, in order to vouch for their purity and weight, and to secure them from damage.—HENRY W. HENFREY, M.N.S., &c.

[3850.]—THERMOMETER.—If "Thermometer" will take his instrument by the end furthest from the bulb, and give it a good shake by swinging his arm, he will probably find all the mercury unite.—IXION.

[3895.]—PARASITES ON CANARIES.—To cleanse the bird, tie a piece of unslaked lime about twice the size of a walnut in a piece of coarse calico exactly as a woman makes a blue-bag, leaving ends to it; dip it in water, and put it on the bottom of the cage. As the birds fly about, the fumes from the lime as it slakes penetrates between the feathers, and cause the lice to drop from the bird. Keep the bag in about a week; it will not hurt the birds. To clear the cages, &c., make a strong solution of alum and water, wash the whole with it; this will kill the lice dead as stones, and is far better than lime-washing. The breeding-boxes can be dropped into a pail containing alum solution for a few minutes, and then hung up wet as they are; it will not hurt the birds. Special attention should be paid to the moss, seed, and egg pans, as it is under these that the insects breed in the greatest numbers. This process can be repeated as often as necessary, and it is better to have a spare cage to put the birds in while cleaning their own, if they are breeding. By paying attention to this the birds can be kept free from the pest.—A NEW SUBSCRIBER.

[3895.]—CANARIES.—The disease with which your canary is afflicted is a troublesome one, and if the cage is infested with vermin it is best not to use it again. Those parts of the bird where the vermin are most likely to lurk should first be syringed with water in which a little quicksilver has been allowed to remain for some hours, or with a weak infusion of tobacco. Some recommend fumigation with this herb, but the inhalation of it by the bird, which can hardly be prevented, must prove prejudicial. Frequent bathing, great attention to cleanliness both as regards the cage and its inmate, and a daily supply of fresh sand, are also necessary to effect the ejectment of these troublesome visitors. A cage of which they have once taken possession is, however, never entirely freed from them; and it is best to get rid of it. If you cannot do this, wash it often, sprinkle the joints and crevices with turpentine or a weak solution of white precipitate powder, taking care not to put the birds into it for some hours after the operation is done. With this solution also, should the vermin prove obstinate, the body of the bird may be washed at those parts which it cannot reach with its beak.—A LOVER OF BIRDS.

[3895.]—PARASITES ON CANARIES.—Some years ago I found that my birds were infested with these pests, and wasting flesh as though they had some disease. I tried several washes and powders, but found none so good as the following:—Well soak the cages in water to loosen the dirt, then carefully scrub them inside and out, dry them, and drop a little paraffin oil into all the cracks and crevices. If there are any in the bird, hang a white cloth over the cage at night, and they will soon leave the cage for the cloth, when they may be shaken off in the morning.—J. H. P.

[3896.]—LADDER PROBLEM.—I note that "Ignoramus" has not given the height of the man who has to go up the ladder for his head to be level with spout; for a man 5ft. 6in high, it would take a ladder 32ft. long; height where resting against wall, 21ft. from ground. For a man 6ft. high, it would take a ladder 31ft. 4in.; height from ground where resting against wall, 20ft. 4in.—J. PARKER, Swindon.

[3909.]—COPPER COIN.—No. 1 is a third brass, of Constantine the Great. The full legend on obv. is VRBS ROMA. The rev. represents the tradition of Romulus and Remus, founders of Rome, suckled by a wolf, the letters T. R. P. in the exergue signifying, I think, Treveris Pecunia. No. 2 is not defined sufficiently for me to make out.—D. T. BATTY, 9, Fennell-street, Manchester.

[3911.]—GALVANIC CELL.—"Hermit's" galvanic cell is the same as Bunsen's, and he should therefore use strong nitric acid for the porous cell, and a mixture of about 12 parts by measure of sulphuric acid to 100 parts water for the outer compartment. As the mixture last mentioned gives out great heat on mingling, it should not be prepared in a glass vessel. The cell will give good intensity but moderate constancy.—T. S. CONISBEE.

[3911.]—GALVANIC CELL.—In answer to "Hermit," two exciting fluids are required—one for the carbon and the other for the zinc. That for the carbon is undiluted nitric acid (aqua fortis), and for the zinc diluted sulphuric acid (1 part by measure of the acid to 7 parts of water.) This battery (Bunsen's carbon) is very effective in use, and involves a current of considerable intensity.—ELECTRIC.

[3920.] — MEASURING LIVE STOCK. — TO "A COUNTRYMAN."—Measure round the animal close behind the shoulder, then along the back from the fore part of the shoulder blade to the bone at the tail. Multiply the square of the girth by 5 times the length, both expressed in feet; divide the result by 21, and you have the weight of the 4 quarters in stones of 14lb. Thus, if the girth be 6½ft., multiply by 6½, that gives 42¼ft.; then if the length be 5¼ft., multiply by 5, making 26¼ft.; next multiply the result 42¼ by 26¼, and you have $1109\frac{1}{16}$ft.; this divided by 21 gives 52st. 11lb. as nearly as possible.—M. P. C. S.

[3920.]—MEASURING LIVE STOCK.—Among a host of memoranda I had the following rule, which may be of service to "A Countryman." Measure the girt close behind the shoulder, and the length from the fore-purt of the shoulder-blade along the back to the bone at the tail, which is in a vertical line with the buttock, both in feet. Multiply the square of the girt, expressed in feet, by 5 times the length, and divide the product by 21; the quotient is the weight nearly of the 4 quarters in imperial stones of 14lb. avoirdupoise. For example, if the girt be 6½ft. and the length 5¼ft., we shall have 6½ × 6½ = 42¼, and 5¼ × 5 = 26¼; then $42\frac{1}{4} \times 26\frac{1}{4} = 1109\frac{1}{16}$, and this divided by 21 gives $52\frac{4}{5}$ stones nearly. It is to be observed, however, that in very fat cattle the 4 quarters will be about 1-20th more, while in those in a very lean state they will be 1-20th less than the weight observed by the rule. The 4 quarters are little more than one-half the weight of the living animal; the skin weighing about the 18th part, and the tallow about a 12th part of the whole.—HARRY G. NEWTON.

["Patience and Perseverance" has sent a similar reply.]

[3922.]—REMOVING PAINT.—"House Painter" can obtain at almost any oilman's *caustic paste*, which is sold for the above purpose, but in my opinion burning off the old paint is the only safe method. If any solution be applied to destroy it, the wood will absorb sufficient to materially affect any coating afterwards laid on, and so render the result anything but satisfactory.—HARRY G. NEWTON.

[3927.]—WINDOW-PAINTING.—Let "Sable" take of flux, which is formed thus:—Glass of lead 1lb., of pearl-ashes 6oz., of common salt 2oz. The glass of lead being reduced to a fine powder, and intimately combined with the other ingredients, the whole must be put into a crucible capable of retaining vitrified bodies, and fused. The lower the heat by which the fusion can be accomplished the better; the operation should not, therefore, be hurried. When the mixture has become transparent and free from air-bubbles, it may be poured out upon a clean iron plate. If the composition, when cold, is observed to be very foul, it should be reduced to powder, and re-melted, but if only a few foul specks are observed, they may be picked out. The good part may then be reduced to powder and kept for use. This flux is moderately soft, and has a slight tinge of yellow. The glass of lead is prepared by fusing 2 parts of red lead with 1 part of flints calcined, and finely levigated, or instead of flints the finest white siliceous sand. Take of the above flux 6 parts of gold precipitated by tin 1 part; when these ingredients are thoroughly mixed they are ready for use. The colour thus prepared produces a fine crimson, inclining to purple; its strength may be increased by adding more of the oxide of gold. For the yellow, take of the above flux 6 parts, of calcined silver 2 parts, and of antimony ½ part. Vitrify them, and then levigate them for use. The colour is a deep bright yellow proper for shades; where great transparency is wanted the antimony may be omitted. The silver is prepared by covering thin plates of silver with sulphur, and exposing them to a red heat. If sulphate of iron be dissolved in water and precipitated by pearl-ash, this precipitate, used instead of antimony, will produce a very cool and true yellow, proper forming greens with blue.—D. F. ASHTON.

[3931.]—INDIA RUBBER SOLUTION.—It may be made with various solvents—turpentine, chloroform, benzole, &c.; but the best is, I believe, a mixture of 6 parts alcohol (absolute, not mere spirits of wine) with 100 of sulphate of carbon; the latter is the real solvent, the alcohol has an indirect action. The quantity of solvent required depends on the consistency of solution required; if heat (moderate) is used, and the mixture shaken, the whole dissolves, but a better solution is obtained for adhesive properties by using a large quantity of solvent, not shaking, but drawing off only the clear glazy liquid.—SIGMA.

[3931.]—SILK SOLVENTS.—Several substances dissolve silk, such as the ammoniacal solution of oxide of nickel; that of copper also dissolves silk as well as cotton: the silk is precipitated by acids. Chloride of zinc saturated with zinc oxide also dissolves silk, but in no case can silk thread be dissolved without the "thread being decomposed," for solution of course involves the destruction of the mechanical constitution.—SIGMA.

[3937.]—CHEMICAL QUERY.—See "Urban's" letter.

[3937.]—CHEMICAL QUERY.—As liquid nitrous oxide raised to a gas at 0°C. and 760mm. is just at the normal condition for calculating gases, it is only necessary to divide the 200grms. by the weight of a litre of the gas, which may be calculated off hydrogen as follows:—As a litre of H = 0896grms.; therefore a litre of ON_2 (density 22) = ·0896 × 22

Consequently $\dfrac{200\text{grms.}}{\cdot0866 \times 22} = 101{\cdot}46$ litres, the answer required.—NIGHT SCHOOLBOY.

[3941.]—MARKING INK.—If "Daisy" put the ink on a piece of velvet, and then rubbed it over the types (or to glue it round a roller would be better), I think he would succeed. I have used the ordinary writing-ink that way, and found it succeed.—PRINTER.

[3948.]—BEES.—For simplicity there is nothing like "Payne's Bee Book." He was a really practical apiarian at Bury St. Edmunds, and loved the old straw hive, but never destroyed a bee, nor allowed them to swarm unless he pleased.—ANON.

[3950.]—GOMUTU FIBRE.—The Gomutu palm is the sugar palm, *Arenga saccharifera*, Labill, occurring in great abundance in a wild state throughout the islands of the Indian Archipelago, and cultivated generally by the various people who inhabit this region. The Malays call the tree "anoa;" the liquor (toddy) obtained from it "tonak," or "nera;" the horsehair-like material covering the base of the petioles "Edju," or "Gomutu;" the Portuguese call the tree "Saguero," "sago tree," or "Sagwire." The fibrous substance of the base of the petioles—superior in quality and cheapness to coir or cocoa-nut fibre, is used by the natives for every purpose of cordage. The coarsest parts are used as pens by all the natives who write, and also as arrows for their blowpipes. I do not find any mention of these fibres being employed for brooms or brushes. *Cabo negro* is, according to the Spanish Catalogue of the Paris Exhibition, the name given to the tree by the Spaniards of Manilla. More particulars, *vide* "Seeman's Popular History of the Palms," and many other works. The coarse chocolate-coloured fibres used for making the brooms for sweeping the streets, the decks of ships, &c., and also employed for Withworth sweeping-machines, come from the Piacaba palm, *Attalea funifera*, and are imported in England from Bahia; a finer sort coming from Para is produced by another palm tree, *Leopoldina Piacaba*, which I find in an horticultural catalogue named "*Leopoldina Piacaba vera*," the *Attalea funifera* being the known by gardeners as *Leopoldina piacaba*. The introduction of *Pará piacaba* into industry was an example more of the application of a simple observation. a bundle having been made up at Pará for a vessel, to let down of the bulwarks as "fender," to prevent collision, &c. The ship arriving at Liverpool the bundle was thrown upon the quay; a brush-maker took it and made a few brushes from it; they were found to answer well; a small quantity more was imported, and the trade began. It was formerly imported as "dunnage," but orders having increased, *piacaba* is now imported from Bahia and Pará on freight. A price current I have before me quotes Bahia fibre 12s., and Pará do. 65s. per cwt. The nuts of the *Attalea funifera*, or "Coquilla nuts" are used for turner's work.—BERNARDIN.

[3954.]—SCREWING LATHE.—If P. N. Hasluck lives near London he had better get my address from the Editor, and come and see my lathe, from which he may gain a hint or two worth having. 1. The length and breadth he mentions will do. 2. A screw such as I have just made for my 5" lathe—viz. ¾ diam.. double V thread, ¼ pitch, will suit. I have in now a screw of 10 to an inch, and this is to take its place. It should *not* be inside, as it is sure to get dirty wherever it is, and is much easier to clean if outside, and hence likelier to get kept clean. 3. A ½ nose of Whitworth's thread will do very well. 4. Geared lathes are generally made 2 pair of wheels or pinions of 3 to 1, giving a reduction of speed to 1-9th; this I think much too great for a small lathe, and I have made, or had made, several, and am now making a 5" for my own use, with wheels of 3 to 1 in front of pulley, and 2 to 1 behind the pulley, giving a reduction to 1-6th of speed. I have by me a set for a 4½in. lathe of 3 to 1, and 2 to 1, or a reduction of ⅙. The numbers suitable are 72 and 24 for the front, and 66 and 33 behind, both of the same size of teeth which in my case is to be nearly No. 9 on the Manchester guage, giving the 72 wheel 8" diam. by ½ thick, and the other pair only ⅜ thick as the strain on them is less. The teeth are to be cut in gun-metal. If you have cast wheels 60 and 20 on the No. 8 guage give distance of centres of mandrels 5in., and a pulley of 7½, which you will hardly get into a 4½ head, and the 10 guage gives a 6½in. pulley, which is too small. Perhaps Lloyd may have gear wheels specially for 4½ lathe by *him*. Mine are 66 and 33 on the 10 guage, and are in Lloyd's hands, with liberty to cast from them. 5. I should not advise self-acting surfacing, which I do with a band from overhead. I should make the bottom slide project over the rear side of bed 2 or 3in. in addition to the ordinary length. The last I made was a 4½ one, and the bottom slide measured 10½, and I was sorry I had not made it 12" before I had done it. The top one may run 4in. more or less. The best tool holder swivels round on a centre bolt, and is of square shape supported under two of the corners by a couple of pillars, and has set screws attached tapped down through the other two corners, which are provided with bosses for the purpose. 6. You cannot wish for a better wheel cutter than mine figured in No. 245 of the ENGLISH MECHANIC. If you use a dividing-plate with holes, it should be 4 times the diam. of the wheel to be cut, or more if possible. (See *p. 44 of present vol. for some remarks* on dividing pegs.)—J. K. P.

[3955.]—SCALE PARAFFIN.—I should think the quantity of scale paraffin produced last year (in Scotland) would be about 1500 tons.—REFINER.

[3956.]—WEIGHT OF GAS.—See G. E. Davis's letter.

[3957.]—POWERS OF NUMBERS.—I believe the easiest way is to make use of the formula log. (an) = n log. a: for example, if we have to calculate $x = \frac{3}{5}$, I put log. x = log. $10\frac{3}{5} = \frac{3}{5}$ log. 10 = 0·60000, and I find that 0·60000 is very nearly the logarithms of 0·3982; thus $x = 0{\cdot}3982$.—BERNARDIN.

[3964.]—CAST IRON.—Chipping is as much an art, and to be done really well requires practice as much as filing does. Any smith any where will draw you out a chisel and show you how to use it. The steel generally used is either octagon rolled for the purpose, or round, flattened on the sides. I keep an earthenware pan in the garden, and put a casting into the acid water left from last time, and then pour in strong sulphuric acid, till I see the hydrogen come away freely, and leave it for 12 hours. This will bring most of the sand away. I think the best stuff to make casts of for electrotyping is white wax with a lot of rottenstone melted up with it. The powder makes the cast hard, prevents it shrinking so much, and makes it heavy enough to sink in water; it blackleads very well too.—J. K. P.

[3967.]—MAGNETIC NEEDLE.—In a vertical galvanometer the strong needle would give the greatest deflection; in a horizontal galvanometer there would be a slight difference, as both the forces would diminish alike by the weakened magnetism; the difference really found would be due not to the magnetic difference, but to the relation of the actual deflecting force to the weight of the needle—*i. e.*, its inertia, and to the friction on its support. In my own experiments I have found that with everything the same in other respects, different needles give different deflections, but the same needle weakly or strongly magnetised gives the same.—SIGMA.

PAINTING WOODEN PAILS.—The practice of painting the inside of wooden pails, to prevent leakage, is only to be recommended when the paint contains no white lead or baryta, both of which we found in the paint of some pails examined lately. All over the country these pails are used in the kitchen, and although either lead or baryta are not very soluble in water, yet frequently the paint peels off in flakes, and may have serious consequences when getting into the teakettle, and thus into the food. The paint for such purposes should be either whiting or gypsum, if required white, but the most preferable is ochre, against which the sanitary objection cannot be raised.

NOTES AND QUERIES.

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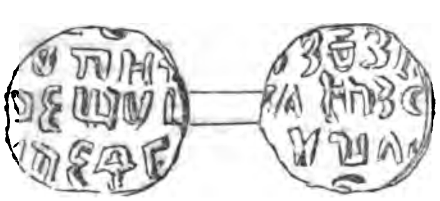
[3972.]—IRON STAINS.—Could some brother reader tell me what will remove iron stains from linen or calico? The question has been asked before, but never answered.—J. H. P.

[3973.]—A WATER VELOCIPEDE.—Noticing that you have taken great interest in your journal in the velocipede movement, I make free to ask if you can tell me where I can get a water velocipede. I have recently lost my right arm so am debarred from taking part in most outdoor amusements.—J. D.

[3974.]—BOEHM FLUTE.—Would H. T. Leftwich kindly give a detailed working account of the "equisonant flute," also where it can be obtained, and if it is much more expensive than the old flute? Can he or any other reader say where I could obtain keys and fittings for the same and other description of flutes cheap.—ANOTHER FLAUTIST.

[3975.]—VALUE OF COIN.—Can any reader tell me the value of a coin in my possession, of which I send a sketch?



The characters are roughly formed and raised. It is, I believe, silver.—HARRY G. NEWTON.

[3976.]—BRITTLE INDIARUBBER.—I observe that sheets of vulcanised indiarubber become brittle after some time; what may be the cause of this? Is there any means of preventing it?—CAOUTCHOUC.

[3977.]—BRAZILIAN RAILWAYS.—To what extent are the different railways diverging from Bahia in activity? Are the constructions advancing?—H. Z. Y.

[3978.]—ROUND ZINC WIRE.—Is round zinc wire manufactured so small as No. 23, B. W. G.? I have tried several wire mills, but cannot get it.—THEORUM.

[3979.]—BRICKS AND POTTERY.—Will any reader tell me of a good practical work on pottery from which I could gain a knowledge of the different operations carried on in the potter's art; or a good book on brickmaking? I have Mr. Dobson's work, published by Virtue, Bros., which is a a capital rudimentary treatise, but I should like something larger, with more detail, if possible.—OLD SUBSCRIBER.

[3980.]—CLINTON'S FLUTE.—I hope Mr. Leftwich wil be so kind as to accept our Editor's offer. I see he recommends Clinton's flute. Has he ever tried Carte's improved Boehm flute.—J. H. M.

[3981.]—BOOKS.—Will any reader inform me in your next publication of the ENGLISH MECHANIC if he knows whether there is a book published that gives the weight of different sizes and lengths of iron, viz., rounds, squares, flats, &c., allowing for heating, rolling, and cropping, the name of it, and where it can be bought? Or can you recommend a book to assist a mill manager in his work, one with tables giving the weight of the pile to produce finished bars? An answer through your valuable journal will oblige.—L. M.

[3982.]—WORKS ON SOAP MAKING.—Could any of our readers give me the names of the authors and publishers of any good practical books on the above subject? Also, if they could refer me to any periodical or journal where good papers or articles have appeared on the subject?—M. G. MORGAN.

[3983.]—ENGINE INDICATING.—If some one of our excellent correspondents could kindly give me a little instruction on engine indicating I should feel greatly obliged. I have heard of one young man in this neighbourhood who is giving as much as 5s a lesson for instruction on the subject. I believe it would be interesting to many of our readers. What I want to know is, how to take a diagram, then how to measure it up so as to get the power; and how I must get the pressure per square inch? The diagram before me is divided into 40 lines, and every fifth line is extended to the margin and marked "Atmospheric 5, 10, 15, 20" upwards, and the same downwards, but the fifteenth line downwards is marked "Vacuum." I should be glad of an explanation, and also wish to hear of a good book on the subject.—VACUUM.

[3984.]—ALUMINIUM BRONZE.—I shall feel obliged if any of your readers can inform me of the proportions used in the mixture of aluminium bronze.—ALUMINIUM.

[3985.]—FLEXIBLE PIPE.—Would any reader inform me if there is any flexible pipe that will stand boiling water, or if indiarubber canvas hose pipe would answer the purpose?—E. L. V.

[3986.]—CYANIDES.—TO "SIGMA."—Would "Sigma" say where I can get the latest information about the manufacture of cyanides from the combustion or heating of char, coal with nitrogen and potash; also if soda-barytes, &c. have as good effect as the potash?—J. W.

[3987.]—OIL TESTING MACHINE.—I use a great deal of oil for lubricating purposes, and I have observed in your journal some time since an advertisement of an oil testing machine. Can any of your readers inform me the machines that are now generally approved for that purpose?—WM. JOHNS.

[3988.]—STUFFED BIRDS.—I have 37 Australian birds which I want set up in case with glass front. The case is 4ft. by 3½ft. and 13" deep. The birds vary in size from magpie to humming bird. I should like to construct an artificial tree, but don't know how to proceed. If any kind friend would give me sketch of tree and instructions how to make it through your valuable paper, he would extremely oblige—ONE IN A FIX.

[3989.]—SCREW ENGINE FOR CANOE.—How large a screw engine with double cylinders ought one to have to drive a canoe 15ft. long and about 2½ft. wide; also size and shape of boiler; also about what price if I buy them?—A YOUNG SUBSCRIBER.

[3990.]—YELLOW DYE.—Will any reader tell me how to make a deep yellow dye that will stand the air?—A COUNTRY MAN.

[3991.]—DARK LINES IN SOLAR SPECTRA.—Will "T. A." say how, according to his atmospheric hypothesis, he accounts for the dark lines in the spectra of the fixed stars; they being totally different from the solar spectrum and from each other? If the amount of iron, for instance, necessary to produce the iron lines in the solar spectrum is, as he says, contained in our atmosphere, and continually falling to the earth, is it more than probable that the Bunsen burner would give some indication of it in the same way as it does of sodium?—STEERSMAN.

[3992.]—SIZES OF ROPES.—Having read with pleasure the article on "Strength of Materials," bearing as it does on my own trade, I should feel obliged if any one could inform me if there is any published tables of the number of threads and strands for given sizes of circumference and diameter of ropes from the smallest to the largest sizes?—ANXIOUS TO LEARN.

[3993.]—PASSAGE TO NATAL.—Will any one inform me through the MECHANIC the best and cheapest way to get to Natal, South Africa.—A CORNISH MAN.

[3994.]—ELECTRIC MOTOR FOR SEWING MACHINE.—I see from a back number of "All the Year Round" that a Frenchman, Mons. H. Cayal has invented an electric motor for working a sewing machine. I should be much obliged to any one who will give me some particulars about it?—J. H. MERIVALE, Ealing.

[3995.]—BOOKWORMS.—Can some reader inform me what will effectually destroy bookworms without injuring the books?—BOOKWORM.

[3996.]—BOOKBINDING.—Will any of our numerous subscribers tell me whether brass type or handle letters will be best for me (an amateur bookbinder) for gilding letters on the covers of books, also the price of leather per skin, and cloth for bookbinding per yard?—Q. Yorkshire.

[3997.]—ARTIFICIAL FOUNTAIN.—I wish to make an artificial fountain, the same as seen in watchmakers windows occasionally, where a glass rod is made to revolve. I have the movement of an old watch, and 3 small cog-wheels, but I cannot manage to fix it in any way. Would some kind friend give me a few hints?—T. P.

[3998.]—ORGAN MOVEMENT TO HARMONIUM.—I have made a harmonium with two rows of reeds. Will "Lever" or any other tell me how I can put the organ movements on. I see on my catalogue that I can get the full organ movements for 3s. 6d. Could any one tell me what they are, and how they are fitted on?—YOUNG AMATEUR.

[3999.]—CYLINDER.—Will any reader be kind enough to give me the dimensions of cylinders for small steam carriage?—IXION.

[4000.]—SODA WATER.—Will any brother reader be so kind as to inform me how to test a very small quantity of tartaric acid in a tumbler of water from citric or *vice versa*.—ONE IN A FIX.

[4001.]—ATMOSPHERIC INFLUENCE ON ELECTRIC CLOCKS.—Has the atmosphere any influence on electric clocks?—ELECTRIC.

[4002.]—MUSLIN DRESS.—I have a muslin dress, originally a bright violet, but now very much faded. Will any of your numerous correspondents kindly inform me either how to extract the colour entirely, or to restore it?—BETA.

[4003.]—WATERING GARDEN.—Will anyone kindly inform me of the easiest and cheapest plan for raising water and watering a garden, say 20yd. long? The river runs close to the garden, but is about 8ft. lower than the level of the ground. Something of the force-pump style, but less expensive?—F. H. JONES.

[4004.]—SPECTROSCOPE.—Will "F.R.A.S." kindly give us another paper describing "some rude and makeshift apparatus by means of which rudimentary spectroscopic observations might be made," as it would be very acceptable to many of his readers. Also will he say whether solutions of sodium, salts, &c., will give absorbtion bands if placed between the lamp and slit of the spectroscope; if so, will he tell us which solutions will give us the most striking results as experiments? I hope he will do what he intended in relation to Sirius, as I am sure the Editor will not deny him as much space as he likes for what is interesting to so many of his readers.—H. W. BISHOP.

[4005.]—GUN BARRELS.—I should feel much obliged if anyone will tell me how to clean the inside of gun barrels in the lathe, so as to make them look like the gunsmiths do?—A NEW SUBSCRIBER.

[4006.]—DRESSING STONE.—Can any reader inform me whether there is in operation any machinery for working or dressing the hard grit stone such as is used in the buildings of Lancashire and Yorkshire.—STONEMASON.

[4007.]—CURING HERRINGS.—Will you kindly allow me to ask if any of your readers will tell me the way to cure herrings, or name any book giving such information.—J. BASKERVILLE.

[4008.]—GRAINING STUFF.—What is the colour made of that grainers use for oak grain, not the ground colour, but that over it.—J. BASKERVILLE.

[4009.]—HEATING BOILERS WITH GAS.—Will some brother reader give some information respecting heating steam boilers with gas. I believe they require very little attention, and can be kept in readiness for work by turning on sufficient gas to keep the water boiling. I think also that insurance companies do not charge extra premium where these boilers are erected. These are certainly very great recommendations if there are no corresponding drawbacks. I had thought an ordinary vertical boiler would answer if the furnace bars were removed, and gas pipes put in. I should think the flues ought to be smaller. Possibly one tube bent into a spiral form running from bottom to top would give good heating surface, and be sufficient to carry off the products of combustion. I should like to know also whether there is any objection to feeding a boiler with boiling water; it seems to me it must require a deal less fire in the furnace to raise the same amount of steam.—CORN FACTOR.

[4010.]—MELTING AND CASTING METAL.—Would some experienced reader be kind enough to assist me in the melting and casting of a metal similar to printers type metal, but much harder when cast. I want to get a nice clean sharp cast of designs I have, the moulds of which are of iron and brass, and will make a cast about 2in. square and about ⅛in. thick. I have tried zinc, tin, and other metals, but without success. I should like to know the exact proportions of metals to mix to get what I want, and whether it should be melted in a ladle or crucible, and how to tell when hot enough, and if anything should be put on the mould to assist the sharpness of the cast; in fact anything that would be necessary for anyone ignorant of the process to know would be most thankfully received.—A BRISTOL AMATEUR.

[4011.]—PRICKING BARRELS OF BARREL ORGANS.—Would "Adept" or any other subscriber kindly describe in detail the process of pricking the tunes on the barrels of mechanical organs? I should be very greatly obliged for such instructions as would enable me to set out tunes and overtures on the barrels of an organ having a complete scale, and working its own stops.—PUPIL.

[4012.]—WORM-EATEN ORGAN BARRELS.—Can any one inform me what would prevent dry wood from being worm-eaten (weevils I think they are called)? Some of my organ barrels are becoming completely honeycombed by these troublesome creatures, and I should be glad to know if there is any solution which will kill, or prevent them from doing further mischief.—PUPIL.

[4013.]—TO N. S. HEINEKEN.—Would N. S. Heineken kindly state the price of "Le Manuel du Facteur d'Orgues," and where in London or Paris it could be obtained? Also state if it gives practical instruction in organ building?—PUPIL.

[4014.]—MEDICAL ELECTRICITY.—Will one of our knowing friends kindly answer one or two questions:—1. I have seen it stated that a current from a secondary is of no use for medical purposes; but only that from the primary wire—Is it so? 2. Will an induced current induce a current in a coil laid on the second? I have seen a beautiful little apparatus made by "Rosenbloom" (I think that is the name) the current of which might be modified in a most simple and beautiful manner. On the baseboard there were a number of brass studs, numbered from 0 to 16, placed in the form of two arcs. These communicated under the board with fine wires from the coil. Attached to binding screws were two brass movable arms which, on being placed on corresponding studs, would vary the power of the current. When placed on studs No. 0, it was so gentle that a child could bear it with pleasure; but when moved to the highest number, it would be sufficient for several adults. A friend of mine who has one has been very successful in relieving many obstinate cases of contraction of limbs, rheumatics, &c. Now I think if an affirmative can be given to both my questions, then an apparatus with various shades of power can be easily made by coils of various lengths laid on each other, their ends communicating with the corresponding studs. I may just say the coil was worked with a single pair of plates C and Z, the C about 1in. by 3, the Z in the form of a U, so that each side of the C was used.—O'BEC.

[4015.]—ARTS EXAMINATION, ROYAL COLLEGE OF SURGEONS.—Will some brother reader who has passed the above kindly inform me what is the minimum number of marks, and how soon one is informed if he has passed?—GADDHA.

[4016.]—ARMY COMMISSIONS.—Will anyone inform me through the MECHANIC what is the limit of age for purchasing commissions in the line regiments? On referring to the Army Regulations I find 17 to be the earliest age at which a commission can be held, but it gives no other limit. For men it is 18 to 45, what is it for officers?—LINESMAN.

[4017.]—CRICKET BATS.—Would some of my brother readers versed in the manufacture of cricket bats kindly give some information as to what kinds of wood are used for the purpose; also how made; the respective merits peculiar to each kind of wood; in short, any information that will guide a lover of cricket in making his own bats?—STUMP.

[4018.]—ISOMETRICAL DRAWING.—The sense of my query (3923) was lost last week by the substitution of the word "geometrical" for "isometrical." Readers who intend to favour me with a reply will kindly notice this correction.—C. J. H. COTTHESON.

[4019.]—SAFETY VALVE.—I want to have 20lb. pressure on the square inch of a boiler, the length of which is 11in. long by 6in. broad, and 4in. high. Would "Jonath" kindly give me the rule for finding the size of safety valve, length of lever, &c?—O. G.

[4020.]—WOULFFE'S BOTTLE.—I have a 3-necked Woulffe's bottle, but in two of the necks the glass has not been taken out in the inside so it is of no use. How can I take the glass out without injuring the other part of the bottle? Would a common diamond do to scratch it, and could the glass be then knocked out?—M P.C.S.

[4021.]—COINS.—Will some brother reader inform me what the following coins are, and their relative value? A coin (silver) slightly larger than a sixpence. Obv: female bust—Anno. Dei. Gratia. Rev: 1777 Mag. Bri. Fret. Hib. Reg. with large cross. Another the same in circumference, but thinner than a shilling. Obv: (I take it) CAROLVS. VI. D. G. ROM. IMP. SEMP. AVG. with double-headed griffin with mace and a sword, I.H.L. in small capitals. Rev.: Castle with wreath around, and below a circle with IIII SCHILL inside. Around margin, Hamburger. Current 1725.—VELOCE.

[4022.]—TUNING BELLOWS FOR HARMONIUM REEDS, &c.—If our talented correspondent "Eleve" will answer the following questions I should feel grateful:—1st. Which way must I set about to make a pair of tuning bellows that will answer for tuning any size reeds, or where could I purchase one similar to those used in large establishments? 2nd, What sort of "holders" to hold the reeds (any size) during vibration? 3rd. What construction of bellows to keep a continual vibration at pleasure without breaking off the wind? Would a couple of bellows answer, one to go up while the other is going down? Details with diagrams would oblige.—REED TUNER.

[4023.]—ORGAN STOPS.—Will the "Harmonious Blacksmith" or "Adept" please give an opinion on the following? I am about to build myself a small organ with about 4 stops, which stops would suit best? I have thought of open diapason, stopped, principal, and fifteenth, or would a flute in place of fifteenth answer better?—JOS. B. CROSSLEY.

[4024.]—GALVANISING CAST IRON.—Would any of your readers kindly explain the process of galvanising cast iron. Mr. Meredith in one of your "replies" says the process is the same as for wrought iron; but not knowing the process I am compelled to trouble you again?—B. WEBB.

THE ENGLISH MECHANIC LIFEBOAT FUND.

Subscriptions to be forwarded to the Editor, at the office,
31, Tavistock-street, Covent Garden, W.C.

	£	s.	d.
Amount previously acknowledged	£180	18	10
Frederick	0	5	0
The Naval Brigade, Wolverley	3	14	1
J. H. Merivale	0	2	6
Another Flautist	0	0	6
A Well-Wisher (2nd donation)	0	2	6
W. H. E, Bath (3rd donation)..	0	2	0
G. Bamford	0	1	0
	[illegible]	[illegible]	[illegible]

ANSWERS TO CORRESPONDENTS.

⁂ All communications should be addressed to the EDITOR of the ENGLISH MECHANIC, 31, Tavistock-street, Covent Garden, W.C.

The following are initials, &c., of letters to hand up to Friday morning, June 3, and unacknowledged elsewhere:—

S. Rogers, Thos. Selby, Rev. E. Kernan, T. S. W., G. R. S., Berero, Gimel, C. Wyndham, D. Wright, Constant Reader, J. Sharpe, J. Harrison, C. Burgess, W. E. D., R. H. Harrison, H. P., Anxious Nephew, G. A. S., G. Prew, J. Gillingham, J. K. P., G. R. S., W. Drew, Sceptic, F.R.S., W Butler, James Kemp, Hopeful, J. W. D., R. W., R. Lloyd, J. Thomas, J. E A., L. & J., E. Bubb, B. W. R., H. Garland, J. B. Tenby, F.R.A.S., Ab Initio, J. F. Stant, Alfred Hancocks, C. de T., W. Binns, Contralto, E. R. T., W. H., Beginner, J. C., S., W. J. C., Hyperion, Jas. Grimby, Always Welcome, J. T. Capt. S. L., Payne & Sons, Geo. Luff, W. H. E., W. D. R., Robert Tonge, Messrs. Macquard, George Smith, H. T. Vivian, Brother Reader, R. Bolton, J. H. T., W. B.

A. W. N. C.—As a rule, we select queries that are likely to evoke replies which may not only be useful to the querists themselves, but others similarly situated. Hence we prefer the information should pass through our columns.

SILENT RUBBER will oblige by communicating the information to Mr S. V. Pocklington through our columns.

JOHN C. SHEWAN.—We can't afford space or money for such illustrated corrections.

GRASPINGS AFTER KNOWLEDGE.—Mr. Hermann Smith, who received a letter of inquiry which he has forwarded to us, says:—"The writer has not given his name or address, as very likely he is ashamed of his poor writing, and so keeps dark. But I must confess those grasping after knowledge are to me as interesting as the most elegant language of well educated correspondents." We reproduce this sentence from Mr. Smith's letter because we thoroughly agree with him.

G. R. L.—Your letter on "Health Helps" contains many good points, and some weak ones. It is, however, so jauntily put together that we have been obliged, reluctantly we admit, to discard it.

MR. ROGERS.—If you have any reliable information on the Western States of America in connection with emigration, we will put space at your disposal.

F. H. LINTON.—Is a Russian coin of the Empress Anna, and similar to Query 3860, replied to by "Bernardin," p. 261.

E. H. C.—Too indistinct for illustration; probably an old jetton or counter of the 14th or 15th century.

D. D. BATTY (Manchester).—Many thanks.

BERNARDIN.—A classified list of all the vegetable oils, &c., would be a good subject for an article; also, on the modes of refining them.

F. W. G.—The congratulation should by right have a name and address.

T. WARD.—No stamps enclosed for advertisement.

J. H. D.—Should be glad of the articles on silver coins, with as many illustrations as are necessary.

W. SCOTT.—We never send private addresses without the consent of the writer.

OUR ever obliging "F.R.A.S.," in a private note, says:—"I assure you I personally recommend the ENGLISH MECHANIC right and left to every scientific friend I have, and to others who, without claiming any title to that appellation, yet wish to know what is going on in the way of physical and mechanical discovery; and I am bound to add that I never made any recommendotion more conscientiously. It certainly seems to me that such a twopenny worth as the MECHANIC must ultimately act as "Edex-rerum,' and swallow up not only its so-called competitors, but the mass of our popular scientific serials to boot."

THE Sixpenny Sale Column is the only place in which can appear queries sent by "Saepe," H. E. Turner.

J. THOMAS.—You cannot obtain a specification until six months after the date of application for the patent.

J. HAYWOOD (Barnsley).—They are quacks of the worst description. On no account send them more money, or you will lose it. If you really wish to try galvanism, apply to some respectable medical man, and he will recommend you a proper apparatus.

T. P.—Your views are correct. The sol-fa system is not superior to the old notation.

A NEW SUBSCRIBER.—See back numbers.

A SIX MONTHS' SUBSCRIBER.—To the Registrar-General, Somerset House. Cost trifling.

THOMAS SMITH.—See our advertisement pages.

H. RAYNER.—The 6s. edition has a key and also a, valuable appendix. We cannot recommend any book on the other subject named.

TRAVELLER.—Apply to any optician.

J. W. BEDFORD.—The contributions you offer would be acceptable if up to the mark.

VELOCE.—You will find some information on the subject of rubber tires in the description of the "Phantom" bicycle, in this number.

LIVERPOOL READER.—See Mr. Perry's advertisement on Vol. VIII., page 270.

WORKING FOR THE LIFEBOAT.—I enclose you 2s. 6d, in stamps for the Lifeboat Fund, being 3d. per 100 on the orders I have got for label printing. As an amateur printer, I hit on this plan to raise funds for our boat, and to send more from this week's advertisement. I enclose you two or three specimens.—C. FORREST, Lofthouse, near Wakefield.

W. on Pitman's Phonography next week.

W. C. COLLINS.—Thanks for the kind offer.

W. B.—You will see from a notice elsewhere that the day of publication will be altered without any alteration in the date. The ENGLISH MECHANIC will at the same time appear in new type. So we shall not only be stronger by the absorption of "Scientific Opinion," but, we hope, look better.

AMANUENSIS.—Send name and address.

CAPT. PETERSON.—Another letter on the "Steam Lifeboat," which was in type before yours came to hand, is inserted.

ELECTRICAL DISCOVERIES.—Isham Baggs next week.

PAUL GILL.—Nothing in the letter.

T. GILLINGHAM.—Letter on the City of Boston much too dreamy for practical mortals.

ERRATA.—"J. K. P." writes:—In my note on brass instruments, page 261, for "care" read "ease," and "gain" for "jam" in my note on throttle valve, in same page.

THE INVENTOR.

IN obedience to the suggestions of a number of readers, we have decided on appropriating a portion of our space to a condensed list of patents as nearly as possible up to the date of our issue.

APPLICATIONS FOR LETTERS PATENT DURING THE WEEK ENDING MAY 30, 1870.

1494 H. O. M. Ximenes, Wargrave, Berks, and E. Betincourt Boulogne-sur-Mer, improvements in hardening, preserving, and facing building materials

1495 J. Fletcher, 6, Bridgewater-street, Salford, improvements in coking and desulphurizing the coke after obtaining the gases, oils, and other products from coal

1496 E. A. Leigh, Manchester, improvements in shafting and in transmitting power

1497 E. Walbank, Leeds, apparatus to expedite the fitting of "uppers" in all kinds of boots and shoes

1498 E. Leigh, Manchester, improvements in piles for engineering purposes.—A communication

1499 H. B. Brook, Westminster, an improved medicinal compound or stomachic cordial

1500 W. E. Newton, 66, Chancery-lane, improvements in earth closets.—A communication

1501 B. Hunt, 1, Serle-street, Lincoln's-inn, improvements in mechanism for fastening French or folding windows at any desired point when partially opened.—A communication

1502 A. Cochran, Kirktonfield, Renfrew, improved apparatus for discharging water from steam pipes

1503 J. H. Johnson, 47, Lincoln's-inn-fields, improvements in machinery or apparatus for making metal cop tubes.—A communication

1504 J. Yule, Glasgow, improvements in motive-power engines

1505 T. J. Mayall, Lifford Mills, King's Norton, Worcester, improvements in parlour foot-balls and other india-rubber articles

1506 W. R. Lake, Southampton-buildings, London, improvements in supporting apparatus for the rollers of spinning frames.—A communication

1507 R. H. Pounds, 1, Emmett-street, Poplar, improvements in ropes and cables

1508 L. Perkins, 6, Seaford-street, Regent-square, improvements in connections for fire-engine hoses and other pipes

1509 C. Topham Coleman-street, Bunhill-row, improvements in certain parts of machines for mincing or minutely dividing meat

1510 J. S. Starnes, 13, Broad-street, Ratcliffe, a new or improved ventilator for the cabins, holds, and compartments of ships

1511 J. McNaught and W. McNaught, St. George's Foundry, Rochdale, improvements in machinery or apparatus for washing and drying wool, yarn, or other fibrous materials

1512 W. R. Lake, Southampton-buildings, improvements in washing machines.—A communication

1513 C. W. Siemens, 3, Great George-street, Westminster, improvements in regenerative gas furnaces and apparatus connected therewith

1514 G. Thomas, Colchester, improvements in the construction of gas stoves.

1515 J. W Horsfall, Camden Town, improvements in ventilating mines

1516 J. Falconer, New York, U.S.A., improvements in machinery for forming bats of wool for felting purposes.—A communication

1517 J. Shanks, Arbroath, wheels for traction steam engines and other heavy vehicles

1518 S. E. T. Steane, Barking, improvements in domestic fire-escapes

1519 A. M. Clark, 53, Chancery-lane, self-acting machine for cutting wood screws and eye-bolts.—A communication

1520 C. B. Barton, 173, King Edward-street, Great Grimsby, breaking of ice for the preservation of fish and other purposes

1521 R. C. Robinson, Preston, improvements in fire-grates

1522 J. Appleton and R. C. Ross, Manchester, an improved process and apparatus for preparing and finishing printed paper

1523 G. Schuck, 13, Idol-lane, London, an improved machine for watering and sweeping streets.—A communication

1524 D. Jones, Clerkenwell, improvements in the manufacture and treatment of coal gas for illuminating purposes

1525 G. Lunge, South Shields, improvement in the treatment of esparto grass and other fibrous materials

1526 J. Bullough, Accrington, improvements in looms, warping or beaming machines

1527 J. Bernard, Salisbury-street, Strand, improvements in blast and other furnaces, and in extracting metals from their ores and from metallurgical products

1528 J. Webster, Birmingham, improvements in converters for the manufacture of steel and other metals

1529 W. Horton, Sheffield, improvements in centre bits

1530 B. Cooper, Frome, improvements in looms for weaving

1531 J. Eastwood, Bradford, and H. W. Whitehead, Holbeck, improvements in machinery for combing wool, cotton, flax, and other fibrous substances

1532 W. E. Newton, 66, Chancery-lane, improvements in looms for weaving.—A communication

1533 W. Arnold, Barnsley, and W. Carnelley, Manchester, improvements in steam boilers

1534 L. Walker, and F. A. Walker, Liverpool, an improved setting lid

1535 W. Malam, New-road, Rotherhithe, an improved furnace or apparatus for consuming creosote and other hydrocarbons for the production of heat

1536 J. Bernard, Salisbury-street, Strand, improvements in the treatment of certain ores and metallurgical products, and in the extraction and recovery of their metals

1537 W. Astrop, Homerton, improvements in motive power

1538 A. Frerichs, Hamer Hall, Rochdale, improvements in machinery for spinning and doubling cotton and other fibrous materials

1539 J. I. Taylor, Manchester, improvements in washing, churning, and mixing machinery

1540 G. Zeller, 12, Great Prescot-street, Goodmans-fields, Middlesex, improvements in fire-arms

1541 W. Morgan, Rotherhithe, improvements in carriage axles and bearings

1542 R. Gammon, Warminster-road, Westbury, an improved railway sleeper for permanent ways

1543 J. Sellers, Preston, improvements in mileage indicators for vehicles

1544 J. Henderson, New York, improvements in the process of refining and purifying cast iron for foundry and for other purposes

1545 P. G. B. Westmacott, Elswick, Newcastle-on-Tyne, improvements in apparatus for grinding or polishing plate glass or slabs of slate stone, marble or other substances

1546 H. Blandy, Nottingham, improvements in the construction and arrangement of vessels employed in the manufacture of nitrous oxide gas

1547 H. Rose, Albany-street, Regent's-park, improvements in the mode of attaching mineral teeth

1548 J. Dargue and W. Dargue, Bradford, improvements in machinery or apparatus employed in the process of bleaching, scouring, dyeing, and sizing warps or yarns and fabrics

1549 B. J. B. Mills, 35, Southampton-buildings, improvements in safety attachments for steam generators.—A communication

1550 J. Cope, New North-street, Finsbury, an improvement in steam engines

1551 H. A. Bonneville, 10, Sackville-street, Piccadilly, improvements in breech-loading fire-arms.—A communication

1552 H. A. Bonneville, a new and improved label holder and fastener.—A communication

1553 W. E. Gedge, 11, Wellington-street, Strand, a new or improved system of grooves for rolling and shaping iron or other metals.—A communication

1554 W. E. Gedge, a new or improved plough.—A communication

1555 G. Stevens and J. Hendy, San Francisco, an electro-magnetic motor for sewing and other machines

1556 W. S. Moore, Percival-street, Goswell-road, an improvement in hand mirrors and other like articles

1557 W. J. Schlesinger, Union-court, Old Broad-street, improvements in producing rotary motion, applicable to egg beaters, churns, bottle washers, washing machines, drills, tools and other instruments.—A communication

1558 P. Tommasi, Paris, Boulevart de Strasbourg, 23, an improved thermo press

1559 H. Bessemer, Queen-street-place, London, improvemen in the construction of steam ships and other vessels employ for the conveyance of passengers, and in the means a apparatus employed to prevent or lessen sea-sickness on boa such vessels

1560 W. Cleland, Linacre, near Liverpool, improved mea and apparatus for exhausting, forcing, and purifying gas fo heating and illuminating purposes

1561 S. H. Stephens, Grass Valley, California, machines fo grinding, concentrating, and refining tin and other ores

1562 A. Manbre, Baker-street, improvements in apparatu applicable to the conversion of cereal and vegetable substance into saccharine matter

1563 E. A. Strubin, Notting Hill, improvements in cameras for reflecting and magnifying opaque objects.—A communication

1564 G. T. Leitch, Rutherglen, a new agricultural impleme

1565 W. T. Small, 13A, William-street, Holloway ments in the method or methods of supply and ex and other fluids, respectively to and from aquari cisterns, and other like vessels

1566 A. M. Clark, 53, Chancery-lane, machinery for corrugating and moulding sheet metal, which improvements are als applicable for other purposes.—A communication

1567 R. J. Collins, 15, 16, and 17, Bartholomew-close, improvements in the manufacture of embossed fabrics in imitation of quilting

1568 R. P. Williams, Great George-street, Westminster, improvements in railway switches or junction points

1569 C. D. Abel, 20, Southampton-buildings, Chancery-lane improvements in the manufacture of sockets and ferrules of wrought iron and other metals.—A communication

1570 C. D. Abel, improvements in the manufacture of wrough metal tubes.—A communication

1571 C. D. Abel improvements in apparatus for drawing tub skelps.—A communication

1572 W. Farini, Marseilles, improved apparatus to a employed in gymnastic performances

1573 H. Bryant, Hartford, Connecticut, an improv apparatus for illustrating the motions of some of th heavenly bodies and explaining various celestial phenomena

1574 W. Reamish, 5, Elgin-road, Saint, Peter's-park, Paddin ton, constructing a cylindrical iron kerb for the receptic repairing, and maintaining telegraph wires

1575 C. Mather, certain improvements in machinery apparatus used in sizing and dressing yarn

1576 J. P. Wiles, Sun-court, Cornhill, improvements i electro-magnetic engines

1577 W. E. Gedge, improvements in knitting machines.— communication

1578 A. V. Newton, improvements in looms for weaving.— communication

1579 L. Mignot, Boulevard de Strasbourg, 23, improved ma chinery for making ice

1580 H. Bessemer, Queen-street-place, London, improvement in the construction of stea ships employed for the conveyance of passengers' luggag nd cattle, and in the apparatus employed for such purpose on board ships, and for lessening or preventing sea sickness

PATENTS SEALED.

3521 J. L. Booth, improvements in the manufacture of rails for railroads

3596 J. . Tongue, improvements in machinery or apparatus for sewing or stitching together the numbers or separate parts of a volume in the operation of bookbinding.—A communication

3622 R. Johnson, improvements in the arrangement and construction of granaries.—A communication

3675 G. T. Bousfield, improvements in the treatment of aromatic secondary monamines for obtaining colouring matter. —A communication

3678 G. Ermen, G. A. Ermen, and W. Foster, improvements in the construction of brushes

3687 C. D. Abel, improvements in ploughs and cultivators for tilling the soil.—A communication

3724 H. E. Newton, improvements in traction engines.—A communication

48 W. Wield, improvements in machinery for winding yarn or thread on to bobbins

91 F. H. Knevitt, improvements in shutters and blinds for windows

100 G. Kent, improvements in rotary knife-cleaning and polishing machines

722 J. Moysey and C. Thorne, improvements in hackling machinery

776 W. Rainforth and W. Rainforth, jun., improvements in rotary corn screens for dressing and separating grain

851 J. Bradbury, J. Bradbury, and J. Roberts, improvements in machinery for felting hat bodies

954 W. MacLean, improvements in printing, lithographing, and zincographing

963 A. Barlow and J. Taylor, improvements in machinery or apparatus to be employed in preparing cotton or other fibrous substances for spinning

3451 T. Reissig, improvements in making a new derivative of phenol, and in producing certain colours therewith upon textile fabrics and yarns

3461 C. H. Hudson, improvements in cots or bedsteads, and guards to be attached thereto

3462 E. T. Hughes, manufacture of elliptic springs, and in apparatus employed therein.—A communication

3463 A. W. Pocock, improvements in meters or apparatus for measuring water and other liquids

3464 W. H. Willis, a new or improved apparatus for registering or indicating the points of games

3465 R. Acton and J. Mustard, improvements in machinery for feeding carding engines

3472 W. Spence, improvements in the manufacture of soda crystals

3473 T. G. Green, appliances for use in the manufacture of articles of earthenware and chinaware

3480 J. Peirce, improved compound machine for cutting tenons and mortises and sawing wood

3485 G. Hammer, improvements in cork-cutting machines

3488 A. Mitchell, improvements in caissons or apparatus to facilitate the building of bridge piers

3494 P. A. S. Langlois, and L. S. Thomassin, improvements in the manufacture of sulphuric acid

3495 E. Field, valves for steam fire-engine and other pumps

3496 W. Tatham, improvements in machinery for opening and breaking hard waste, rags of cotton, woollen flax, or silk, and for scutching and carding fibrous substances

3658 A. M. Clark, improvements in Jacquard apparatus.—A communication

3683 E. Shakespear and G. Illston, improvements in sewing machines

3695 H. Green, improvements in lubricators

1048 A. H. Brandon, improvements in looms.—A communication

3477 J. T. Griffin, improvements in preparing, treating, and curing sponge to render it elastic and suitable for use as a stuffing for beds.—A communication

3488 F. C. Webb, improvements in the manufacture of submarine telegraphic cables

3499 J. C. Wilson, an improved revolving engine and pump

3507 J. Boyd, improvements in machinery for winding yarn or thread upon conical surfaces

3523 W. Shanks, improvements in machinery for forging shoes for horses

3541 J. H. Johnson, improvements in crucibles, melting pots, retorts, and furnaces.—A communication

3545 E. Edwards improvements in photo-mechanical printing

3548 G. Preston and J. Prestige, improvements in apparatus for regulating the supply of water to waterclosets

3566 J. Ballantyne, improvements in the manufacture of yarns or threads

3585 W. I. Hetherington, improvements in motive-power engines, specially adapted for propelling ships

3615 W. E. Newton, improvements in harness for looms.—A communication

3621 B. Moss, improvements in kilns or apparatus for the manufacture of malt.—A communication

3625 J. Askew, refrigerator for cooling brewers' and distillers' wort

3661 J. C. Martin, an improvement in the manufacture of finings as a substitute for isinglass

3670 S. Butler, improvement in the manufacture of lace in twist lace machines

130 A. M. Clark, improvements in wooden pavements and in cutting the blocks therefor.—A communication

71 . Chatwood and J. Sturgeon, improvements in direct-acting power hammers

The English Mechanic
AND
MIRROR OF SCIENCE AND ART.
FRIDAY, JUNE 17, 1870.

ACCIDENTAL COLOURS.

IN our recent articles on "Colour and Colour Blindness, it will be noticed that we have treated merely of *objective* colours; that is to say, of colours that may be said to have a real existence, arising from the decomposition of white light, and in regard to which the eye is to be considered simply as a passive instrument forming the organ of vision, and is in no way employed in the formation of the effect it witnesses. But under particular circumstances the eye itself is capable of producing a certain degree of colour which has no real existence, and is visible to the eye only as long as the circumstances that produce the unreal colour are capable of exerting their effect upon the organ of vision. To these colours has been applied the term *subjective* or *accidental*, and their production is owing to a reactionary property that the eye possesses under the influence of light, more or less vivid, and which converts the organ of vision into an active from a passive state. This reactionary power is well described in a letter from Newton addressed to Locke, in which he describes an experiment performed at the peril of his sight. Newton subjected his eye to the action of a great amount of concentrated light, by looking at the image of the Sun reflected from a mirror, and then turning his eye, when sufficiently fatigued, to an obscure corner of the apartment, he closed the eyelid and prepared to watch the result, when he saw a luminous image of the Sun, surrounded with coloured rings, which, growing weaker, by degrees, finally disappeared. "I repeated this act a second and third time. At the third repetition, when the luminous image, and the colours which surrounded it were rapidly disappearing, and while my attention was concentrated in the expectation that I should completely lose sight of them, I saw them, with no little surprise, again make their appearance, and gradually become as vivid and strong as they had been at the moment when I ceased contemplating the Sun." This experiment satisfactorily establishes the fact that the retina, after having been excited by the action of a luminous object, is gifted with the power of calling up a succession of coloured images that have no real existence, but as the experiment performed by Newton is highly dangerous, and likely to be attended with disagreeable results, we shall content ourselves with describing experiments which equally well attest the active power of the retina to produce unreal images, and which can be performed without danger or difficulty.

If a red wafer be placed upon a white ground, as a piece of paper, for example, and be attentively examined for some time, there will be perceived around the wafer a ring of green, and if, after this, the eye be directed to a second piece of white paper, at the same distance from the eye as the first on which the red wafer was laid, an imaginary green wafer will be perceived of the same dimensions as the original red wafer, which will gradually grow fainter and finally disappear as the irritation occasioned by the red rays from the wafer gradually dissipates itself. This is the manner in which the experiment was effected by Buffon, but Scherffer has noticed that the accidental colour was both more brilliant, and the outline better defined if the natural colour was viewed on a black ground, and the eye afterwards transferred to a white.

If the wafer be of a yellow or blue colour, the eye, on being transferred from the natural colour, will see a phantom wafer of violet or orange; if it be black, the consequent object will be white, and *vice versa*. Therefore this experiment makes us acquainted with the fact that the accidental colour arising from the prolonged contemplation of a natural colour is of a *complementary* hue, the term *complementary* being understood to imply two colours, which when blended together produce white. An attentive consideration of the simple experiment we have just described convinces us that two distinct phenomena are going on at the same time, namely, that which produces the border of the complementary colour around the wafer while it is being examined, while at the same time the eye is so affected as to be capable of producing a phantom colour, after the removal of the wafer. To the first of these two classes of subjective colours has been applied the term *simultaneous*, to the latter, *succedaneous*. We will treat of the latter class first, taking M. Plateau as our guide.

The researches of M. Plateau on this subject have led him to decide that the disappearances of images do not vanish with a gradual and regular decrease of brilliancy, but are accompanied with a succession of disappearances and reappearances. The method of observation employed by M. Plateau was as follows :—While one of his eyes was closed and bandaged, he directed the other with fixed attention for a minute at least at a red paper, cutting off all extraneous light by adapting a blackened tube of about fifty centimetres in length, and three in width, to his uncovered eye. When the eye was sufficiently fatigued, he turned his eye to the ceiling, without removing the tube, and without uncovering the closed eye. On the ceiling, he saw projected a green circle, soon followed by a red circular image of feeble intensity ; this red spectrum was followed by a green, which again gave place to the red, and so on, the red appearing as often as four times, though of course gradually decreasing in brilliancy. Notwithstanding Sir David Brewster's assertion that the manifestation of these phenomena are physically impossible in a perfectly darkened room, the complementary image, and precisely the same appearances, can be produced by closing the eyelids, and pressing the fingers upon them to exclude all light. This fact has required some modification of the hypothesis advanced by Brewster to account for the phenomena, of which we shall say more hereafter.

The experiments of Scherffer have decided that accidental colours are capable of combining and blending together precisely as objective colours ; thus, the accidental blue and yellow form a green; the red and blue, a violet, and so on. The method of proceeding of Scherffer was exceedingly simple. He placed on a black ground small squares of violet and orange (the complementaries of these being yellow and blue respectively), and fixed his eye steadily first on one, and then on the other without moving his head, till each had been examined four or five times. He then turned to a white wall, on which he perceived three squares in juxtaposition, coloured yellow, green, and blue, the middle square being formed by the combination of the two accidentals, yellow and blue. If orange and green had been the objective colours examined, violet would have been the colour of the centre square ; in every case, the colour of the mean would be a mixture of the colours of the two extremes. There is, however, one exception to this rule, which occurs when one of the objective colours is the complementary of the other; as, for instance, if red and green be the two colours subjected to scrutiny. The centre square in this case is not white, but of a dark neutral colour, if projected on a white ground, and completely black if the eyes be closed.

Since two accidental colours are capable of combining, it might be expected that an accidental could be blended with a real colour, and this is the case, which shows that accidental colours have all the attributes of real colours, excepting stability. The experiment to show this combination is easily effected by changing the black or white screen which we have hitherto considered to be employed as the material on which the accidental colour is projected for a coloured screen. If, for instance, the accidental red arising from prolonged contemplation of the objective green be thrown on a blue screen, a brilliant violet will be the result. But it should be noticed, if the accidental red arising from the same circumstances as detailed in the last experiment, be projected upon a green screen the effect will be simply to produce a neutral grey, of a dark tone, that is to say, in general terms, that when the accidental image is projected on a screen of the same colour as the objective, the effect is simply one of obscurity. On the other hand, when the screen is of the same hue as the accidental, or the complementary of the natural colour, the brilliancy of the phantom colour will be much enhanced, and stand out prominently from the neighbouring coloured surface. This will be the case, for example, if the exciting object be yellow, and the coloured screen violet. Such are a few of the properties of *succedaneous subjective* colours. Before we proceed to mention the cause of the phenomena we will add a few of the familiarities pertaining to *simultaneous subjective* colours.

As we have already said, this is the name that physicists have applied to the accidental colour that is created *during* the contemplation of a coloured object. Many experiments prove beyond all doubt the capability of the eye to imagine colours while so occupied, and the *simultaneous law of contrast* is one of no little importance in the many trades and professions in which coloured decorations are employed, and the assortment of tints involved. As the coloured fringe, which we have described as appearing round the border of a luminous circular image, is not without its objections as a proof, and as an instance of the existence of this law, we will describe another experiment easily performed, and which dispels all doubt on the subject. Take two pieces of paper of about twenty inches square, each of which is coloured by an even tint of two different (the one red, and the other yellow, for example) colours, of as near as possible the same intensity, and cut the two squares in halves. Fix the four pieces of paper upon a piece of brown holland opposite to a window in such a manner that two edges of two differently coloured pieces of paper may be in contact, and at a distance of about ten inches suspend the two other pieces of paper each on the side of its own colour (these two exterior slips to serve for comparison). On examining carefully the entire arrangement, it will be seen that the two centre half sheets undergo reciprocally a modification of tint, and are no longer identical in colour with the separated sheets, but each has taken such a tint as would result from the original colour being tinged by the complementary of the colour of the other strip. In the example we have supposed, the interior red strip will tend to a violet colour, and the adjacent yellow strip to a green. M. Chevreul, to whose ingenuity we owe this decisive experiment, had abundant proof furnished him of the existence of this phenomenon in his official capacity as Superintendent of the Dyeing Department of the Royal Manufactories of the Gobelins, by the complaints of drapers who had given cloths of a single colour, red, violet, or blue, to have black figures painted upon them; on the red cloths appeared to them green patterns, on the violet cloths, greenish-yellow ones, and upon the blue, orange-coloured, instead of the black that had been ordered. In each case it will be noticed that the colour with which the black appeared to be tinged was the complementary of the colour on which it was painted. M. Chevreul covered up the groundwork of the cloth in such a way as to allow only the black to be visible, when the designs appeared as black as could have been desired, and the fault was entirely in the ignorance of the drapers to this law of simultaneous contrast.

The researches of M. Chevreul on this subject are extensive and exhaustive. We shall merely mention here the conclusions to which his experiments and experience have conducted him ; they can all be deduced from the general enunciation of the law of simultaneous contrast. If two colours are in juxtaposition, of which one is the complementary of the other, since each has the tendency to overspread the surrounding space with its complementary tinge, the brilliancy of each must be enhanced, and the result must be to produce colours of greater purity and brightness. The knowledge of this fact is of great use in a variety of cases. For instance, the employment of red hangings and decorations in apartments is not desirable, since the effect of such a colour would be to give a greenish tinge to the countenances of the inmates, and destroy the reddish colour which is highly prized in mahogany furniture, giving it the appearance of oak or walnut wood. Judging from optical principles, the head-dress that is best calculated to adorn a fair complexion would be a green hat lined with rose-colour, because the rose-tint is *reflected* on the countenance, and is further heightened by the complementary of the green overspreading the face. Undoubtedly, our example is a work of supererogation, but it equally well serves our purpose of illustration.

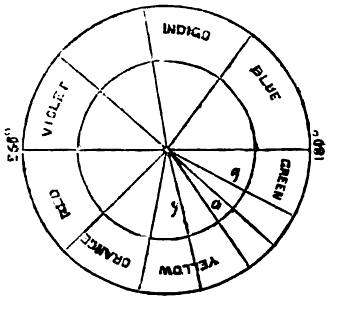
If white be brought into contact with any colour, it is of course slightly tinged with the complementary of that colour, but the colour employed becomes deeper and brighter. The same result follows from the involuntary contrast of black, and any colour, and when black and white are in juxtaposition, the former becomes deeper, and the latter more brilliant than when viewed separately. The same modifications of colour take place, though less distinctly, when the two objects are not in contact, the alteration of colour becoming less as the distance between them becomes greater.

Simultaneous accidental colour manifests itself in another entirely different manner, but not less interesting, as is evidenced in *Coloured Shadows*, which differ from other accidental colours, which are difficult to perceive and eminently transitory, by their vividness and strongly-marked characteristics; "and the mind, however convinced of their unreality, repels with difficulty the notion that they are no simple illusions, no purely subjective appearance, but in truth real colours." These coloured shadows are produced with no great difficulty, and no very extensive apparatus. It is sufficient to interpose a body illuminated with white light between the coloured light and the screen on which the light falls, when it will be seen that the shadow is tinged with the colour that is complementary to the coloured light. For example, if we have a cone of red rays falling upon a sheet of paper, and an opaque body illuminated by white light be introduced in front of the paper, the shadow will be intensely *green*. Of course, by varying the colour, by means of a succession of coloured glasses, the shadow of the interposed object may be made to pass through all the varying shades of the spectrum. Count Rumford has been one of the most enthusiastic observers of this class of subjective colours; he expresses his admiration in no measured terms. "The shadows," he says, "were tinged with an infinite variety of colours, the most unexpected, and often the most beautiful; they varied unceasingly, sometimes with inconceivable rapidity; the eyes were fascinated and the attention involuntary fixed on this magic tableau, equally enchanting and new. The clouds carried by the winds seemed each in its turn to bring an endless succession of different colours with the most harmonious tints." Yet this "magic tableau" was produced with the most simple apparatus; nothing more than two little apertures covered with coloured glass, sufficiently removed from each other that the light of the Sun which passed through these coloured glasses might throw two distinct shadows of the same opaque body. Although the opaque body must be necessary to produce a shadow, the experiment can be varied to show the light tinged with the complementary of the surrounding coloured light. Meusnier vouches for the success of the experiment performed in the following manner:—In a room where the illumination is effected by means of the solar light transmitted through a red curtain, the light of the sun passing through a small orifice cut in the curtain, and falling on a white screen, will not be white but green.

However difficult it may be to *believe* that we are deceived in the colour of these shadows, it is by no means difficult to *prove* that we really are so. We are indebted to Count Rumford for removing all doubt, that attaches itself to this section of subjective colours, and for tearing away the veil of mystery that surrounded them. He arranged his apparatus as usual, and made quite sure that the phenomena of coloured shadows were duly manifesting their peculiarities, and attractions on the screen; he then proceeded to examine these shadows through a blackened tube, that cut off all the surrounding light, and left visible the shadow *alone*, and, lo! all the brilliancy and attraction of the phenomenon had vanished, a colourless and obscure shadow was all that was visible, and the philosopher was convinced of the deception. The explanation of the phenomena of coloured shadows is to be found in a moral, rather than in a physical cause, and the theories that account for subjective colours will fail when applied to coloured shadows, and consequently considerable uncertainty attaches itself to this description of phenomena.

The explanatory theory suggested by Scherffer, and accepted by Sir David Brewster, will, with a slight alteration and addition, be sufficient to explain most of the phenomena that the subject of accidental colours produced. To make this sufficiently clear to our readers, it will be necessary to refer, even at the risk of repetition, to some of the well-known properties of colour. It is well known that if a disc of paper be painted with the seven prismatic colours in certain proportions, and be swiftly whirled round from the centre point, each colour loses its individuality, and all appears of a uniform light gray tint. If the colours were perfectly pure, the result would be a white light. The diagram shows the proportional size of each sector in order to produce such a result. The arc of the circumference occupied by the Violet tint is 80 deg., of Indigo 40 deg., and of Blue 60 deg., which occupies one-half of the disc. On the other half are arranged the other four prismatic colours in the following proportions:—Green, 60 deg.; Yellow, 48 deg.; Orange, 27 deg.; and Red, 45 deg.

But if one of these sections be painted black, instead of the appropriate tint, the result is not a white light, but is of a colour the complementary of that which has not been allowed to appear. An easy method of determining the colour that arises from the mixture of any of the prismatic colours can be understood from the accompanying diagram, where each sector is supposed to be covered with the appropriate tint. Let us suppose that the colour is concentrated in the centre of gravity of each sector, then, if any colour be left out, the resulting light will be that colour which is nearest to the centre of gravity of the remaining sector. For instance, if Violet be painted black, or left out, the centre of gravity of the sector will fall in the line *a*. This line falls between the Green (*g*) and the Yellow (*y*), hence the prismatic colours without Violet would combine, and form a greenish yellow tint, in which the green preponderates. If green be left out the centre of gravity would fall between the red and violet, which is the true complementary colour of green. Hence, in all cases, the complementary of any colour can be determined by producing the line that bisects the arch it covers, to the opposite side of the circle, when the point at which it meets the circumference will indicate the complementary colour.



We are now in a position to explain how it is that the contemplation of a coloured object developes in the eye a tendency to perceive a phantom object of a complementary colour, simply by supposing that the irritation occasioned by the red rays has to some extent destroyed the sensibility of the eye to red light, and that in the contemplation of a white light the eye is in precisely the same position as in viewing the coloured disc when the red has been omitted, when by the rule given above, the light emitted would be a green tending to blue. This simple theory is sufficient to explain most of the phenomena present in the succedaneous subjective colours, but there are certain peculiarities of which it affords no competent and satisfactory explanation, such as the production of subjective colours in complete darkness, and the combination of the accidental with the real objective colours. The first objection, as we have seen, was asserted by Sir David Brewster to have arisen from a decided physical impossibility; but M. Plateau, too long employed in these observations to be easily deceived, has stated that he has seen such an effect, and its existence is now so completely recognised by physicists, as to require some modification of Scherffer's theory, for it is manifestly absurd to suppose that the insensibility of the eye to a certain coloured light should in the *absence* of all light, produce a complementary colour. Neither can this theory be held sufficiently to explain the irregularity with which the accidental image vanishes, and the occasional reappearance of the natural image. The ingenious theory of M. Plateau seeks to evade none of these difficulties. He begins by remarking that accidental images are due to a physical modification of the organ, since the size of the accidental image is considerably modified by the distance of the surface on which it is projected, from which it is to be inferred that the visual angle is constant, and that consequently the image is increased, acco[illegible]ing as we refer it to a greater distance, which [illegible] in accordance with the fact. "We see no reaso[illegible] says he, "why it should be so on the hypoth[illegible] of a moral cause; the image should then al[illegible] appear to us of the same magnitude [illegible] object."

This prefatory remark being admit[illegible] be necessary to consider the effect pro[illegible] the retina by the contemplation of a colour[illegible]ject, both during and after the action of [illegible] coloured rays. It seems most natural to supp[illegible] that after the organ of vision has been excited [illegible] coloured light on the withdrawal of the caus[illegible] excitement, the retina should gradually regain [illegible] normal state, which would occasion the persistence of the primitive impression, growing feebler as the impression vanishes, yet without changing its nature, till, like the oscillatory motion of a pendulum, it passes through its normal state, or point of rest, when the reactionary property produces the subjective image, which, when it has again reached the maximum degree of brightness, gradually tends to reproduce the primitive impression. All the phenomena that depend upon *time*, that is to say in which *time* enters essentially in order to produce the phenomena, are explained by this ingenious reasoning, and by an analogous reasoning, with reference to *space*, the phenomena of the simultaneous subjective colours are explained. "If while the retina is subjected to the action of the coloured light, we examine the parts of the organ which surround the place directly excited, we see that the normal state is not found except at a distance more or less considerable from the contour of that space, and that this normal state is reached in passing through the effects of irradiation, and of the accidental colours of the second (simultaneous) class." Here, then, we have presented to us two kinds of oscillation, one of *time* and the other of *space*, which separately considered, are sufficient to explain *all* the phenomena with which we are occupied, and M. Plateau has pointed out "that they are connected with one another in the most natural manner—that they are simple consequences of the law of continuity." M. Plateau does not absolutely deny the existence of the law of involuntary contrast, but he rightly doubts its competency to explain all the circumstances that accidental colours present, and we think it will be admitted that where possible, it is better to trace the effect from physical causes than from moral, and that the reasoning of M. Plateau is more satisfactory than that of M. Chevreul.

We cannot close this short article without expressing our sorrow and regret that the researches of M. Plateau, and of M. Fichner, scarcely inferior to him in his enthusiasm, but less happy in his deductions, have been crowned with a common misfortune. Too enthusiastic in their endeavours to produce these subjective colours, and analyse the sensations, they have been smitten with blindness. Under proper medical treatment. we believe M. Fichner recovered the use of his eye, but the illustrious Professor whose name has been mentioned so many times is thoroughly incapacitated from pursuing those inquiries, which have shed around his name an immortal lustre.

A PRACTICAL TREATISE ON THE HARMONIUM.*

BY HERMANN SMITH.

THIRD DIVISION.—CHAPTER IV

OF THE CHANNELS OF THE SOUND-BOARD.

> THE masses of air which are enclosed in a pipe are not brought with the same ease into every possible kind of vibrating motion, but by means of external action each mass of air is enabled only to give these particular vibrations which are not opposed to the reaction from within.—OERSTED.

TO whatever extent you may be tempted to investigate the nature of the harmonium, you will do well to take the sentence of the great Scandinavian philosopher as the fitting prelude to a thoughtful survey of the characteristic features of the instrument, and of the varieties of quality possible in its tones. The stops of the harmonium form a topic for critical discussion, and each speaker on his own showing professes to be a judge and connoisseur. Nothing is more common than the demand for a good oboe stop, a good clarionet, trumpet, and violoncello, and other conceivable stops to fit the musician's fancy—nothing more common, unless it be the assertion that somebody possesses or knows somebody that possesses an instrument, harmonium or organ, with stops of so perfect a kind that the best judges could not distinguish their sounds from those of the genuine instruments with which they are supposed to compete. The extent of the delusion is the measure of the imperfect knowledge of the limitations of art, and of the lack of real acquaintance with the instruments brought into comparison. No professional artist would admit the claim for a moment, unless with a smile of condescension to the questioner. Imagine asking Barrett, or Puzzi, or Lazarus, or Piatti, how far they were deceived by the tones of organ or hormonium in the disguise of oboe, horn, clarionet, or violoncello. The old ambition is rife as ever. The dream of the alchemists for an universal solvent, the quest of the Rosicrucians for the transmuting stone, trouble us no more, yet men after another fashion endeavour

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to pass through Nature's bounds,

and all in vain. Our counterfeits pass with energetic warranty as quite equal to originals; but the true seer is never deceived; the fine royal mint-mark is beyond dispute, and makes visible its supremacy. We imitate wonderfully well the flavours of fruits, and the perfumes of flowers, yet our skill in chemistry is abashed in a moment in the presence of the simplest offering from orchard and garden; in all our attempts there is "a hidden want," and we are obliged to confess that Nature holds charms in her laboratory that we cannot match. In the same mood of thought we view musical instruments as Nature's work. The several classes of instruments forming the modern orchestra belong to distinct types, and however we may vary these in grade and power, and increase their mechanical excellence, yet we cannot originate a new type, nor afford to banish a single species. The form of each instrument, the mode of its musical excitation, and the range it can compass, these determine the characteristic tone by which we identify the species, and hence it will be obvious that if we depart from the type, and make new moulds after our own fancy, the natural results cannot possibly be the same. Our imitation may be a marvellous good likeness, yet it would be dangerous to our self-complacency to place it side by side with the original—our paste diamond lying in the effulgence of the one fair jewel

flashing and smouldering in her hair.

Do not lightly allow this view to pass from your mind. Let it be firmly impressed upon you that the thorough comprehension of it is of essential value in the study of our instrument. Fixity of type ensures the reproduction of character. We copy the form and mode of the chief solo instruments of the orchestra, and the tones we listen to are the same in kind as those heard by our forefathers. The family likeness is recognised in every country where the art is practised. Take for instance the "Oboe" or "Hautbois." A tube of certain length, two reeds, a slender throat, slender as the throat of the nightingale, a pipe of conical bore, and apertures at definite distances, and the tone from such an instrument is of so unmistakeable a character that we identify it as belonging to a species, and call it for all time "oboe-tone." The form and the mode determine the product; alter these in any degree, and the result will inevitably be a different result. Do you ever consider that the influences which go to produce that sensible existence in aërial waves which we call "tone" and "quality of tone" is as truly a compound of forces acting in definite relation, and stimulating the ear to recognition just as much as the food we taste and discriminate is a combination of chemical constituents in definite proportions? There is no chance in the result of any of these combinations, though there may be in our attempts at its attainment. Here the words of Oërsted come in to our aid, and indicate why there is no chance. Nature in these, and we might as truly say, in all her movements follows the simple plan of taking the path of greatest ease. Water tending to its level, the projectile pursuing its flight and sinking to its rest, the planet tracing its orbit, all are seeking the line of greatest ease, under the composite and many-sided influences impelling and surrounding them. With as absolute a certainty, sound is generated according to the associated influences under which it comes into existence or activity, for as Locke wisely defines it, "sound is nothing but motion."

In the making of Oboes, art faithfully abides by its traditions, and the same holds good in respect of other typical instruments. In making the channels designed for the several registers of the harmonium, we unfortunately have not the same advantage of antiquity and of recognised models. Our art is as yet immature and undefined, and present models are imperfect or but casually satisfactory. A little reflection will show the difficulties inherent in our task. We attempt to imitate an instrument of fixed type which contains in one tube or pipe a whole range or compass of notes. In the harmonium we have a separate instrument for each note, each channel being virtually an individual pipe with an independent character and very independent ways of showing it. In the original, one conformation of tube determines the whole series of notes, each one growing out of the parsent stem in due relation to the others. We, on the contrary, have to deal with dozens of distinct cuttings, all of which have to be grafted and cultured into family likeness. The original has a certain length readily measured into correct divisions; we have only fractional representatives or multiples of such, and the various proportions of our channels, and the relations of each proportion to the whole have never yet been determined with the precision which would yield us a referable standard. Incidental variations too minute for accurate measurement yet powerful to influence the resultant quality of tone. Variations in length of channel, in depth, in width, in length and breadth of apertures for reed and pallet, in thickness or thinness of veneers, in scale of reed, in elasticity of swing in setting, and voicing, in lift of pallet, in depth of keytouch, in covering and enclosing, in strength and volume of wind, and modifications of impulse—these and many others, all more or less determine the character of tone of every register, and inasmuch as each one may be considered as a distinct element in the composition of forces in every given sound, each variation we could name would count as a power controlling or disturbing the grouping and arrangement of the clustering spheres of aerial waves where of every sound is composed. The form of the motion, and the complexity of the undulations constitute the "quality" of the sound, and whatever has power in least degree over the combinations of the form will undubitably exercise an influence in determining the path of greatest ease, whether it shall be parallel or divergent from the prefigured course on which our calculations have been made. Within every pipe giving utterance to musical sound there is a contention of waves for the mastery, or an accordance of undulations reciprocating the vibratory impulses of the exciting agent. Thus it is that by the preponderance of one or other proportion of pipe and reed we gain distinctive character of sound. As in chemistry, a very little difference in elemental proportions fixes the character of sweet or acid, of condiment or poison, so it is in musical tones the most minute differences of relation conduce to our pleasure or our pain, and cause us to distinguish the agreeable and the dissonant.

The form of the sound? Yes, the expression is uncommon, no doubt, yet it is only the bare truth, and it is not altogether beyond the power of science to afford us glimpses of these shapes of air. Another time we may say something of "the theory of vortex atoms" as bearing on our study, and of some beautiful optical demonstrations of sound; but at present we need only call to mind how the shapes of divergent water jets are formed by the pipes whence they issue, how the courses of streams in their channels are resultant from combinations of force, how the surfaces of lake and ocean are marked with circles, intricately interlaced, and many patterned fringes of wave, all telling of contending or reciprocating activities—let us watch these forms visible and palpable, and we shall have no plea for doubting that the invisible air, subject to the same laws, bears its rich tapestries and wondrous traceries of sound.

We say of men, character displays itself; we have many proverbs that emphasise our belief in inherited virtues and vices, and the family likenesses that bespeak parentage and affect behaviour. In like manner, pipes, channels, and other musical agents, have predispositions which are always ready to display themselves. Each gives the tone that comes most natural to it, most easy under the forces that bear upon it—the greatest ease is its nature, because the inanimate has no will, no aspiration. A channel that is connected with a reed gives not its own tone, but the tone resultant from the combination of itself with the reed; the offspring takes after both parents. If the channel is deeper at the pallet than at the reed, the tone will be very different to that given by a channel that is deeper at the reed end, or that arches in the centre. Even a pipe 8ft. long, if only bowed the mere fraction of an inch more at the centre than at the ends, will give a perceptibly different quality of tone to that which will be produced from a pipe with perfectly parrallel sides. A fact of significence if you only consider it.

We have now to study the shapes to be given to the channels of our soundboard, and you will readily gather that we place more value on the appreciation of the principles concerned in the structure of the harmonium than on mere arbitrary measurements, which, whilst they wholly misled the learner, cannot fail to cause disappointment when results are tested.

Remember and forget not the words of Oërsted; thoughtfully considered they will help you over many a difficulty, and give a new interest to the facts that arise under your observation.

Continuing the argument, we shall in our next chapter place before you several illustrations of the various forms of channel for characteristic registers.

(*To be continued.*)

MECHANICAL MOVEMENTS.*

(*Continued from page* 269.)

149. Another form of parallel ruler. The arms are jointed in the middle and connected with an intermediate bar, by which means the ends of the ruler, as well as the sides, are kept parallel.

150. Traverse or to-and-fro motion. The pin in the upper slot being stationary, and the one in the lower slot made to move in the direction of the horizontal dotted line, the lever will by its connection with the bar give to the latter a traversing motion in its guides *a a*.

151. Stamp. Vertical percussive falls derived from horizontal rotating shaft. The mutilated toothed pinion acts upon the rack to raise the rod until its teeth leave the rack and allow the rod to fall.

152. Another arrangement of the Chinese windlass.

153. A modification of the tilt or trip hammer. The hammer helve is a lever of the first order.

154. A modification of the crank and slotted cross-head. The cross-head contains an endless groove, in which the crankwrist works, and which is formed to produce a uniform velocity of movement of the wrist or reciprocating-rod.

155. The gyroscope or rotascope, an instrument illustrating the tendency of rotating bodies to preserve their plane of rotation. The spindle of the metallic disc, C is fitted to turn easily in bearings in the ring A. If the disc is set in rapid rotary motion on its axis, and the pintle F at one side of the ring A, is placed on the bearing in the top of the pillar G the disc and ring seem indifferent to gravity, and instead of dropping begin to revolve about the vertical axis.

156. Bohnenberger's machine, illustrating the same tendency of rotating bodies. This consists of three rings A A^1 A^2 placed one within the other and connected by pivots at right angles to each other. The smallest ring A^2 contains the bearings for the axis of a heavy ball B. The ball being set in rapid rotation, its axis will continue in the same direction, no matter how the position of the rings may be altered; and the ring A^2 which supports it will resist a considerable pressure tending to displace it.

157. What is called the gyroscope governor, for steam engines, &c., patented by Alban Anderson in 1858. A is a heavy wheel, the axle B B^1 of which is made in two pieces connected together by a universal joint. The wheel A is on one piece, B and a pinion I on the other piece B^1. The piece B is connected at its middle by a hinge joint with the revolving frame H, so that variations in the inclination of the wheel A will cause the outer end of the piece B to rise and fall. The frame H is driven by bevel gearing from the engine, and by that means the

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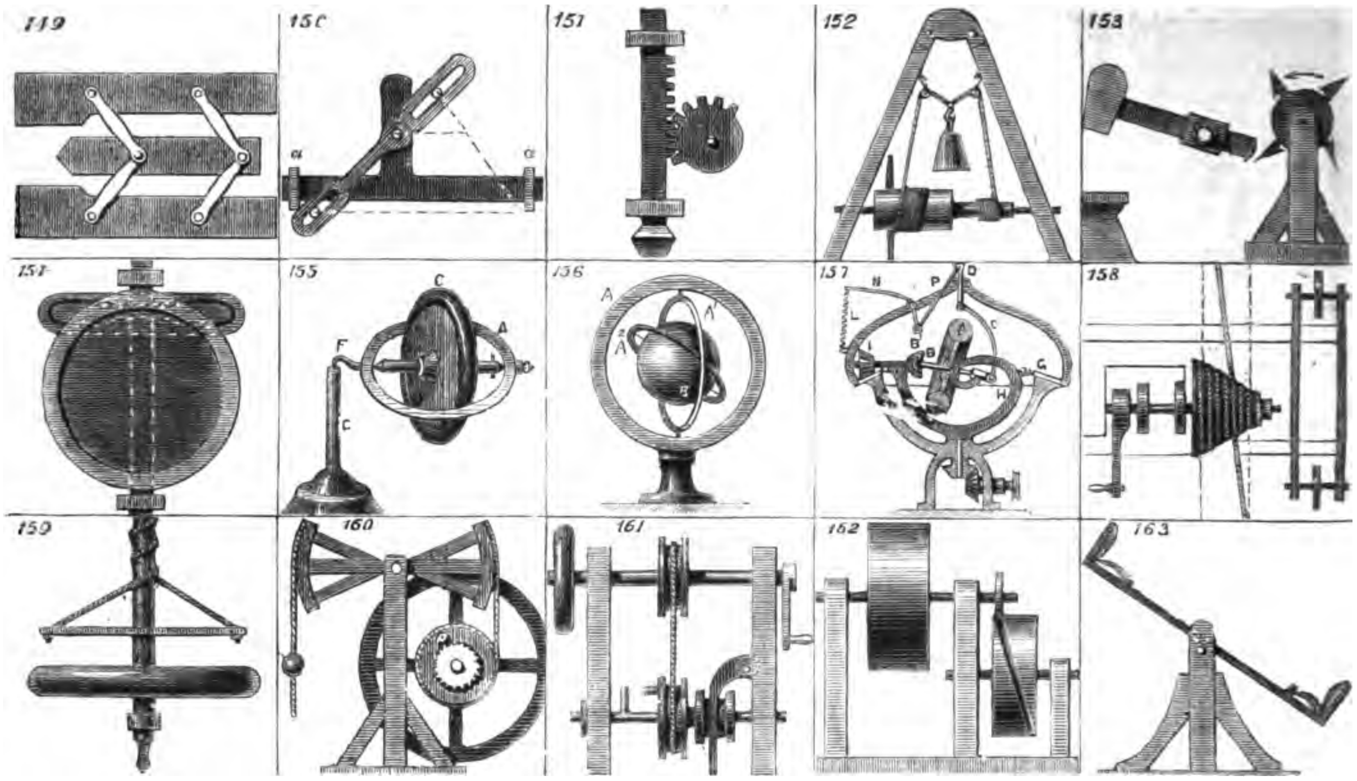
* Extracted from a compilation by Mr. H. T. Brown, Editor of the "American Artisan."



MECHANICAL MOVEMENTS.

pinion I is carried round the stationary toothed circle G, and the wheel A is thus made to receive a rapid rotary motion on its axis. When the frame H and wheel A are in motion, the tendency of the wheel A is to assume a vertical position, but this tendency is opposed by a spring L. The greater the velocity of the governor, the stronger is the tendency above mentioned, and the more it overcomes the force of the spring, and vice versa. The piece B is connected with the valve-rod by rods C D, and the spring L is connected with the said rod by levers N and rod P.

158. Traverse of carriage, made variable by fusee according to the variation in diameter where the band acts.

159. Primitive drilling apparatus. Being once set in motion, it is kept going by hand, by alternately pressing down and relieving the transverse bar to which the bands are attached, causing the bands to wind upon the spindle alternately in opposite directions, while the heavy disc or fly-wheel gives a steady momentum to the drill-spindle in its rotary motion.

160. Continuous rotary motion from oscillating. The beam being made to vibrate, the drum to which the cord is attached, working loose on fly-wheel shaft, gives motion to said shaft through the pawl and ratchet-wheel, the pawl being attached to drum, and the ratchet-wheel fast on shaft.

161. Another simple form of clutch for pulleys, consisting of a pin on the lower shaft and a pin on side of pulley. The pulley is moved lengthwise of the shaft by means of a lever or other means to bring its pin into or out of contact with the pin on shaft.

162. Alternating traverse of upper shaft and its drum, produced by pin on the end of the shaft working in oblique groove in the lower cylinder.

163. See-saw, one of the simplest illustrations of a limited oscillating or alternate circular motion.

(To be continued.)

PARSONS' WHITE BRASS.

At the conversazione of the Civil Engineers held a few nights since, Mr. P. M. Parsons, well known for his labours in the improvement of ordnance, sent samples of his white brass. Exactly of what this very peculiar alloy consists (says the *Engineer*) we shall not pretend to say. It is unlike Babbit's or any other white metal with which we are acquainted, will not clog the file, and has in practice proved very effective. It differs materially from the generality of alloys known as white metal, being harder, stronger, and sonorous; it is, in fact, as its name implies, a species of brass, and behaves like it under the tool when bored or turned, and it is susceptible of a very high polish; at the same time it fuses at a lower temperature than ordinary brass, and can be melted in an iron pot or ladle over an ordinary fire. This renders it useful for fitting-up engines and machines where first cost is an object, as it can be run into the plummer-blocks or framing to form the bearings, bushes, sockets, &c., without the expense of fitting or boring them, or it can be cast in metal moulds, or like ordinary brass or gun-metal, in sand or loam. The white brass has been found by carefully-conducted experiments to surpass in durability all other anti-friction metals against which it has been tested, and to prevent heating of the journals. The durability of the white brass was ascertained several years since by some very carefully conducted experiments on the Great Northern Railway, with carriages running in the express train between London and Edinburgh, the axles being fitted with bearings of white brass at one end and ordinary brass at the other. These experiments were made under the direction of Mr. Sturrock, late locomotive engineer of the Great Northern Railway, who states that two bearings under No. 45 brake van, East Coast Joint Stock, diminished in weight 2oz. in running 19,400 miles, whilst the two brass bearings in the other end lost 2lb. 4oz.; that under No. 36, third-class, E. C. J. S., the two white metal lost only 2¼oz., against 1lb. 6oz. whilst running 20,000 miles; and two under No. 35, E. C. J. S., third-class, lost only 2¼oz. against 1lb. 12oz. of the brass bearing whilst running 20,000 miles. The bearings during these periods ran perfectly cool, and were lubricated with oil.

MANAGEMENT OF GAS.

At the seventh annual general meeting of the British Association of Gas Managers, on the 7th inst., at the rooms of the Society of Arts, Mr. Magnus Ohren, vice-president, in the chair, the Chairman, in the course of his address, referring to purification, said that nothing was more unsatisfactory than the present state of the ordinary coke scrubber, and it was a question whether iron could not be substituted advantageously for coke. One fact, however, had recently been ascertained—viz., that purification by scrubbing was not, after all, such a friend to gas managers as they had supposed it to be. The amount of sulphur in the gas varied from day to day. The gas referees appointed by the Board of Trade had to determine what should be the maximum of sulphur compounds allowable in the gas of those companies under their jurisdiction, and, therefore, their proceedings were of the greatest interest, not only to the public, but also to the gas managers. The referees had not yet issued any public report on the subject; but experiments were in process, under the instructions of the referees; which, unquestionably, would throw much light on the point. *Among others*, a systematic series of experiments was *being* made to ascertain the efficiency of each separate part of the various purifying processes adopted in gasworks. The Chairman then alluded to a new apparatus devised by the gas referees for the more efficient testing of the gas of the companies for sulphur compounds other than sulphuretted hydrogen, and thought that its adoption should, in justice to the gas companies, be properly taken into account by the referees before they fixed the maximum of sulphur to be allowed in the gas of the companies placed in their supervision. One of the questions referred to the referee had been to determine the burner to be employed in testing the gas for illuminating power. As appeared from their report, the referees carefully examined the various kinds of burners in use, and also some new ones. Their inquiries also revealed in an extraordinary manner the badness of the burners in common use. The investigation of the referees, as detailed in their report, showed that some of the burners gave barely 20 per cent. of the real illuminating powers. These facts prove in a remarkable manner that the fault had really lain with the consumers themselves, who have been in the habit of wasting the gas supplied to them, and throwing away large sums annually by the use of shamefully bad burners. This was a point of great importance to the public, and it was to be hoped that the result of the publicity given to this report by the Board of Trade would be to lead consumers to adopt better burners.

COCOA UNDER THE MICROSCOPE.*

(*Continued from page* 175.)

We now proceed to the consideration of the facilities afforded by the microscope for the detection of adulteration of cocoa, those offered by chemistry having been already shown in our last number. On examining a seed of cacao theobroma, we notice that it consists, like all seeds, of an outer membrane, or husk, enclos-

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* From the *Food Journal.*

FIG. 5.

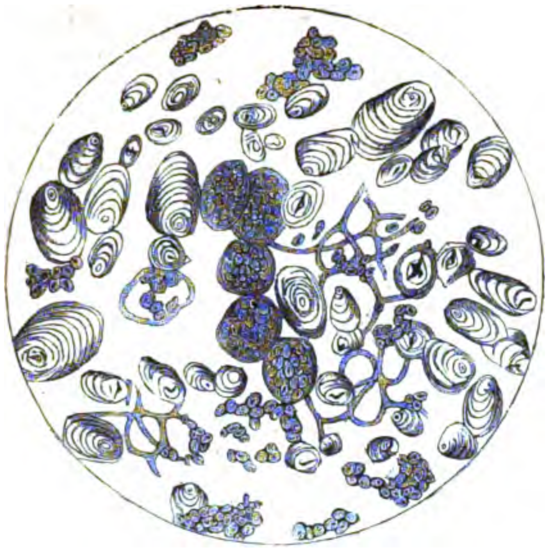


FIG. 6.

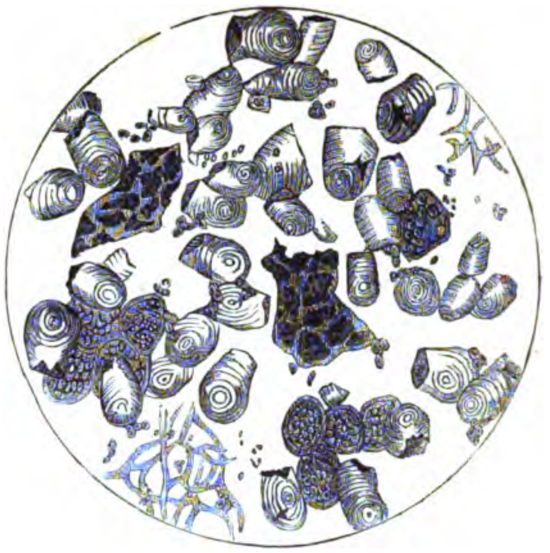


FIG. 7.

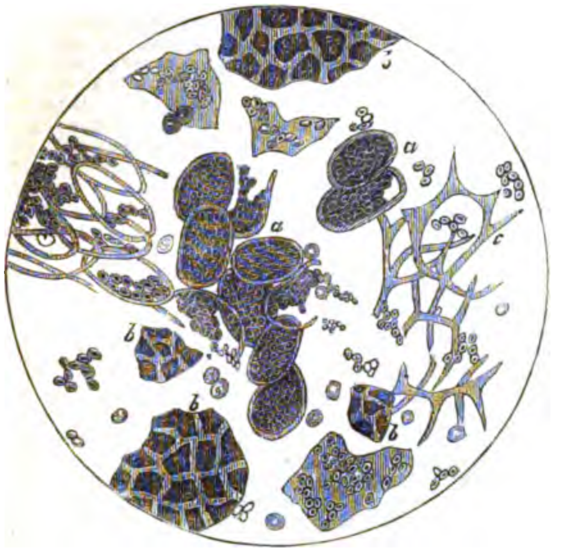
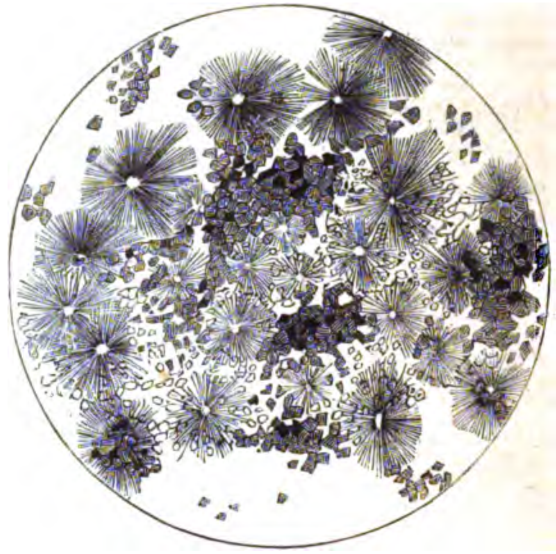


FIG. 8.



COCOA UNDER THE MICROSCOPE.]

ing the useful portion of the seed itself. This latter is covered by a thin skin, penetrating into its substance, and dividing it into irregular portions, called lobes. In carefully prepared cocoa, entirely deprived of its husk, we have therefore only to look for the structures exhibited by the lobes, with their covering, and also those of the embryo, which exists in one portion of seed, so embedded as not to be separable in the process of decortication. It thus follows that, under the microscope, we may meet with three distinct structures in good cocoa, and these we will notice *seriatim*

1. *The Structure of the Thin Membrane.*—This is shown at *a*, in Fig. 7, and will be observed to consist of a mass of angular cells filled with oil, and much resembling the similar cells shown in the illustrations of genuine coffee. This membrane is usually of a brilliant dark golden colour, and the edges of the cells appear to stand out somewhat from the rest of the structure.

2. *The Structure of the Lobes.*—These consist entirely of ovate cells, filled with innumerable starch granules. The starch corpuscles are very small, and generally rounded, but no distinctive markings can be seen upon them, except by the highest powers of a very fine instrument, and even then, it is only on some of the granules that a spot or *hilum* can be observed. These cells of starch are also somewhat coloured, and are shown at *b*, Fig. 7.

The Structure of the Embryo.—This is seen at *c*, Fig. 7, and consists of broken and irregular tissues of cells, but which have a characteristic appearance. They are usually of a more delicate colour than the other structures, and frequently exhibit a most beautiful pink tint.

The most abundant of all these forms are the starch cells; but all of them ought to be present in a good sample. The chief use to which the microscope can be applied, besides that of proving the existence or otherwise of cocoa in the semple, as above described, is the detection of starch which has been added as an adulteration. In Figs. 5 and 6 we show samples of cocoa adulterated with common arrowroot, and also with sago flour. It will be observed that the starch granules of these substances are very much larger than those of cocoa, and at the same time exceedingly characteristic in shape. A short study of the drawings will render their forms familiar to our readers; but we reserve any detailed description of them for our article on the starches.

To examine any sample of cocoa, it is only necessary to mount a few grains on a glass slide with water in the usual way, and look at it with a ¼-inch power and A eye-piece. Masses of red colouring matter, such as ochre, &c., can be easily detected by the microscope; but for the detection of sugar, it is best to employ the process of solution already described. Half an ounce of good cocoa, stirred up in a pint of water, allowed to settle, collected on a piece of blotting paper, dried at a low heat, and weighed, should not lose more than 50 grains at the very most.

We cannot leave this subject without a word in favour of the excellent idea lately introduced by a few of the leading firms—namely, that of selling pure cocoa very finely ground and deprived to a considerable extent of its oil. As we have already pointed out, the richness of cocoa was a bar to its use by dyspeptic persons, and had thus lead to some authorities even approving of the "skilful chemical adjustment," or in plainer language, the "diluting and adulterating it with starch and sugar." But we most decidedly hold that this admixture is not a chemical adjustment at all, as it is simply replacing one carbonaceous matter by another, and by so doing, diluting the whole substance, and thus materially reducing the percentage of the most important nitrogenous constituents of the cocoa. The most sensible way is undoubtedly to express a portion of the fat, and thus to leave an article in which all the remaining constituents are not only retained, but their percentage increased in a high degree. We would therefore counsel our readers to prefer, in every case, a cocoa thus prepared; as, if an increased proportion of fat is desirable, it can be easily attained by making their beverage with milk instead of water. These preparations have also the advantage of real cheapness, because a much smaller quantity may be used to make a cup of cocoa than with an ordinary starched and sugared article, especially if the substance be boiled for a minute or two to extract more thoroughly the soluble portions. We gave last month a comparison, on Dr. Johnston's authority, of cocoa and milk, which we now repeat with the addition of a column for cocoa prepared in this manner:—

	Cocoa Nibs.	Dried Milk.	Cocoa Essence.
Fat	51 ...	24 ...	25½
Casein	21 ...	35 ...	31¾
Sugar and Starch	22 ...	27 ...	33¼
Ash	4 ...	4 ...	6
Theobromine...	2 ...	0 ...	3

So we thus see that the analogy to milk is rendered much more perfect by the process of fat extraction.

Since writing our last month's article, we have received a communication from one of our leading cocoa manufacturers, which shows that had our collectors purchased the lower priced cocoas, a much worse picture would have been presented. The firm in question says, "You can hardly be aware of the enormous quantity of cocoa that is retailed at 6d. per lb., in square red packets; in many of these cocoas you would not find one-fourth part of pure cocoa, the other three-fourths being composed of starch and sugar, though generally, molasses are substituted for the latter. We need hardly say that we do not manufacture this article, believing, as we do, that to sell such an article for *cocoa*, or even as *prepared cocoa*, is monstrous." So that we live and learn, and when we again advert to the subject of cocoa, we shall assuredly keep our eye on the 6d. red packets.

FRICTION IN STEAM CYLINDERS.

By Mr. P. Jensen.

(Continued from page 274.)

WITH the view of placing the question of friction in the steam cylinder in a clear light, it is proposed to work out an example from experiments made. With a 12-horse horizontal steam engine of good make—the cylinder 11¼in. by 16in. stroke—the indicator diagram gave 2·155lb. net average pressure for driving the engine alone. This, at 110 revolutions per minute, is equal to 1·88 horse-power. It is now proposed to calculate the friction of all the moving parts which can be conveniently got at, leaving piston and packing friction as the rest or balance.

Friction of Crosshead Pin.—2in. diameter, mean pressure on same, say 200lb.; $\frac{\text{connecting rod}}{\text{crank}} = 4{\cdot}75$, friction, co-efficient, ·065; $1 \times \frac{1}{4 \times 4{\cdot}75} =$ 1·05, which is a factor used several times; Mr. M'Farlane Gay's abbreviated formulæ used; then with 110 revolutions—

$$\frac{200 \times {\cdot}65 \times 1}{12 \times 8 \times 4{\cdot}75} \times 1{\cdot}05 = 03 \times \text{velocity, which} =$$

$$\frac{6{\cdot}28 \times 110}{4{\cdot}75 \times 12} = 12 = 3{\cdot}6\text{ft. lbs. only.}$$

Friction in Guides. $\frac{0 \times {\cdot}07 \times {\cdot}7854}{4{\cdot}75} \times 277 =$ 641ft. lbs.

Friction of Crank Pin.—3¼in. diameter

$$\frac{200 \times 1{\cdot}625 \times {\cdot}065}{7{\cdot}63 \times 8} \times 1{\cdot}05 \times \frac{10{\cdot}2}{12} \times 110 =$$

33·3ft. lbs.

Friction of Crank Shaft.—Here we must add the weight of crank, fly-wheel, &c. (say 900lb.), then

$$\frac{1100 \times 1{\cdot}5 \times {\cdot}065}{7{\cdot}63 \times 8} \times 1{\cdot}05 = 1{\cdot}932 \times 110 \times \frac{9{\cdot}425}{12}$$

160ft. lbs.

Slide Valve Friction.—The acting area exposed to pressure being 18 square inches, and friction co-efficient 1-10th, then, $1{\cdot}8 \times \frac{4{\cdot}5}{12} \times 110 \times 2{\cdot}155 =$ 160ft. lbs.

Adding these results together gives nearly 1000ft. lbs.; if we allow another 300ft. lbs. for the rest of the friction, including air resistance of fly-wheel, but not piston and stuffing-box friction, we see at a glance what an enormous proportion the latter bear to the whole. 2·155 × 103·9 × 277 = 50848ft. lbs., out of which 49548ft. lbs. for piston and packings, and 1300lb. for all the rest. It may be said that this is not a fair way of putting the case, as the friction of the load will alter this considerably when the engine is up to its power. Supposing, then, we say, as is actually the case, that this engine, when working full power, has a ten times higher average indicated pressure. The total number of foot pounds developed would be 508,480, out of which there are 13,000 for all the friction except piston and packings, the amount of the latter being as before 49,548. This, then, is a fair example, and here we find that out of the total friction of 49548 + 13000 = 62548, very nearly 4-5ths are absorbed by piston and packings. Here we are at the root of the matter, and if we want to economise, here is a wide field for every foot pound lost in friction means a direct loss in money or fuel. It should be noticed that in this case the piston friction per square inch of the same, is (say) 1⅜lb. As the piston has two Ramsbottom steel rings, and their total frictional area is 36 square inches, we arrive at a friction co-efficient of ·23 for continually but sparingly-greased steam. A piston fitted with ordinary cast-iron packing rings would, for this case, have it 2¼in. deep (instead of 2½in. steel rings), and the friction co-efficient with same total friction would then become about 1-10th lb.

The aim should, therefore, be to reduce the piston and the packing friction to a minimum. The slide valve friction is proportionately small, it having been shown that when working at full power it is only 1600ft. lbs., or about 1-39th of total friction. Nevertheless, if working with dry steam and without special lubrication, the slide valve friction may become considerable, even three times higher than stated. But worse than the friction itself are its results—namely, undue wear, scoring, &c., causing extra loss in fuel by leakage of fresh steam into the cylinder and the exhaust. The piston friction co-efficient does not under the same circumstances increase in the same ratio, at least, not in ordinary unjacketed cylinders, in fact, were it not for the much greater friction it absorbs *per se*, it would not require extra lubricating material to the same extent as the slide valves, and for the following reason:—While the steam passes the slide valve little or no liquefaction occurs, but the opposite of this takes place in the cylinder itself, as the work done by the steam causes a proportionate amount of liquefaction, and this is the reason why many engines using rather wet steam and not having steam jackets work without special means of lubrication. The attraction of the walls of the cylinder tends to the deposition of a very thin film of water, which acts as a lubricant. The case is, however, different if the steam is dry, when little or no condensation takes place, and it is then that greasing the steam is of importance. If this is not done heavy wear and friction of the piston will naturally result. It is better, for the sake of economy, to use steam just so much superheated that it retains its gaseous state during an expansion carried as far as circumstances will admit. The steam jacket will answer the same purpose.

In connection with this point it may here be of interest to mention an experiment, the particulars of which the author has obtained. A compound high and low pressure engine, which drove the machinery in the shop of Messrs. Humphreys, was tried both with and without a steam jacket to satisfy the firm of the utility of the jacket. The following are the results:—With steam in the jackets it took 22lb. pressure of steam in the boiler to drive the engine at 135 revolutions per minute; without steam in the jackets it took 29lb. pressure at the same speed; when the outsides of the jackets were well felted 12 gallons of water were condensed in the jackets; without the felting 15 gallons were condensed in the same time. The 12 gallons, or the greater part of it, went to supply heat to the steam in the cylinder, while the 3 gallons apparently were lost by outward radiation.

The waste heat of the uptake is often used for superheating purposes with or without steam jackets, but whether the one or the other is done, the saving of fuel is found to be very great. There is, however, one indispensable condition, namely, to keep the slide valve and piston from undue friction and wear, and the packings from getting hard and charred. Both these objects are attained in the most perfect manner by continuously greasing the steam before entering the ports. It is, therefore, highly necessary that all users of steam power should fulfil the condition by having recourse to an efficient steam lubricator, of which there are several now before the public.

(To be continued.)

COAL MINING IN DEEP WORKINGS.

WE now give, as promised last week, an abstract of a second paper on "Coal Mining," which was recently read before the Institution of Civil Engineers, by Mr. Emerson Bainbridge, Stud. Inst. C.E.

In this communication the principal conclusions arrived at were to the following effect:—

Judging from the statistics of the past few years, the production of the British coal fields could not be considered to increase annually in a constantly increasing ratio, as had been surmised, but might be estimated at an average "output" of 105 millions of tons yearly. Estimating the coal remaining in the British Islands to a depth of 4000 feet to be 37,300 millions of tons, this quantity of coal would supply the annual demand of 105 millions for 355 years; and, taking the limit to deep mining to be a depth from the surface of 7000 feet, the further quantity of coal estimated to be workable to this depth was 57,222 millions of tons, which would extend the supply for a further period of 535 years. The chief localities in the British Islands where coal would probably be found at greater depths than had hitherto been reached were (1) the West Coast of Ayrshire, (2) the West of Lancashire, (3) the East of Yorkshire, Derbyshire Nottinghamshire and Staffordshire, and (4) below the seams worked at present in the South Wales basin.

Deep mining has been carried on much more extensively in Belgium than in England, there being only twelve pits of a greater depth than 1500ft. in the latter country, as compared with sixty-eight in the former. The deepest coal mine in the world was probably that of Simon Lambert, in Belgium, which had attained the great depth of 3489 feet. The deepest coal mine in England was the Rosebridge Colliery, in Lancashire, which has reached a depth of 2418ft., the temperature of the coal at that depth being 93·5°. The distance from the surface of the ground to the stratum of invariable temperature might be taken at 60ft., and the constant temperature at that depth at 50°. The accounts published between 1809 and 1840 of several hundred experiments, relating to the temperature of coal and metalliferous mines, showed the increase of temperature to vary from 1° for every 45ft. to 1° for every 69ft.; the distance from the surface at which the experiments were made varying from 100ft. to 1700ft. (Table III.) The results of more recent experiments in England and on the Continent were irregular, and showed an increase varying from 1° for every 41ft. to 78ft., the distances from the surface being from 700 ft. to 2600 ft. (Table IV.) On comparing the experiments made at the two deepest English coal mines—viz. Rosebridge and Dukinfield, it was found that the increase of temperature due to the depth was much less rapid at the latter colliery than at the former; and this difference was assumed, in a paper read recently by Mr. Hull, to be due to an amount of heat being lost at Dukinfield, owing to the heavy inclination of the strata, which was about 1 in 3, whilst at Rosebridge the coal seam was nearly level. (Table V.) The relation of the position of the bottom of a mine to the sea level influenced the temperature, as shown in tables VI. and XXI. In the latter table the average increase of the temperature of three mines of a high elevation was 1° for every 71·6ft., whilst the increase for three mines at some distance below the level of the sea was 1° for every 62·3ft.

The experiments relating to the underground temperature of the air at the Rosebridge Colliery showed an increase in the temperature of the air in passing from the downcast to the upcast shaft of from 55° to 63°; the air passing through workings the temperature of which was 78°, and the normal temperature of the coal being 93.5°. The experiments at Monkwearmouth (Table VIII.) showed the effect of a large volume of air in preventing a rise in temperature. At a distance of 1800 yards from the shaft, with 80,000 cubic ft. of air passing per minute, the temperature was 55°; whilst at a distance of 2600 yards from the shaft, with 10.000 cubic ft. of air circulating per minute, the temperature was found to be 67°.

The normal temperature of the coal might be estimated, from the results of experiments at Seaham Colliery, to exist in a main air channel, which had been exposed to the air for some time, at a distance of about 13ft. from the surface of the mineral. The highest temperature at which coal mines were worked was probably in Staffordshire and at the Monkwearmouth Colliery, where the temperatures varied from 80° to 85°. At the Clifford Tin Mine, in Cornwall, the temperature was 120°, in which the miners could only work for twenty-five minutes consecutively, this high temperature being due to the heat of the water issuing from the rock.

It would appear, from the contradictory results of the experiments relating to the temperature of different minerals, that no rule could be laid down.

It was probable, however, that the temperature of mines was effected to some extent by the varying conductive power of different minerals.

In regard to the increase of temperature with the distance from the surface, a careful comparison of all the experiments quoted, and especially of those taken at a greater depth than 2000ft led to the conclusion, that as far as could be judged from the experiments already made, the increase of temperature would be 1° for every 55ft. in depth, from the stratum of invariable temperature. The data afforded by the experiments were so irregular, that no law could be established as to the ratio of increased temperature augmenting or decreasing with increased distance from the surface, though the experiments at South Hetton and at Mouillelonge, as recorded in the paper, appeared to indicate that the rise in temperature became more rapid as the distance from the surface increased. Assuming the rate of increase in temperature to be as previously estimated, the normal temperature of a mine 7000ft. deep would be 176°.

Of the three modes by which heat was lost by one substance and absorbed by another, viz., radiation, conduction, and convection, the only influence likely to come into action in a well ventilated mine of the depth stated would be that of convection. From the observations recorded, it would seem that, as a rule, when the temperature at the surface exceeded 66°, the temperature at the bottom of the pit was less than at the top; but when less than 66° at the top of the pit, an increased temperature was found at the bottom. The increase in the temperature, due to the increased density of the air in deep mines, was estimated at 1° for every 800ft., making the mean temperature of a pit 7000ft. deep about 59°.

The effect of the heat emitted by workmen, candles, explosion of gunpowder, &c., was estimated not to have any appreciable influence on the temperature of the air circulating in the mine. The experiments at Seaham showed the temperature of the return air to be 0·5° *lower* when the mine was in full operation than when the pit was off work, and when no lamps, workmen, &c., were in the workings. An unexplained cause of high temperature had been observed at several collieries, but more particularly at Monkwearmouth, where the temperature of the air on one occasion was found to be 95°, or upwards of 10° higher than the normal temperature of the mineral. The question, as to the effect of pressure upon deep workings, was unquestionably of great importance, and necessarily very speculative. The mode of working coal, suggested for a depth of 7000 ft., was arranged as far as possible in accordance with the principle, that the coal should be removed so as to present long lines of fracture, and should be so worked as to cause the superincumbent weight of the strata overlying the "goaf," or space where the coal was worked out, to have all its pressure upon such "goaf," and a minimum pressure upon the coal.

The increase in temperature in an underground air channel appeared from Table XXIII. to average about 1·5° for every 500 yards.

The question of ventilating a mine 7000ft. deep, to an extent sufficient to absorb the heat emitted by strata having a normal assumed temperature of 176°, was one of the most important in the inquiry, and the general results arrived at might thus be enumerated: A. The temperature of the air was estimated to increase from 59° at the bottom of the downcast pit, to 65° at the point where it reached the workings. B. The length of time which would be occupied in cooling the main air-way, to such an extent that the sides of the road would have an average temperature of 62°, and the normal temperature would be found as far as 12ft. from the surface of the mineral. was calculated to be 40 days. C. The total number of units of heat emitted by the strata per minute was found by calculation to be 45,320. D. The volume of air introduced at a temperature of 65°, and assumed to leave the workings at a temperature of 89°, necessary to carry away this number of units of heat, was calculated to be 73,000 cubic feet per minute. E. Then, the total quantity of air necessary for the ventilation of the pit to be 110,000 cubic feet per minute, the power required to produce this quantity would be 141 p.p., which represented an average temperature in the upcast pit of 90°, for the attainment of which mean temperature, a temperature of 141° was required at the bottom of the upcast pit. F. The quantity of fuel necessary to raise the temperature of the return air from 96° to 141°, was found to be 14·04 tons every twenty-four hours.

The laws upon which the amount of power necessary to produce a certain quantity of air under every condition were stated to be as follows:—The pressure per unit of sectional area of an air-way required to overcome the friction of the air, varied directly as the length of the air channel, as the length of the perimeter, and as the square of the velocity of the air, and inversely as the sectional area of the air-way. The action of these laws was demonstrated in the several examples given, where it was shown that the power required to overcome the resistances varied as the cube of the velocity. In drawing a comparison between furnace and mechanical ventilation, it was calculated that, at a depth of about 2,500ft., the two modes of ventilating were equal, while below this depth the furnace became the more effective power.

In regard to raising the coal, the probable limit from which it might be drawn at one lift was estimated to be about 900 yards, below which depth one winding engine at the surface, and one in the shaft would be required. An increase in the cost of sinking to great depths, and in the cost of producing the coal, must necessarily be expected; but since the selling price of coal would, to a great extent, be adjusted accordingly, this could scarcely be considered as a difficulty of much consequence.

The employment of machinery, in place of manual labour, would probably be found very beneficial in cutting and breaking down coal in deep mines having a high temperature. Some of the coal cutting machines now at work were driven by compressed air, and the sudden decrease in temperature which compressed air underwent on exhaustion had been thought likely to be of use in reducing the temperature of a mine. In reality, however, scarcely any reduction could be anticipated, since the quantity of air exhausted bore so small a proportion to an ordinary current of air, that the effect on the temperature was only to be observed locally, and to a very slight degree. Of other modes which had been proposed for facilitating the working of coal at great depths, neither that of casing the airways with non-conducting substances, nor the employment of the electric light, nor the use of cold water and ice, could be anticipated to have any effect worthy of note. The hygrometrical experiments recorded showed that the dryness of the air was considerably increased with increased depth, especially in the return air courses; and though this usually caused a high temperature to be borne more conveniently, it could not, in the case of the heavy labour required in working coal, be calculated to confer any benefit.

Finally, it might be stated, that the question of coal, at greater depths than had hitherto been attained, could not be considered to be one which presented difficulties of any importance, nor was it one which required immediate consideration.

The author had endeavoured to prove that coal could be worked at a depth of 7000ft., but it would probably be centuries before such a sinking would actually be required, and improvements in the various descriptions of mining machinery, especially such as were intented to facilitate the "getting" of coal, would possibly before long render mining to such a depth, as practicable as the working of the deep mines of the present day. Commercially, as had been observed, the question would adjust itself to the requirements and the expenditure of the times.

THE AERONAUTICAL SOCIETY.

THE general meeting of members of the above society was held on the 3rd inst., in the theatre of the Society of Arts, Adelphi. The chair was taken by Mr. Glaisher, of the Royal Observatory. The Chairman, in opening the proceedings, expressed his regret that the objects of the society had not made much progress during the past year, but hoped that the papers they were about to have read would prove interesting. Mr. Walter Clure then proceeded to give his views on aëronautic science. He contended, as we understood, that manual flight would be the ultimate triumph of aëronauts, and reminded the meeting that the ancients had devoted their attention exclusively to that branch of the subject. He combated the many popular errors that prevailed as to the indispensable conditions of manual flight, contending that the means by which birds were enabled to fly were as yet very imperfectly known, even to the scientific. He believed that man would ultimately be made a flying animal, but there were certain artificial difficulties to be overcome before the much-desired object was attained. Air was, as a matter of fact, as solid as any other material, and it only required that the person seeking to fly should be able to get up a sufficient initial velocity to create in the air a solid resistance. His suggestion was that man should be taught to fly as youths were taught to swim in Germany—namely, by being suspended by a rope, when he could in safety make experiments with an artificial flying apparatus. He was quite willing to offer himself to the furtherance of science as a rotatory pendulum bob, if the Aëronautic Society should think anything of his suggestions.—Mr. S. Harrison described some experiments which he had made with what he called an aerial velocipede. His starting principle was that a screw-propeller set to act in the air merely churned the column of air upon which it worked without making progress, but if it were attached to a velocipede upon which a good rider could advance at the rate of ten miles an hour on a smooth road, the weight of the velocipede and its rider would be gradually diminished, and flight might thus at last be attained. His plan was to attach a plane of oiled silk to the velocipede, and at the corners of this plane to fix his propellers. Mr. Harrison illustrated his theory by chalk diagrams on the black board, and seemed to convince the meeting that he had at least made some advance towards a true theory of aërostation.—The Chairman said that the last speaker had really touched the true principle. If ever they obtained perfect aërostation it must be by means of an initial velocity acting on an inclined aero plane. Mr. Harrison's idea seemed to lead up to both these desiderata, and he thought it would be worthy work for the society to test his theory by experiment. After some purely scientific discussion on the anemometer, a gentleman suggested that a light canoe working on the water would be a better medium of experiment with the propellers than the velocipede.—Mr. Louis Olrick, consulting engineer, observed that the inventors of the sewing machine had not succeeded by endeavouring to imitate the old sewing process. They started on an entirely new principle, and aëronauts, if they wished to succeed, must do the same. They must not follow or study the flight of birds, but invent an entirely new plan of aërostation. What they wanted was patient experiment, and experiments cost money; aërostation could therefore only be studied successfully by wealthy societies. The discussion terminated with the usual vote of thanks to the readers of the papers. An instrument for measuring the pressure of the air was exhibited, and explained by Dr. Smith, and very much commended by the Chairman.

A THEORY OF NEBULÆ AND COMETS.*

(*Concluded from page* 273.)

I WILL now examine what account the present theory gives of comets.

There are some reasons for supposing that the sun itself is a nebulous star, or that it is enveloped by matter extending to an immense distance beyond its visible photosphere. The phenomenon of the zodiacal light, the bands of meteoric matter passed through by the earth in its revolution about the sun, the retardation experienced by comets, all point to this conclusion.

We cannot suppose that this envelope consists of solid or liquid matter only, without the presence of gaseous matter; for at no known temperature can liquid or solid matter exist in a vacuum without evaporation. If, then, we suppose for a moment that solid matter exists without being enveloped by gas, it will immediately begin to evaporate and form an atmosphere about itself. This atmosphere will be very rare and very extensive, as the central mass, being comparatively, very small, will exert but a feeble attraction on it.

Or, again, if we suppose that meteoric matter unenveloped by gas would not acquire an atmosphere by evaporation, it would do so in another manner; for it is certain that some of the meteoric bands approach very near to the sun in their perihelion. These would attract to themselves a part of the sun's atmosphere; which they would carry away with them on their departure; and portions of this they would, in their turn, part with to every meteor which came within a sufficiently small distance from them.

Graham has found that meteoric matter which has fallen to the earth, gives evidence of having been exposed, when at a high temperature, to hydrogen existing under a pressure of several atmospheres.

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* By A. S. DAVIS, B.A., Mathematical Master. Leeds School, in the *Philosophical Magazine*.

We conclude, then, that the sun is surrounded by an envelope of gas, which is not a true solar atmosphere, but is the aggregation of the atmospheres of numberless meteoric bodies revolving around it.

Now M. Hoek has shown that comets are detached portions of large masses of matter ; and it has been suggested that these large masses may be nebulæ. Admitting this, a comet, before its entrance into the solar system, will consists of a solid or liquid nucleus surrounded by a large mass of very rare invisible gas. On its approach to the sun, the nucleus will make its way most easily into the solar envelope, and the comet will enter with its tail directed away from the sun. A chemical combination will take place between the tail of the comet and some of the gaseous elements of the solar envelope ; and where this combination occurs, the gases will become visible from the light evolved, and, if the compound formed be in a solid or liquid state, from the light also which it reflects from the sun—or if, as probably would be the case, the matter be in a state of minute subdivision, from light scattered by that kind of dispersion which Professor Tyndall has lately shown is produced by finely-divided matter.

On passing through its perihelion, the comet loses a great part of its tail, which soon cools down and becomes mingled with the rest of the solar envelope.

On leaving the sun, the tail begins to increase, from the addition to it of matter rendered gaseous by the heat of the sun. Those parts of the gas where chemical action has taken place being heated, and therefore rendered specifically lighter than the unheated invisible gases, will have a tendency to escape out of the solar envelope in addition to that which they possess from their momentum in common with the rest of the comet. Hence the comet will depart with its tail directed away from the sun.

The hollow appearance of many comets, and isolation of the nucleus from the vertex of the coma, are in accordance with this theory.

On a comet's approach to the sun, it often happens that a tail of immense length is formed in a very few days. It is usually supposed that the matter forming the tail has all been projected from the head within the time of its first becoming visible, and consequently that it has moved with enormous velocity in a direction opposed to the sun's attraction. Hence it has been conjectured that the matter forming the tail is not subject to the same mechanical laws as those which govern all other known matter.

On the present hypothesis there is no need to assume this enormous velocity. A comet, in fact, enters the solar envelope with a tail of invisible gas. It may be that chemical union cannot take place between this gas and the sun's envelope until the heat of the sun, acting on the head of the tail, has set up chemical action or combustion—until, in short, the comet has been lit by the sun's heat. When once combustion has commenced, it would spread into the tail with prodigious velocity.

Tails of comets have been observed to form with enormous speed only on their approach towards the sun. The tails which form when a comet is receding from the sun are produced with comparative slowness : this we should expect ; for in this case there is not already in existence a tail needing simply to be lit to become visible.

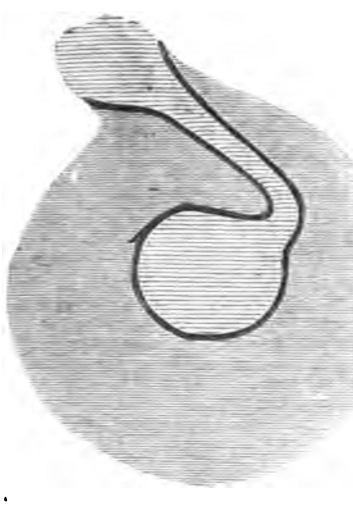
The more any portion of the gas of a comet becomes removed from the nucleus, the greater will be the volume it occupies, because of the diminution in the attractive force of the nucleus. This will account for the spreading shape of the tail of a comet.

We may explain in a similar way the increase in the size of a comet as it recedes from the sun ; for the pressure of the solar envelope upon it will become less as its distance from the sun becomes greater. M. Valz has attempted an explanation of this fact in a somewhat similar manner. He conceives that the increase in the size is due to a diminution in the pressure of the ætherial medium, which he supposes to be denser in the neighbourhood of the sun than elsewhere. Sir J. Herschel objects to this explanation, on the ground that we must suppose that the ether does not pervade the matter composing the comet.

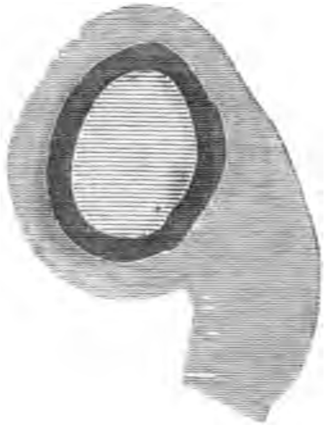
This objection does not amply to the present explanation.

The following figure is intended to represent a section of the nebula (Lassell, pl. 2. Fig. 9, Royal Astronomical Society's Memoirs, vol. xxxvi.) shown on page 273.

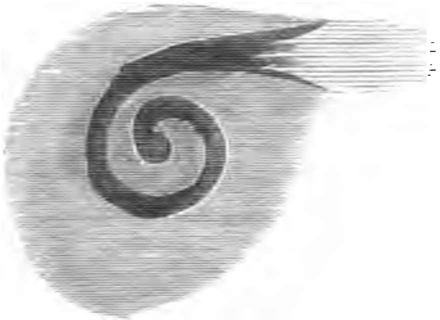
The parts represented by the medium shading and the light shading denote, respectively, the large mass of rarer gas and the small mass of denser gas. The dark shading denotes the part rendered visible by chemical action.



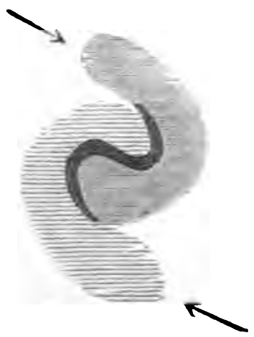
Immediately below is shown the mode of formation of an annular nebula. The mass of gas indicated by the medium shading must be smaller than that indicated by the light shading, and also rarer. If it were denser, it would ultimately enter into it, and a spiral nebula would be formed. The dark shading, as before, shows the visible part.



This represents the formation of a spiral nebula.



Lassell gives several drawings of S shaped nebulæ having nuclei in the middle.



The above diagram is intended to represent the mode of formation of a nebula of this kind.

Two masses approaching each other move in parabolas, having their centre of gravity as a common focus. On approaching each other they are drawn out into an elongated form ; and if a collision occurs, the common boundary will be shaped as in the figure.

SCIENCE FOR THE YOUNG.

BY THE REV. E. KERNAN, CLONGOWES COLLEGE.

(*Continued from page* 269.)

CHAPTER III.

VARIOUS TERMS, EXPLANATION OF.

THERE cannot be a greater obstacle to progress in any course of study, than not to understand the terminology (names, words, expressions) it requires Mechanics as every branch of science has its technical terms. Besides, it frequently calls in the aid of mathematical language and argument. With these latter, the student is supposed to be sufficiently familiar ; there remains, therefore, nothing to be explained, but the mechanical terms. Some of the more obvious of these have already, of necessity, been used, and might be considered as sufficiently understood. Yet a few words of definition may not be amiss.

Matter.—Every thing known by the senses.

Body.—Every quantity of matter.

Atoms.—The mechanically indivisible parts of matter.

Mass.—The quantity of matter. This is the ordinary definition ; but mechanicians express mass of matter by a formula, too abstract to find place here.

Volume.—The space occupied by any quantity of matter.

Force.—Any cause capable of producing or modifying motion. An ivory ball laid upon a table, Fig. 46, is struck with a cue ; the *motion* resulting is caused by the force communicated to the cue. After a while, the ball stops ; the table exerts a force which gradually modifies the velocity of the original motion, and finally stops the ball. Let it meet a block of marble A, Fig. 47, it changes its course ; the marble, without moving, exerts a force which modifies the direction of the original motion. Force, therefore, does not necessarily imply an evident motion ; in the effort at motion lies the exertion of the force.

FIG. 46

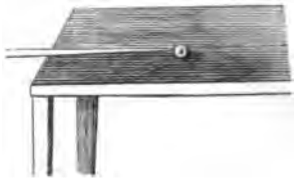
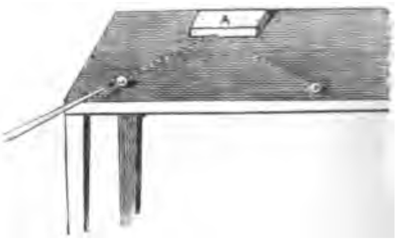
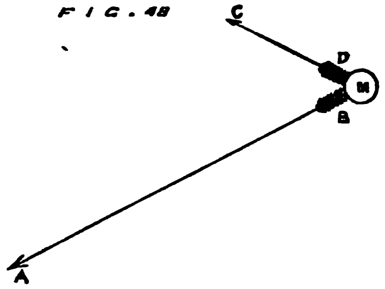


FIG. 47



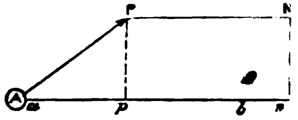
Force, Elements of.—They are chiefly three ; *direction*, the line along which the force acts, or tends to make a body move ; *intensity*, the amount of force exerted ; *point of application*, that part of the body at which the force is exerted. All three elements are represented in mechanics by lines. In one symbol, a line, the three great questions regarding a force are answered. For a line is eminently fitted to represent the *direction* and *point of application* ; and the *relative intensities* of two or more forces can be shown by the proportional lengths of line. Thus, suppose two forces acting upon a body, at fixed points and at a given angle ; one force three times as strong as the other. Lines will show these conditions to the eye. Let A B and C D, Fig. 48, be the two forces acting on the body M ; and A B = 3 × C D. Now A B is made to show the direction and point of application; and represents by its length the relative intensity of the greater force. C D does the same for the lesser force. Besides this concise clearness, lines are subject to the control of mathematical principles. What is mathematically true of them as lines, can be applied to the forces which they represent, and thus exact laws can be established on the unerring basis of mathematical argument. In experimental proofs of the laws of forces they are usually represented by weights, which is very convenient —weights can be so well compared and are so familiar.

FIG. 48



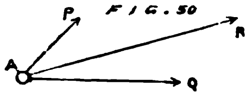
Requirements.—The requirement of a force is its *relation to all positions in space.* In the plainest terms, this signifies *what a force wants to do with a given body* in regard to some fixed position, or to all positions in space. Example: the force P acting upon the body A, Fig. 47, is represented in direction and intensity by the P A; and its *requirement* regarding the position *a b* is indicated by the perpendicular P *p* on *a b* from P, the point of complete exhaustion of the force. Therefore, the requirement in this example answers to the question: what does the force P want to do with the body A, as regards the position *a b?* It wants to place the body at a certain perpendicular distance from *a b.* It *may* move the body to P, but if not allowed, its want (requirement) is still satisfied if the body at another point N be at the same distance from *a b* as if at P—*i.e.*, if N *n* = P *p*.

FIG. 49



Resultant.—Signifies the effect which any number of forces *do* produce, or *could* produce if allowed to act. In Fig. 50, let P and Q be two forces acting on the body A—(forces will always be represented by a single letter at the "point" of their lines.) It shall be shown later, that when the forces are allowed to act, the body A will follow the line A R. This line, or the force R, is the resultant of the two forces P and Q.

FIG. 50



Components.—The forces which produce the effect. Thus, P and Q are the component, Fig. 50.

Composition.—The replacing two or more forces by one resultant. P and Q replaced by R.

Decomposition.—The dividing up of one force into two or more, that will produce the same effect as the original one. R divided into P and Q.

System of Forces.—A number acting at one time together upon a body.

Equilibrium.—There is equilibrium when a body under the action of a system of forces is at rest—*so-called rest;* for there is no such thing as absolute rest. That, in its strict sense, would suppose an absence of all force, which is not possible in the ordinary state of bodies. Absolute rest has another meaning, as opposed to *relative rest*, of which there is no question now.

Mobility.—The power of moving which some bodies have, or the allowing themselves to be moved. Immobility is the opposite.

Motion.—The exertion of the power of moving, or the being forced to change position in space.

PART II.

MECHANICS OF THE THREE STATES.

The preliminaries being well understood, there will be nothing to divert the attention from working out the definition of mechanics, *the study, &c.* This part will contain three chapters, one for each of the states. The first of the three, of "solids," treats what is usually understood by mechanics. It is much longer than the other two, as therein are established the principles of the science in its widest sense. The second and third chapters show how far these principles apply to the liquid and gaseous states, and how they are modified by the nature of those states. Each chapter shall be divided into four sections; the first, the study of the general properties of matter, with special regard to the state under consideration; second, bodies at rest; third, obstacles to theoretic truth; fourth, bodies in motion from the action of forces.

CHAPTER I.

MECHANICS OF SOLIDS.

In this chapter the great important subjects are the laws of bodies at rest, or "Statics," and the laws of bodies under the action of forces, or "Dynamics." The section on "obstacles" to theory is of absolute necessity, as showing how far the theoretic principles shall be modified in practice. With regard to the solid state, as concerns the general properties of matter, little remains to be added in an elementary course, to what has been already said. With more advanced students this section would hold a very important position as being the exact place for the study of "molecular action," the principles of which should be constantly used throughout the entire course. Such study for beginners is quite impossible. However, as this section is of immense importance in the two other states, for uniformity the division as indicated above, is even introduced here.

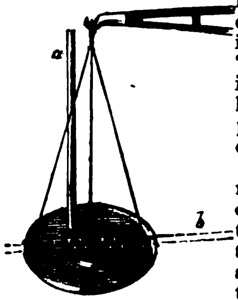
SECTION I.

MATTER, GENERAL PROPERTIES.

Solid bodies may be said to possess all the general properties of matter in a greater or less degree. There are two however, which are very marked in the solid, when contrasted with the liquid and gaseous state. And these are—figure and gravitation. Some solids, as stated, affect certain definite forms; but all are indifferent to any form which external causes may give them. The most complicated crystal, cut into a simple form, retains this form. On the other side, many solid, or rather all that deserve to be called solids, are quite unaffected by the form of a recipient; nor can they be made to take its form except by great force. A mass of iron, has the same form when cold, no matter what the shape of the recipient which contains it. Still, it is known, Tresca of Paris, has proved it by many and long-continued experiments, that metals (cold) can be made to flow, somewhat like liquids.

Gravitation has the same effect on solids no matter in what position they be placed. A long rod of glass, for instance, resting on a table, on a single point, will press equally, whether laid horizontal or vertical. Again, a disc and rod of iron, Fig. 51, will press no more upon the pan of a balance, when the rod is (screwed) perpendicular *a*, than when it lies horizontal *b*. The reason of remarking these two well-known facts will appear in the Mechanics of liquids.

FIG. 51



Other properties might be mentioned, of which the effects in the solid, contrast with those in the liquid and gaseous state; but the two just spoken of are sufficient to direct the mind to other facts, of themselves quite obvious.

SECTION II.

STATICS.

To treat this matter as it should be, the various principles of equilibrium would be contained in a series of propositions, like those of mathematical works, to be proved slowly, step by step. This, the true method, is to be found abundantly in a variety of excellent works on Statics. But, besides other considerations, the students for whom this course has been compiled, are not supposed to have time at their disposal sufficient for protracted study. No more, therefore, than the great principles can be discussed; to these, however, may be reduced, at least in a general way, all the practical applications which have given to mechanical study its paramount importance.

It will be well to impress deeply on the mind, that, in this section, the object always is, to determine how equilibrium may be produced, or as it is usually expressed the "conditions of equilibrium" of forces applied to a body.

Forces can be applied to a body in two ways only; 1° parallel, 2° parallel to a point, or its equivalent. As regards the action of the forces this can be shown experimentally. In Fig. 52 let the rods P and Q represent two forces parallel acting upon the body A at the pivots *a a*. Move the rods to an angular position, the dotted lines; their direction prolonged must meet somewhere in a point B. Their new action at *a a* is the same as if they were transferred to the point B. For it is an admitted principle that if a force applied to a body be transferred to any point of space in the line of its direction, its action is not changed, provided that point of space be rigidly joined to the body. There is a simple experimental proof of the principle. Suppose a body A, Fig. 53, under the action of three forces P Q R in equilibrium. The forces P and Q hang parallel from the corners; R is a weight at the back (seen below) which takes effect over the pulley *p*. The forces are now changed to an angular position, by drawing the cords over the side pulleys *a a*, and the weight R adjusted to suit the new conditions of equilibrium, which was disturbed; —why?—no matter, just for the moment. Now, whether the forces P and Q be kept pinned to the corners, or allowed to act along the prolongation of their direction at B, the state of equilibrium remains. Therefore the action of the forces P and Q is not changed by the transfer. It is clear, moreover, that the point B might be anywhere outside the limits of the body A, provided the condition of rigid connection, between the point B and the body A be secured. To the body A, Fig. 54, two forces are applied at *a a*. These forces are transferred till they meet, and the point of joining rigidly connected by the bar C to A. There is no change of equilibrium. All the principles of Statics ("the conditions of equilibrium") are therefore to be classed under the two titles "forces applied to a point;" "forces applied parallel to a rod."

FIG. 52

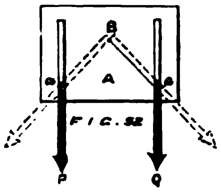


FIG. 53

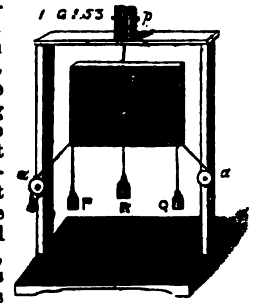
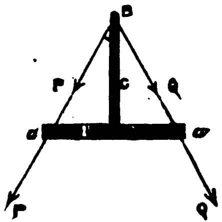


FIG. 54



Into a course of Statics is always introduced the explanation of the so-called, "machines," *mechanical powers.* And though, in practice, they are much used for motion, and are often exhibited in motion, they are not out of place in statics. For they are constructed according to, and act by, the principles of equilibrium. Besides, they can be viewed only as a means of obtaining equilibrium. That an increase of force produces motion for practical purposes does not make any change in the conditions of equilibrium of the machine.

(*To be continued.*)

GALVANIC BATTERIES.*

There have been within the past few years a variety of batteries invented in France; some of them have been used to a very considerable extent, among which may be mentioned the Sulphate of Mercury and Graphite Battery, by Marie Davy; the Peroxide of Magnanese, by Leclanche, and the Gravity Battery, by Callaud. These elements are referred to in Ganot's physics as "new batteries." At one period the Telegraph Department used either the sulphate of mercury or the peroxide of manganese element, and, later, the Callaud was introduced into the service: each of these inventions had its advocates. Every requisition upon the department for battery materials specified the kind of battery desired; they were all for the same purpose, but there was great diversity of opinion as to their merits. Essays were published setting forth the advantages of each kind over the others. This difference of opinion soon became a matter of serious annoyance and embarrassment to the administration, and, to settle the vexed question, a commission was appointed by the Director-General of Telegraphs, Vicomte de Vougy. This committee was composed of the most competent and practical electricians in France; it numbered twelve persons; M. Gaugain was chosen president, and M. Abel Guoyt, secretary. The advocates of the different systems were required to set up their favourite batteries, which were put to work, and results were compared. The commission commenced their labours on the 8th of June, 1868, and finished on the 9th November following, and made their report to the Director-General, who immediately issued an order that all supplies for battery material should be from that date of the element known as "pile de Calland," and the battery controversy, for the time being at least, was put to rest.

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* From the "Electric Telegraph Review."

There were two reports made, one by the president, M. Gaugain, and another by M. Guillemin, each equally conclusive as to the results obtained by the commission. The report of M. Gaugain describes the various methods by which the electro-motive force of each element was determined, and, making that of a Grove cell 100, they stand as follows:—

Grove	100
Marie Davy	76
Leclanche	82
Calland	56
Daniells	56

Which means that a Grove cell has the same strength, or will produce on a circuit 100 miles in length, the same deflection as a Daniells would on a circuit 56 miles in length; or, again, that two Daniells would produce, in a circuit 112 miles in length, the same deflection as one Grove would in a circuit of 100 miles, and so forth—of course, leaving out of question the fractions of resistance in the different elements themselves. There were no researches made with the Grove, but we give it here as a unit to show approximately the relative electro-motive forces of the different systems in presence. We now view the important points examined by the committee.

Constancy.—How long do the different batteries work before having to be renewed? With Marie Davy the electro-motive force fell from 253 on the 1st of June, to 247 on the 27th of October, on an open circuit; but the current is always very irregular in a closed circuit; it polarises rapidly, or, in other words, the current is weakened or neutralised by local counter currents and gas bubbles upon the surface of the plates.

Leclanche's.—The same difficulty is found to exist with this element. When connected up in "short circuit," a weak resistance, in electromotive force, falls very rapidly; but when the circuit remains open for a great portion of the time, or when the resistance interposed is great, like the Marie Davy, it will answer a very good purpose.

Calland's acts very nearly in the same manner, whether in closed or open circuit. Its electromotive force fell from 194 on the 4th of June to 174 on the 3rd of November. It polarises very little when connected up in short circuit, weak resistance; but this feature is not perceptible, when the resistance is of the magnitude of ordinary telegraph lines. In this respect the Calland's behaves very much like an ordinary Daniells element.

INTERNAL RESISTANCE OF THE BATTERIES.

M. Gaugain says, that with the Calland, when set in spring or river water, the internal resistance is considerable; but as the water becomes saturated with sulphate of zinc, this resistance diminishes. He puts its minimum value at five and a half Siemen's units, which, for all practical purposes, we may call five and a half ohmads. For the Daniells, when first set, he found as high as sixty Siemen's units, but its resistance fell rapidly, the minimum being between ten and seven units. This decrease depends very much upon the condition of the porous cup and the quality of the material. If dry and compact in its body, it is some time in becoming fully saturated. However, after complete saturation, M. Gaugain could not discover that it interposed much resistance, though he experimented carefully and upon the porous cups for that purpose. He found that the less permeable or less porous cups answer the best in keeping the liquids separated, and prolongs the action of the battery. The resistance of the Leclanche, after full saturation of the porous cup, was about four ohmads. In the Marie Davy the resistance is about six ohmads. It does not increase, as had been supposed, and M. Gaugain thinks that some savants have been led into error, in this respect, by experimenting while the battery was polarised, and that this apparent increase may have been accidental.

In conclusion, M. Gaugain says that Marie Davy's could be used for the work of one wire, but that its resistance is too great to have more than one line per battery. He did not find this difficulty with the Leclanche. Its internal resistance is least of all, but it polarises rapidly when traversed by currents of much quantity. M. Gaugain believes this could be remedied by increasing the size of the plates; he found the ammonia, generated when the battery is active, disagreeable, and fears that those emanations might prove dangerous, and even poisonous where many couples would be used.

The Commission found that the elecro-motive force of the Calland's did not decrease more than one-tenth in five months, and they think it would take a much longer period to wear it out. M. Gaugain, therefore, believes that it would be well to adopt it. It requires the care of supplying it with sulphate of copper, but has the advantage of giving currents of various quantities without much polarising.

EXTRACT FROM M. GUILLEMIN'S REPORT.

"A battery suitable for the purposes of the telegraph, should not fall in its energy to an appreciable extent for the space of five or six months. It should not have too great an internal resistace, as it is this feature with which we have to deal in working more than one wire from the same battery. The less the internal resistance of the battery, and the greater the external resistance of the wires, exactly in these proportions is the number of wires which can be worked from or supplied by the battery. The resistance of the wires is variable, and results from imperfect insulation. This cause reduces the circuits, often to half, sometimes to one-quarter, and even to a smaller fraction of their proper resistance. The battery should, under these unfavourable circumstances, give a sufficient quantity. The different batteries which have been measured and compared side by side, are the Marie Davy, the Daniells, the Calland, the Leclanche, and the Meidinger. These comparisons were made with intermitting currents, in which the circle was broken and closed by Foucault's automatic arrangement, at the rate of four to five times per second. The resistance in the interpolar, the wire resistance, was about seven and a half Siemens' units per element. The larger-sized cells or elements have least resistance, and give more regular and constant currents. They are preferable. Calland's large size is the only one remaining regular in its action during several months. Its electro-motive force decreased only about one-fortieth of its normal value during a period of over three months. This loss was more than compensated by the decrease of its internal resistance. It is the only battery which presents these qualities. Daniells' battery is irregular. This is due to the rapid incrustation and deterioration of the porous cups. Marie Davy's: This battery is unfit for good service, for two reasons. When the line resistance is weak, and short circuit, its electro-motive force diminishes very rapidly, and its internal resistance increases rapidly, so, on a whole, or taking these two features into account, it loses its energy. It will, however, recover a portion of its initial force when the circuit has been opened for a time. The Leclanche polarises less rapidly than the Marie Davy. Its energy is well maintained when the resistance of the circuit is not too weak."

The foregoing reports were published about a year since. The report of M. Guillemin appears to be more recent, and supplementary to that of M. Gaugain, president of the commission. From advices received from France up to the present writing, we learn that the Calland battery has given very general satisfaction, and has now superseded all others. The Calland battery costs about half that of Daniells' and is fully twice as enduring or constant, so that its ultimate cost is only about one-quarter that of Daniells'.

GLASS CUTTING.

THERE has, says *Morgan's British Trade Journal*, been a very laudable desire of late, by many glass manufacturers, to make glass so beautiful in its finish when it leaves the hands of the glass-blower as not to require any ornamentation afterwards. But the great demand is for cut glass, especially for table use. This cutting, or, if the term may be allowed, sculptured glass, is effected as an after process, and is a separate and distinct business from glass-blowing. In the glass-cutting room there are, in most manufactories, from forty to seventy workmen. Each man has in front of him a revolving wheel, first of iron, then of stone, then of wood. The iron wheel is for the first process, in which the forming of patterns or figures upon the plain surface of the glass is effected. The stone is for cutting off the rough surface left by the iron, and the wood for polishing to a brilliant lustre. Supposing a certain pattern is designed, the workman etches it on the body of the article which is to be cut. He then holds his glass to the edge of the iron wheel, changes his hands to all the positions required for the form he wants, until the whole surface is covered, and the pattern is indented in the article. To prevent fracture from friction, as well as to accelerate the process, sand and water is allowed slowly to drop on the wheel from a wooden vessel hanging over it. Thus is the glass kept at a proper temperature. Sometimes the wheel will of necessity have to be changed to suit the character of the work, many sizes being used for the purpose. The edge of the wheel is that part by which the cutting is effected, and different shapes and thicknesses are given to the edges, in order to produce different results. The stone wheel then passes over these indentations, with water dropping upon it, giving it a semi or half polish. Run the wooden wheel with pumice stone emery continually used on its surface until the pattern is thoroughly brilliant. The object to be attained in cutting glass is to present such a surface to the rays of light that instead of their passing directly through the glass, they may be broken or refracted, so that there may be a "play of light," as it may be termed, upon its surface. To effect this, it is necessary that the lines forming the figure or pattern upon the exterior of the glass be the reverse of the line of the interior, and that the indentations upon the surface, as well as the projections left by them, be such as to form angles. In the cutting called diamond or prism cutting, this object is at once attained. The same effect is also produced by fluting or flat cutting; because whenever two flat cuttings meet at the edge, they form an angle, forming with the line of the interior an imperfect prism. The broader the flat cuts are, the more acute the angle, and consequently the greater the refraction of light. As these flat cuts are always made with the cutter's wheel upon a circular surface, the broader the flats the more expensive they will be.

The same theory holds good of all lapidary or flat cutting upon solid glass; that is, when the cutting is all over the surface. To produce the requisite effect, it is essential that whatever the patterns, flats must be opposite angles. It is by due attention to this that the refraction so necessary to luster and chandelier work is obtained.

When two or more colours are seen in the same article, it is because the glass cutter cuts off the skin of ruby or blue which has been put on by the glass blower; these edges of ruby produce a most beautiful effect by contrast with the flint glass beneath it.

In addition to the cut surface of glass vessels, whereby such a lustrous play of colours is produced, there are others engraved, which is a more delicate process of cutting than that we have described. The glass engraver, seated at a bench, has before him a lathe; he has at hand a series of small metallic discs or wheels, generally made of copper, and varying from an eighth of an inch to two inches in diameter. He attaches one of those to his lathe, and keeps it in constant rotation, as in the case of glass cutting, either by steam power or by the action of the foot. He touches the edge of the rotating wheel constantly with a little emery moistened with oil, and then holds the glass against the edge of his wheel, by which the desired effect is produced. By dexterous changes in the position of the glass and in the different forms and sizes of his wheels employed, he combines the delicate indentations so as to produce beautiful intaglios or sunken pictures; our opinion of this delicate process is that it is strictly a branch of the Fine Arts, and places the glass engraver on a different level to the other workmen. Taste, both natural and cultivated, and a knowledge of the external forms of natural objects, and great delicacy both of eye and hand, are all required in this operation, and it says much for the artisans of this beautiful calling, that they were quite equal to all foreign competitors in the Paris Exhibition. Such operations as glass cutting and engraving afford an ample field for the display of art knowledge and design. The reader, may, perhaps, form some conception of the high artistic finish of engraving upon glass, when we inform him that one shallow dish in the English department of the Paris Exhibition, only 7in. across, was valued at 300 guineas.

Another kind of ornamental manufacture is what is termed the crystallo-ceramic, or glass incrustation. It consists of an opaque substance, embedded in a mass of colourless glass. A medallion or bas-relief, representing any device whatever is modelled in a peculiar kind of clay capable of resisting the heat of melted glass. The medallion is enclosed between the two pieces of soft glass in their melted state; the main difficulty of this process consists in so placing the medallion that all the air bubbles shall be excluded. The glass in its molten state is dropped upon the surface of the medallion with such skill and cleverness, that when annealed and polished by the glass cutter, its appearance is singularly chaste and beautiful, for the white clay seen within the clean and highly-refractive glass presents an appearance nearly resembling that of unburnished silver. This process of art—*i.e.*, incrustation of clay devices, was invented about 73 years ago by a Bohemian. At a later period some French manufacturers invented medallions of Napoleon in this way, which sold at enormous prices; but since the introduction into England, under an improved form, a wide extension has been given to its applicability. This incrustation may be painted in metallic colours which will remain uninjured by the heat required in the process.

SYSTEMATIC MICROSCOPIC EXAMINATION.

MR. HENNAH, F.R.M.S., President of the Brighton and Sussex Natural History Society, recently made the following remarks on systematic microscopic examination with microscopes of moderate powers:—

"I wish simply to enter a protest against the loss of time involved in the employment of unsuitable means. Whether we use high or low powers, we should—in original investigations—be on our guard against the unconscious tendency of the mind to "make the wish father to the thought;" and although we cannot be altogether free from preconceived ideas, their influence should be limited to the suggestion of inquiry. It is necessary for a just appreciation of our own work (and that of others) that we should be well acquainted with the literature of the microscope. It is, however, already so much scattered that it is difficult to ascertain the actual amount of knowledge on any given subject, and much time is wasted in investigations which should be but past steps in our progress. At the same time, we should not too readily accept authority on matters difficult of proof, as a false idea of the state of microscopical knowledge is frequently given, and doubt arises as to our powers of observation or the instruments we are using. I may instance the structure of some of the diatom valves, which, although demonstrated nearly fifteen years ago, was, in consequence of the erroneous views of Griffiths, Wallich, and others, held still to be an open question until only last year, the President of the Royal Microscopical Society announcing his demonstration of their structure as a "new birth to the microscope." In making these remarks, I wish to acknowledge fully the obligations we are under to men who have laboured so earnestly to our advantage, and in calling attention to exceptional error, I am but endeavouring to provoke careful, original investigation amongst us in place of idle reliance on any authority. In the frequent intercourse of men engaged in a common pursuit—such as it is the intention of this Section to promote—lies the best substitute for individual experience; the knowledge acquired by any should be available for all, and errors of solitary observation are soon corrected when brought to the test of criticism and comparison. Most conducive to a true knowledge of objects is their examination in a recent state, and an acquaintance with the appearance of ordinary things will be found much more valuable than the settlement of a diatom or podura question. In the food we eat, the clothes we wear, the parasites that plague us, and the very dust about us, there is a large field for investigation as a necessary preparation for other studies, which has also an interest of its own, in a time when the President of the Board of Trade tells us that adulteration is but a form of trade competition. The poor Welsh impostor gave evidence of her fatal deception only a short time since, in the starch which the microscope discovered in her stomach; and many other instances might be adduced to recommend the study of common things. Our principal object, however, should be to inquire into the natural history of our own locality, the minute fauna of which has been but imperfectly examined. Our shore offers every inducement to extend research. The smaller Crustaceans are scarcely known amongst us, although two of the most curious and interesting—the Caprella and Ammothea—abound on the weed at Kemp Town, and give promise of allied species of greater rarities as a reward for search. Acorn barnacles and shore crabs are instances of strange metamorphosis, as are also the polyps, of which *Laomeda obliqua* and Geniculata abound. The urn-shaped egg-cases of *Purpura lapillis* and the riband-like strap of eggs of *Doris tuberculàta* can generally be found to illustrate the extraordinary embryonic developement of the mollusca; there is, in fact, scarcely a limit to the list of subjects waiting for examination. For full appreciation of minute structure, comparison with permanent specimens is both necessary and interesting. They cannot, however, be seen under sufficiently varied condition; and we may as well take an ancient Egyptian as a specimen man, and trust exclusively to the mummies in balsam which fill our cabinets; we must, instead,—as students of Nature,—follow her home, and watch her ways patiently, as far as we can. Nothing can be known of the protozoa, or rotatoria, unless we examine them in life. Cyclosis in vegetable cells must in like manner be seen in life to be seen at all. The generation of the cryptogams would be really hidden if the germination of their spores had not been a subject of unwearied attention. The structure of the Foraminifera was not demonstrated by Carpenter without systematic work. The discovery of the alternation of generations was due to careful study, and the knowledge of the fact of the Polyps of our shores having other existences as free swimming Medusæ considerably modified our previous ideas respecting them. The well-known sections of insects, by Dr. Hallifax, show the viscera and nervous system undistubed, and—better still—the advantage to others, as well as ourselves, of well-directed work. As a concluding illustration, I may mention that the stupendous tale of past life, read by the microscope in our chalk cliffs, would have been incomplete without that systematic comparison with the bottom of the present ocean which has proved the persistence through ages not only of the laws of nature, but of the forms of life. I have not chosen Pathological examples, notwithstanding the pre-eminent importance of microscopic examination in Pathology, as its study is scarcely within our province. I hope, however, that I have sufficiently supported my opening statement of the advantage of systematic work in place of such desultory observations as are comparatively worthless. Our interest must increase with well-directed study; and numberless facts which we at first pass by, unnoticed, may eventually teach lessons of lasting use. The prism had shown the spectrum to thousands before Newton's intellect gave its interpretation; and, although the comparison may seem far-fetched, there are subjects within range of the microscope which, by the exercise of thought and reason, may still further demonstrate the connection of the infinitely great and the infinitely little, and assist us to know more of the life which it has already taught begins in a germ—apparently the same, whether it results in the highest or lowest of organised beings. We can all make some advance to such knowledge by the systematic study of recent things, which I have endeavoured to recommend, even by tedious repetition; and I trust that by our work we may justify the formation of this Section of our Society.

THE BURLEIGH DRILLING MACHINE.

(*Illustrated on next page.*)

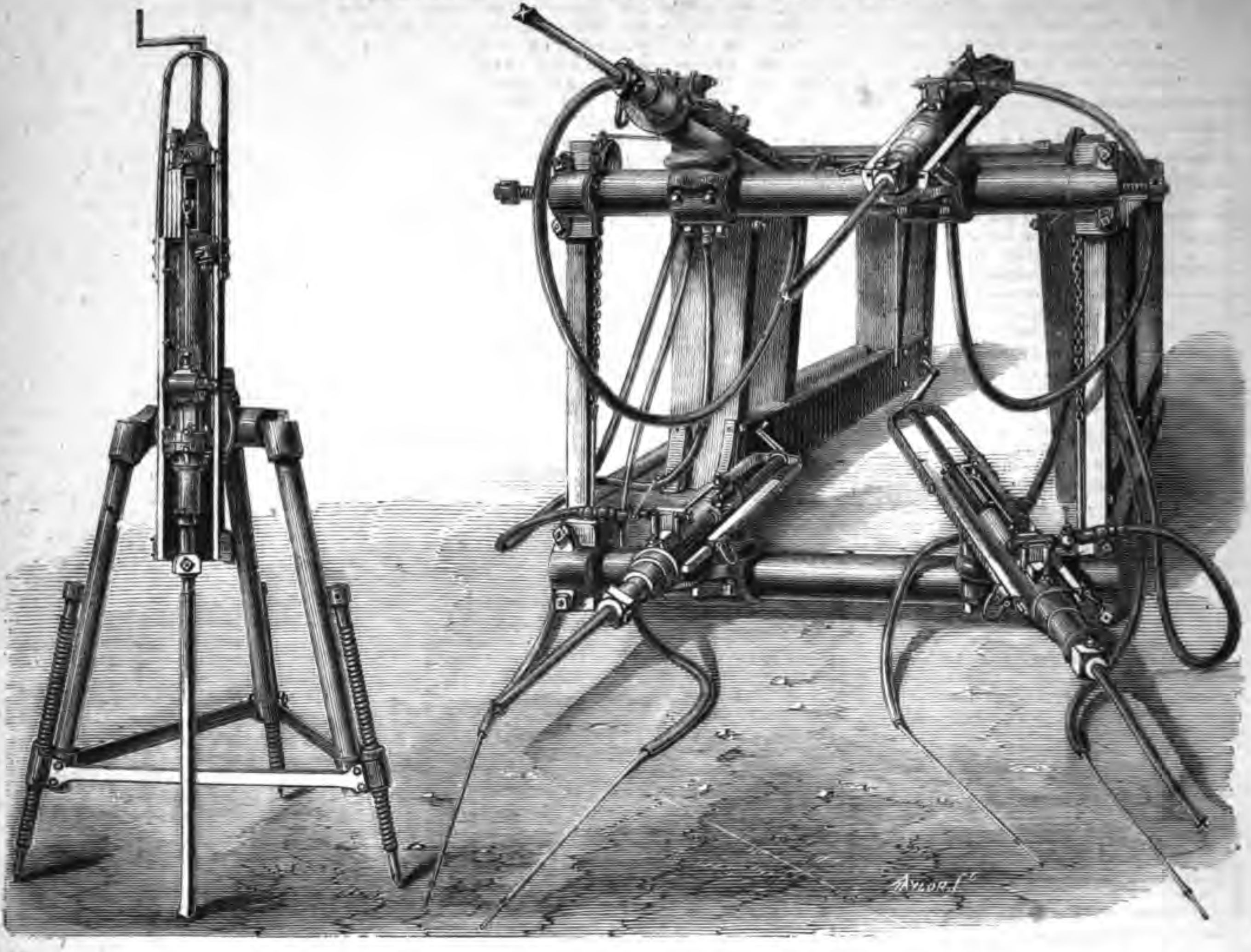
LAST week we gave an illustrated description of diamond-pointed steam drills used for boring rocks, and which are exciting some attention in the United States. We now give a description of a drilling machine which is ex
attention this country.

On the 19th ult. a large number
scientific men, and others assemble
Freeman and Co.'s stone wharf,
to witness a series of expe iments wi
drilling machine invented by M
Burleigh, and in extensive use in
States. The apparatus (an illustrati
we give) owes its origin to the gigan
in Massachusetts by which the Hoosa
are being tunnelled. This great
may be said to rival the Mont Cenis
commenced some fifteen years ago
direction of Messrs. Francis and Wil
mining engineers, of Canada, and is
be completed early in 1874. The im
labour of such magnitude of obtai
which could be worked rapidly by
duced several ingenious mechanic
special attention to the subject, a
among these was Mr. Burleigh. T
the occasion above referred to
satisfactory in every respect, and
which the apparatus did its work
high approval of the practical men w
its performances. Blocks of st
thickness, were bored through in
minutes, two men and a boy being
the work. The hole thus bored, at
rate of 9in. per minute, was 2¼in. in d
the motive power was derived fro
engine, with a pressure of steam of
square inch. There are five sizes, d
¾-in. to 5¼in. holes, and feeding fr
84in. without change of drill point
recommended for general mining i
size, its weight being about 400lb.

The main elements of the drill a
the cylinder, and the piston. The c
a trough, with ways on either side, i
cylinder, by means of a feed-scr
automatic feed-lever, is moved for
drill cuts away the rock. The piston
and forth in the cylinder, propelled
substantially like the piston of
steam engine. The drill point is att
end of the piston, which is a solid
The piston is rotated as it moves ba
by ingenious and simple mechanis
ward motion of the cylinder in th
regulated by an automatic feed as
cut away; the advance being more
as, by the variation in the nature of
cutting is fast or slow. It will thus
the drill point and solid steel piston
the shock of the blow. When the
been fed forward the entire length
screw it may be run back, and a
point inserted in the end of the pis
ingenious peculiarity in the form o
edge of the drill-point, perfectly rou
insured; thus giving a greater area
and a larger percentage of the pow
bottom. The regular rotation of t
sures the delivery of each blow at
greatest efficiency; each wing of th
striking the rock at a point just fa
advance of the cut of the precedi
chip away the rock lying between.
of the chip saves the edge of the dri
thus the advance of the drill point
without sharpening, is ten times gre
possible in hand-drilling, where the h
by the crushing and pulverising of th

With a pressure of 50lb. to the squ
drill strikes the rock from 250 to 3
minute. The machine can be operat
steam or compressed air; but for
work under ground compressed air
motor. After the compressed air ha
is exhausted from the drill into the
materially aids the ventilation o
Compressors are built to run from
drills at once. In using compress
motor a loss of about 15 per cent.
shown in the compressing of the air
more than compensated for by the
air in assisting the ventilation.
Tunnel, where the Burleigh drills ha
exclusively for more than two and
the compressed air is carried upwar
a-half miles, and at that distance
drills at once. This invention is als
operation at the Hoosac Tunnel (fo
quarter miles in length), at the Hell
New York Harbour, and at the Chi
City, Lake Superior, Colorado, and
mines, &c.

THE BURLEIGH DRILLING MACHINE.—(See previous page.)



ENGLISH MECHANIC SOCIETY OF ARTS.—EDINBURGH BRANCH.

THE second monthly meeting of the ENGLISH MECHANIC Society of Arts, Edinburgh Branch, was held on Thursday evening, the 2nd of June, in the New Waverley Hotel, Waterloo-place, Mr. W. T. Williams, President, in the chair, who delivered an inaugural address, bearing chiefly on the important points to be gained by the proper carrying out of the objects contemplated in the formation of the society, and also on the amount of good its members would reap for themselves, and the benefit to the nation at large, by the careful study of those subjects brought under notice in the MECHANIC, which paper he characterised as a complete self-instructor on every point requiring technical education. After pointing out its numerous features and characteristics, and eulogising some of its contributors, he gave a number of useful hints on the working out of the various experiments and examples given weekly in its pages, remarking on the great advantage of being able to perform them, as well as understanding their theory; he himself had found much, besides saving some pounds, by trying, and ultimately succeeding in making several of the instruments, and perform the experiments given—for instance, in the series of articles on Electricity, by Mr. Sprague. He concluded by urging on all to study well, and closely aim at perfection, having no doubt but that, ere long, fruit would come forth.

After some remarks by Mr. Gordon, Mr. D. W. Kemp read a paper on Boomerangs, or Bommerengs, illustrated with diagrams and specimens. He stated that there were several varieties of this weapon, and that it was not confined to Australia, but had its representatives in various countries, under characteristic names and slightly varying forms, but all possessing, in a greater or less degree, the singular property of returning within a few yards of the thrower. In Africa, the southern tribes have the Hunga Munga, which is a double curved instrument, and made of iron. The Central African tribes have the Trombash, with a curvature of double the Australian weapon, and also made of iron. The tribes of the Desert have the Sellem, or Es-Sellem, which is made of the root of the gum arabic tree, and is straight for four-fifths of its length, the point only being curved; and, unlike the preceding ones, which are all flat missiles, this one is perfectly round. But apart from the remarkable property which this weapon possesses, owing doubtless to its partaking more or less of the curve of a parabola, the great antiquity of it gives additional interest to the subject. In a mummy's hand, in the British Museum, is an ebony specimen of the Es-Sellem; and on an ancient basso relievo at Thebes, and an Egyptian slab in London, are represented huntsmen who are about to throw a species of boomerang at some birds. But the most curious of all, are the sculptured slabs from the excavations of Nineveh, one being supposed to represent Nimrod, the "mighty hunter;" he holds a weapon in his hand which is analogous to the Australian boomerang. It is therefore singular that a weapon which was in use so many thousand years ago, should still be found in use with the aborigines of Australia and Africa.

This paper led to a very interesting conversation, in which a large number of the members took part. The secretary then read a letter to Mr. Kemp, from J. Passmore Edwards, Esq., thanking the society, through him its founder, for the honour conferred by electing him their first honorary president. The revised rules were also read and approved of. Mr. Gordon afterwards brought up a proposal, to the effect that all exchanges in Edinburgh which appear in the columns of the MECHANIC, be transacted through this society. This having already been considered by the committee, and unanimously approved of, met with the same response from the society, and the secretary was instructed to intimate to the Editor to that effect. It was also agreed to get up a subscription to the ENGLISH MECHANIC Life Boat, Mr. Kemp kindly undertaking to receive and transmit any amount sent to him for ehat purpose. Several new members were enrolled.

Mr. Gordon will read a paper on "Education," at the next meeting, to be held on the 7th of July.

NOTICE.

FOR years past the ENGLISH MECHANIC, though professing to be published on each Friday morning, has in reality been published on the preceding Monday. We have, therefore, been obliged to go to press on Friday evenings, or a week before the nominal day of publication. As this arrangement has occasioned no end of inconvenience to correspondents and advertisers, it has been determined in future to go to press on Tuesday evenings, and publish early on Friday mornings; in other words, on and after the 8th of July next, the ENGLISH MECHANIC AND MIRROR OF SCIENCE will be published at the same time as the widely-circulated London weekly papers. In order that no inconvenience or disappointment may arise, our readers will oblige us by informing their respective booksellers or newsagents of the contemplated alteration in the day of publication.

We beg also to inform our Subscribers that we have purchased the copyright of *Scientific Opinion*, and that on the day mentioned—the 8th proximo, that well known and high-class scientific publication will be incorporated with the ENGLISH MECHANIC. *Scientific Opinion* has a good staff of contributors and correspondents; these, added to our own, will no doubt materially enhance the value of the ENGLISH MECHANIC.

LETTERS TO THE EDITOR.

[We do not hold ourselves responsible for the opinions of our correspondents. The EDITOR respectfully requests that all communications should be drawn up as briefly as possible.]

***** All communications should be addressed to the EDITOR of the ENGLISH MECHANIC, 31, Tavistock-street, Covent Garden, W.C.**

All cheques and Post Office Orders to be made payable to J. PASSMORE EDWARDS.

I would have every one write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that, as to other things, knows no more than what everybody does, and yet to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks: a vice from whence great inconveniences derive their original.—*Montaigne's Essays.*

TO SQUARE THE CIRCLE BY PRACTICAL GEOMETRY.

SIR,—I beg to send the enclosed original diagram, intended to represent a possible method of reducing the area of a perfect circle to the area of a square, and which will admit of the proof by means of ocular *demonstration* as a geometrical problem, and thus without any loss of material, all the parts of the same size, number, and shape can be identified in each.

The possible geometrical method by means of which the circle can be squared, and proof of its relative accuracy tested by ocular demonstration, is shown in the accompanying diagram. It may be so constructed that in each different figure may be found exactly the same number of pieces, of the same identical shape and size—a proof that no loss of materials is involved in substituting one figure for the other of equal area. Divide the circle into any number of equal parts; draw lines from the centre to the circumference, and for reference number them; make every alternate wedge a shade darker for distinction.

Then make a parallelogram, with exactly the same number of wedges, dark and light alternately, of exactly the same size as those used in the subdivision of the circle, and transfer the same numbers used to the so-called wedges for references. The proportions of the parallelogram are made by taking half the circumference for the length, and half the diameter of the circle for the breadth, exactly. The parallelogram is then converted into the square by means of a mean proportional, and the identical parts A B C cut out and inserted in the square, which is exactly equal

FIG. 2

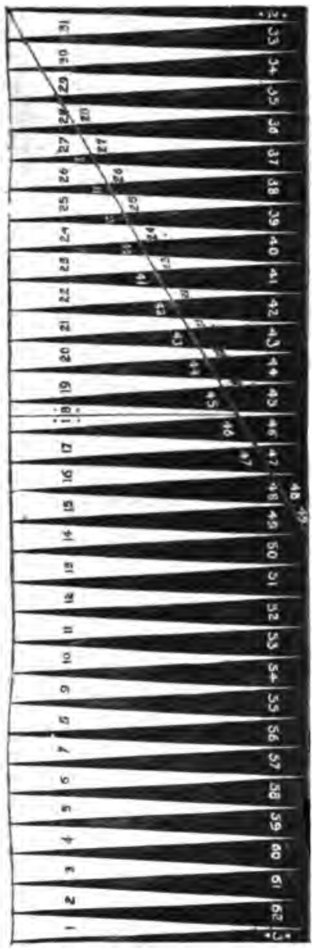


FIG. 1

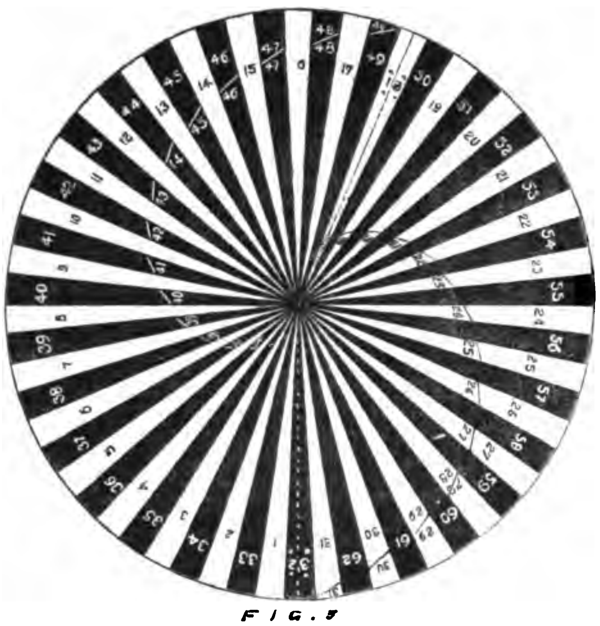


FIG. 3

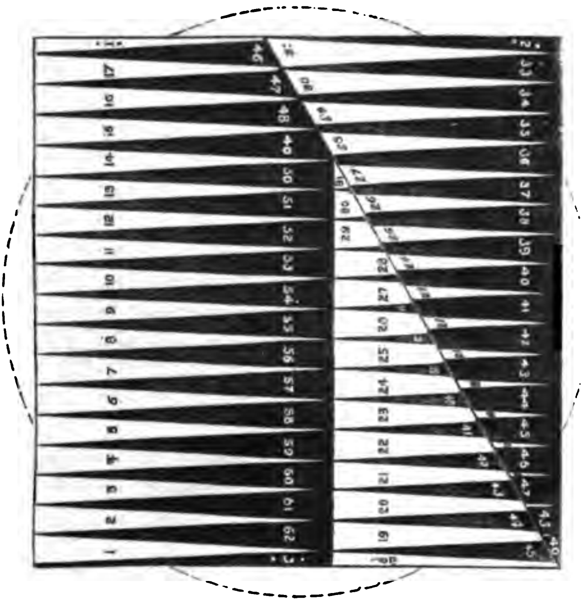


FIG. 1 — FIG. 2 — FIG. 3 &c

SQUARING THE CIRCLE BY PRACTICAL GEOMETRY.

to the area of the circle (by Prop. XIV., Euclid, Book II. In actual experimental trials, to make the divisions of the circle too small, and, consequently, too numerous, involves the risk of failure, and would be very tedious in the transposition of the different wedges from the circle to the square to prove the correctness of the principle by actual test, and by ocular demonstration; but, abstractly, on paper, the more numerous the divisions, the nearer the critical exactness, and a perfect identification as a curious geometrical coincidence is insured, and without loss of material. All the regular polygons have been reduced by the method indicated into perfect squares, and admit of the means of teaching by occular demonstration, geometrical propositions, and performed with great facility. To give an interest in the study of practical geometry by the mere exercise of ingenuity, may, it is presumed, exert an influence upon popular scientific education, and tend to cultivate the powers of observation by pleasing the taste.

Arthur Gearing, Great Paris-street, London, S.

FLY WHEELS OF STEAM ENGINES.—ANSWER TO "STEAM SPIRIT."—OBSERVATIONS ON J. HARRISON'S DICTUM ON THE "LINK MOTION" AND "LLAH'S" ECONOMISER OR FEED WATER HEATER.

Sir,—The weight and diameter of the steam engine fly wheel depend upon several considerations, of which the following are the most important—viz., the nature of the work to be done, whether it is of a regular steady character like driving a corn mill, where no sudden and violent fluctuations occur in the work, in which case a moderate-sized fly wheel will suffice, or whether it is of a variable and unsteady nature, and subject to violent and frequent alternations, like that of a rolling mill, in which case a very heavy fly wheel is indispensable. If the engine works very expansively it will need a much heavier wheel than would suffice if it is worked with little or no expansion. If it is a double cylinder engine with the cranks set at right angles to each other, and working with short expansion, a much smaller fly wheel will do than would be required by a single cylinder engine of equal power, and equal length and number of strokes. A compound engine will do with a much less fly wheel than a single cylinder engine, of equal power and equal ratio of expansion, on account of the pressure exerted on the crank-pin being in the former case more uniform than in the latter, and therein consists the only advantage possessed by the compound engine over the single cylinder engine; in every other circumstance and aspect of the comparison of the two systems, the single cylinder engine has a decided superiority over its rival, and the delusion that has sprung up within the last few years in their favour, and the revival of a system which was tried and exploded 60 years ago, is most extraordinary and unaccountable; the only case in which it has a shadow of advantage is in screw boat engines, where a fly wheel is inadmissible or impossible from want of room, but in every other situation where a sufficiently heavy fly wheel can be adopted with the single cylinder expansive engine, it is beyond all comparison the best and most economical in first cost, in fuel, in lubrication, in friction, in wear and tear, and in repairs.

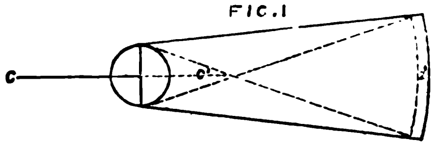
No rule can be given for fly wheels which can take in all the above circumstances, and practical men are seldom guided by mere "book rules" in this matter, but rather consider, and very properly so, the circumstances of each case in themselves.

A very absurd idea with regard to fly wheels for corn mill engines is that the rim of the fly wheel should move faster than the periphery of the mill stones to prevent "back lash"; this old tradition, which has been handed down from generation to generation of millwrights, and accepted without question as an "infallible dogma," is like many other traditions we know of, "false and absurd" and without foundation in fact or theory. What is back lash? It is the tendency of the driven parts of machinery to over-run the driving power, and thus cause a nasty rattle and jar among the teeth of the wheels concerned, and the mere diameter of the engine fly wheel in a corn mill has nothing to do in causing or curing that.

When the steam is shut off in order to stop the mill, if the engine, owing to the want of sufficient weight and momentum in the fly wheel, has a tendency to come to rest before the millstones, then the latter become the drivers of the former for several revolutions, and "back lash" or back action of the teeth of the wheel ensues. The same thing occurs if the engine is working very expansively and has but a light fly wheel; in this case, as the piston approaches the end of each stroke, its power falls below the mean necessary for driving the mill, and the millstones become the drivers of the engine till the crank passes the dead centre, when the piston again becomes the driver; thus twice in every revolution of the fly wheel is the order of driving and driven reversed, causing a terrible racket in the gearing, and great wear and tear in all the parts concerned.

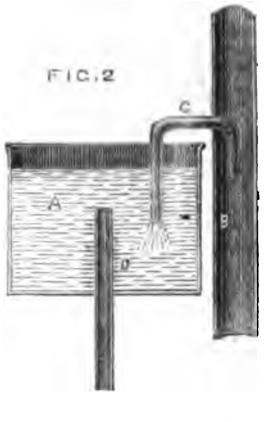
The obvious cure for this state of things is not a fly wheel of a certain diameter, but one of sufficient weight to cause the engine to continue in motion for a few seconds after the millstones would have ceased moving by their momentum. The order of driver and driven would then never be reversed, and back lash could not exist.

FIG. 1



There is no rule that I ever heard of which will give the proper dimensions of the fly wheel for such cases; experience alone, and a judicious use of the "good old rule of thumb" are the only guides the practical man has to fall back upon. Nevertheless, some sort of rule is useful as a starting point, or, for what we may call normal cases, such as where the work to be done is regular and uniform, and the engine not working with much expansion, as is the case with the majority of low priced non-condensing engines

FIG. 2



Every book on the steam engine contains a rule for the fly wheel, but I shall not trouble you or "Steam Spirit" with the repetition of any of them here, as no two of them agree, and all lead to different results, and, as I presume, what he wants is a verbal "rough and ready" approximate rule, easily remembered. I therefore give him the following rule, which he will find useful in a majority of ordinary cases. Let the diameter of the rim be equal to eight times the length of the crank; let its breadth be equal to one-twelfth of its diameter, and its thickness equal to two-thirds of its breadth. This rule pre-supposes the usual proportion of stroke of piston to its diameter—viz., 2 to 1.

Mr. J. Harrison (in No. 268, reply to query 2639), in laying down the law for J. W. Bedford's information, about the link motion, says, "When they are properly set the links ought to vibrate on the valve spindle or stud without imparting any motion to either spindle or stud, when his lever is in the centre notch." This condition is impossible of attainment, and if it could be attained would be utterly useless as a valve motion, instead of being the "perfect curve" Mr. Harrison supposes. The function of the link motion is two-fold —viz., that of reversing the engine, and that of cutting off the steam at any required part of the stroke within certain limits for expansive working; for this latter purpose the slide valve must always have some lap, and it is the custom with all engineers to give it some lead also; now if the lap and lead be added together and multiplied by 2, the product is the amount of vibration that the middle of the link *should have, and it must have that amount and impart it to the valve spindle too, and if it does not do so it is all wrong.* Suppose the valve has 1¼in. of lap, and ½in. of lead, these together make 1¾in., which, multiplied by 2, gives 3½in. as the proper amount of vibration, for the middle of the link for such a valve.

The impossibility of constructing an ordinary link motion which shall give no vibration to the middle of the link is illustrated in the annexed diagram (Fig. 1). The circle is the path described by the centres of the eccentrics (the eccentrics themselves are omitted, as it is only necessary to consider their centres); these are set diametrically opposite each other, and at right angles to the crank C, that being the position in which they will impart the least possible vibration to the centre of the link. The eccentric rods are 3ft. long, the diameter of the circle described by the centres of the eccentrics is 8in. and the length of the link is 16in. from centre to centre of eccentric rod ends.

The full dark lines show the position of the rods and link when the crank is on the back centre at C, and the dotted lines show their position when the crank has made half a revolution and arrived at C¹. The whole body of the link is now in a position exactly parallel to its first position, but there is a distance of 2in. between the two positions; this is owing to the crossing of the eccentric rods in the latter position, which shorten the distance between the shaft and the link; this crossing of the rods is an unavoidable necessity of the case and involves the condition of motion at the middle of the link, in the present case as a minimum.

If this link motion be employed to drive a valve whose lap is 2in. and lead ⅛in., which together make 2⅛in., and multiplied by 2 give 4¼in. as the least distance which should intervene between the two positions of the link, and this 4¼in. is the minimum amount of vibration which the centre of the link should have when working, and to obtain that the centres of the eccentrics must be shifted round towards each other to a position 1¼in. in advance of the diameter line they at present stand upon.

The belief that the middle of the link has no motion and should, if properly constructed, have no motion, as Mr. Harrison says, is not peculiar to that gentleman, for, strange to say, it is very common amongst working engine fitters and erectors, and I have even met with several foremen who, from their position, one should think ought to know better, who were firmly grounded in the same faith, although a single glance at any link motion when working should be sufficient to disabuse their minds of such a very palpable error.

On page 181, No. 268, May 20, a feed water heater is described and illustrated, "for general information to 'Manchestrian' and others," by "Llah" (this word when transposed will spell "Hall," probably the gentleman's name). He says that "This very effective appliance or economiser will heat the feed water to within 10 degrees of the steam in the boiler." The fallacy of such an assertion cannot be too widely or too promptly exposed, as from the very tempting promise held forth others might be induced to construct similar "economisers," with the certainty of being disappointed by their performance, for it is physically impossible that any water heater, deriving its heat from the exhaust steam, can raise the temperature of the water passing through it to within 10 degrees of the steam in the boiler. I mean the boiler of a non-condensing engine, which "Llah's" is, or it would have no waste steam pipe.

The temperature of the waste steam escaping from a non-condensing engine is 212 degrees or so, and that is the maximum of heat which it can impart to the feed water passing through it, but as a matter of fact it never does do so by many degrees; however we will give "'Llah's' effective appliance" the benefit of the doubt, and admit that it does heat the feed water to 212 degrees, then if to that we add 10, the number of degrees which "Llah" says it is short of the heat of the boiler, we have 222 degrees for the heat of the steam in that vessel. Now what is the pressure of steam whose temperature is 222 degrees? *Why just 18lb. per square inch above a perfect vacuum, or 3lb. above the atmosphere.* Will "Llah" kindly tell us if his engine works with steam no higher than 3lb. per square inch?

But as yet I have said nothing about the "latent" heat of the steam, and have only spoken of the "sensible" or "thermometric" heat, for as I infer from "Llah's" letter, it is very likely that it is the only heat recognised or understood by him. I have, therefore, in the first instance, taken it by itself, to show that steam in the boiler only 10 degrees (sensible heat) hotter than the waste steam escaping from the engine can have no efficiency or moving force in the non-condensing engine, and it is only equal to 3lb. per square inch above the atmosphere.

But I must now add to the 222 degrees of "sensible heat of such steam, its 958 degrees of "latent heat," making in all 1180 degrees as the "total heat," and the heat of the feed water being at most only 212, *we see that it is 968 degrees short of the heat of the steam in the boiler instead of 10 only, as imagined by* "Llah."

I have hitherto taken it for granted that the "economiser" in question raises the feed water passing through it to the boiling point 212 degrees, in order to try it under the most favourable aspect, but I am very far from believing that it will do any such thing, and I will give you my reasons for the faith that is *not* in me respecting it. The engine is a 14-horse power non-condenser, and if it works without much expansion it will require about 14 cubic feet of water per hour for steam, or 24192 cubic inches. The heating pipe is 1½in. in diameter, or 1·76 square inches area, and if we divide 24192 by 1·76, we get 13745 lineal inches per hour, or 229 per minute, as the rate at which the water passes through the heating pipe, which is 18ft. long, or 216 inches; this gives 56½ seconds as the time that the water is in contact with the heating pipe, a time totally insufficient in my opinion to raise it to the temperature of the waste steam surrounding it.

The above calculation is founded upon the supposition that the water travels regularly and continuously through the pipe to the boiler, and is the most favourable view of the case, but if the boiler is fed intermittently, off and on, as is often the case, the water must be driven more rapidly through the pipe, and will consequently be a shorter time in contact with it, and of course pick up less heat with it.

There is no appendage of the steam engine which is, in general, less understood than the feed water heater, and the benefit to be derived from it is always over-rated, "the inevitable 25 per cent" is the least saving ever promised by the patentees and inventors of these contrivances, and many of them in their utter ignorance of the scientific principles of the matter go in boldly for a saving of half the fuel. The utterly delusive nature of these promises become apparent when we know that from the very nature of the case, a saving of less than one-fifth of the fuel is the greatest that can possibly be obtained, for if the original temperature of the water be 32°, and it is raised to 212° by the "Economiser," we have 180° saved, but to raise this water into steam of only atmospheric pressure, requires an addition of 966 degrees more, or 5·3 times the amount saved, and that is all that can be done by heating the feed water before entering the pump; thus it appears that $\frac{1}{5{\cdot}3}$ of the heat escaping from the waste steam pipe is all that can be utilised, and the generality of "economisers" do not even do half that, and their efficiency may be taken at 1-8th or 1-10th of fuel saved.

The most efficient "economiser" I know of also fortunately happens to be the most simple and cheapest—it is illustrated in (Fig. 2). It consists of a small cistern A set up in close proximity to the waste steam pipe B, and elevated a few feet above the pump, a small pipe C is introduced into B in the manner shown, its outer end turns downward and dips 5 or 6 inches below the surface of the water in the cistern and—that is all. At each aspiration of the engine, a portion of the waste steam passes through C into the water, and by coming into direct contact with it is instantly condensed, causing a crackling noise, and heating the water very quickly; D is the pipe to the pump; it should take the water from near the surface, as it is hottest there. The supply to the cistern depends of course upon local circumstances.

JAMES BASKERVILLE, Manager, City Foundry, Limerick.

"T. A."

SIR,—"T. A." is free to write what he pleases on his own account, but I wish he would not put nonsense into *my* mouth. I object to being made to assert that "Kirchhoff was right in ignoring crepuscular evidence." My words were—"Kirchhoff was right in preferring what his spectroscope plainly taught him to what he might have vaguely guessed from the aspect of the crepuscular curve," and it is not fair on "T. A.'s" part to substitute words having a totally different meaning.

RICHARD A. PROCTOR.

EMIGRATION.—TO "COTTON CLERK."

SIR,—Under the above I have read several replies to queries respecting emigration; some are extolling the colonies or the continent of South America.

With your permission I will endeavour not to state more than anyone having South American experience can endorse; mine is based upon some ten years ex-residence in various parts, from Buenos Ayres to Pernambuco, which is in and out of the Tropics.

Although it is some years since I returned from the River Plate, and from all accounts I glean up to the present, it is making rapid progress in colonisation, there are, in my opinion, greater facilities offered in the River Plate than in Brazil, since the Argentine Government has for years encouraged such, and now there are to be formed settlements upon its plains of nearly every European nation's children, but at the same time, this republic has serious drawbacks, from its lack of wood and stone, and together with the droughts, which are periodical, also the utter want of hill and dale, which in Brazil are perhaps too frequent; yet the great objections of the absence of timber and stone are over-supplied in the adjacent empire. I can speak with a greater degree of confidence of the latter since I returned from there since last Autumn. South of the City of Bahia is a rich fertile country, all along the coast, well watered by endless rivers, and an abundent supply of wood, stone and fish, both sea and fresh, to say nothing of wild game and fowl. Grants of land are easily obtained from the provincial governments, either given or purchased, but in either case there are difficulties to encounter, since the exact spot is not given, and also the district may not be suitable as regards soil or locality. Everyone intending to make this country his future abode should chose a spot where there is a river (navigable for canoes the whole year round) close at hand, or he may find his means of arriving there greatly increased by having to make a road through a dense wood, streams are to be met with in most localities, which are preferable to the main river. Anyone going out should first remain a short time at one of the small towns on the coast and gather there what information he can about the various localities in the neighbourhood, by going to one of the large seaports such information cannot with any degree of correctness be obtained, besides the expenses of living are much increased by living in cities, even for only a week. I know most of the small coast towns from Bahia to Rio Janerio, some 750 miles, having visited them. But again, unless the intended emigrant speaks and understands Portuguese how can he get along? I was some three years in Brazil and never spoke one word of my own language, nor had I an opportunity: my companions were for the greater part of that time Indians and slaves. There is one great trait in all the natives' characters, they are hospitable to one and all. It is true that food, such as they are accustomed to command, is plentiful, and costs next to nothing, but such is very unsuitable to our European palates. I was six weeks before I could eat the "jerked meat and farinha," such as forms the staple of their living. There is plenty of wild game, fowl, and fresh fish, but Europeans have not the experience of catching such. There are thousands of difficulties to be met with that none but those that have been among these people would ever dream of. All our everyday condiments of food are not to be met with, there is no bread, butter, potatoes, nor beer; there are thousands in Brazil that live and die, and never see a piece of the commonest bread or even have the most remote idea of how such is made.

The difficulties, changes, and hardships that a newcomer has to put up with are such as to make all who elect to adopt such empire as their home, hesitate at the first start.

In time we take things as natural, and about eighteen months since I sat down to a dinner where a great luxury was served, a "haunch of tiger." If your correspondent can manage to put up with such joints, in consideration for the gain, why I say, go, and God speed him, will be my wish.

J, G.

P.S.—I could readily give further details, but your space will not admit of such monopolisation.

SIR,—As you have given me permission, I will state my views on emigration with regard to the best place to go to. As to the necessity of emigration, I think there cannot be two opinions. It should be looked upon as a duty, I could almost say, as a privilege, and not as an expatriation. I cannot see any evidence that it is intended we should congregate in large cities, or remain crowded in a little island manufacturing articles which do not directly sustain life, when at the first sign of repletion in our overstocked market thousands are without food to eat. On the contrary, I do find that, right away from the first emigration movement at Babel, that emigration and agriculture have been the means of placing food in the mouths of the hungry, and prosperity and independence in the possession of all who would or could go where land was to be had for little or nothing.

With these thoughts I have recently reviewed the various emigration fields presented to our notice. I look upon the Australias as too distant, Canada as afflicted with a severe winter, and the South American States, though possessing a fine soil and climate, yet with another language, and the governing powers being in the hands of a foreign race, where Englishmen would not feel so much at home as elsewhere.

Then we have the United States to consider. There we have our own language, and laws equal and in some respects superior to those of England, with an extent of climate from a Canadian winter to a tropical summer, and midway between these are a few states destined at no distant day to be in the line of the overland route to Australia. The states I allude to are Nebraska, Colorado, and Kansas, the latter of which I think to be the best. Kansas is somewhat larger than the whole of England. It contains 81,318 square miles, but at present only 46,318 have been surveyed. The educational machinery of the United States is, I think superior to that which we are discussing at the present time, and Kansas, though a young State, has taken advantage of its benefits, for there are now 953 schools, with 45,150 pupils; besides these schools there are eleven or twelve universities, colleges, and institutes. In this State alone there are millions of acres to be disposed of, at prices from 1¼ dol. to 4 or 5 dols., and land not like Canadian land, which costs more to clear it than its original price, but principally prairie land, where its first year's crop will frequently pay all its cost. It is indeed so prolific that at one of the agricultural fairs there were exhibited potatoes of five and six pounds' weight, turnips of nine pounds' weight, and cabbages of thirty and forty pounds' and a gentleman who lived at Kansas I happened to see in England a short time since said he took some radish seed with him when he went out first; he sowed it and found radishes nearly as thick as his arm. Fruits also thrive abundantly; large quantities of apples, peaches, and grapes are produced. Then, with regard to minerals, iron has been found, coal is being mined in several places, and marble has been met with, and limestone of various colours, from a red tint to a fine cream colour, is abundant.

And we must bear in mind that all the minerals belong to the freeholders, and almost every person can become such under the Homestead or *Preemption* laws, and I believe one-eighth of the population are freeholders. These laws contrast so favourably with our own(that in them I think I see one cause of the rapid prosperity of the United States. Then with regard to labour, I had before me a week or two since the *Missouri Democrat*, published at St. Louis, date April 6, 1870, when amongst others I saw an advertisement for a timekeeper for a mill, wage 90 dollars per month; same paper, boarding-house list, board 4½ to 5 dols. weekly, leaving rather more margin for saving than most timekeepers have here.

The authority I have for these facts is not obtained from any railway agency or land jobbing company, but I have lying before me the report of the General Land Office for 1869, published at Washington under the authority of Joseph S. Wilson, Chief Commissioner, who, I may say, has written a letter to a friend of mine, in reply to a few questions, wherein he says that Englishmen will be heartily welcomed, and that the size of the country is so vast, and its domestic wants so numerous, that there is ample room for the exercise of the most diversified labour and skill.

Now, with these facts before us, a few working men at Mile End have united together, and done what the Rochdale men did long ago, put their pence and shillings together, only we do it for the purpose of forming a Co-operative Emigration Society. We have at present no capitalist amongst us, only bona fide working men, and we are progressing slowly but surely. If any brother mechanic wishes any further information I will reply to the best of my ability.

J. D. ROGERS, Bruce-road, Devons-road, Bromley, E.

COTTON SPINNING.

SIR,—The question raised by "Factory Lad" on draughts in a drawing frame, when taken in connection with the doubling, is about one of the most important that occurs in the whole range of cotton spinning. On a good or bad arrangement of the draughts and doublings depends in a great measure the goodness or badness of the yarn when finished; any defect here affects the whole of the subsequent processes through which the cotton passes, and is very materially felt in the spinning frames, where the attenuation of the thread is carried out to a great degree: so that at this stage of the work it is of the highest importance that the best judgment and the greatest care should be used in setting out the different draughts so as to obtain the best results.

For ordinary work there are generally three heads of drawing to what is called a drawing frame, each of which is furnished with 4 lines of rollers; a certain number of ends or slivers—say 6—from the carding engines are put up side by side at the back roller of the first head; in passing through the 4 lines of rollers, these slivers are drawn out or lengthened, so that the 6 slivers are reduced in thickness, and form jointly a sliver of about the same thickness as one of those put up at the back; 6 from the first head are then put up at the back of the second head, and reduced by drawing as before to 1 sliver; 6 from the second head are put up at the third or last head, and reduced to 1 as before. From a consideration of these processes it will be evident that the sliver from the last head is made up from 216 slivers, or, as we say, there is a doubling of 216 of the slivers from the engines. Now assuming, for the sake of illustration, that the sliver delivered at the last head is the same weight, for an equal length, as the engine sliver (although in practice this is seldom the case), and that there has been no loss in the operation, it will also be evident that each sliver from the engine has been drawn out or elongated to 216 times that of its original length at the engine;

or, as we say, the total draught in the drawing frame is 216; and these 216 attenuated engine slivers, if the work has been properly done, compose a sliver at the last head which for smoothness and regularity in thickness throughout its length is far superior to the sliver at the engine head. The thickness would be the average thickness of 216 of the slivers from the engines. I say average thickness, because the slivers from the engines not only vary in thickness from each other, but are also unlevel of themselves; the fibres are in a ruffled, entangled state, being crossed and doubled over each other in all directions.

The object or use of the drawing frame is to double a certain number of slivers together so as to equalise the different thicknesses; to straighten the fibres out parallel to each other, so that they will the better twist together in the spinning frames. It will thus be seen that the drawing and the doubling are necessary to each other, for the drawing could not be carried out to any great extent if there was no doubling, neither could there be any doubling without the drawing.

I think very little explanation is required to show to any one at all acquainted with the subject that this total draught of 216 should not be divided equally between the three heads; the draught should be easier at the second head than at the third head, and easier at the first head than at the second, because at the first head we have to contend with a rough, uneven sliver, and if too great a draught were used here we should lose the benefit that should be derived from the doubling; the fibres being brought into better order by the draught at the first head, we may increase the draught in the second head, and so on with the third head. Some spinners take advantage of this fact by also putting more doubling in at the last head than at the first.

The above remarks are offered with a view to a better understanding of "Factory Lad's" question as to how the draughts should be distributed between 4 lines of rollers for a total draught of 7 in the drawing frame. There appears to be some misapprehension as to which of the three heads of drawing this question refers. My impression on heading the question was that this draught was at the last head; I did not for a moment suppose that he would have a draught of 7 in the first head; this, however, seems to have been the impression, judging from the remarks in their replies, of "Harmonious Cotton Spinner" and "Mutual Improvement" (the latter of whom thinks my preparing draughts too keen), and this appears to be the right one according to "Factory Lad's" last communication; if this be so, my advice to "Factory Lad" is that the sooner he reduces this draught the better, as I am quite satisfied he would find an improvement by so doing. Whatever class of cotton he uses, this draught is, in my opinion, considerably too much at the first head. I really do not see what need he has for 4 lines of rollers at all if he makes no more use of the back line than to get a draught of 1·17, or what is the same thing, where the length at the first pair of rollers is only increased by 1-6th towards a total draught of 7. If this is all the advantage he gets out of the back line, it is worth while to consider whether he would not find it a saving to dispense with that row altogether, and distribute this very small draught between the three lines of rollers—thus, 1·9 × 3·68 = 6·99, which are not very materially different from the 2 draughts he gives for the 3 rollers.

Assuming that "Factory Lad" has a total draught of 216 in the three heads, and wishes the draught at the last head to be 7, I should arrange the draughts as follows:—

$$\begin{array}{lcccc} & \text{front \& 2nd.} & \text{2nd \& 3rd.} & \text{3rd \& back.} & \text{Total} \\ \text{1st head} = & 2{\cdot}27 \times & 1{\cdot}73 \times & 1{\cdot}31 = & 5\frac{1}{7} \\ \text{2nd do.} = & 2{\cdot}44 \times & 1{\cdot}82 \times & 1{\cdot}34 = & 6{\cdot} \\ \text{3rd do.} = & 2{\cdot}65 \times & 1{\cdot}93 \times & 1{\cdot}38 = & 7{\cdot} \end{array} \left.\vphantom{\begin{array}{l}1\\1\\1\end{array}}\right\} = 216$$

The arrangement in the first head is on the supposition that there is a slight draught at the engine head.

The importance of this question to cotton spinners has induced me to enter at this length into the subject; as I have said in a previous letter, it is a question on which widely different views are entertained by practical men, and I am sure you will be doing good service to an important industry by allowing it to be freely discussed in the pages of the ENGLISH MECHANIC, and I hope that others will not hesitate to follow this with letters giving their views on the matter, knowing as I do that there are large numbers of readers of our journal in these districts who are well qualified to give an opinion on the matter.

E. Slater, Burnley, not only appears to have mystified your readers by his first reply to "Factory Lad's" question, but from his second reply he appears to have got into a muddle himself. I cannot conceive how he could expect that anyone would gather his meaning to be 2·5 × 1·69 × 1·67 = 7·055 from the figures 2⅓ + 2⅓ + 2⅓ = 7, which he calls setting out the draughts equal.

I have no doubt but that the "intelligent old man" who told him to make his draughts equal knew very well what he was talking about, but at the same time I think the assertion would be qualified when he made it, and this Mr. Slater appears to have lost the end of entirely. The figures I gave in a previous letter, as well as those above, are founded on that rule, and it may exercise the ingenuity of those interested to find out from them what is meant by the phrase of "making the draughts equal."

There is another matter in Mr. Slater's letter on draughts with which he says he was at one time very much puzzled—that is, where a "given time" is mentioned as having to be taken into account when finding the draught between any set of rollers. Time is an element that need not be introduced into the calculation at all, as it would only make it more complicated. The draught is simply, as I have stated before (p. 136), "the ratio between the surface speeds of the first, or taking in roller, and the last or delivering roller," and this ratio can be found without the trouble of finding their respecting speeds for any "given time." By putting the speed of the first roller as equal to 1, multiplying and dividing by the figures representing the various wheels and rollers, we get a proportional speed for the delivering roller, which is the draught between the rollers. As an example, take the figures given by "Mutual Improvement," p. 111, ranging them as follows:—

$$\begin{array}{rcl} 154 - 17 & & 154 - 17 \\ 26 - 26 & \text{cancelling} & 207 - 45 \\ 207 - 45 & \text{we get} & 2 - 1 \\ 4 - 2 & & \end{array}$$

The product of the figures in the left hand row, divided by the product of the figures in the right hand row, will give 83·34, the draught of the carding engine between feed rollers and callender rollers.

If "Harmonious Cotton Spinner" has not tried the best common starch, mixed with a little tallow, for pasting the bottom of his cops, I would recommend him to do so. The paste is run out of a box, through a brush, on to the spindles.

B. W. R.

SIR,—Our friend "The Harmonious Cotton Spinner" has succeeded, as I expected he would do, in finding a mare's nest. He says that "I seem very much disposed to 'pick a fellah up before he's down.'" He seems to forget that it was he who kindly undertook to render *me* that thankless service (see his letter, p. 183).

After what has been said by me and others on the draught between lap and feed rollers, I thought that it would cause him to examine the matter more closely, and thus save both of us from troubling you again with this simple matter.

I am glad he has now given the wheels and rollers of the engines (in which he says there is no draught between feed rollers and lap rollers, as we shall now be able to see for ourselves whether there is or is not a draught in his engines), and from them I think I shall have no difficulty in proving both to the satisfaction of "H. C. S." and others that there is a draught, and one, too, greater than is required.

He says (p. 283), "Let me inform him for his edification that we have at the present about 140 carding engines at work, and if he can find the slighest draught in any one of them I dare forfeit the engine he finds it in.—Diam., feed rollers, 1¾in.; lap roller, 6in.; a 14 wheel on end of feed roller drives a 48 on lap roller." Looking at this question in a superficial manner, most people might take these figures as "H. C. S." has done, and say that there was no draught here, thus, $= \frac{48 \times 1\frac{3}{4}}{14 \times 6} = 1$. But in cotton spinning, as in all arts and sciences, it is necessary at times, if we wish to get at the truth, to "penetrate" through the surface, and see if there be any thing below likely to help us in getting at something near a correct result.

Now, I happen to be very well acquainted with the make of engine from which these figures are taken, and had they been an exception to the rule I gave, I certainly should not have gone in the face of them by making the statement to which "H. C. S." took exception, as I had satisfied myself some time ago that there was a draught between the rollers in engines geared as above.

I will not hold him to the challenge given above, for if I took him at his word he would be very soon minus the whole of the 140 engines now under his charge. I do not believe there is an engine working anywhere but what there is a slight draught between the rollers.

The lap roller has a smooth surface, and is 6in. diam. The feed rollers are "fluted," and are 1¾in. diam. on the tops of the flutes. The flutes are made to work into each other like a pair of toothed wheels. The lap in passing between the rollers follows the form of the flutings, and being pressed by the tops into the spaces, will deliver as much length of lap to the taker-in as plain rollers of about 2in. diam. would do. If "H. C. S." doubts this, let him take out the taker-in, and after turning off with three or four revolutions of the lap roller a certain length of lap, measure the length that has been delivered by the feed rollers, and report if he find the draught very much different from $\frac{48 \times 2}{14 \times 6} = 1{\cdot}14$, which is more than necessary for keeping the lap stretched. Your correspondent, "B. H., Rochdale," gives (p. 235) one and one-tenth, which is ample for the purpose. I think "H. C. S." has not tried fluted back top rollers on his drawing frames and other frames, or he would have found out this simple matter long ago.

If "H. C. S." cannot see how a lap can bag without a draught, I am not answerable for that. Let him take a cord, and stretch it as tight as he likes between any two points, and he will find it to bag in the middle to a certain extent, and if so with a twisted cord, how much more with a loose wadding of cotton?

It is not necessary to notice further his remarks about the draw box and delivery rollers, as I do not consider my argument answered by a quibbling over words.

To his inquiry respecting yarn testers, Mr. Samuel Taylor, clock and watch maker, Penn-street, Rochdale, is, or was, the maker of a very good one.

B. W. R.

SIR,—Reading your paragraph in last week's edition, about the "chaff" that seems to be going on among us cottonians, I must say that I was at once struck with the force of your remarks. For my own part I shall always strive to let you have as much of the grain as possible, but it is sometimes very difficult to keep a little "chaff" from going in with it. With respect to the letter of "Mutual Improvement," the substance of it is just what I am anxiously waiting for myself. Will E. Slater, before he takes up any other subject, kindly give his attention to the following queries, and let us have them in a plain, simple manner. What does he mean by saying he did not expect "Factory Lad" to have so many replies to his question, and yet to give him a rule which, if correct, not one of the hundreds of subscribers can understand, even now he has given two explanations? 2. Does he mean in his statement of successful spinners that they "succeed in spite of the evil of draw-boxes," *knowing them to be an* evil? 3. Why is a bobbin when leading more *equally* pressed than when the flyer leads? 4. Will he kindly allow me to see his Jack frames making 6½ hank roving, the spindles running 130, and the bobbins leading? 5. Can he run them 130" per min. and put ½ turn per in. in his roving—or rather slubbing—with the bobbin leading? Lastly, will he explain what he means by "putting the cart before the horse, if I intend it to go?" (No chaff.) The above queries, answered in a clear, definite manner, will please his brother subscribers, be satisfactory to our worthy editor, and will greatly oblige.

THE HARMONIOUS COTTON SPINNER.

MR. BEARDSLEY'S TRUTH AND TEMPER.

SIR,—Did you realy concieve it possible that your readers were *all* so "flat" as to believe that you "believed in free discussion" when you said so in your remarks on page 210? It realy is of no use trying to convince a "staff"-bound editor, so I do not attempt it further; but I will just remind you that the reason why I did not send you my fifth letter last week in the usual course was that I saw plainly that fair play in connection with the ENGLISH MECHANIC was out of the question, and I therefore did not think it worth postage. You know you have been guilty of the grossest partiality, and as such is the case I beg to tell you plainly your conduct shows you neither encourage "free discussion" nor do you appear to have any desire to keep "your promises," and as a matter of course "redeem them." But you can inform your intimate friend Proctor (B. A. and I do not know what besides) that if there is "Other Worlds than Ours," there is also other printing presses than that which turns out the ENGLISH MECHANIC. I now take leave of yourself and that trio of sophists you priviledge, by subscribing myself a disgusted subscriber, but a hater of humbug,

J. BEARDSLEY, Langley Mills, Nottingham.

[If Mr. Beardsley has lost the truth, he might have endeavoured to keep his temper. His reason for not sending his *fifth* letter is not the true one. He did not send it because we did not insert his fourth letter, which we received about three weeks before; and the reason we did not insert it was that everybody, with the exception of Mr. Beardsley, considered that the insertion of such letters was an utter waste of space. Mr. Beardsley's reason for not sending his "fifth" letter is of the same character and quality as his reasons for the earth being a plane and not a globe. We never promised him unlimited space for the ventilation of his childish theories, and he ought to be obliged to us for the indulgence we have shown him. He may abuse us to his heart's content, as it will neither ruffle our feelings nor disturb our decision.—ED. E. M.]

[We print Mr. Beardsley's letter *verbatim et literatum*.]

GEOLOGY.

SIR,—As Mr. Proctor has now concluded his so ably written papers on "The Earth, its Figure and Motion"; I should be most happy, with your consent, to write a series of articles on "The World, its Formation and Antiquity," in which I would endeavour to impart the elements of physical geology to those of my fellow-subscribers who may be as yet unacquainted with them. I will not here enlarge on the beauty, or the utility, or the interesting nature of this science; let it suffice to say, that it is the most practical, next to chemistry, and the most beautiful and sublime, next to astronomy, of all the classes of natural knowledge. I think that these recommendations alone, entitle it to have its leading principles more generally known than they are, and, Sir, I know of no more certain means of arriving at that desideratum than through the pages of the journal of which your are, without flattery, the head in every sense of the term. It may seem presumptuous on my part to take upon myself to teach this branch of science, when the other branches are represented in your pages by men so much superior to me, both as writers, and teachers; but believe me it is merely in the absence of someone else, that I offer my poor pen for the service, conscious, however, that it will shine but feebly in comparison with those of "our" astronomical, and other authors.

ARTHUR UNDERHILL.

[We most cheerfully afford Mr. Underhill space for his letters, and particularly at the present season, when what we may term out-door scientific pursuits may be so advantageously followed.—Ed. E.M.]

ANGLES AND TANGENTS.

SIR,—In reading over the pages of the ENGLISH MECHANIC of the 10th June, 1870, I noticed on page 85, "Hugo's" assertion, without proof, that "angles are not proportional to their tangents." May I beg to ask him is an angle, or corner, at the centre of a circle, the measure of an arc of that circle? and is the tangent an arc of that circle? If the lesser leg of a right-angled triangle be divided by the other leg of that triangle, the quotient in every case will be the tangent of an arc or angle opposite the lesser leg, as in the following case, by logarithms—viz.:—

7·968689 : unity : : 3·5972639 : 5·6285739″ tangent.

And in every case where the given terms have the same ratio as the foregoing we will have the same result, as, 7·968689 : 7·410648466 : : 1·50103944 0·9429990. = 8·769988″, as in the other case. And in every case the sine of any angle is to unity as the cosine of the same angle is to the tangent of that angle.

VERITAS.

THE "PHANTOM" WHEEL.

SIR,—A writer who signs his true name cannot be called upon to reply to anonymous critics, as such writers may possibly be presumed to be either ashamed or afraid to put their real names to their letters. As Mr. J. A. Mays, however (page 256), has signed his last communication to the ENGLISH MECHANIC on the subject of my "velocifere," I will beg the favour of a small space for the explanation.

Mr. Mays is perfectly justified in upholding the views of the "Phantom" Co., but I should very much wish to know the reason why that gentleman has selected my velocifere for animadversion out of hundreds that appear so frequently in yours and other journals, in all of which high speed is impracticable, for at 10 miles an hour only the legs of the driver would have to make 90 double strokes per minute.

Mr. Mays seem to have a jealousy in regard to speed, but he must himself know that on smooth roads, and all roads are smooth with deep rubber tires, speed can only be limited by the resistance of the atmosphere, very great at high velocities, or by the amount of danger in meeting with obstacles. Rubber tires are easily affixed to wheels of any description, and the vulcanised india-rubber rings may be obtained of the proper dimensions and thickness, ready to be put on, at any of the rubber manufactories in town or country.

Rubber tires were proved at the Great Exhibition of 1851, when a heavy cart wheel so tired was allowed to run over the toes of the bystanders without causing the slightest sensation of pain. I have no pecuniary interest whatever in the matter, as my velocifere is not secured by patent rights, to which I have a most decided objection. The patent laws as they now stand form a lottery from which 99 out of a 100 applicants derive a loss instead of a prize, neither have I any faith in any possible improvements being carried out, for the public is the only judge of the value of an invention, and no committee, or jury of scientific men can forestall, or anticipate that judgment.

I need scarcely allude to the disagreeable concomitants of even a successful patent—piracy plagiarism, riders, men of straw, and of expensive law suits the costs of which must be drawn from the pockets of the great mass of the public, the consumer.

HENRY W. REVELEY, Reading.

STEAM LIFEBOAT.

SIR,—Allow me space in your valuable columns for a reply to the objections to the adoption of my improved self-righting steam lifeboat enumerated in the letter of Mr. Richard Lewis, which appeared in your number of the 27th ult. I have fully considered and provided for the necessary requirements, for which purpose I will take the objections in Mr. Lewis's letter *seriatim*:—

"1st. That owing to the large quantity of water which must break over lifeboats in heavy surfs, amounting often to three or four tons weight, it would be difficult to keep the fires from being put out, and at the same time provide sufficient ventilation."

To prevent the extinction of the fires, I provide the funnels and air-shafts with a cowl of peculiar construction, which, whilst permitting of free draught for the fires, and perfect ventilation, prevents any influx of water by the breakage of a heavy surf over the boat. Nor can these cowls be carried away by the wind, or when struck by the sea, or capsizing of the boat. The second objection made is, that "the motion of boats under such circumstances is so great and violent that they sometimes stand almost perpendicular, with either the bow or stern uppermost; that the propellers would work at great disadvantage, and the machinery would perhaps be liable to disarrangement."

I obviate this objection by providing a screw propeller both at the stem and stern of the vessel. These propellers being mounted on the same shaft, will always work in unison; and as one at least will always be submerged, there is no fear of the engines "racing." I dispose and secure the boilers and machinery at the bottom of the vessel in such manner that the engines, &c., could not by any possibility become displaced or disarranged by the motion of the boat.

3rd. "That the space occupied by the engine, &c., would make it impossible to use oars if the former should become disabled whilst afloat," &c.

Not only do I leave room to man the usual number of oars without increasing any of the dimensions of the vessel, but by merely adding one foot to the ordinary length I am enabled to man 12 oars, instead of 10, as usual. Moreover, should the engines be disabled from any cause, the propellers can be immediately unshipped and the vessel propelled by sails or oars alone.

4th. "That . . . . such boats . . . . would require to have a qualified engineer (engine driver) to keep the machinery in order and work it when afloat," &c.

This I do not consider an objection to my invention, as I am convinced that the increased expense attendant on increased efficiency in the means of saving life and property will be amply defrayed by the benevolent public, who have already done so much to further that object.

5th. That "some time would be lost in lighting the fires and getting up steam."

By the use of oil as fuel, steam may be got up in from 10 to 15 minutes, even while the boat is being carried down to the beach and prepared for launching; so that no time would be lost. Indeed, my boat could set off, if necessary, with three or four only of her crew, whereas ordinary lifeboats are frequently detained, for want of hands, when every moment is of vital importance.

6th. That "it would be difficult to apply the self-righting property to such boats; and if they were to remain more than momentarily keel up, the fires would be put out, or they might set the boat on fire."

I provide air chambers of my improved construction above the deck, which ensure the righting of the boat; and as the machinery is disposed entirely at the bottom of the vessel, it must increase the self-righting property of the boat. The funnels and air-shafts are provided with self-closing caps, which prevent any influx of water when the boat capsizes, whilst the boat may be built of, or lined with, metal, to avoid all chance of its being set on fire.

7th. That "the cases of failure of the present lifeboats are so rare, that the committee of the Institution have not felt called upon to expend large sums of money on experiments which might not afterwards be attended with beneficial results."

I need hardly refer to the award of £100 made to me to show that the Committee of the Royal National Lifeboat Institution are fully satisfied of the benefits likely to result from the introduction of my improved steam lifeboat, whilst a reference to the *Shipping and Mercantile Gazette* will show that the present service is not by any means efficient in all cases.

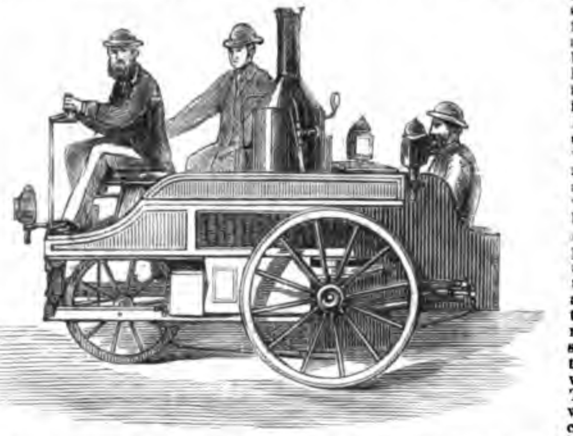
8th. That "wherever steam tugs are available, I think it provable that steam power can be advantageously applied through their instrumentality."

In reply to this assertion, I will only refer to the number for January 1, 1869, of the *Journal of the National Lifeboat Institution*, in which appeared an article from the pen of the Rev. J. Gilmore, M.A., of Ramsgate, entitled "Saved at Last: A Tale of the Ramsgate Lifeboat." By this it will be seen that had steam power been applied in the lifeboat itself, instead of depending on the steam tug for assistance, much danger might have been obviated in that case. Besides, the desirability of applying steam power to lifeboats is fully set forth at page 1 of the same number of the *Journal of the Lifeboat Institution* above mentioned.

C. W. PETERSEN, Master Mariner.

STEAM CARRIAGE.

SIR,—I enclose a photograph of a steam-carriage that has run 1000 miles at the cost of 1d. per mile, carrying four persons, coal, oil, and toll-gates, making one farthing per mile for each person. It has run 62 miles in 7 hours—that is, from Birmingham to Gloucester, ascending and descending some of the steepest hills in the Midlands; weight 15cwt. The engines are driven by gearing 5 to 1; carries water 10 miles, coal for 60 miles can do its 80 miles per day with ease. It has a patent "Field" boiler, 4-horse power; general working pressure 50lbs on levels; 90 to 100 up sharp hills; never worked past 100lb. steam.



G. PREW,

ON THE PIANO.

SIR,—I am sorry that severe pressure of business has prevented me hitherto in forwarding my promised communications on the piano. Pray accept the miserable excuse of "better late than never," the more especially as my esteemed friend the "Harmonious Blacksmith" has deputed me to reply to several questions addressed to him in the ENGLISH MECHANIC as being more acquainted, as he is pleased to term it, with practical details than himself, an assertion he cannot prevent me questioning.

My present subject is on the improvement of the basses and trebles of pianofortes. A German harpsichord maker put additional bass strings to his instruments, which were sounded by pedal keys; and one of Handel's favourite "concert" harpsichords had this alleged improvement. At a later date a Scotch pianoforte maker used very thick brass and copper strings in a similar way in his grand pianofortes. More recently attempts to reinforce the bass have been made by enlarging the sound boards, as carried out by Godwin in 1836, and others, including my friend the "Harmonious Blacksmith," (see his rather costly design for an upright grand cottage piano in No. 235); and yet more recently by Mr. Steward, who extends the sounding board to the left of the bass strings at the cost of rendering the instrument yet more unwieldy. In addition, separate pedal pianos have been made by Woolfe, see his patent of 1858, No. 1081; and we are soon to have a public performance of Bach's pedal fugues by a celebrated French pianist on one of these instruments, which, so long as its use is confined to such music, may be pleasing, but hardly so effective as organ performance. If used to give breadth to the bass of legitimate pianoforte music, it is not only not needed, but is less suitable for accompaniment than the bass of a good piano of the ordinary construction, usually quite powerful enough without even additional surface of sound-board. Witness any of Broadwood's magnificent concert grands. So I think I am justified in asking the designers of the so-called improvements, *cui bono?*

Many years ago I put a set of pedal keys to my piano, and I can testify to their great utility for the mechanical practice of organ music. I found them also capable of greatly assisting the judicious performer of organ music not written with a separate pedal part; but whatever convenience they afforded for this purpose, I never required them to make more noise than could be done by the finger. I never found any difficulty in making quite noise enough with the bass of a good pianoforte. Indeed I have been too often disgusted by the want of taste exhibited by that class of performers who so very logically infer that because all music is sound, the louder the sound, the better the music. If such "hammer and tongs" players, and their name is Legion, were entrusted with pedals, not to mention a Woolfe's separate pedalier, no quiet-minded person with a musical ear could endure living within three doors of their residences, supposing the party walls to be of the usual thickness, or rather thinness.

As it is far easier to make a piano whose bass overpowers its treble, than one whose treble is too powerful for its bass, as Sam Weller would say, "I should *werry* much like to hear one"; but I have very little hope, or rather I quite despair of doing so. I have yet to learn the advantage, except in a commercial sense, of making an independent pedalier—in other words, of making *two* basses to *one* treble in *one* piano, for this is exactly what it amounts to. That the independent pedalier can be made with a very wide scale, extremely heavy hammers, for what Mr. Herman Smith terms "foot touch" is powerful, unusually thick strings and an immense sounding-board, and that it may, and probably does produce magnificent sounds in consequence of its extraordinarily great proportions, is quite true. Its employment as a sole instrument, or for the accompaniment of a large number of voices would probably be very effective, though I suspect it never can rival the organ, or even a large harmonium, for such a purpose. When employed as an addition to genuine pianoforte music, it must, just in proportion to its overpowering loudness, destroy its true musical effect by drowning the melody.

Another proposed method of increasing the loudness of pianos, is by causing one set of strings to put two or more sounding-boards into vibration. I believe this was employed in some of the earlier harpsichords, and is successfully carried out in the violin. Its application to the piano was patented by Broadwood in 1783. I have but little hope of its success when applied to the *treble* of a piano, however much it might improve the tenor and bass. In the violin the vibrations of the strings are maintained by the bow, which is not only a powerful instrument for impulsion compared with any amount of resistance to motion which a fiddle-string is capable of, but the fact that the vibrations can be *maintained* for *any length of time* at the pleasure of the performer, completely alters the conditions. Were the treble strings of a piano urged by a powerful bow, it is very probable their vibrations, being maintained, might be communicated to many sound-boards placed above and below the one to which the bridge upon which the strings rest is attached. The maintenance of their vibrations would afford time for them to be communicated to the several sound-boards, just as they are to the back of a violin through its belly and its sound-post: but the vibrations of pianoforte treble strings endure so short a time (when struck by hammers only) that they cease *before* they can be communicated to many soundboards, therefore we can hardly expect to obtain additional tone from those additional sound-boards. I firmly believe one good properly-made sound-board is better than many, although more than one may probably be of use in the middle and bass of a grand whose sound-board (from its narrowness at the tail end) is often too small for its bass strings, whose vibrations endure so long, that there is ample time for them to be communicated to at least two other sound-boards placed one above, and the other below the normal one. But I greatly doubt if there is any practical advantage to be obtained by using more than one, which may not be better realised by enlarging the single sound-board commonly employed. Room for doing this is easily obtained by widening the usually too narrow tail of the case at its right hand or treble side, to the great improvement of its tone as well as appearance. In upright instruments, the sound-board may be made of any desired width without widening the case; indeed it may be made to extend over the whole surface of the back. Erard's do this, but after all it is improving the treble and not the bass, which is the thing required.

If instead of trying to do what every pianoforte maker who understands his business can do easily, my friend the "Harmonious Blacksmith" and some of my fellow-readers who are more practical in their crotchets than he is, would exert their ingenuity to increase the power and *purity* of the treble, I should have no need to ask *cui bono?* It has been attempted, but I have seen none yet decidedly successful. One method is to enlarge the sound-board *beyond* the bridge; but this in the two specimens I saw, though most elaborate in every respect, resulted in failure. Extending the sound-board *within* the bridge seems more promising. From the time of Dodd, Goodwin, Nosworthy, and A. Wornum, to the late design of Steward we have had repeated attempts to carry out the idea; but I have yet to see it carried out successfully so far as increasing the power of the treble is concerned.

Another and more promising mode of increasing power in the treble is doing there what the independent pedalier does for the bass, viz., using two pianos instead of one, in the same case, the whole of the strings of the said (literally) two pianos being actuated by one action or mechanism. In No. 208 "J. J." proposes this plan, and in No. 278 the "Harmonious Blacksmith" has offered some suggestions of a more practical character than many of his crotchets for carrying it out. "J. J.'s" design is not intended to increase the loudness of the sounds uttered by any given string in the treble; but it really is what I have before stated it to be, viz., two treble pianos in one case. It is true, there is but one sounding-board common to both, but each string or set of strings has its separate pair of bridges, although one bridge of each pair is on the same sounding-board, and each of the other pair is on the same intermediate metal bar. Each string also has its own hammer, though they are both on one shank, and move on one centre. I feel, therefore, quite justified in terming "J. J.'s" design two treble pianos placed above each other in one case. We all know two pianoes, sounded together, are louder than one.

The chief objections to this plan are the difficulties of construction (perhaps the "Harmonious Blacksmith's" design for carrying it out might be cheapened and simplified): also the unavoidable increased height of the instrument. To me personally this latter is no objection at all. I much prefer a six feet cabinet to a four feet cottage; but commercially it don't pay to make pianos more than 4ft. 4in. at the utmost. People *don't know what is good for them*, and won't buy tall instruments with plenty length of string for producing basses of fine quality. If "J J.'s." plan were carried out as far down as the compass as pitch C, it would add something like two feet to the height, thus making a four feet cottage as tall as a four feet cabinet. I fear only the few who *prefer music to furniture* would become purchasers.

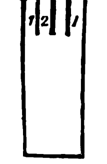
I fancy that the difficulty of tuning such an instrument would be considerable, and I know from experience that the majority of pianoforte tuners are neither careful nor intelligent enough to tune either this or any other instrument requiring unusual care or intelligence. The pitches of the upper and lower strings must be altered, but very little at one time, or a large proportion of the whole tensile force of the strings would be resolved on the intermediate metal bar which carries the two bridges. To avoid this evil will require an amount of care and caution that tuners who are accustomed to "pull up" strings a whole tone or more at once can hardly be expected to exercise—but perhaps, like the Tory party, they might be "educated." Some difficulty might be experienced in adjusting the upper hammers to strike their strings at the same instant, and with the same force, that the lower hammers strike their strings, but it can be done if the workman's head is screwed on the right way. No one who works only by "the rule of thumb" should be entrusted to do it. I know I could do it myself; indeed, after more than thirty years practical and extensive experience—not to mention the *many, many* long months I have been engaged during my spare hours in carrying out no end of what I may term the "curiosities" of pianoforte making, for my friend the "Harmonious Blacksmith," there is literally nothing I should be afraid to undertake. If originality of idea (unfound in the Patent Office records), occasionally even to me appearing to verge into absurdity—utter disregard for the ordinary usages and practices of the trade, which has caused many a wrangle between us, and his persistent determination, to test to the very last, the pros and cons of his ideas at any cost, cannot fail to give a man experience in his trade, I ought to confess to myself under deep obligations to him. I have not only learned more theoretically from him, a mere amateur, than any man in the trade could have taught me, except I had access to the knowledge locked up in the archives of such firms as Broadwood, Collard, and Erard, which only oozes out by driblets in their productions; even then it is only visible to those with brains to appreciate—but I have learned in the pleasantest possible way—viz., by being well paid for my time. We must all pay for our fads, and he is no exception to the rule that "Children must be paid for."

In my next, with your permission, I will reply to a few questions by "Harmonious Blacksmith's" desire, though addressed to him.

W. T., Pianoforte Tuner and Repairer.

ROBERTS' GALVANIC BATTERY.

SIR,—It gave me pleasure to read in your ENGLISH MECHANIC for 27th April, page 141, the testimony borne by Mr. H. Chapman to the great advantages of the galvanic battery which I invented in 1852. Permit me to say that the cost of the battery (which he properly states is great when platinum is used as a negative plate) is reduced fourfold by substituting graphite for platinum, and the battery is not much diminished in power by such change. I have used my battery for electric light, and for fusing iridium many successive hours with undiminished force. I used long drain pipes (stopped at bottom) to contain the exciting liquid. These pipes were about 36in. long. The plates being 9in., were hung at the top: thus, 1, 1, graphite, or platinum; 2, the zinc plates. The vessel was then filled with dilute nitric acid, sp. gr. 1240°. The action is as follows:—Part of the oxygen of the acid combines with the tin, forming metastannic acid, which, being comparatively insoluble, falls away from the surface of the tin plate to the bottom of the deep vessel. The surface of the plate is thus kept clean, and the exciting liquid is not encumbered with any opposing metallic solution (an evil in all other batteries). Further, the metastannic acid falls down as a hydrate thus carrying with it an equivalent of water, which tends to maintain the supernatent liquid nearly at its full strength. Again, the product of the battery, after obtaining the electric force, is a marketable commodity, metastannic acid being used in calico works. We sent more than a ton weight of this product of the battery to Manchester, and sold it at a price which paid nearly for the cost of working the battery But the competition by Young's process of making metastannic acid direct from the ores of tin kept the price down, otherwise we should have had our electric power for nothing. I would venture to observe that this is the end to which experimenters in electricity should direct their attention—viz., to make the product of the battery pay for the plates and exciting fluid. As the nitric acid gave up part of its oxygen only to the tin, nitrous acid fumes were given off abundantly; but these fumes were collected into a peculiar kind of reservoir, in which they were condensed, and part of the acid thus recovered. Circumstances directed my attention to other matters, and I have not followed out this matter as I ought to have done.

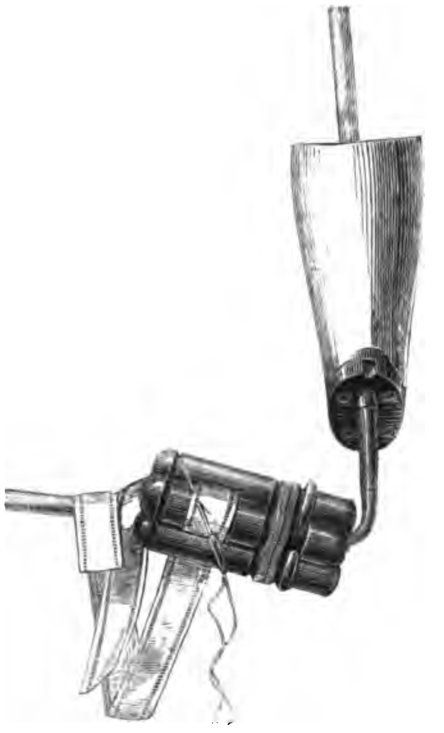


I cannot refrain from bearing testimony to the exceeding usefulness of your publication and the excellent spirit in which it is conducted.

MARTYN ROBERTS, Pendarrow House, near Crickhowell.

MECHANICAL FINGERS.

SIR,—I have just invented a very useful mechanical contrivance, a photo of which I enclose. Three weeks ago, I had a machinist apply for an arm amputated a few inches from the shoulder, and she wanted amongst a number of appliances, an instrument that would hold the work like the natural fingers, to enable her to hem, stitch, and tack her work for the machine,



After many trials I succeeded, and so successful is the appliance, and simple, that in a short time she was enabled to stitch and hold the finest or coarsest fabric, with almost as much ease as with the natural fingers.

The instrument is fixed in the wrist, and is removed, as you see, instantly on touching the spring. There are three rods corresponding to the thumb and the first and second finger; the two under rods are fixed; the top one, over which the work is drawn, is movable in any direction, and bound to the other two by a vulcanised rubber band; this band according to its tension keeps the work. On to each rod is a piece of brass tube, which revolves when the work is drawn. Over the two under tubes is slid a piece of vulcanised rubber pipe, The work is placed in the instrument precisely as it is in over the index finger, the vulcanised rubber holds the work just like the soft cushions of the fingers; as the person stitches she can draw the work, the rollers revolve, and thus they can hem, and stitch at any length. Ladies who have lost an arm at the shoulder, above or below elbow, may now by the use of this instrument follow their favourite employment, which through their loss they may have long been deprived of

J. GILLINGHAM.

SELF-ACTING BLOWPIPE.

SIR.—I beg to send the following description of a self-acting blowpipe:—By means of the bellows air is driven into the lower portion of the cylinder, which contains a quantity of water, and has a diaphragm in the middle of its height, with a wide pipe reaching nearly to the bottom. When the apparatus is at rest the water remains below the diaphragm, as shown in Fig. 1; but when air is blown in, it gradually rises through the pipe to the position shown in Fig. 2. The water as it descends presses out the air in a steady stream at the nozzle; a valve prevents it from returning into the bellows.

FIG. 1.

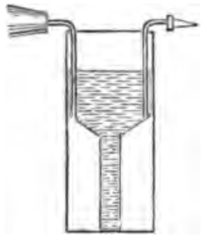
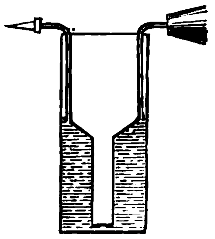


FIG. 2.



CUTHBERT.

MICROSCOPIC CONDENSER.

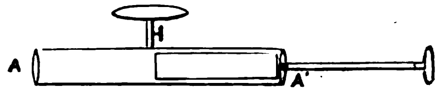
SIR,—I have a Kellner eyepiece which I am desirous of mounting as a condenser, but I find that the focal distance is so short (about ¼in.), that when it is placed under the stage the upper surface of the eyepiece interferes with the movement of the mechanical stage. I have tried the mirror with both surfaces, and have used both ends of the eyepiece uppermost. I presume that the eyepiece is the proper one for the purpose, as I mentioned the use for which I required it, when getting it from Messrs. Smith and Beck.

Will any reader kindly assist me by suggesting a remedy for the above defect, or if this cannot be done, would he recommend any cheap form of condenser with a longer focal length.

X. Y. Z.

THE AIR PUMP.—THE HIGHEST VACUUM.

SIR,—A common exhausting syringe will produce a vacuum sufficient for the experiments mentioned by "Inductorium," p. 252, but at the expense of much labour. Certainly "Inductorium's" air-pump should do the work well. If, however, he requires stratification, the case is very different. I have never been able to produce it with a double-barrelled pump, but a small pump which I have, on Yates' plan, gives me very good results. The form is shown in sketch, omitting unnecessary details. There are valves at A and A' opening out wards, but none between the barrel and the receiver to be exhausted, so that the rarefied air has no work to do in lifting valves. The pump is hard to work at first, but beomes easy as the exhaustion proceeds. Were "Inductorium" not so well acquainted with the subject, I should suppose that the joints of his apparatus were not air-tight, but that, I suppose, is impossible, and therefore I can not account for his failure. If "Inductorium" will furnish details of his coil giving 4in. sparks with a single small cell, and having only 4in. of secondary, he will much oblige.



J. V.

SALADS.

SIR,—On page 159 of our MECHANIC, "Beta" appears strongly to advocate the use of dandelion as a salad. But he forgets to consider that mankind in general do not relish the taste of this herb as a salad, and hence it is rejected by almost everybody, at least in this country, nor will any commendations of its good qualities, which it assuredly possesses, induce people to use it, knowing, as they well do, that there are other herbs as good, and even superior when used as salads.

Dandelion is most effective in diseases of the liver. It may, in fact, be considered, particularly the roots of the herb, as almost a panacea for ailments of that organ. On the kidneys, too, it acts beneficially, and no doubt on the spleen as well. But dandelion as a salad is most unpalatable, and even when blanched it is anything but agreeable. I have tried all kinds of salads, and there is nothing, in my opinion, to excel our old friend watercress. It is always welcome, and always wholesome, and can scarcely be sufficiently praised. We ought to eat a good deal more of it than we do. It seems to be universally liked, and, like plantain, seems to follow man wherever he goes; I have seen it growing profusely near the Falls of Niagara, and I believe in the neighbourhood of Montreal and other places. In "Beta's" list of salads, I observe the word "beer," this, of course, is a misprint, and should read "beet." I am rather surprised that this gentleman has not included mustard in his list, for it is well liked and largely eaten mixed with cress, nor has he mentioned young onions, which are much consumed in the spring time of the year.

I may add that the leaves of Indian cress (the common nasturtium), are a good salad. They are not as hot as horse radish nor as cool as a cucumber, but agreeably piquant, and far preferable, I think, to dandelion leaves. On the Continent this cress is, one may say, in general use, but here in England we do not seem to care about it as a salad, and only admire it for its gay and variegated flower, and for the great ease with which it is grown. I cannot agree with "Beta" in his remark that through ignorance or prejudice many of the salads mentioned by him are at present despised by mankind. They are not despised, but simply unused, mankind having discovered other salads more agreeable to their tastes.

TAUTAU.

ORTHOTOPTICS.

SIR,—Your esteemed correspondent "The Welsh Shepherd," at page 257 calls attention to a subject which has been frequently discussed among physiologists—namely, the rectitude or inversion of vision. Now, to begin. We are perfectly acquainted with the anatomy and mechanism of the organs which subserve that sense, and we know that, in contradistinction to all our other senses, a perfect fixture, though very small, and inverted, is actually produced on a convenient part of each of these organs. But there our knowledge ceases to assist us as to the effect produced upon the so-called *sensorium*, and this, in all likelihood, will remain a mystery so long as we are in the flesh. As for conjecture, there has been plenty of that, but none of it can be of much utility. If I understand the "W. S.'s" communication rightly, the gist of his argument is that monocular vision would present objects in an inverted position to the mind, while binocular vision would produce the sensation of erection. In other words, that two upside downs are equivalent to one right-side-upwards. In attempting to show this, he adduces the case of a little boy who was afflicted with disease, and perhaps congenital deficiency. But this case unfortunately, proves too much; for it is said that, in drawing the picture of a house, for instance, he drew it wrong side upwards; but then, if he had done that, his delineation, like everything else, would also have been inverted to him, and, consequently, seemed to him what would be right side upwards to us, and so, wrong side upwards to him. It would appear, then, that he was merely endeavouring to hoax the bystanders. This would seem the more probable, for we are assured that "the very rudiments of the optic nerve on the left side were wanting." Now, if this description be accurate, it would imply a very extensive deficiency of the brain, reaching back as far as to what is called the *external geniculor body*, and would excite no wonder at a perversion of intellect, for the malformation would probably not be confined to that tract. The aspect of a fungous growth at the bottom of the eye is not crystalline, but metallic, and was well described some time ago in your columns by Dr. Ussher, whose good-tempered articles we have recently missed. It is easy for anybody to try whether monocular vision inverts the impression on the sensorium by simply closing one eye, or, if that will not satisfy the "Welsh Shepherd," we have no end of cases of most extensive lesions of the brain on one side only to aid us. His theory about the decussation of nerve fibres in the optic commissure will not hold water for one instant, the fact being that the crossing merely produces a distribution of right hand fibres to the right hand side of both eyes, and *vice versa*, thus securing a consentaneous action of the two sides. We have a most remarkable case on record bearing on this subject narrated by Locke, I think, in his essay "On the Human Understanding." The question was propounded to him by the celebrated Mr. Boyle, whether, supposing a person to be born blind and to have his sight afterwards given to him, he would, by mere inspection, be able to distinguish a cube from a sphere. Locke, after some reflection, replied that he would not, and shortly afterwards an opportunity presented itself of testing this, for one of our great surgeons, Mr. Cheselden, encountered a young man 21 years of age, who was born blind, and remained so, having congenital cataract. Mr. Cheselden operated on him, and he recoverrd his sight. He was not able to tell a cube from a sphere without manipulation; he saw objects in their upright position, but everything appeared painfully close to his eyes. After a period he saw like other people.

There are, then, no means of ascertaining in what position we see objects, or, indeed, if we all see them in like manner, because their *relative* positions and magnitudes are similar in all cases; it does not, however, follow that because the picture is inverted at the fundus of the eye, it should be so carried to the sensorium, for it may be there presented horizontally with the base forward, and if so there would be a solution of the question.

But we are not to suppose that people always know whether they are looking at an object right or wrong side upwards, for if we go to the palace at Hampton Court, we shall find the visiters looking at the pictures on the ceilings from all parts of the rooms. Few may be aware of it, but such, notwithstanding, is the fact, that the large majority of persons contract a habit of using but one eye, to the detriment of the other, so that the unused eye loses, partly or entirely, the faculty of focussing and adapting itself to see at different distances; and this may be perceived if we take a book and attempt to read first with one eye alone, then with the other, also alone. This should be attended to by those who have to wear spectacles, as it frequently happens that glasses of different focuses are required for the two eyes. We cannot, as just observed, tell how others see, as we have no means of instituting a comparison, and, for aught we know, one person may see as though he looked through the small end of an opera glass, and another as through the large end. The impressions produced by colours may also be widely different.

To conclude,—it is of little consequence to us whether objects are presented to us upright or inverted, as all know who are in the habit of using the microscope, for here the bottom appears to be the top, and the right hand size the left, and *vice versa*, but our experience soon enables us to supply the correction.

F.R.C.S.

PECULIARITY IN EYESIGHT.

Sir,—For about two years my eyesight has been failing me out of doors (to correct which I use concave glasses). For reading it is as good as ever. In looking at, say, a flagstaff with the left eye, I am favoured with three images thereof—namely, the flagstaff proper, and an image parallel thereto like a shadow at each side. With the right eye, and with both eyes at once, there is only one shadow—to the right. In looking at a pretty girl this peculiarity is agreeable enough (my wife here pulled my ears), but it detracts very much from the appearance of a landscape, &c. I suppose it is caused through the irregular flattening of the eye lens through natural decay, perhaps accelerated by following my daily avocation in a too glaring light. I have a window in front or me and one to my left. Thus, my work is in the light, while the light also falls upon my eyes. Now, it seems to me that this disposition of the light will cause the pupils to contract irregularly, and that the centre will flatten by age and use; but that the outer edge (irregularly protected) will be preserved in its original convexity, thus causing two or more foci in the same eye. What strengthens me in this opinion is, that at dusk, while other people can see easily, everything is a blur to me, and when it becomes dark, by the greater dilation of the pupils, the focus of the outer edge becomes the principal one, and so I can see tolerably well again. Should any of my brother readers confirm me in this opinion, I will take steps to remove the cause. An opinion will oblige.

Blackburn Amateur.

VENTILATION OF BUILDINGS.

Sir,—I have read with much interest Mr. Henry W. Reveley's letter (No. 269) on the ventilation of buildings. Seeing that the enjoyment of health so much depends on the proper supply of pure air, especially to dwelling-houses, the importance of this subject cannot, I think, be over-estimated. Mr. Reveley's plan is to supply the fresh air from above, through the ceiling, and expel the bad air through the floor. Would it not be better to reverse this plan, and supply the pure air from beneath, while the impure was expelled from above, seeing that the heat and breath of the body and the products of combustion have all a tendency to ascend—at least there exists a general belief to that effect? Mr. Reveley, however, probably has good reasons for supplying the air from above, and I, for one, would be most happy to have further information respecting his novel plan. He also refers to the benefits arising from the carrying off of the products of gas combustion by means independent of the general ventilation. A proof of what may be easily effected in this way lately came under my observation. An old house, having rather a low ceiling, was fitted up with gas, but the air always became very oppressive when the gas was burning. The occupant being an ingenious man, had a tinned iron funnel constructed, some 10 or 12in. diameter, and suspended over the burner; the funnel terminated in a tube about an inch in diameter, through which all the products of gas were carried into the house flue. After the adoption of this plan the air in the room remained cool and fresh.

J. Hastings.

SIMULTANEOUS EQUATIONS.

(Continued.)

Sir,—To continue:—

(7.) (1) $7w - 13z = 87$

(2) $10y - 3x = 11$

(3) $3w + 14x = 57$

(4) $2x - 11z = 50$

Multiply (1) and (3) by 3 and 7 respectively, subtracting products.

$$21w - 39z = 261$$
$$21w + 98x = 399$$

Multiply (4) by 49, adding to (5)

(5) $-98x - 39z = -138$

$$98x - 539z = 2450$$
$$-578z = 2312$$
$$578z = -2312$$
$$z = -\frac{2312}{578} = -4$$

$$2x - 11z = 50$$
$$2x + 44 = 50$$
$$2x = 50 - 44 = 6$$
$$x = \frac{6}{2} = 3$$
$$3w + 14x = 57$$
$$3w + 42 = 57$$
$$3w = 57 - 42 = 15$$
$$w = \frac{15}{3} = 5$$
$$10y - 3x = 11$$
$$10y - 9 = 11$$
$$10y = 11 + 9 = 20$$
$$y = \frac{20}{10} = 2$$

(8.) (1) $ay + bx = c$

(2) $c + az = b$

(3) $bz + cy = a$

Multiply (2) by b, (3) by a, subtracting product

$$bcx + abz = b^2$$
$$acy + abz = a^2$$

Add to this (1) multiplied by c

(4) $bcx + acy = b^2 - a^2$

$$bcx + acy = c^2$$
$$2bcx = b^2 + c^2 - a^2$$
$$x = \frac{b^2 + c^2 - a^2}{2b}$$

(11.) $\sqrt{(2x)} - 7x = -52$

$$\sqrt{2x} = 7x - 52$$
$$2x = (7x - 52)^2 = 49x^2 - 728x + 2704$$
$$-49x^2 + 730x = 2704$$
$$x^2 - \frac{730x}{49} = -\frac{2704}{49}$$
$$x^2 - \frac{730x}{49} + \left\{\frac{730}{98}\right\}^2 = -\frac{2704}{49} + \frac{532900}{9604} = \frac{2916}{9604}$$
$$x - \frac{730}{98} = \pm\frac{54}{98}$$
$$x = \pm\frac{54}{98} + \frac{730}{98} = \frac{784}{98} = 8, \text{ or } \frac{676}{98}$$

(12.) $x^4 - 14x^2 + 40 = 0$

$$x^4 - 14x^2 = -40$$
$$x^4 - 14x^2 + (7)^2 = -40 + 49 = 9$$
$$x^2 - 7 = \pm 3$$
$$x^2 = \pm 3 + 7 = 4 \text{ or } 10$$
$$x = 2 \text{ or } \sqrt{10}$$

(13.) $2x + \sqrt{(4x + 8)} = \frac{7}{2}$

$$\left\{2x - \frac{7}{2}\right\}^2 = 4x + 8$$
$$4x^2 - 14x \frac{49}{4} = 4x - 8$$
$$4x^2 - 18x = 8 - \frac{49}{4} = -\frac{17}{4}$$
$$x^2 - \frac{18x}{4} = -\frac{17}{16}$$
$$x^2 - \frac{18x}{4} + \left\{\frac{9}{4}\right\}^2 = -\frac{17}{6} + \frac{81}{10} = \frac{64}{16}$$
$$x - \frac{9}{4} = \pm\frac{8}{4}$$
$$x = \pm\frac{8}{4} + \frac{9}{4} = \frac{17}{4}, \text{ or } \frac{1}{4}$$

(14.) $2\sqrt{x} + \frac{2}{\sqrt{x}} = 5$

$2x + 2 = 5\sqrt{x}$, squaring both sides

$$4x^2 + 8x + 4 = 25x$$
$$4x^2 - 17x = -4$$
$$x^2 - \frac{17x}{4} = -1$$
$$x^2 - \frac{17x}{4} + \left\{\frac{17}{8}\right\}^2 = -1 + \frac{289}{64} = \frac{225}{64}$$
$$x - \frac{17}{8} = \pm\frac{15}{8}$$
$$x = \pm\frac{15}{8} + \frac{17}{8} = 4, \text{ or } \frac{1}{4}$$

C. H. W. B.

SPECTRUM ANALYSIS.

Sir,—I observe a correspondent, H. W. Bishop, (4004), asks that another series of articles shall be given upon spectrum analysis. Allow me to support this suggestion, and add that no doubt there are many who like myself possess a small laboratory for experimental chemical investigation, and who would be glad to add to their stock a spectroscopic apparatus if it could be provided at a not too great cost.

My own case is this:—I have a good practical knowledge of analytical work, and desire to acquire an equally practical knowledge of spectrum analysis. At present I know little more than the name, and to make my laboratory more complete and useful, to add a spectroscope for chemical purposes. Therefore any information conveyed through your columns to assist in either making, arranging, or where to purchase and work the necessary apparatus, will be duly appreciated.

W. R.

TRADE AND COMMERCE.

Sir,—The second paragraph of "F. W. M.s" letter on page 257, expresses a very common belief, but one so pernicious, that the error cannot be expressed too often. He thinks that we ought to refuse to buy cheap goods from the foreigner if he refuses to buy cheap goods from us, "because if we did so buy them we should be paying the wages of the foreign workman who made them, and therefore there would be just so much less (money) for our own workmen," who are therefore compelled to emigrate. "It is pretty plain that for each foreign workman we support in this manner, one English workman is compelled to leave his country or to become a pauper."

As all this is heresy of the blackest hue in the eyes of all orthodox true believers in political economy, I thought I might safely leave this portion of "F. W. M.'s" letter to other and more competent writers; and therefore confined myself last week to vindicating my first letter, which "F. W. M." somewhat cruelly held up to ridicule. Having a most salutary horror of encroaching on your space I intend to state principles without any of the qualifications they require in practice.

I will start with two axioms.

1 A country that imports goods, pays for them by its own exported products.

2. Wages are paid out of the accumulated wealth of a country.

In these questions one part of the transaction is obvious, the other, the compensating one, requires some attention to find out. When I buy a foreign-made article, "F. W. M." even sees, that part of the money I pay for it, goes to support the foreign workman who made it. What he does not see is, that some foreign gentleman pays an equivalent sum for some English article that strikes *his* fancy, and that part of *his* money goes to support an English workmen, for taking the whole of one nation's trade with another, the one transaction cannot happen unless the other happens too.

Therefore, when we have got only thus far, we find that the English workman is *equally* supported whether I buy a British or a foreign made article. Let us now go one step further. If I buy a foreign article in preference to an English one, it must be, because it is, *cæteris paribus*, cheaper than the English one. Let us suppose, for instance, that I get for £10 a foreign article; whereas if I bought a similar English one I should have to pay £20 for it. No one can deny that I am £10 richer for my intelligent preference, and have that extra £10 to lay out on another article; for no sane person now puts away his savings in an old stocking, he invests it somehow or other, therefore, I shall still lay out £20, on industrial products—English or foreign makes no difference to the English workman, as we have found above. The result is that I am richer by £10 for choosing the foreign product; that is to say, that the fund from which wages are paid is increased by that sum; which, in the long run is *good* for the working classes; *ergo*, buying a dear

English product when you can get a foreign one *as good* for less money is a dead loss to the community.

HERBERT.

DESIGNS FOR THE LATHE.

SIR,—In your very interesting paper I have noticed some letters inquiring about the best mode of trying and recording designs executed in the lathe. The common method of doing this, by a paper on the chuck and a pencil in the slide rest, is at best so very inconvenient and unsuccessful, that many amateur turners among your readers will doubtless be glad to learn a much superior proof. That you may be able to judge of the result obtained, I enclose a couple of samples; and these are selected on account of their *imperfections*, that you may see what are the difficulties to avoid.

The card is common enamelled or ivory faced cardboard, such as may be bought in sheets of any card maker, and cut to fit the chuck. This cardboard, after being cut, is brushed over with Indian ink, two or more coats in opposite directions, until a jet black surface is obtained. This must be done quickly, with a light hand, so as not to soak up the enamel; and the ink must be good and rubbed smooth, free from lumps, as the least knot on the paper injures the design. These cards are held upon any flat chuck by a narrow brass rim; the rim is fastened down by a catch on each side of the chuck.

The tool is a needle-point, which is pressed forward by a spring; its penetration is regulated by an adjustable shield, as the card will never lie perfectly flat.

The lines, being white upon a black ground, will be distinctly visible however fine they may be drawn; and there is scarcely a limit to the delicacy of the work which may be executed in this way. The cards may be easily preserved, and the "sittings" noted upon the back of each for future reference. If the designs are wanted for publication, any photographer can copy them, enlarged or diminished, if required; and they are much more effective than the patterns printed from blocks, on account of the greater distinctness and delicacy of the lines.

Should any of your readers who are turners desire it, I will send a drawing of my tool; I do not now do so because I am not a good draughtsman, and am, moreover, not certain of the favourable reception of my suggestion. Still I wished to share with my fellow amateurs an invention which has given me much amusement and much pleasure to many friends.

V., New York.

[The specimens enclosed by our New York correspondent are exquisitely executed. We should be glad to give, for the benefit of our readers, an illustrated description of his lathe.—[Ed. E.M.]

THE "GERM THEORY."

SIR,—Will you allow me to say that, while agreeing with "J—— M——o" in a great deal that he says, (p. 258), I cannot imagine that the "building" he speaks of would be of the slightest use in *curing* consumption. I do not think Prof. Tyndall is quite sure himself what the molecules floating in air really are; for although when the stream of air was passed through a red heat the molecules "were destroyed," similar phenomena occurred when a tin case containing boiling water was held underneath; so the molecules may be organic or inorganic for all that has been *proved* at present.

That persons living at high altitudes rarely if ever suffer from consumption I imagine arises from the air being "lighter" as well as purer. Thus the lungs would take deeper inspirations, and become fully inflated and, so to speak, aërated. In other words, because the pressure of the atmosphere is not so great on a high mountain it becomes necessary to obtain the requsite amount of oxygen to breathe more deeply, and to expand the chest more fully, and consequently the lungs. For myself, I do not believe tuberculous matter can exist in well-aërated lungs. "J—— M——o" says that "air of great tenuity (?) will not suspend the germs mechanically and carry them about." Surely, there is *some* mistake here.

But I should like to hear Dr. Ussher's opinion on the whole subject.

SAUL RYMEA.

TOURISTS' TRIPS.—IRELAND.

SIR,—The great number of inquiries resulting from my note on the "Midland and Western Districts of Ireland" fully proves that a tour through that romantic part is not without great interest, but as I cannot answer all inquirers individually, I hope you will again do me a favour by inserting the following remarks, &c., for the benefit of those numerous kind friends who, by their letters, evince a great desire to visit the Irish. 1st. I would address myself to those who have only a week at their disposal. A circular tour through the county Wicklow they would find very interesting. We take the train from Westland-row station, Dublin, for Kingstown, a sixpenny ride, and then proceed on foot through the pretty towns of Dalkey and Killiney, where having obtained permission to ascend a mount, formerly belonging to John Mappas, Esq., we view a splendid panorama of many square miles in extent stretched out before us. A little farther on lies Bray, with its celebrated promontory stretching out into the sea, called the Head of Bray. Here we must stay a day or two to visit the "Seven Churches," the "Devil's Glen," and the "Dorgle." The legends attaching to these places told by the carmen in their own vernacular, are droll in the extreme. This glen of the Dargle is the most beautiful spot in the country. The rugged and precipitous sides rise on either hand to the terrific height of 400 or 500ft., and are covered with the most luxuriant vegetation, among which are several families of splendid ferns; at the bottom winds the stream from which it takes its name. The sublime scene and the music of the waters as they rush along over the rocky bed cast a spell over the lover of nature which enchains him to the spot; but we pass on through densely-wooded ravines, until we reach Enniskerry, where we must also stay a day or two to explore. About 5 miles from here, past the Sugar Loaf Mountain, lie the domains of the Earl of Powiscourt, and by the courtesy of his park keeper, Mr. Hopkins, we were permitted to view the Deer Park Falls by moonlight, a scene that will ever be photographed on our memory. We retrace our steps to Enniskerry, and find comfortable quarters and an obliging landlord at the Hotel Royale; then, again taking the road, past Lough Bray, we visit some genuine Irish cabins on the hill side, containing, as usual, the pig that pays the rent, all the poultry, very little crockery and furniture, and a great deal of peat smoke. One thing you are sure of, and that is a hearty welcome to share their meal, which chiefly consists of potatoes (cooked with the bone in them), and milk. A more generous people I never met with; they are ever ready to assist and wish you "God speed." But we travel on past the Reformatory of Glen Cree, containing about 700 inmates, under the paternal supervision of Father Fox, to Round Town, through Rathmines and Rathcar, into Dublin, and what time we have we may spend profitably by visiting Phœnix Park, the Cathedral, and many interesting places in the old city. And now—2nd. To those who have a fortnight's leisure. We take the excursion from Blackstone Station, Dublin, to Galway (all particulars of the Midland Great Western trains may be had by writing to the courteous traffic manager, Mr. Skipworth), a distance of 130 miles, passing *en route* Maynooth College, Mullingar, Ballansloe, and other interesting places. The old town of Galway is thoroughly Irish; the women are seen in droves, dressed in the old red cloaks, and without shoes and stockings, carrying fish and turf. Visiting Queen's College, the famous salmon fishery, and the curious colony called the Claddaugh, and the pretty suburban town of Salthill, we book ourselves as passengers by the steamer that plies daily between Galway and Cong, the fare 1s. 6d., a distance of about 30 miles. This is a pleasant little trip on the fresh waters of Lough Corrib; numerous islands are dotted here and there, and feeding on the shore we saw flocks of cormorants. Passing the residence of Captain Blake, and several dilapidated and deserted nunneries, we reach Cong, and by the kind permission of Sir A. Guinness we are permitted to roam over the spacious domain. About 3½ miles distant are the waters of Lough Mask, flowing into Lough Corrib through a subterranean passage formed in the limestone, which has sunk in many places, forming immense caves. The inhabitants of Cong light them up with straw whenever visited by strangers. From here we pass through Ma'am (past Lynch's Hotel, a most remarkable structure, the front of the place being, as the Irish express it, all at the back; the front part facing the road certainly has neither door, window, nor sign, and it is only by passing round that we discover signs of life), on to Clifden, from here to Kylemore, and through the pass, visiting the castle of Mr. Henry, one of the benefactors of Ireland, especially in the west, through Letterfract and Lenane, two charming places, from there to Westport, spend two or three days here, ascend Croagh Patrick and feast our eyes with the scenery around the Bay of Westport, then take the train and pass to Foxford, from here by road to Ballina, a town numbering about 5000 souls; here we see the quaint old Irish style of travelling, the wife riding behind the husband on the same horse, and holding by the tail of the animal with one hand and clasping her husband with the other, from here we take the public car and travel comfortably to Sligo, the extremity of our tour, and here you may pass several days, as the neighbourhood is extremely interesting alike to the botanist, geologist, and the pleasure-seeker. Trips are arranged on Lough Gill most days. We now leave Sligo and return by train through Ballymole and Longford to Dublin, and thus ends an excursion through a district exceedingly beautiful, but thinly populated, capable of being far more extensively cultivated than at present. Apologizing for the length of this letter, I shall be happy to answer further inquiries.

F. HARWOOD, 33, Newark-street, Leicester.

[We should be glad to insert other letters containing reliable information for tourists, and particularly about localities which more or less abound with beautiful scenery or objects of scientific interest. Information on railway and steamboat fares, hotel charges, &c., would also be appreciated, and no doubt received with thanks.—ED. E. M.]

DRY PLATE PHOTOGRAPHY.

SIR,—I strongly recommend "Tannic Acid" to try the gum gallic process in preference to the tannin. He will find it more certain and better in every respect. For full details I must refer him to the "Year Book of Photography for 1870," price 1s., as to give them here would require an unfair amount of space; but I can briefly state it thus:—To make the preservative, dissolve separately, gallic acid, 3grs.; water, 6drchms.; and gum arabic, 20grs.; sugar candy, 5grs.; water, 2drchms. These are to be mixed and filtered just before use. The plate having been coated with a suitable collodion, is excited and washed as usual, flooded with the preservative, and drained and dried. It may be developed with pyrogallic acid, but Mr. Gordon recommends the following iron solution:—Gelatine, 1gr.; glacial acetic acid, 15 minims; protosulph. iron, 20 to 30grs.; water, 1oz; a few drops of silver solution to be added before using. The exposure is about from four to six times longer than for wet plates.

DÆDALUS.

PERFORMANCE OF SPECULUM.

SIR,—Your correspondent, "Optical Bricklayer," in soliciting my opinion on the performance of his 7 5-16ths in. mirror, has, so far as I can judge, accomplished a decided success. He does not, however, give the number of the MECHANIC in which the engraving referred to is to be found; but if the lines of letterpress are smaller than the ordinary correspondence columns, such would, at a distance of 100 yards, be a sufficiently severe test for any ordinary aperture. The *readability* of such small type at the above distance is of itself a good recommendation; but if, in addition to this, the letters are not grey, but *black*, it proves beyond all question that there can be no false light, consequently no aberration, and therefore all the rays unite in one precise focus. I certainly incline to the opinion that very small letterpress constitutes not only one of the readiest, but one of the finest tests for any telescope, while the far greater immunity from atmospheric disturbance which such terrestrial tests possess renders them much more handy than celestial objects for severe scrutiny. I dare say "Optical Bricklayer" will get still better definition with a properly, constructed eyepiece.

W. PURKISS.

FOCAL LENGTH OF CONCAVE LENS.

SIR,—It may perhaps interest "A Fellow of the Royal Astronomical Society," page 251, and his querist "Scorpio," to know that on page 19 of "Smith's Optics," there is given a method of finding the focal length of a concave lens by experiment. It consists in covering the lens with a piece of paper, in which a few pin holes have been made. The focal length may then be discovered by holding the lens in the sun's rays at such a distance before a sheet of paper that the distance of any two holes on the sheet of paper may be double the distance from each other of the two corresponding holes in the paper on the lens. The distance of the lens from the sheet of paper will then be equal to its focal length. The experiment may be somewhat varied by placing a piece of cardboard with a single circular hole in it in contact with the lens and a sheet of paper on which a circle has been drawn of twice the diameter of this hole at such a distance behind it that the diffused circle of light from the lens may just fill the circle. The distance from the lens to the paper is its focal length, as before. If the lens be ground on its edge, it may be sufficient simply to hold it before a sheet of paper on which a circle twice its diameter has been drawn.

HENRY T VIVIAN

A CUMBERLAND MINER'S APPEAL

SIR,—Having witnessed a very serious accident to-day, by which a comrade has lost his eyesight for ever, I seek the assistance of my fellow-subscribers for the means to prevent such accidents.

In blasting iron ore we use a tool called a "pricker," it is of various lengths, ranging from 1ft. to 4ft.; it is made of ⅜in. best nail rod iron (horse shoe), and drawn to a point. The use of this tool is, that during the process of charging it is kept in the hole so that when withdrawn it leaves a space in the "stemming" down to the powder, into which we introduce the straw. The straws we use are corn straws dried and filled with very fine powder. As all our work is by contract, we never use the patent gutta percha fuze, except in very wet places, because we cannot afford it. The danger of the "pricker" is that during the process of pulling down among the powder it ignites, and, of course, the powder is blasted in the man's face. We have made the prickers of copper, but they do not answer, as we flatten them whilst "stemming," and then we cannot withdraw them.

As such accidents are of almost daily occurrence, it would be a blessing to us poor miners could there be something invented to protect us.

A CUMBERLAND MINER.

ELECTRICAL DISCOVERIES.

SIR,—I was not a little surprised, I may even say electrified, to read in the last number of your excellent magazine an account of the so-called "discoveries" in frictional, or high tension electricity, purporting to have been made by Mr. J. N. Hearder, F.C.S., of Plymouth, and exhibited under what he considers to be a new form of instrument, and terms the Electric Fulgurator. Permit me to say that these very discoveries, in all their identity, and in the very means employed in their elucidation, were made by me three-and-twenty years ago, fact for fact, and almost letter for letter, and word for word! These discoveries formed the substance of a paper which I forwarded to the Royal Society in 1847, and which was read before that learned body at Somerset House, in January or February, 1848. The *Literary Gazette*, of that period, gives a report of the paper, and will furnish the exact date. See also *Proceedings of the Royal Society* for 1848. In May, June, and July of the same year I delivered a series of lectures at the Royal Polytechnic Institution, on "The Phenomena of Thunder Storms, and the Cause of Lightning," &c., and I exhibited the powerful effects of my discoveries by producing loud and dense flashes of concentrated lightning through an uninterrupted interval of air three feet in length. I use the word concentrated, as referring to *quantity*, which was here combined with intensity. I employed 12 immense Leyden jars, having a coated surface of upwards of 100 square feet, and rapidly charged to the utmost by the hydro-electric machine of the institution. The flashes were sometimes straight, but generally zigzag, or like a long line of W W's, slightly bent, in the form of an irregular curve from the earth, and they were so powerful that any one of them was capable of destroying life. Each jar was insulated upon a stout varnished glass pillar, 3ft. high, and the series were connected together by a framework of levers, so that when charged, they could be suddenly thrown into striking position, to determine the disruption of the flash. Singularly enough, two-and-twenty years afterwards, this self-same discovery and this self-same arrangement, even to the system of levers and the glass insulators, exactly 3ft. high, are brought forward as novelties by Mr. Hearder. I tried at the time, however, to carry the thing further, and make a far more imposing demonstration than that above named. I proposed to the directors of the institution to produce, by such a combination of jars in their large theatre, a flash of lightning through an uninterrupted interval of 12 or 20ft. of air, which I could easily have accomplished, and without danger, but they were afraid of the occurrence of some fatal accident, and for this reason alone my proposed demonstration was abandoned. In proof of the facts above stated, I refer to the Polytechnic advertisements and notices of the summer of 1848, which may easily be seen by consulting an old file of the *Times*, *Chronicle*, *Post*, *Herald*, *Sun*, &c., &c. I may also appeal to the testimony of numbers who attended my lectures, and I think I may say further, that there is scarcely a living electrician of note, who did not witness my experiments. I feel bound to say in conclusion, that I am convinced Mr. Hearder has acted entirely under a mistake, and was not cognisant of the facts above quoted. I merely speak to settle the question of my original discovery in this important electrical development, and I am truly glad to perceive that Mr. Hearder, whose general electrical experience is well understood, is bringing his researches to bear upon so prolific and so interesting a field of physical investigation.

ISHAM BAGGS.

PITMAN'S PHONOGRAPHY.

SIR,—Will you allow me to inform "Hermit," page 255, that there can be no doubt whatever that Pitman's phonography is the best system of shorthand. It is founded on philosophical principles, and its alphabet may truly be called the alphabet of nature, as it contains a symbol for each simple and distinct sound in our language. Those who write other systems will generally be found to be persons advanced in life, who learned shorthand before Pitman's system was introduced, and I feel sure they would all recommend the latter to a beginner. In comparing phonography with other methods of shorthand, it is sufficient to say that it is easier to learn, easier to write, and, what is almost of greater importance, easier to read. In fact, I may safely say, that phonography is the only kind of shorthand which, when put into actual practice, and written with any degree of speed, can be read with perfect accuracy by any one else besides the writer. It is no uncommon thing for verbatim reports of speeches, taken in phonography, to be sent to the compositor without any further transcribing. I think it needless to occupy one or two columns of our valuable space in dilating on the advantages of shorthand. "Hermit" will find an essay on the subject at the commencement of any treatise on the art, if his common sense has not already suggested them to his mind. Suffice to say, that it is a great mistake to suppose the art is only useful to reporters; persons in every situation of life would find a knowledge of shorthand of the greatest use to them; they would find time and labour saved to a very great extent. Phonography can be written at a speed three times that of ordinary writing with scarcely any muscular fatigue, and the shorthand writer can keep it up for about half an hour without any intermission, whereas a longhand writer, if he writes at the top of his speed, is dead beat in a very much shorter time. With regard to the length of time taken to acquire a knowledge of shorthand, nothing definite can be said. Some people will learn as much in a month as others will in a year. I have had some experience with shorthand classes, and I have found that while, as in everything else, only a few attain to real excellency, yet all are able easily to comprehend the simple and very beautiful principles of phonography, and by a moderate negree of *bona fide* application, to acquire a fair knowledge of the art in less than a year. I have known a person without any previous acquaintance of phonography, write with very great accuracy in six weeks' time. This of course is an exception. It will generally be found that a moderate amount of daily application will enable anyone to write phonography at the same rate of speed at which he writes longhand in, from two to six months' time, varying, of course, according to the ability of the learner, and the amount of time he gives up to it. Further practice increases both the speed and the ease of writing. Expert verbatim reporting can only be acquired by years of constant practice, and if "Hermit" says, "How many years?" I think I might say, that if you are naturally clever, and take a liking to the thing, and work hard at it, you may perhaps be able to follow very closely on the heels of a speaker at the end of two years' time. It is impossible to say how long it would take to be able to follow a very rapid speaker verbatim. My own opinion is there are not half a dozen men in England who can do it.

The spread of phonography has been very much retarded by the constant changes—I ought rather to say improvements—which Mr. Pitman has from time to time had the honesty to introduce into the system, to the detriment of his own pocket and the vexation of old phonographers. I am, however, happy to say, that a great deal of time and labour, has lately been expended in bringing the system as near to perfection as it is possible so to de, and phonography, according to the 13th edition of the "Manual," which will, I believe, shortly be published, is likely to remain, for the future, substantially the same. These changes are of course only on minor points, and do not at all affect the general principles of the art, nor do they in any way deter anyone from making use of the existing edition of the "Manual."

All needful books can be obtained from Mr. Isaac Pitman, Bath, and the *Phonetic Journal*, published weekly, contains a list of persons who correct exercises sent through the post, gratuitously.

W.

SEWING MACHINES.

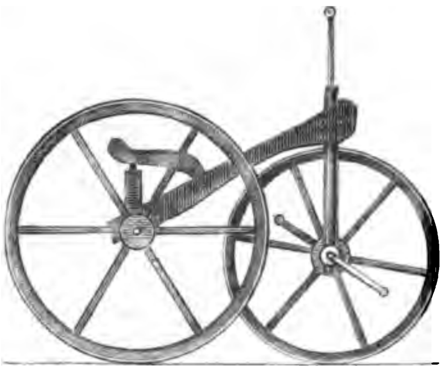
SIR,—If you think the following remarks will be of any use, you may insert them in your next notice of sewing machines.

In your impression of May 6th the cotton is represented, on page 157, as coming off the shuttle from the top, whereas I find from experience it comes off easier and more regular from the bottom. Let anyone who has a machine try for himself. In Fig. 10, on same page (if your instructions are intended for anyone to make one for himself) the spring should be made long enough to catch the brass end of shuttle reel, and it only wants to be just enough of a spring to keep the reel from turning after the tension in making the stitch ceases. I think the method of keeping the reel in shuttle as represented in Fig. 8 is preferable to No. 9 with a hinge at the end, because if the reel is not pressed firmly down, the hinge goes behind the end of the shuttle reel and shuts it out, instead of in. I have found this to be the case two or three times with persons I have sold machines to. I think Howe's shuttle admirable for leather or heavy work, but think those represented on page 157 are quite as good for general purposes. I have had and worked a machine 10 years. My opinion respecting the pause spoken of by "Study," on page 211, is, that it is good, but in my machine the needle bar goes down to the full extent, then comes up a little way (thus making the loop for shuttle to pass through), then goes down again just as the shoulder of shuttle is passing through the loop, and, as it were, eases the thread over the thick part of shuttle, and finally the needle bar comes up, immediately the shuttle is past the needle, to tighten the stitch. Is his the same?

GROCER.

AN IMPROVED TRICYCLE.

SIR,—I have enclosed an elevation of a tricycle, which I have been altering and simplifying for the last twelvemonths until I have reduced it to little more than the three wheels and the smallest possible amount of framing. I can do ten miles an hour on a road composed of the average amount of up and down hill, and more on a level road. There are india-rubber tires (of a good substance) on all the wheels. The front wheel is the driving and steering wheel, and nothing can exceed it for easy and luxurious riding. In designing a tricycle, there are certain points to be observed to insure success; I have found them out by experience, and now offer my brother readers the benefit of them. The first is, to keep the seat well down between the hind wheels, so as to employ the forward thrust of the foot instead of the downward pressure, as is usual. The second is to proportion the distance from the seat to the treadles to the length of the intended rider's leg. The third is, not to put more weight on the driving wheel than is absolutely necessary to keep it to its work; that is to say, to prevent its slipping: and last, but not least, to have good indiarubber tires to all the wheels, but especially to the driver. My front wheel is 30in. in diam., and the trailing wheels 36in.; the reach is composed of two pieces of ash, bolted together at the front, and separated about 6in. at the back with a square mortice through each, through which a piece 2in. square, passes to carry two iron arms for the back wheels; the seat is centered between the two pieces of the reach, and supported on a spring at the back; there are no iron tyres on the wheels, which makes a considerable difference in the weight—it weighs altogether 70lb.



Mr. Shipton, page 253, has a good deal to learn in the matter of velocipedes; he has too many levers about his machine. He will soon find that working his arms and legs (spider fashion) will soon exhaust him.

T. COOKE.

SINGING.

SIR,—As so many in your columns have been afforded opportunities for the consideration of musical instruments, I feel sure of a little corner for a few words from an old author on the cultivation of the voice. Singing is not only the expression, but an aid to the acquirements of the "merry heart," which, as Solomon tells us, "maketh a cheerful countenance," "hath a continual feast," and "doeth good like a medicine."

William Bryde, one of the greatest musicians of the Elizabethan age, in the preface to his collection of "Psalms, Sonnets, and Songs of Sadness and Pietie," published in 1598, gives the following reasons for learning to sing, the amusing quaintness of which is mingled with good sense:—"Reasons briefile set down by th' auctor to persuade every one to learn to sing. 1. It is knowledge easilie taught and quicklie learned, when there is a good master and apt scholar. 2. The exercise of singing is delightful to nature, and good to preserve the health of man. 3. It doth strengthen all the parts of the heart, and doth open the pipes. 4. It is a singular good remedy for a stuttering and stammering in the speech. 5. It is the best means to preserve a perfect pronunciation, and to make a good orator. 6. It is the only way to know where nature hath bestowed the benefit of a good voice, which gift is so rare, that there is not one amongst a thousand that hath it; and in manie, that excellent gift is lost, because they want art to express nature. 7. There is not any musick of instruments whatsoever comparable to that which is made of the voyce of men, where the voyces are good and the same well sorted and ordered. 8. The better the voyce is, the meter it is to honour and serve God therewith, and the voyce of man is chiefly to be employed to that end."

"Since singing is so good a thing.
I wish all men would learn to sing."

G. R. LUFF.

OLD MUSIC.

Sir,—If one of your "Harmonious" correspondents, sitting down to his organ or piano, was asked to play the oldest tune in the world; what tune would it be? Let me suggest that it would have to be a Welsh tune. Why not? The Englishman is often too ready to sneer at Wales and Welsherie. But, there were Welsh bards; they *had* music, harps and all: much of their music has come down to our scoffing age; some of it must be old, and I want to know whether it does not comprise some of the oldest music extant? Take one tune, by no means the most ancient—"Morfa Rhyddlan." It commemorates a battle which occurred in the year A.D. 801; more than a thousand years ago. The air, indeed, is said by the *English* tourist, Bingley, to be "infinitely too artificial for those dark ages; but, does not this viciously beg the whole question, whether those ages were "dark" in the sense of musical skill? Also, the tune, as a plaintive elegy, bewailing, a local slaughter, would not have been likely to be composed except at a time when feelings were fresh. To doubt the date, seems to be mere doubt for doubtings sake, and as gratuitous scepticsm, as when again the *English* Dr. Burney doubts whether the Welsh could have invented counterpoint; and yet counterpoint is found in full force in the Welsh manuscript Berorìœth. Let me select as what I conceive to be the oldest of the old Welsh tunes, the beautiful and really 'sacred' air "Nos Galen." It has strange antique grace, and a fine flow of melody; and it is alluded to by one of the greatest and most indubitable of the bards. This bard was Aneurin; he flourished A.D. 570; his poem "The Gododin" has come down to us in a perfect state; it is highly epic in its tone, and is unmistakeably primitive in its grandeur; if it belonged to any other country but the Wales which the Prince of Wales never goes near, all our English glossographers and antiquity-mongers would rave about it. This Gododin poem of Aneurin has been ably edited, word for word, and translated by Williams. At line 884, are the granitic old Welsh words, "Cann calan a darmeithei," meaning which he wove into a song for the calends of January. Thus this is a direct recognition of the air Nos Galen—*Nos* is night, and *Galen* or *calan* is calends; Nos Galen is Christmastide; and why do not our British churches use this oldest of Christmas carols? I fancy "Rousseau's Dream" is a mere adaptation of it. Will some friend adduce a tune older than this "Nos Galen," which is 1300 years old?

GIMEL.

DRY PLATE PHOTOGRAPHY.

SIR,—Different systems seem to succeed with different manipulators. For my own part, I could make nothing of tannic acid, and little of collodio-albumen, but I succeeded well with Fothergill's process. My method was as follows:—Sensitise as usual; wash in six drachms of distilled water; pour albumen over the plate, and let it run well over the surface backwards and forwards for nearly one minute; wash in three waters, and let the plate stand to dry; develop with pyrogallic. I used Keene's collodion, and never found blisters, or anything of the sort. There was no need of the black varnish, as the film was perfectly secure.

This is a more tronblesome process than "Tannic Acid's" and consequently his is preferable on that account, if the result is as good. Perhaps he will try this, and I will try his, when I can.

M. W. G.

INTERFERENCE RINGS ROUND THE SUN.

SIR,—On page 265 of the present volume, in the last paragraph but one of Mr. Webb's "Hints to Astronomical Students," he says respecting interference rings:—"I have noticed a border round the limb of Venus undoubtedly due to such a cause, and in all probability it would be very conspicuous round the sun were it possible to view him without such a darkening apparatus as must extinguish all such appendages." I think an experiment I have tried will enable him to see the interference rings round the sun very easily, and also possibly lead him to suspect that such an appearance in optical instruments arises, not from the passage of light through space, but from the character of the media we employ. I took a simple pocket lens and placed it in the sun, then stood about a yard off. The lens was about an inch focus. The image of the sun in this position resembles a brilliant star. I then took a narrow slip of card, and with a pin pierced a small hole; then about half an inch from this I made a smaller hole. Then, at the same distance, a third, pricked with either only the point of the pin or with a small needle; a fourth was made still finer. Now, on looking through the first hole, held close to the eye, the interference rings were plainly perceptible, but through the second still more apparent, and the spurious disc of the sun larger; in the third hole the disc appears larger still, and in a very fine hole the disc is larger still, with only two or three interference rings. I tried the experiment also with a hemispherical lens, with rather a better result. It was a very interesting experiment, and the view of the minute image of the sun resembled a very distinct image of a brilliant star as seen through a good telescope. Now, on making the experiment at night with the same instruments, only using a paraffin lamp for the source of light, I found exactly the same effect produced, where, of course, the effect of distance could not be taken into account.

W. C. M.

THE EYE.—INVERTED PICTURES.

SIR,—Our friend and instructor, "F.R.A.S.," page 277, justly answers "The Welsh Shepherd" as to "inverted images." When the top and the bottom of the *mind* is determined we shall find that the position of the picture upon the retina will affect our judgments as to the real position of visible objects. The "W.S." appears to forget that if the little boy saw everything around him in an inverted position (as "W.S." presumes) that he would see his own drawings in the same manner, and therefore represent them in the same position as a normal eye sees them.

YOUNG IDEA.

EXAMINATION QUESTIONS.

SIR,—In his letter, on page 282, by taking the volume of one gramme of hydrogen as 11·16 litres, instead of using the more accurate value of 11·161, Mr. Davis makes the answer to "Zeta's" query 101·454 litres, instead of the more correct volume of 101·461 litres. This discrepancy between "Zeta's" replies might confuse him, so I have referred to it to explain how the difference arose. In answering such questions as this a certain degree of accuracy is essential, and it is to be regretted it is not always used.

Also with regard to methyl, Mr. Davis has assumed the theoretical specific gravity 1·0365; Frankland and Kolbe's researches, though, indicate a specific gravity considerably higher, approaching that of ethyl hydride—that is to say, about 1·075.

Allow me to draw the attention of "Sigma" to the letters on page 283, signed by Mr. Kernan and "E. J. W." The latter is especially rich, and its author seems to hold a very different idea of the "safety and security" of the South American Republics to that of Her Majesty's Government, or perhaps I should qualify by saying he "believes."

For "acids," line 10, page 282, read "oxide."

URBAN.

THE FLUTE.

SIR,—As flautists are coming to the front in the correspondence pages of our magazine, perhaps I may be allowed a few words. An eminent composer when asked why he wrote so little for the flute in the scores of his operas, replied that he hated flutes—they were never in tune. This has remained a fact in flutes up to a few years back. I have been in the musical profession as a flautist for a number of years. I began with the old Nicholson flute; and however well it may be made, it is a most imperfect instrument. There are always some of the notes a great deal weaker than the others, especially C and E, and the instrument is generally more or less out of tune, defects arising from the holes not being in their proper position. If they were so, the fingers could not reach them. In the flutes (Siccama Patent) sold by Chappel, New Bond-street, it is sought to remedy this by the introduction of a key for the third finger of each hand by making the holes and bore of the instrument larger. They are very good instruments. The flutes sold by Boosey (Pratten's Perfected) are also very good, but neither of them attain to what is wanted—equality of tone and tune. I played some years on the Boehm Flute, and although the change of fingering involves the student in an extra amount of practice, I feel assured that in the end, from increased tone, correct tune, and ease of execution, he will congratulate himself on having adopted the Boehm system. A recent correspondent speaks of the constantly-recurring difficulty in executing rapid passages on this flute. This is directly contrary to my experience. With the old system of fingering it is impossible to execute in a creditable manner many slurring passages in extreme keys; they are simply botched and struggled over. With the Boehm Flute it is about as easy to play on five or six flats as to play on that of C natural. The flute I use at present is Carte's patent, combining Boehm's fingering with Carte's fingering and improvements. For volume and quality of tone and facility of fingering, I believe they are unequalled. And for the great desideratum in flutes—that of being well in tune—I can almost say, using the words literally, they are perfect. The only objection I have to them is their price—to the profession £22. Before purchasing this instrument I was induced to read Clinton's essay on his flute, and naturally thought great things of his instrument. I made inquiry of some flautists who have held good positions in London. I was told his flute was gradually being abandoned, and that the Carte-Boehm is adopted by the principal players in the profession; personally I know nothing of it.

ORION.

TURNING HORSES OUT TO GRASS.—"C. E. S." in a letter says:—"When horses have suffered in their work from anything of the nature of strain of the sinews or their ligaments, or when their legs are very much the worse for wear, they should be allowed no exercise but such as they can get in a loose box; they should be treated as a man would be who had sprained his ankle and must be confined to his sofa. On the other hand, I have seen horses which were pretty good on their legs, but stale, groggy, and tucked up from hard work and dry and exciting food, improve as if by magic when turned out to grass on the following plan. I have housed them during the day time in a well-ventilated building, darkened so as to exclude the sun and flies, giving them about half a peck of corn daily, with bran and clover chaff; they have then been turned out at night in a pasture in which there was an abundance of grass. Under these circumstances they are never tormented by flies, when they are out all is cool and quiet, the long grass saturated with dew supplies an admirable, cool, refrigerating poultice to their legs and feet, and the grass they get, combined with their daily feed of corn, seems to plump up their bodies without much interfering with their condition for work. I have taken up horses treated in this way as late as September, and had them in a very fair order for work by the commencement of the hunting season."

USES OF VINE LEAVES.—A correspondent of the "Philosophical Magazine" states that from experiments which he has made he finds that, on being dried, which should be done in the shade, and infused in a tea-pot, the leaves of the vine make an excellent substitute for tea. He has also found that, on being cut small, bruised, and put into a vat or mashing tub, and boiling water poured on them in the same way as done with malt, the prunings of the vine produce liquor of a fine vinous quality, which, on being fermented, makes a very fine beverage, either strong or weak, as you please; and, on being distilled, produces an excellent spirit, of the nature of brandy. In the course of his experiments he found that the fermented liquor from the prunings, particularly the tendrils, when allowed to pass the vinous, and to run into the acetous fermentation, makes uncommonly fine vinegar

EXTRACTS FROM CORRESPONDENCE.

REV. E. KERNAN'S "SERIOUS ERRORS."—"Inertia" writes:—"On page 257, of our journal, Mr. O'Connor has attempted to correct *serious errors* in the very useful and instructive papers written by Mr. Kernan, occasionally given by you, and doubtless read by the majority of your readers with great pleasure and satisfaction; for my own part, they recall old lessons and laws (sometimes nearly lost in a practical life) with a freshness and simplicity so readable, that few of us will finish the chapters without some benefit, even if it but refreshes the memory of rudiments too often forgotten. Surely the presumption so visible in one that has yet to learn the correct meaning of inertia and momentum, will meet with the remarks from your better informed correspondents they deserve. Allow me to observe, Sir, that this one incorrect "correction,' forms the "few errors" so ostensibly displayed by your correspondent. With regard to the classification, if Mr. O'Connor will read the former paragraphs in connection with the one he has quoted, I think most of your readers will form their own conclusions as to the one which is so 'much superior' to the other."

EMIGRATION.—R. Smith writes:—"I am very glad to see the emigration question in your pages, and I cannot but think, an amount of useful information will be obtained by its ventilation. I have travelled in the United States, and will answer with pleasure any inquiry from brother readers. I think there is great hope for "Railway Clerk" in the Western States, where he could tickle the earth with greater advantages to himself and family, than ledger tickling in railway depots in England.

THE BICYCLE.—J. Hare writes:—"A correspondent of yours, who signs himself N. G. Lamborne, and who states he has been a velocipedist more than twenty years, states, 'The bicycle is only fit for those who are fond of dangerous sports.' Now I think this rather too hard on us poor bicyclists, and beg to inform him, that I, a mere amateur, have performed several journeys on both business and pleasure, on this 'dangerous' (?) machine, carrying a considerable weight of luggage on my last journey, and did it all without a scratch. I think the bicycle, made as light as possible, consistent with the required strength, with a few minor improvements, and a pair of the india-rubber tired 'Phantom' wheels, will be the machine of the future. Yet I, along with many of your correspondents, should like to see the merits of the different machines ably discussed in your journal. I must, however say, that I have not tried these celebrated wheels, mine being a machine with a pair of first-class ash wheels, but if they have half the advantages which the advertisement states, they must be indeed a great desideratum to admirers of the bicycle."

COMMERCE AND TRADE.—"A. W. J." writes:—"Your correspondent, 'F. W. M.,' seems to have got into quite a mist; he has been firing wide of the mark, he is discussing a point that 'Herbert' never raised. I consider 'Herbert's' argument is conclusive. 'Herbert' says, 'If I freight a ship with a cargo which costs me £18,000, and she brings me back a cargo in lieu of it, of the value of £29,000, I think my trade would be very prosperous,' &c. Let 'F. W. M.' read this again and then his own mystified reply. Again, let 'F. W. M.' send a cargo, worth £10,000, and in return receive only £9,000; methinks he would soon have to retire on a beggarly nothing. His argument as regards paying workmen's wages, is very childish. I should judge from his note, he is not a business man, nor either that he is acquainted with the laws of trade."

A PRACTICAL METHOD OF DETERMINING THE FOCAL LENGTH OF A CONCAVE LENS.—"S. T. Preston," writes:—"Place the lens in the sun's rays, so that the luminous circle, formed on the screen is equal to twice the aperture of the lens; then the distance from the screen is the focal length required. Or combining with the lens, a convex lens of short focal length, whose focal distance is known, then observe the focal length of the combination, and calling F the focal length of the lenses combined, and f' that of the convex lens, the required focus may be simply got by the formula,

$$\text{Required focus} = -\frac{F f'}{f' - F}\text{"}$$

NUMISMATICS.—Samuel Smith writes:—"I trust that Mr. Henfrey will accept my thanks for his reply to my query about the two coins, as also 'Collector,' who has quite destroyed my belief in the Immanuel de Rohan being a token. I am obliged to him for doing so. I am interested in Mr. Henfrey's articles on ancient coins. I hope, when he comes to treat on the gold coins of England, he will drive away some of the mist that hangs over them, and explain how a noble, which nearly equals our sovereign in weight, and exceeds it in beef buying capabilities twenty times, should be called 6s. 8d. It was valued at 80 pennies, but the penny was a very different coin from our present coin of that name. I fancy an article on that subject would interest a good many readers."

BOILER INSPECTION.—John Swift writes:—"Might I be allowed to draw your attention, and that of your very numerous readers in the engineering world to the fact of a select committee of the House of Commons now sitting to inquire into the causes of boiler explosions, also to remark as to the *personnel* of said committee, that nine out of the fifteen gentlemen are all Lancashire manufacturers, and I think two others also engaged in trade. That there are no 'working men's members' on the committee, but that there are two members for Bolton and no member for Birmingham. The county of Staffordshire, I think, is distinguished for boiler explosions, but Mr. McLean's name is not on the committee."

VELOCIPEDES.—S. James says:—"In reply to 'Isle of Ely,' the oscillating treadle bars of the back-wheel bicycles are 10in. apart only, and the chains never rub the wheel in ordinary turnings. When they do it makes no difference. I think he does not understand the treading motion. It is not an uncommon one, but the same as that in the 'Macclesfield,' 'Edinburgh,' 'English,' and all the improved tricycles."

REPLIES TO QUERIES.

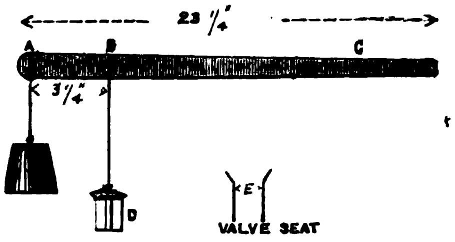
LITHARGE AND GLYCERINE CEMENT.—I am sorry to say that in my hands this has proved a total failure. A very valuable cement, which I have used for many years, and which is especially serviceable where cavities have to be filled, is made by mixing equal parts of litharge and white lead with a sufficient quantity of copal oil varnish. Of course it should be only made as wanted.—T. W. WEBB.

[3734.]—THE GOAT AND THE GRASS PLOT.—In answer to Captain Baxter's query, I beg to inform him that the length of tether required would be 23¼ft.—G. A. S.

[3490.]—THREE-WHEELED VELOCE.—Should key on one wheel on the hind axle, and leave the other to run loose: it turns corners, drives as well as with ratchets, and is economical. I have made one.—J. H.

[3773.]—¼-PLATE PHOTO CAMERA.—I beg to inform "Mus." it is a camera for the studio that I wish to construct first, but hope he will at some future time give sketch and description of a portable one, as I have no doubt many other readers of the ENGLISH MECHANIC would be benefited thereby.—SNATCH BLOCK.

[3779.]—BOILER AND SAFETY VALVES.—I beg to answer this very important question more fully, for the benefit of amateurs and others requiring to know the pressure on safety valves, or weight on lever to equal a given pressure of steam on valves. First find the weight of valve D, spindle, and lever, and add to it the weight of counterpoise weight required to bring the lever to a level in lbs. and ozs. Then find the pressure you want on valve, or by knowing the pressure you want on the square inch; multiply this pressure by the number of square inches of valve surface, or rather outlet, as at E, and the product is the pressure on valve; then from the pressure on valve found subtract the weight of valve, spindle, lever, and counterpoise weight, and multiply this product by the length in inches from A to B, and divide by the length in inches you want the weight to be towards C, and the product is the number of lbs. weight to be hung on the fixed point at C. Example: Say lever 23¼in. long, and valve, spindle, lever, and counterpoise weight weighs 14lb. 10oz., valve 3" diameter, and 60lb. pressure per square inch, 7·0686 × 60 = 424·1160 − 14·625 = 419·4910 × 3·25 = 1363·346750 ÷ 23·25 = 58·64lb. weight required at C, 23¼in. from A. Multiply the square of the diameter of valve by ·7854, and the product is the area of surface 3" × 3" = 9 × ·7854 = 7·0686 square inches in 3in. diameter. Divide the number of ozs. by 16, the ozs. per lb, and the product is the decimal value of the ozs., 10·000 ÷ 16 = ·625 = 10oz.—J. HOVELL.



[3803.]—CHANGING THE COLOUR OF PRIMROSES.—If "J. D. M." wishes to permanently improve his primroses, and to obtain a good race of his own ennobling, I would recommend him to cross-breed them with dark coloured polyanthus, and to save and sow the seeds. The result will most likely be seedlings of various colours; he can save those he likes best, and if he chooses repeat the process of cross-breeding them at pleasure, till he obtains a race which will amply repay him for the slight attention required. I think he will find this a much safer and more interesting method than using chemicals. If "J. D. M." is not familiar with hybridising, and would like to have a few hints, I will (with our Editor's permission) endeavour to give him a few. If he merely wishes to improve those he already has, high cultivation may perhaps do this.—S. ROGERS.

[3839.]—TRACING CLOTH.—Get a 6d. pot of ox-gall, and mix a little both with ink and colours; if ink won't, then take on the cloth, increase the quantity of ox-gall. Rowney's is the best manufactured. As regards colouring tracings, you should always colour on back, as the ink lines are liable to being obliterated on applying the colour. For your walls use lake or carmine; wood, burnt sienna; slates, prussian blue, or indigo and lake. Mix your colours very dark, so as they may appear of proper strength on opposite side.—DRAUGHTSMAN.

[3856.]—SPEED, &c., OF TRICYCLES.—I believe the average rate on tricycles *driving by levers* is about 7 to 10 miles an hour (and, indeed, this is the average rate of most velocipedes). Some of the inventors assert that they are easier than bicycles, but I do not consider they are so in practice, except it be that the seat is easier. The one spoken of by Andrew Johnson would do well for two riders; but for one a tricycle is a miserable affair unless it drives by levers. The cost ought to be about £8 (I can make good ones at that). The driving wheel ought not to be more than 38", and the cranks 6".—S. JAMES.

[3861.]—SIZE OF NOZZLES.—The rule is 3-16ths internally, 5-16ths for water; and for steam it is ⅜, and internally ¼.—J. HARDMAN.

[3869.]—WEIGHT OF WATER.—The bucket will apparently increase in weight as it approaches the top; this is owing to the decrease of leverage by the roller becoming thicker with the rope coiling round it; and not to any difference in the weight of the bucket from difference of distance from the centre of the earth. Mode of calculation. Let a = diameter of roller; b = thickness of roping wound on; w = weight of water at bottom of the well; and wt weight of water at top of the well. Then as $a : (a + 2b) :: w : wt$.—B.

[3869.]—WEIGHT OF WATER.—"Countryman" complains of his bucket of water being so much heavier at the bottom of the well than at the top. He wants an explanation of this, and a simple rule to work it out. The real truth of the matter is that his bucket of water is actually of less weight at the bottom of his well of 90ft. than at the top. Seeing he has gone so far into the earth, the gravity will be a trifle less. The increased weight can only be the rope or chain that he winds up with, and if he knows what a foot of that weighs he can calculate for himself; but as he finds it hard work to wind up the water while the bucket is at the bottom of the well, he should have his roller that he winds up on tapering, and so commence winding at the small end of his roller. He will find this plan a great relief.—H. P.

[3882.]—DOUBLE MOTIVE POWER.—Consult a properly qualified engineer and millwright on the subject. These two motive powers cannot overrun one another if properly governed by governors. If there is not one on the wheel, take all the water, and the engine will govern the difference, unless the quantity of steam power required is very little; connect both powers by a clutch coupling or wheel, that the one can work either with or without the other. When the pinion on shaft is made moveable, it should be keyed on swell with sunk key, and when not required taken off swell and hung clear of shaft.—J. H.

[3911.]—GALVANIC CELL.—The cell described by "Hermit" is called a Bunsen's cell. Nitric acid HNO_3 is poured into the porous cylinder containing the carbon, and dilute sulphuric acid H_2SO_4 into the glass vessel containing the zinc, say about 1 part of H_2SO_4, to 10 of water, H_2O. This cell is one of the most powerful, and is also pretty constant. There is one objection to it, however, and that is, it gives off red noxious fumes during action. These fumes consist of some of the lower oxides of nitrogen. Where strength and constancy are required it is very useful, but where constancy without strength is required, I say use a Daniells. I use for electrolysis a battery composed of 4 or 6 Bunsen cells, and this battery answers very well. The following may represent chemically what takes place in a Bunsen cell. Let (N_2O_5) represent an hydrous nitric acid, which may be written to illustrate the action as (N_2O_4O)—*i.e.*, the nitrogen tetroxide (N_2O_4) and oxygen (O):—

1. Before chemical action.

$$C, + \overline{N_2O_4,O} + \overline{N_2O_4,O} \mid \overline{H_2, SO_4} + \overline{H_2,SO_4} + Zn\,;$$

2. After chemical action.

$$C,N_2O_4 + ON_2O_4 + O\,H_2 + SO_4, H_2 + SO_4, Zn.$$

Now the N_2O_4 does not combine with the carbon (C), but comes off as red fumes. The compound radical (SO_4) combines with the zinc and forms sulphate of zinc ($ZnSO_4$), while the sulphuric acid is made more dilute by the formation of OH_2, water.—J. Harrison, Bradford.

[3911.]—GALVANIC CELL.—I beg to inform "Hermit" that his cell is a Bunsen's; the cylinder is made of very dense charcoal. The liquids used are, dilute sulphuric acid round the zinc cylinder, and nitric acid round the charcoal. The system is as energetic as Grove's, but does not last so long.—A. Boughey.

[3940.]—THREE WHEELED VELOCE.—The best way is to have one hind wheel *loose* on the axle, and the other one *fixed* on it, for turning.—S. James.

[3943.]—BEES.—"S. W." need not be afraid to hive the first swarm he may have in the hive or box of old comb he has, only taking care before hiving the swarm to well sprinkle the layer of comb with sugar and beer, or honey and beer, about ½pt. To show that bees are not very particular about taking to furnished apartments, I will mention a case which occurred among my own bees about 3 weeks since. One of my stocks died about the middle of February; I ascertained they were quite dead, and that the hive (one of the old straw ones) was full of comb, and then placed it in its former position between the 1st and 3rd hives in the row. About the 15th of May a swarm from No. 3, after manœuvring about the front of the hives for a short time, quietly took possession of the empty hive. The next morning I found in front of the hive nearly a pint of dead bees and rubbish These industrious little workers had removed in the night. they have gone on well, and I shall immediately put on them a super hive or cell glass. I shall be glad to know if any of my brother bee-keepers have tried the use of chloroform in taking honey from the old straw hives. I have done so, and found it answered very well, only it is a good bit of trouble, which perhaps was on account of the primitive implements I used, being just what came to hand. The old method of destroying bees to procure their honey seems very cruel. I shall be pleased to hear from some of our more practical and extensive bee-keepers.—An Oxfordshire Farmer.

[3944.]—ARITHMETICAL QUESTION.—Every circle may be conceived to be a polygon of an infinite number of sides, and the semi-diameter must be equal to the perperpendicular of such a polygon, and the circumference of the circle equal to the perimeter of the polygon. Describe any polygon on paper, and cut out each side and place them together, and they will form a parallelogram whose length is equal to half the number of sides, and breadth equal to the perpendicular or semi-diameter.—J. Sharpe.

[3956.]—CHEMICAL.—TO "R. TERSET."—The following is after Frankland's notation. Question 1. A litre of methyl gas $\left\{\begin{matrix}CH_3\\CH_3\end{matrix}\right.$ (molecular weight 30, and density 15), at 20°C. and 760mm., will be ·0896 × 15 × $\dfrac{273}{273 + 20}$ = 1·252grms.

Question 2. Prepare a solution of NaHo by means of CO_2 Nao_2 OH_2, and CaO. Now mix the C_2H_5I with sufficient of the NaHo, and distil over a water bath, when ethylic alcohol will come over and sodic iodide remain. C_2H_5I + NaHo = $\left\{\begin{matrix}CH_3\\CH_2\end{matrix}\right.Ho$ + NaI. This alcohol may now be mixed with the CrO_2Ko_2 and the SO_2Ho_2, when it will be oxidised at the expense of the chromic acids, and acetic acid formed. The following will express these reactions:—

$$CrO_2Ko_2 + SO_2\,Ho_2 = SO_2\,Ko_2 + CrO_2\,Ho_2$$
$$CrO_2\,Ho_2 = O_2 + CrHo_2$$
$$\left\{\begin{matrix}CH_3\\CH_2Ho\end{matrix}\right. + O_2 = \left\{\begin{matrix}CH_3\\CO\end{matrix}\right.Ho + OH_2.$$

Night School Boy.

[3964.]—CAST IRON FOR TURNING, &c.—In answer to part of "Faber's" query about moulding composition, I beg to state that gutta percha, applied with considerable pressure, is far better than wax; and Gore, in "Electro-Deposition," recommends ¼ part of marine glue to be added to the gutta percha by melting them together.—*θηρα.*

[3966.]—TABLES WITHOUT DECIMALS.—You should at once learn decimals, and know the fractional value of money, weights, measures, or any other material.—J. H.

[3967.]—GALVANOMETER NEEDLES.—It is generally admitted that whether the needle of a galvanometer be highly or feebly magnetised, the deflections will be *equal.* The earth's attraction for each needle being in the *same ratio* as that of the coil (made a temporary magnet by the current); of course the needles must be equal in every way as to dimensions and weight.—Excelsior.

[3970.]—STEAMING FOOD FOR COWS.—"R. R" will find an iron tank much the best; also I should advise him to do 50bush. at twice (if that is the amount he uses at one feed), as the utensils for 50bush. would be very clumsy. I have by me a drawing of complete apparatus, but cannot just now find it—will send it next week if I can; meanwhile any engineer will give "R. R." information on the subject if he wants it immediately.—An Oxfordshire Farmer.

[3972.]—IRON STAINS.—Dissolve a little oxalic acid in water and apply to the stains; after a few minutes rinse in clean water.—H. E. Godfrey.

[3972.]—IRON STAINS.—"J. H. P." may remove iron stains by dissolving oxalic acid in hot water in the proportion of a teaspoonful of the crystals to a teacupful of water; the parts melted with the acid must afterwards be carefully rinsed through clear hot water. This method is only suitable for white materials.—Salopian.

[3977.]—BRAZILIAN RAILWAYS.—"H. Z. Y."—There is not, that I am aware of, any line of railway in the city of Bahia, the nearest terminus being Jequitia, some 2 miles from the city. There are 2 tramways from Bomfine to Custom House (lower city), Plaza, to the Barra (upper city); total distance about 6 miles. The Bahia and San Francisco Railway, some 69 miles long, commences at a pillar and ends at a post. The only other railway in the same province is the Paraguassú Tramroad from Cachocira, some 45 miles from the city. This line is in course of construction, to be carried out to the Chapada or diamond district, some 65 leagues in the interior.—J. G.

[3987.]—OIL TESTER.—Wm. Johns, Messrs. J. Bailey and Co., of Albion Works, Salford, make a good machine. Price complete, £9 10s.—J. G.

[4000.]—SODA WATER.—Render a neutral or alkaline solution acid with acetic acid, then add acetate of potash, and a little spirit of wine; stir for some time. A white precipitate indicates tartaric acid—no precipitate, citric acid.—H. E. Godfrey.

[4019.]—SAFETY VALVE.—Had "O. G." known that our kind correspondent, "T. J. O'C." would have given such detailed and explicit examples on the lever safety valve, I have no doubt he would have paused before sending his query for insertion; but as he appeals to me personally, I will give him the rule I use for finding the size, length of lever, &c. The orifice through the safety valve is generally about 8-10ths of a circular in. per horse-power, or a circular inch to 1¼ horse power; or the surface of the boiler exposed to the action of the fire in feet, multipled by ·305, and the square root of the product will be the diameter of the valve in inches at the smallest part for 20lb. pressure to square inch; but as "O. G.'s" boiler is so small, I fear the proportion would be too small to be practicable, as it may be liable to stick, or the lever may be a little tight, or many other things that would have a great effect on so small a valve; so it would be better for him to keep the safe side, and have it a little larger—say 3-16ths or ½in. in diameter; the fulcrum or centre of motion about the same distance from the centre of valve as the valve's diameter; lever about 2½in. or 3in. long. If "O. G." decides on the lengths and diameter, he only requires a rule to find the weight. Rule:—From the required pressure per square inch in lbs., subtract the weight of valve and effective weight of lever, multiply the remainder by the distance in inches from centre of motion to valve; divide this product by the distance in inches between the centre of motion and the weight; the quotient is the weight in lbs. required on the lever.—Jonah.

[4021.]—COINS.—The first coin of "Veloce" is a common sixpence of Queen Anne of 1711, belonging to her second issue, after the union of England and Scotland. It is not worth more than 1s., unless very fine. The obverse bears the bust of the queen to the left, ANNA DEI GRATIA (Anne, by the grace of God) Reverse: 4 shields of arms arranged in the form of a cross, and each crowned. The star of the Order of the Garter in the centre, and the date, 1711, above. MAG. BRI. FR. ET. HIB. REG. (Queen of Great Britain, France, and Ireland). See my "Guide to English Coins," part ii., p. 119. The second coin is a Hamburg piece of Charles VI., Emperor of Germany from 1711 to 1740.—Henry W. Henfrey, M.N.S., &c.

[4021.]—COINS.—In answer to "Veloce," the 2nd coin to which he refers is a 4s. piece of Hamburgh; it is base silver; the one now lying before me of the same year has a double-headed *eagle*, as I think they all have, and not a *griffin*, as he supposes. The other I don't know.—J. G. Symmonds.

[4024.]—GALVANISING CAST IRON.—The first thing in the process is to remove all rust or scale from the iron by immering it in dilute sulphuric acid; after the iron has been in the acid for a few minutes plunge it into cold water. The iron being now ready to receive its coating of zinc, put it in a bath containing zinc, which, previous to its being melted, is covered with a layer of dry sal-ammoniac (hydrochlorate of ammonia); this melts also, and forms a viscid coating, which prevents the rapid oxidation to which molten metal is liable. The bath is constructed of fire-clay. The iron is simply dipped into the zinc, or made to pass through it, and when pulled out it is effectually coated.—Cuthbert.

POISONOUS TEA.—The trade in the lowest class of adulterated tea still continues, and this month Dr. Muter reports that there have been no less than 80 chests exposed for sale, of which he procured samples. This so-called tea consisted of a variety of rubbish, and is being sold for 2½d. per lb. It yielded an ash amounting to 22·86 per cent., consisting chiefly of iron filings, and under the microscope presented the structures of many foreign vegetable matters. But the worst sample which came under his notice was a green tea from India, highly faced, and yielding an ash containing a quantity of copper. This is really a sad thing, because it has previously been a noteworthy fact that our Indian planters refrained from such practices, and that tea from our own possessions could be depended on. We trust, however, that this prompt discovery and exposure of what we think is the first case, may discourage the unprincipled persons who are thus disgracing the commercial honour of our Indian planters. The colour seemed to have been produced by roasting in contact with copper, probably in copper pans.—*Food Journal.*

NOTES AND QUERIES.

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OUTDOOR SCIENTIFIC PURSUITS.

As the time is come for outdoor exercises, amusements, and scientific pursuits, we should be glad to receive from our numerous correspondents contributions on matters more particularly appertaining to the season, including information for scientific tourists, microscopists, geological and botanical inquirers, lovers of natural history, &c. We should also like to place on record practical suggestions on boating, fishing, moth gathering, and a dozen other cognate subjects. The seashore, always attractive, now teems with interest to the observing eye and reflective mind. In fact, we should be glad to receive from any quarter any fragment of information which would be read with interest during the summer and autumn seasons.

[4025.]—HORSE POWER.—How can I prove correctly the horse power of an engine?—Novice.

[4026.]—BOILER PRESSURE.—From what point in the pressure of steam in the boiler does the high pressure commence?—Novice.

[4027.]—MEDICAL COIL.—Having made a coil according to "Sigma's" directions, would that gentleman, or any brother reader, be so kind as to inform me where I can get the pillars for the electro magnet contact breaker and pillar, with a ring to allow the spring to pass through one to hold the screw, and the pillar to hold the end of the spring and studs, and pivot described by "Sigma," as I have written to five or six different places and cannot get them?—A Coal Miner.

[4028.]—FLOORING.—As a boy I lived in Nottinghamshire, and have a vivid recollection of the floors being smooth and polished like marble. I have since been informed that they are made of unburnt gypsum ground fine and beaten, mixed with a little water, until quite hard. Can any of your readers who reside in the parts of Derbyshire or Nottinghamshire where gypsum abounds, give me any information as to the *modus operandi*, and from whence the best gypsum for the purpose can be obtained?—Arched Floor.

[4029.]—FIXING COLOURS IN COTTON MATERIAL.—Can anyone inform me how to fix the colour in a black and blue print, also in mauve and green?—Goss.

[4030.]—LEAD INSCRIPTIONS ON STONE.—Can any correspondent kindly inform me what is the new process of letting inscriptions, &c., in lead into stone? The lead, I believe, is melted by some chemical process, and run in cold, so as to avoid shrinking. The advantages of this method are so obvious that I shall be greatly obliged if anyone can tell me how it is done?—J. B. Fowler.

[4031.]—LEATHER CUTTING.—I cut through the soles of boots with a steel die and a screw press, screw 3in. in diameter, and 4 threads in inch. I find it too hard to drive. I should like to know the strength of a long lever with pinion working into a toothed rack, the rack to press through the die. Can any of your correspondents inform me if this is better than the screw press?—J. C.

[4032.]—GRIP CHUCK.—Would "J. K. P." kindly inform me what sized lathe his grip chuck, described on Oct. 22 last, was made for. Is the length (4in) too much for a 4½in. centre lathe?—J. D. L.

[4033.]—SLIDE REST.—Would "W. H. N." the author of the working drawings for slide rest in your number of the 3rd inst., kindly describe the method of constructing the tangent wheel of a spherical slide rest?—J. D. L.

[4034.]—BOAT STEERING.—I have a 25ft. whaleboat, and find the rudder-head for yoke-lines gives too little power when under sail in a stiff breeze. The distance between the lines is 14in., the thickness of rudder 1in. Can any fellow-reader tell me in what proportion I shall increase the power of steerage by making the distance between the yokelines 24in., assuming part of rudder under water to be 15in. by 14in.?—Excelsior.

[4035.]—ORGANS.—I am acquainted with an organ, the keys of which at the right hand sink down, thereby losing their leverage more or less; the pipes do not speak when they are thus down; the sinking occurs at this season of the year, and the keys right themselves at the approach of winter. Could any brother subscriber tell me the reason, and suggest a remedy? The organ has been built about 12 years.—J. N.

[4036.]—BOTANICAL—CHEMICAL.—Chemicals are applied to the roots of a plant, and effect a change in the colour of its bloom. Now, are seedlings raised from a plant so changed likely to retain the colour so acquired, or to go back to their natural colour? I am inclined to think the latter, and should be glad of the opinion of some of our botanical readers?—S. Rogers.

[4037.]—RULE FOR FINDING SIZES OF WHEELS.—Will "J. K. P.", or some other reader let me know how the relative sizes of wheels are found; for instance, I have a wheel 3in. diameter, with 120 teeth, what size ought one to be to gear with it with 80 teeth? What is the rule used by practical men for the purpose?—R. T.

[4038.]—CONDENSER FOR MEDICAL COIL.—Will "Sigma" say whether a condenser would add to the power of the medical coil described by him, and if so, how would he connect it?—R. T.

[4039.]—BAROMETER TUBES.—Will any reader inform me how to fill my barometer tubes, so as to avoid the air getting in? I have tried, but failed.—Stultus.

[4040.]—WHEEL GEARING.—I have a pair of bevel wheels, the larger of which runs loose on the shaft, and is connected by a clutch. I wish occasionally to vary the speed, and could do it at these wheels by slipping a collar and the bevel wheel back, and putting a larger pinion on. I have, however, been informed that a larger pinion, though having the same bevel at the pitch line, would not run well. Will some of your correspondents give an opinion, especially anyone who has tried it, and oblige.—Kirkby.

[4041.]—BICYCLE QUERIES.—How can I alter a benzolene lantern so as to make it suitable for a bicycle? I have taken the sponge out and tried to burn colza oil; but the light dies out after riding for a few minutes. Is oil or candle used for these lamps? What part of the foot is the best to drive the bicycle from for speed and ease?—Lerk.

[4042.]—MAGNET.—Will some brother reader kindly let me know what size wire would be the most suitable for a horseshoe magnet 3in. long, and composed of iron ½in. diam.;

and also how many layers would be sufficient on each pole?—T. J. O'C.

[4043.]—CORNISH VALVES.—Will some one kindly explain to me the construction of the Cornish or equilibrium valves used in large pumping engines?—F. P.

[4044.]—AIR GUN.—Can anyone inform me the price of a good air gun complete, and if it is capable of killing at 50 or 60 yards wild pigeons? Any other particulars would be very acceptable.—SPORTSMAN.

[4045.]—SPECTACLES.—I should be glad of any information on the choice of spectacles; I am shortsighted, and to see things clearly am obliged to hold them within 8in. of my eyes; a pair of spectacles I have bought afford relief, but with these objections:—After wearing them an hour my eyes become hot and weary; objects appear about ¾ their real size. I cannot recognise people beyond three yards, and not fitting well, they continually fall below the level of the eyes. I may mention that the frames are insufficiently wide to allow the centres of the lenses and eyes to coincide. Is there any advantage in having plano-concave lenses instead of double concave?—J. R. W.

[4046.]—HARMONICON.—I have a three-octave harmonium tuned in the key of G I intend to place the semitones to it; how shall I then tune the instrument, so as to play in any key?—J. R. W.

[4047.]—MUSICAL TERMS.—What is the meaning of "dulciana 8ft.," written on the stop-rod of an organ, there being no pipes of that length in it?—J. R. W.

[4048.]—ROMAN NUMERALS.—How did the Romans perform arithmetical operations with their Z's, Y's, X's, &c.?—J. R. W.

[4049.]—POLISHING COPPER.—Will one of our silversmith subscribers—or any other thoroughly acquainted with the subject—inform me of anything better than rouge for getting a polished surface on copper free from scratches?—H. P.

[4050.]—IRON MOULDING BOXES.—Would any brother reader furnish a sketch of what in Lancashire we call a small workbox, say 24in. long and 12in. broad, 3in. depth each part, and the best means of putting them together in the pins and snugs?—F. R.

[4051.]—TO "F. R. A. S."—May I inquire of your talented and courteous correspondent "A Fellow of the Royal Astronomical Society" whether he could oblige me with any mesures of Xi Ursæ Majoris, subsequent to those of 1866? The measures for that year (in "Webb") give 2″·2 as the distance separating the components, but from the difficulty I have experienced in divorcing them this year, I fancy they must have closed up somewhat since the last measurements. If I may trouble "F.R.A.S." further, (and if I am "in order" in repeating the query of a former correspondent) I should like to ask your obliging correspondent to describe the "bar micrometer." This form of micrometer seems to be the only one obtainable at anything like a moderate price.—ALBERT P. HOLDEN.

[4052.]—ENLARGING CARTES-DE-VISITE.—Will any brother subscriber favour us with a description of the apparatus and operation used for enlarging cartes-de-visite to life size?—ATHOS, PORTHOS, AND ARAMIS.

[4053.]—DRYING GLUE.—I want to know the best mode for drying glue by a constant current of air passing through a room filled with crates or racks of this material. I have an engine 2 horse-power, and have tried to turn two open fans in the centre of the room, but have so far failed in consequence of power, and I was thinking of trying one of the silent fans, but am at a loss to know the effect that it would produce, and in which way to connect it, and whether the engine would be of sufficient power. The room is about 10yds. long by 5 wide.—J. S.

[4054.]—MICROSCOPIC EXAMINATIONS WITH POLARISED LIGHT.—May I ask some of your readers for information on the means of making microscopic examinations with polarised light? I want to examine products of fermentation, and find the compound microscope not fully satisfactory; but I think the means I allude to—although I have little knowledge and less experience in them—should prove helpful. I want particularly to test the condition of the yeast plant, and to detect acetic acid.—JOHN BARLEYCORN.

[4055.]—ORGAN PIPES.—What is the proper thickness of metal of each octave pipe of open diapason from CCC to C″ in alt; and what variation of metal between a stop that is lightly blown and one that is blown with a heavy wind? Also, what is the difference of dimension in length and diameter of open diapason, principal and fifteenth middle C pipe?—J. P.

[4056.]—ELECTRO-MAGNETISM.—I will thank "Sigma," H. Horstman, or any other of your kind correspondents who is posted up in this matter to inform me, whether an electro-magnet placed with its axis in a line with the diameter of a wheel would be more powerfully attractive of an armature of soft iron fixed on the periphery and just clearing its poles, and causing rotation, than a similar armature moving in the line of the magnet's axis, its greatest distance being, say, ½in.? I hope I may be understood.—F. N. F.

[4057.]—GALVANIC BATTERIES.—Perhaps "Sigma," would be so good as to inform me how many manganese or sulphate of lead cells would be required to do the work of a quart Bunsen cell? I use Bunsen's to drive a small electro-magnetic engine, but the fumes from it are so annoying that I wish to get a battery without this objection, provided there be sufficient strength to do what Bunsen's does. A hint as to any other arrangement more suitable would oblige—F. N. F.

[4058.]—MEDICAL COIL.—Would "Sigma" please to tell me how to make an upright medical galvanic coil, with a water regulator, and how much wire it will take, and the size battery for the same? A sketch will greatly assist.—RATHER DULL.

[4059.]—SOLDERING.—Will any brother reader inform me if there is any soldering preparation that will not cause the article soldered to rust, as I want it for small articles of jewellery made of steel?—R. BOLTON.

[4060.]—VULCANISER.—Will anyone give me an illustration or drawing of a vulcaniser such as used by dentists, as I very much wish to make some articles in vulcanite?—R. BOLTON.

[4061.]—DEGREES.—What examination must I pass to become an A.A.?—BERIRO.

[4062.]—EYEPIECE FOR GREGORIAN TELESCOPE.—TO "F.R.A.S." or MR. W. PURKISS.—I have a Gregorian telescope, and though the definition is good, there is a strangely small field, not larger than the field of the eyepiece itself when detached from the body of the telescope. I have seen by the table of details of Short's Gregorian telescopes, given in "Fergusson's Lectures" that the eyepieces of such make were in the proportion of 1in. focal distance for eye-glass, and 3in. focal distance for field glass, placed at 2in. apart. Now, as the proportions of my eyepiece is not the same as Short's, as stated above, I shall feel obliged if "our F.R.A.S." or Mr. W. Purkiss will inform me whether the arrangement of my eyepiece, being different from Short's, is probably the cause of the contracted field? The eyepiece I have is arranged thus:—eyeglass, 1½in. focal distance; field glass, 6¼in. focal distance, placed 4¾in. apart—the field glass being thus 1¾in. longer focus than the proportion of 1 to 3, as in Short's. The speculum is 4in. diameter and 18in. focus; the small mirror 2¼in. focus, and all works well, with the exception of the very small field. Will either of the above kind friends inform me how to remedy this defect?—NORTHERN LIGHT.

[4063.]—COIL CONSTRUCTION.—TO "SIGMA."—If I am not mistaken I noticed some time ago in the MECHANIC someone very decidedly condemning the winding on of the secondary wire, on the two divisions of a coil having a central disc, the one half the wire one way, and the other, reverse. As I have made several large coils in the manner there condemned, and found them to answer most admirably in every way. I shall feel obliged if "Sigma" will say on what grounds this reverse winding is condemned?—INDUCTORIUM.

[4064.]—TURBINE.—Will any subscriber be kind enough to give detail drawings and all particulars in the ENGLISH MECHANIC how to make a turbine water wheel 1 horse-power, also what diameter of water pipe would be required for a fall of 20ft. of water, and how many gallons per hour it would take to drive it, either from a ledge or from the Water-works Company's tap? If a small turbine could be driven very cheaply by Water Company's water, it would be preferable to a steam engine and boiler.—PATTERN MAKER.

[4065.]—CONNECTION OF PRIME MOVERS AND SETTING OF ECCENTRICS.—Mr. Baskerville, (upon whose reappearance I must congratulate the readers of the ENGLISH MECHANIC) or any other of your correspondents, would greatly favour me, and benefit many others, I have no doubt, if he would give me some information on the following two subjects:—1st. Do two prime movers ever work in connection, such as a steam engine with a water-wheel, and if so, how is the coupling so arranged that one cannot overrun the other? 2nd, What is the practical method of setting the eccentric sheaves upon the crank-shaft so that they shall have the required angular advance of the cranks? As this is nearly allied to the subjects of Mr. Baskerville's last two letters, I hope he will give us his method for doing this, selecting as his example, eccentrics adapted for link-motion.—PAUL PRY.

[4066.]—BREWING.—Can any of your brewing correspondents tell me why I cannot get my ales bright? I have for many years succeeded until now. The bitter ales and stout are beautiful, but the mild ale does not get bright, and does not seem to keep more than a fortnight. Is it that the temperature at which I pitch it (which is 58°) is too low?—BREWER.

[4067.]—MUSICAL BOX.—Can any of your musical correspondents favour me with replies to the following queries? I have a musical box playing 8 airs, but an occasional jarring of the notes takes place, which is very unpleasant to the ear. It occurs to several notes but always at the same spot; neither the instrument repairers nor the watchmakers can do anything with it here. I desire the remedy, or the address of a firm who would put it right; also, what causes the buzzing of the regulator?—SALOPIAN.

[4068.]—PRESERVING FLOWERS.—Will any of your kind subscribers kindly give me a hint as to the best mode of preserving flowers or drying them? I chiefly desire to know how to lay them out before pressing them?—G. O. F.

[4069.]—PARSONS' WHITE BRASS.—Can you or any of your numerous correspondents kindly furnish me with some particulars of Parson's white brass? I should be glad to know if it can be purchased in small quantities, and whether it is a patent article?—S. STEVENS.

[A short description appears elsewhere. It does not, however, include the information S. Stevens asks for.—ED. E.M.]

[4070.]—THE LATHE.—I notice that a correspondent in this week's number of the ENGLISH MECHANIC has asked whether fuller particulars of the Saltaire lathe cannot be obtained through your journal, and I am confident such would be of great interest to very many of your readers. In the whole mass of information relative to lathe work which has appeared from time to time in your columns, there is nothing as to the right dimensions of the different parts of the lathe, and a set of reliable working drawings illustrating a thoroughly good amateur's lathe would be of great service. Surely amongst your host of contributors this could be easily accomplished.—S. STEVENS.

[4071.]—DRAUGHT IN BOILER.—About 4 years ago I fixed a small vertical boiler with engine attached, in the bottom floor or cellar of a house 3 stories high, the smoke was carried into an old flue running into the chimney, when the fire was lit we had a first-rate draught, and got steam up in about 20 minutes. All seemed to go on very well for about two years with cleaning out the tubes once a week, then it gradually lost its draught and had to be cleaned twice a week for some time still getting worse. To keep steam up it had to be cleaned every other day, and so on up to the present time, when it has to be done twice a day to get draught enough to keep steam up, although no more work has been added on, and the flue of the chimney has been repeatedly swept, and many sorts of coal have been used, but the effect is the same. I have thought the incrustation may have some effect on it, as there is about 1-16th in. or a little more incrustation on the tubes which cannot be got off. Since fixing the above I have fixed others in similar positions, and I find the same or nearly the same complaint is coming on them. If any of our correspondents can give me a remedy or the cause (but I prefer the remedy) they will oblige?—JONATH.

[4072.]—HARMONIUM QUERY.—Would "Eleve" in his next communication to the MECHANIC be so kind as to state what are the length and breadth of the reed holes in a harmonium pan at top and bottom of the scale; are they the same as the pallet holes?—VALVE.

[4073.]—TESTS FOR TOBACCO AND NUX VOMICA.—Can any brother subscriber tell me of a chemical test for the presence of tobacco in any liquid; likewise, what is the test for nux vomica; and if there is a book published which gives and explains the different chemical tests, where it is to be got, and what the price would be?—BARBADOS.

[4074.]—REFUSE LIME.—Can any brother subscriber explain to me the following question:—When steam is passed over refuse lime of gas works, the ammonia escapes; in what way is the steam passed over; is it by agitation or not? The refuse lime is charged with ammonia NH_3 and cyanogen NC_2.—BARBADOS.

[4075.]—SOLDERING SOFT METAL.—Will any kind friend inform me of the proportions used for soldering metal teapots? I know bismuth is one of the ingredients, but I am ignorant of the others.—IGNORAMUS.

[4076.]—NATURAL SELECTION.—Will someone kindly explain to me the theory of natural selection?—TRAYLER.

[4077.]—WATER ANALYSIS.—I am much obliged to Mr. G. E. Davis for his answer to my query; but what I more particularly want to know is this:—I use Griffin's solutions, which are prepared for me by Messrs. Griffin and Sons, and I want to know how to make them. I have used a few drops of each of the solutions in a small test tube full of water, and by this means I can detect the presence of any impurity. Now, I want to know what quantity of water I should use, and also what quantity of these solutions I should use, and how am I to estimate the quantity of impurities per cent, or in grains per gallon? I want to find out the total solid matters in solution, amount of organic nitrogen, total organic nitrogen, ammonia, nitrogen as nitrates and nitrites; also the suspended mineral and organic matters?—AQUA.

[4078.]—RAILWAY GUARD'S WATCH.—Will any horologist kindly describe the best and most suitable watch for a railway guard; size of watch and full particulars; diagram of balance-wheel and leaver, and how many holes are necessary to be jewelled; and if a lever chronometer is much better than an ordinary lever for a railway guard?—J. HARRIES.

[4079.]—HARMONIUM.—Will any brother subscriber inform me as to any really good book upon harmonium or organ playing, especially upon the fingering; and say if the value of the work has been proved in the experience of the party replying?—JASPER.

[4080.] — READINGS FROM THE GLOBES. — TO "T. S. H."—Will your correspondent pardon me when I ask him to explain how in his interesting "Readings from the Globes" (No. 271, page 252) he arrives at the number "43" as the miles in a degree in the latitude of London? He gives the proportion, 15° : 9½° : : 69¼ miles : 43 miles. But the answer, I think, is not 43, but 44 1-60th. He also accordingly calculates 645 as the rate of miles per hour at which London revolves. But using 44 1-60th, the amount would be 960 1-60th. The difference is considerable; and what then becomes of the computation by logarithms, giving 43·26?—GIMEL.

[4081.]—THE SHIPTONIAN VELOCIPEDE. — Would Ernest R. Shipton be good enough to give the following particulars of his tricycle, a sketch of which appeared on Fig. 1 of 3rd June:—Extreme length and breadth, diameter the driving and front wheels, size of crank; and also whether the frame is partly wood and partly iron, and oblige.—A. H.

DOMESTIC RECIPES.

(From the Food Journal.)

SCOTCH WOODCOCK.—Take a wine glass full of cream, a piece of butter of the size of a walnut, a spoonful of anchovy paste, the yolk of three eggs with the whites of two, and red and black pepper *à discretion*; mix them well together, taking care that the paste is dissolved; place the saucepan on a bright fire, and stir it *always the same way*. When it is cooked it will become thick. Serve on hot buttered toast, as quickly as possible.

FRENCH PANCAKES.—Take two eggs, 2oz. of butter, 2oz. of sifted sugar, 2 oz. of flour, and half a pint of milk; beat the eggs thoroughly, and put them into a basin with the butter, which should be beaten to a cream; stir in the sugar and flour, and when these ingredients are well mixed, add the milk; keep stirring and beating the whole for a few minutes, put it on well-buttered plates, and bake, in a quick oven for twenty minutes. Serve with a layer of jam between each.

MRS. MUSTOE'S CURRY.—Take a rabbit, cut off all the meat in small pieces, and fry them lightly in a fryingpan, without any fat; mix two tablespoonfuls of curry powder with a teacupful of vinegar, two teaspoonsful of chutney, and the same quantity of flour; cut some onions in slices, fry them brown in butter, mix with the preceding ingredients, and stew very slowly for half an hour.

OATMEAL PUDDING.—Put into one quart of milk, just warm, one pint of whole oatmeal, carefully picked, and let it soak for two hours at least. Add ½lb. of stoned raisins, ½lb. of currants, a little salt, 4oz. of sugar, and full ½lb. of butter. It is a capital pudding, whether baked or boiled.—*From an old MS.*

GOOSEBERRY FOOL.—Boil one quart of gooseberries in a skillet, closely covered, in as much water as will cover them, until they are boiled to pieces. Then put them in a pewter dish. Let them boil for about eight minutes, and stir them altogether, adding ½lb. of sugar and ½ lb. of butter. Then add the yolks of 10 eggs, with the whites of three, and stir them together. It is must not boil after the butter is in.—*From an old MS.*

THE ENGLISH MECHANIC LIFEBOAT FUND.

Subscriptions to be forwarded to the Editor, at the office 31, Tavistock-street, Covent Garden, W.C.

Amount previously acknowledged	£185	6	5
J. S.	0	2	6
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IT is a marvel of cheapness and usefulness; in fact, it may be called one of the wonders of the age.—J. W. WORSEY, Operative Chemist, Wandle Ashes, near Ramford, Lancashire.

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"I HAVE every number of your journal. For some months I found little in it to interest me, now there is very little which I do not read with interest"—F. W. G., 7, Union-street, Rochester.

"TRULY, as you have said, 'a Literary Aaron's rod;' having eaten up the 'Mirror of Science' and the 'Penny Mechanic,' you are now about to appropriate 'Scientific Opinion.' We may ask, 'what next, and next?'"—JAMES BUCKLE, 43, Mornington-road, Regent's-park.

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I have for some time intended to give your excellent publication a constant advertisement."—JOHN BROWNING, 111,

me to congratulate you on the improved condition that of the coil"—URBAN.

ANSWERS TO CORRESPONDENTS.

*** All communications should be addressed to the, EDITOR of the ENGLISH MECHANIC, 31, Tavistock-street, Covent Garden, W.C.

The following are the initials, &c., of letters to hand up to Friday morning, June 10, and unacknowledged elsewhere.

J. Hick, M. P., J. Chalk, J. A. M., J. P. J., Canto, C. Gale W. Binns, Jas., Burslem, J. F. E., R. Ferrier, C. G., M. and H., Miss M. A. H., J. A. B. and Co., J. E. Yeates, H. B., J. F., J. T. Piper, Very Rev. F. W. A., E. A. L. M and A., T. W. M. (next week), W. Sheppard, J. H. J. Venceder, J. G., H. P., J. R. T., W. W. B., Simplex, Henry Page, G. R. R., G. Whitsun, H. A., Inventor and Self-taught Mechanic, J. Williams, F. A. F., F. W. G. W. B. B., Constant Reader, C. D.

ERRATUM.—In Reply 3723, "Glaze for Pottery," on page 236, the formula for glaze for pottery should read—"100 parts white lead, 20 parts flint, 40 parts *stone*, and 5 whiting."

E. SLATER, with another letter on cotton spinning.

G. J. WALKER expresses a hope that "F.R.A.S." may have space given him for some account of the two things alluded to at the close of his very well written essay on "What Stripes the Sunbeam." We can only say, that space for the purpose suggested is at the command of "F.R.A.S."

F. W. TICKHURST.—No stamps enclosed, as stated.

MARTYN ROBERTS, Pendarrow House, near Crickhowell; thanks for letter, which is inserted, and for private letter so full of hearty sympathy.

BERIRO.—First query inserted; for information sought in the second, see back numbers.

J. S. ASHTON.—Consult indexes. The numbers inquired for are in print, and can be obtained through any bookseller.

G. W. A.—Should be glad to receive the drawings,

SIGNATURES.—More than one correspondent has lately commenced the practice of adopting Greek signatures. Such a practice is rather pedantic, and altogether unnecessary; it moreover prevents the majority of our readers from referring to them by name. We refer to the use of the *Greek characters* only, and not to the use of Greek or Latin words, which are often convenient, serving as they do to distinguish a correspondent from the hundreds of "constant subscribers," &c., who daily address us.

EMIGRATION.—"F.R.G.S." says, "No man possessing human sympathies, but would be moved to his inmost soul by the letter of 'Cotton Clerk,' in your last issue but one. Such men will raise our colonies to renown. I am, at the present time, preparing a short article on Victoria, to be followed by one on Queensland, then Canada, &c..

WM. LANE, Smethwick.—No stamps enclosed.

ONE WITH A DRAWBACK.—Consult a mechanical surgeon.

T. BUTT.—Exchanges are paid for.

E. E. F. asks rather too much.

J. LEASTON.—Drawing not good enough; besides, it is rather late in the day to ask opinions on notions connected with bicycles.

H. B.—Your advertisements did *not* arrive in time, or they would have appeared. They are inserted in this number.

TRAYLER.—Contribute under a nom de plume.

THE SIXPENNY SALE COLUMN is the only place in which can appear queries sent by "Virgo," Chas. Edmonds, "Ignorant," "R. S.," "Salopian," W. Scott.

CUCKOO.—Your advertisement contains no address, and its insertion is therefore delayed until we hear again from you.

G. E. J.—Your query *has* received a reply, see p. 285.

ANXIOUS NEPHEW.—If your relative emigrated to any organised settlement or town, your best plan would be to write to the authorities. A letter to the bishop of the diocese, asking him to inquire for you of the clergyman in charge of the district, might procure you some information. We have a considerable number of subscribers in South Africa, and if you like to forward a query, giving your uncle's name and other particulars, we would insert it, and it *might* reach the eye of some subscriber who knew him.

J. H JOHNSON.—Too metaphysical and speculative.

E. M. HARRISON.—If useful to readers, communicate through "Notes and Queries;" if for individual benefit, select the Sixpenny Sale Column.

A. T.—We know of no such book. Perhaps you mean Brewer, not Ure.

D. WRIGHT.—Such a proposition might appear invidious.

HY. JAMES.—We don't know the address.

URBAN.—Thanks for expression of good opinion. As a rule, you are right about the exclusion of medical queries.

W. H. HENFREY.—"Ancient Coins" next week.

PAUL GILL.—We simply thought you merely glanced at the question you wrote on. You say "I am fully persuaded that it is your earnest wish to treat your correspondents impartially, but almost unconsciously we now and then repudiate things only because they cut against the grain or fame of our good friends." All are "our good friends" who have useful information or criticism to offer. As we cannot insert all the letters we receive, we are obliged to make a selection, and as a rule the most substantial or the most suggestive have the preference. Of course we may be mistaken, but we endeavour to act for the best, and never to forget the interests and tastes of the *mass* of our readers. Let "Paul Gill," who is unquestionally an educated and intelligent man, send us a letter on any subject in harmony with our general purpose and tendency, and not likely to evoke a personal controversy, and the letter shall be inserted. He will then be numbered with "our good friends," because he adds to the common stock of knowledge for the common good.

URBAN.—We intend to give reports of scientific societies after we have amalgamated *Scientific Opinion*.

J. W. T.—See our notice elsewhere on "Outdoor Scientific Pursuits."

THE INVENTOR.

APPLICATIONS FOR LETTERS PATENT DURING THE WEEK ENDING JUNE 6, 1870.

1581 P. D. Hedderwick, Glasgow, improvements in printing

1582 A. Dyson, Huddersfield, improvements in machinery or apparatus for carding wool

1583 L. Gardner, Manchester, and T. Bushby, improvements in pill making machines

1584 B. Hunt, 1, Serle-street, Lincoln's-inn, electro-magnetic apparatus for moving panoramas, or other things required to be exhibited.—A communication

1585 W. E. Newton, 66, Chancery-lane, an improved ink or mucilage stand.—A communication

1586 S. Cohne, of Cheapside, an improved disinfecting and cleansing powder

1587 J. Leighton, 40, Brewer-street, Saint James, improvements in ornamenting the edges and margins of books and paper.

1588 W. J. Barron, and E. C. Barron, 17, Aldermanbury, improvements in the manufacture of soles and heels for boots and shoes.—A communication

1589 J. H. Carruthers and S. Alley, Glasgow, improvements in wheels

1590 R. Hughes, Worcester, improved apparatus for scraping and cleansing streets and roads

1591 G. Lowry, Salford, and S. Brookes, Lower Broughton, improvements in the construction of machinery for preparing and hackling flax

1592 W. Winter, Leeds, improvements in sewing machines

1593 C. D. Abel, 20, Southampton-buildings, Chancery-lane, improvements in the manufacture of phosphorus.—A communication

1594 A. M. Clark, 53, Chancery-lane, an improvement in machines for working and preparing peat for fuel.—A communication

1595 J. James, 40, Princes-street, Stamford-street, improvements in apparatus for compressing gunpowder and other substances into pellets

1596 T. Holder, Westbourne-road, Barnsbury, an improved elastic sandcrank boot or hoof covering for horses

1597 H. S. D. Gugisperg and C. Scheib, New York, an improved machine for making cut-nails

1598 W. V. Pulliam, Kansas, improved self-adjusting couplers for connecting and disconnecting railway carriages

1599 W. R. Lake, Southampton-buildings, London, improvements in couplings for railway carriages.—A communication

1600 J. Priestman and T. Priestman, improved means and apparatus for dressing or finishing leather

1601 A. H. Brandon, 13, Rue Gaillon, Paris, improvements in carding and spinning machines.—A communication

1602 F. Dingey, Truro, improvements in machinery for pulverising or reducing ores and other hard substances

1603 A. V. Newton, 66, Chancery-lane, an improved mode of preventing the corrosion of iron exposed to water or dampness.—A communication

1604 W. E. Newton, 66, Chancery-lane, improvements in furniture springs for seats and mattresses.—A communication

1605 R. Leake Manchester, and H. Larkin, Hydes, Theydon Gernon, Essex, improvements in machinery for engraving or etching rollers for calico printers

1606 E. W. Hodgetts, Moreton-in-the-Marsh, Gloucester, improvements in rick cloths or covers

1607 H. Timmins, Acton, improvements in the manufacture of hinges

1608 A. Segard, Arvilliers, France, improvements in and applicable to knitting machines

1609 M. Henry, 68, Fleet-street, an improved bit.—A communication

1610 J. F. Rogers, Featherstone-buildings, Holborn, an improved machine for decorticating fruits and vegetables

1611 W. R. Lake, improved means for preventing fraudulent alterations in bankers' cheques and other monetary instruments.—A communication

1612 C. H. Murray, Southwark, improvements in machinery for pressing bricks, tiles, and other articles made of clay or other plastic substances

1613 A. V. Newton, 66, Chancery-lane, improved apparatus for cleaning knives.—A communication

1614 W. Haslam, Bolton, improvements in woven fabrics applicable for towelling and other purposes, and in the method of and apparatus for weaving the same

1615 W. H. Taplin, Dulwich, an improvement in the manufacture of lasts for the feet

1616 J. Burley and L. Glover, Birmingham, a new or improved moustache support

1617 J. Oddy, Birkenshaw, and H. W. Whitehead, Holbeck, improvements in machinery for combing wool, cotton, flax, and other fibrous substances

1618 C. Kenney, Glensavage, Dublin, facilitating the mounting a horse or velocipede

1619 H. Brinsmead, and R. Lyons, Ipswich, improvements in thrashing machines

1620 E. Heycock, Manchester, improvements in that portion of gentleman's wearing apparel known as "suspenders"

1621 C. Clarance, Takeley, improvements in breech-loading fire-arms

1622 J. R. Jefferies, Orwell Works, Ipswich, improvements in ploughs

1623 S. Adams, Saltley, improvements in velocipedes

1624 J. H. Johnson, 47, Lincoln's-inn-fields, improvements in furnaces for metallurgical purposes.—A communication

1625 E. Ratcliffe, Birmingham, certain improvements in vestibule lamps

1626 D. Spill, Hackney-terrace, Hackney, improvements in compounds for insulating telegraph wires

1627 J. Gabb, Bewdley, a new or improved boiler and furnace for heating churches

1628 J. B. Mirrlees and W. R. Watson, improvements in desiccating sugar-cane refuse

1629 S. Lake and G. Kingdon, Coombe, Dartmouth, improved arrangements and apparatus applicable to trawlers and other vessels

1630 W. McLean, Norfolk, Virginia, improvements in hinges.

1631 T. A. Marshall and C. D. Marshall, Bishopsgate-street, improvements in attaching or fixing the devices for effecting the water mark in paper to the covers of the dandy rolls, and to the moulds used in the manufacture of paper, also in the construction of such dandy rolls, covers, and moulds

1632 A. Johnson, Healey, Ossett, near Wakefield, improvements in milling or fulling and washing machines

1633 D. Bentley and J. B. Jackson, Bury, improvements in rag engines

1634 A. W. Pocock, Pimlico, improvements in meters, pumps, or other engines for water or other liquid

1635 T. Restell, Birmingham, improvements in military and sporting guns, and also in cartridges applicable to the same or other descriptions of breech-loading arms

1636 T. Lishman, Stockton-on-Tees, improvements in the grate bars and other parts of steam boiler and other furnaces

PATENTS SEALED.

3514 H. Alexandre, improvements in organs and similar musical instruments

3519 T. Clark, improvements in the covers of umbrellas and parasols

3534 J. Jonas, improvements in packing and consolidating :a and other substances

3550 O. Sipriot, Milan, an improved apparatus for exhibiti placards and other advertisements

3575 C. A. McCalla, improvements in closing and stoppering bottles

3568 H. Kershaw, improvements in apparatus employed in spinning worsted or other fibres

3570 W. E. Gedge, improvements in velocipedes.—A communication

3581 A. A. Croll, improvements in the treatment of ammoniacal liquor of gasworks

3587 W. A. Marshall, improvements in the manufacture of electric telegraph cables

3645 A. M. Clark, improvements in the manufacture of superphosphate of lime.—A communication

3710 W. B. Williamson, improvements in fastenings for trunks, portmanteaus, and boxes

317 A. V. Newton, improvements in treating iron.—A communication

318 A. V. Newton, an improvement in the process of manufacturing wrought iron or steel.—A communication

380 J. T. Greenfield, an improved side-arm for clearing the chambers and rifling of ordnance

511 W. R. Lake, an improved pneumatic engine.—A communication

524 H. A. Bonneville, an apparatus for the manufacture of the legs of half boots.—A communication.

541 H. A. Bonneville a new and useful improvement in steam engines.—A communication

811 W. Woofe, improved means and apparatus for guiding ploughs, and also for regulating the depth of working of the same

1015 C. H. Wight, an improved inkstand

1051 J. Henderson, an improvement in the manufacture of wrought iron and steel

The English Mechanic
AND
MIRROR OF SCIENCE AND ART.
FRIDAY, JUNE 24, 1870.

COMETS AND METEORS.

By Richard A. Proctor, B.A., F.R.A.S.
Author of "Other Words than Ours," &c.

WHEN, more than two centuries ago, Kepler asserted that there are more comets in the universe than there are fishes in the ocean, he was laughed at as a theorist. Yet the assertion was founded on sufficient evidence—it was, indeed, founded on evidence which, paradoxical as it may sound, is not simply probable, but absolutely certain—the evidence from probability. He saw that the chances against the detection, by us, of any comet, supposed to be selected at random from the hosts which people space are so enormous that for every single comet we recognise there must be millions which escape our observation. Therefore he argued conclusively (only the men of his day could not see the force of the argument), that since many comets have been discovered, untold millions must exist throughout space.

We now know that the illustrious German was right—nay, we know that the theory which seemed to his contemporaries so startling, fell very far short of the truth. For he only knew of those bright comets which are palpable to ordinary vision. He had no reason to believe that for every large comet there are myriads of smaller ones—that is, of comets not merely inferior in apparent size and brilliancy, but in reality minute by comparison.

Now I propose to exhibit the really startling conclusions which may be drawn from what we know of the cometic and meteoric system within the solar scheme, these conclusions being not hypothetical, as they might be thought on a first view, but as legitimately inferrable from the evidence as Kepler's daring proposition respecting the comets which people space. I propose to show that the solar system is full of comets and meteors—in this sense, that though the combined volume of all the cometic or meteoric substance existing in any given space within the solar system may be almost indefinitely minute, yet that no considerable space (no space so large perhaps, as the moon's globe), exists without some such substance within it. I wish it to be particularly understood that I am not about to theorise. I propose only to pass by legitimate inferences from the known and unknown, and I shall be especially careful to distinguish what is doubtful, or at least not absolutely certain, from that which must be held by all who understand the laws of probability to be thoroughly established by the evidence.

Let us picture our earth circling on her wide orbit around the sun. That orbit has a diameter of about 180 millions of miles, and therefore the space through which the earth actually sweeps on her course round the sun must be regarded as being (relatively to him) a ring of cross-section equal to the earth's. We know what the actual volume of that ring must be; it is, in fact, equal to the volume of a circular cylinder nearly 8000 miles in diameter, and equal in height to the circumference of the earth's orbit. But the real volume of the ring does not at present concern us.

Now in sweeping onwards upon her orbit, the earth encounters a multitude of meteoric substances, of different size and weight, some exceedingly minute no doubt, others—a very few—weighing many hundredweights or even tons.

This particular ring of space within the solar system is peopled, then, with meteoric bodies. This fact is beyond all question. Let us, inquire, however, how many meteors may be supposed to be within the ring at any moment, then afterwards proceeding to inquire whence they came and whither they go, as also according to what laws they are associated with each other and with other bodies, we shall find conclusions of a somewhat surprising character flowing from this first simple relation.

It has been calculated by Professor Newton* that the average number of meteors which daily enter the earth's atmosphere is about 400,000,000, though of these only 7,500,000 are such as can be seen by the naked eye. Now the earth occupies, as we know, about 365¼ days in circling around the sun, therefore she encounters in the course of a year no less than 146,100,000,000 meteors of various dimensions, but the great majority exceedingly minute. And by the way, before passing on it may be well to consider by what amount the earth's actual weight increases each year under the influence of this continual rain of meteors; for it must be remembered that only a very small proportion of them can escape after once reaching her atmosphere by passing grazingly through it. Suppose we assume that on the average 1000 of these meteors weigh one ounce—this will not be thought a very exaggerated estimate of their weight—then the earth's weight increases yearly by 146,100,000 ounces, or by 913,125 pounds, or by upwards of 4000 tons. The moon, too, must increase in weight by upwards of 250 tons per annum. Yet these accretions, enormous though they seem, are utterly insignificant compared with the volume either of the earth or moon. Were it otherwise the moon would soon begin to show the effect of the increased weight of her primary and herself, by circling more swiftly around the earth.

Let it be remembered that though these results are so far doubtful that we have deduced them in ignorance of the actual average weight of the meteors our earth encounters, yet no doubt whatever rests on the conclusion that each year the earth grows many hundreds of tons heavier by the continual fall of meteoric substance upon her surface.

But now we have to inquire whether the ring round which the earth travels is the only part of the solar system which is thus peopled by meteors. Such a conclusion seems in itself altogether unlikely, but yet the consequences which follow from supposing any very large proportion of the sphere ruled over by the sun to be thus peopled, are so astonishing that we may well require very clear evidence before admitting that this supposition is just.

Certain peculiarities of meteoric motion serve conclusively to establish the thesis that our earth's orbit is by no means exceptionally thronged with meteors. Those peculiarities I shall indicate somewhat briefly, premising that the evidence we have on the matter is absolutely beyond question.

In the first place, there are certain parts of her path where the earth encounters more meteors than elsewhere. Picturing her as she swiftly travels round the sun, we have to conceive the existence along certain parts of her path, of richer aggregations of meteors than exist elsewhere. Now, if it were possible for an aggregation of meteors to stay in a certain definite part of the solar system, we should not learn much from the peculiarity here considered. But there is no such thing as rest under the influence of the sun's tremendous attractive energies. Those aggregations, if initially at rest, would in no brief space fall in upon the sun's surface. The fact, then, that year after year, as the earth returns to the same part of her orbit, she either always, or commonly, shows that there must be a system travelling round the sun, and intersecting the earth's orbit in that particular region.

One thing, then, has become very obvious. The whole of any such system, except the part crossed by the earth (a mere line through the system one may almost say—since the earth's diameter is as nothing in such a relation), passes altogether clear of the earth's orbit. We must therefore add to the conceptions we have already formed of meteoric abundance this further consideration, that meteoric systems exist of whose members only the minutest conceivable fraction ever become recognisable by us.

Mentioning, in passing, that 56 such systems have been distinctly recognised by Mr. Alexander Herschel, while German astronomers have shown that yet larger numbers exist, the reader will begin already to see that we are upon a subject involving cosmical relations of the utmost importance.

Yet, after all, these systems might all have orbits, so closely approaching the earth's orbit in figure and position as to render their actual intersection by the earth's orbit no very striking circumstance. It would remain, of course, abundantly wonderful that so many meteoric orbits crowded along a greater or less portion of their extent with discrete masses should exist within the solar system. But there might be the end of the matter—a family of meteor systems would be found to exist somewhat resembling in distribution the family of the asteroid outside the orbit of Mars.

Infinitely more wonderful, however, are the conclusions to be drawn from the observed relations of the meteoric systems.

(To be continued.)

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* The results of this calculation are quoted in Mr. Lockyer's "Elementary Lessons in Astronomy;" but with a remissness, somewhat too common in that compilation, they are not referred to their author. It cannot be too often insisted upon that not courtesy alone, but common justice requires that all special results of this sort should be distinctly assigned to him who has been at the pains to calculate them.

THE WORLD, ITS FORMATION AND ANTIQUITY.

By Arthur Underhill

CHAPTER I.

Tamdiu discendum est quamdiu nescias et si proverbio credimus quamdiu vivas.—Seneca.

TO the student of Nature, who regards creation with that love of it for its own sake which is so necessary to the thorough enjoyment of any pursuit whatever; the subject of these papers cannot but afford a wide field for pleasure and thought. The science of geology is of itself most interesting, and the observation of its phenomena gives to the so-called *constitutional*, that zest which is so often wanting to it; imparts an interest to every stone, and clothes each roadside quarry with a history which dates far anterior to the race of man. To those who regard science in a more practical light, and who look rather to the utility, than to the philosophy of knowledge, geology ought, to be most entertaining. Its great use in engineering, mining, and agriculture, must recommend it to *them*. To the artist, it cannot fail to be of interest, diversifying as it does so greatly the scenery of the globe. To the architect, the facility of obtaining stone for his building presents itself as an element in the conception of his design, and by a slight knowledge of geology, he is enabled to tell what particular kind of material he will find upon, or near his site, and so choose that which, with an equal appearance and durability, may be most easily obtained.

Seeing, then, how pleasant and useful is the cultivation of this branch of natural knowledge, I think it requires nothing more from me to show that its elements deserve the perusal of all who are in any way interested in science, and I shall therefore without further preface proceed to my task.

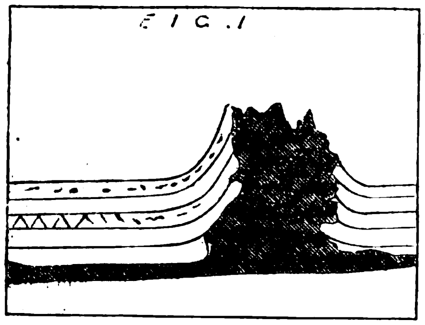
Looking at the earth as it now is, we see that it is greatly diversified by hills and vales, mountains and plains, whose firm and solid appearance impress us at first sight with the idea that they were co-existent with the creation of the world. Such is not, however, the case. The loftiest Alpine peak, whose snow-capped summits now rises proudly above the clouds, was once sunk fathoms deep beneath the ocean, and the quiet secluded dell did not always enjoy its present state of humble repose. Change, ceaseless, and in some cases so slow as to be scarcely perceptible in a century, has been, and is even now altering the face of the earth; here, by means of the untiring sea, wearing away the isthmus of hard granite and finally cutting a channel through it; there upheaving the land by earthquakes, and volcanic agency and erecting new islands—aye, in some cases even continents where formerly was a mere waste of water, and throwing up the plain into the most rugged and picturesque mountain ranges. At one place by the aid of the tornado drifting huge masses of sand over the country, and converting the fruitful land into a sterile desert; at another, deep buried in the earth, forming those mineral treasures which are so useful to man. Even the smallest of created beings helps to push on this ceaseless mutation, and the coral insect whilst building its own habitation forms a foundation for that of man.

We find, then, that geological change is due to five agencies—namely, the aqueous, the igneous, the atmospheric, the chemical, and the organic. (or that caused by animal or vegetable life).

Geological research is necessarily confined to the upper crust or shell of the globe, as it is impossible to penetrate more than some two or three miles below the surface, and only that far through the help of landslips and upheavals of the crust by igneous agency.

I must here premise that the sense in which the term "Rock" is used by geologists is different to that which is popularly ascribed to it. By "rock," in this treatise, will be meant *every kind* *of formation which enters into the composition of the crust of the globe;* thus, soil, sand, clay, &c., are, geologically speaking, rocks, although they are not indurated or stony.

If we could cut a huge wedge-like slice out of the earth, we should find that the sides of the dyke or valley this formed would be arranged in a series of layers, or bands of different kinds of rock; these layers are called strata, and those rocks which are always found thus arranged are called stratified, aqueous, or sedimentary rocks. Perhaps, however, we might find a place in our valley where another species of rock had forced its way upwards, upheaving the strata, and in some parts breaking through it, and inclining it at all angles to its previous condition, as in Fig. 1, where the parallel lines are the stratified rocks, and the shaded portion that which has broken through and upheaved them. This species of rock is called igneous, unstratified, or amorphous, from two Greek words, signifying without form. It never occurs in the form of regular layers, as the stratified rocks do, but always in irregular masses. All rocks, then, belong to one of these two classes, but it is principally by means of the aqueous rocks that the geologist traces the former history of the world.



We always find that if we go deep enough we at length come to some igneous rock, and we therefore conclude that the foundation, as it were, or interior of the earth, is a huge mass of amorphous rock. With this foundation geology has little to do, but confines itself chiefly to its shell or outside coating. In my next paper, I shall endeavour to show the successive revolutions which have rendered the earth habitable, and which have changed what must have be rocky wilderness, into the fruitful and pleasant abode which man now occupies. Until then I recommend my readers to study the subjoined list of some of the most ordinary rocks.

AQUEOUS OR WATER-FORMED ROCKS.

MUD OR SILT is the massing together of impalpable particles of rock, worn by water and deposited at the bottom of seas, and other large bodies of water.

CLAY is plastic mud.

SHALE AND SLATE are both formed from consolidated mud and clay respectively, which has been subjected to great pressure, and under high temperature. These rocks are laminated—*i.e.* possess the property of splitting into plates.

CLAYSTONE is not laminated, but is formed from consolidated clay. All argillaceous (from *argillaceus*, clayey) are recognisable by a peculiar odour which they exhale, when breathed upon.

MARBLE, LIMESTONE, AND CHALK are all of the same family; composed of carbonate of lime as a base; they are detected by a drop of sulphuric acid, which causes them effervesce.

SAND is formed of the minute particles of water-worn rock; gravel is composed of the larger portion of these same rocks.

SANDSTONE AND CONGLOMERATE are respectively consolidated sand and gravel. Conglomerate is also called pudding-stone.

QUARTZ is a massive crystalline rock. The small rounded white and yellow pebbles of gravel are pieces of quartz.

IGNEOUS OR FIRE-FORMED ROCKS.—GRANITE is formed of crystals of quartz, felspar (a laminated glassy substance), and mica (a transparent glittering mineral). It is of various colours.

BASALT is a hard dark rock, which always assumes a columnar structure.

TRAP ROCK is a hard dark formation, generally found arranged in a series of steps, or terraces.

(*To be continued.*)

ANCIENT COINS.—IV.

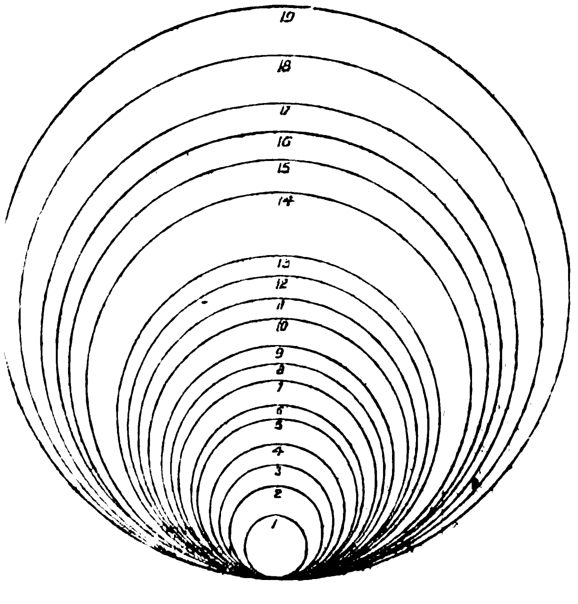
BY HENRY W. HENFREY.

ON the 23rd of May, and the three following days, a very valuable collection of ancient coins and medallions was dispersed under the hammer of Messrs. Sotheby, Wilkinson, and Hodge, in Wellington-street, Strand. It was the property of Mr. Jules Sambon, of Naples, and realised a very large sum.

We intend to select from this sale the most important specimens, and give their prices, with remarks and descriptions, in order that the collector may form some idea of the present value of the rarer coins in the several series.

In the following list the terms "patina" and "patinated" very frequently occur. We think that they may be best explained in the words of Pinkerton:—"Nothing contributes so much to the conservation of brass or copper coins as that fine rust, appearing like varnish, which their lying in a particular soil occasions. . .
For in gold and silver the rust is prejudicial, and to be removed, whereas in brass and copper it is preservative and ornamental, a circumstance remarked by the ancients, as the *pocula adorandæ rubiginis* of Juvenal may prove, and that exquisite Greek phrase, which terms patina χαλκου ανθος 'the flower of brass.' This fine rust, which is indeed a natural varnish not imitatable by any effort of human art, is sometimes a delicate blue, like that of a turquoise; sometimes of a bronze brown, equal to that observable in ancient statues of bronze, and so highly prized; and sometimes of an exquisite green, a little on the azure hue, which last is the most beautiful of all. It is also found of a fine purple, of olive, and of a cream colour or pale yellow, which last is exquisite. . . . . The Neapolitan patina is of a light green, and when free from excrescence or blemish, is very beautiful. Sometimes the purple patina gleams through an upper coat of another colour, with as fine effect as a variegated silk or gem. In a few instances a rust of deeper green is found, and it is sometimes spotted with the red or bronze shade, which gives it quite the appearance of the East Indian stone called blood-stone. These rusts are all, when the real product of time, as hard as the metal itself, and preserve it much better than any artificial varnish could have done, concealing at the same time not the most minute particle of the impression of the coin."

The *sizes* of the coins refer to the scale of Mionnet, of which we give an engraving.



The *exergue* of a coin is that part which is divided from the field by a line, upon which the figures of the reverse stand. The *field* is the open space in the centre of a coin where no figure is placed.

With these explanations, which are intended only for the beginner, we will now commence our lists.

Lots 1 to 31 were the bronze cast coins of th[illegible] Græco-Italian cities of Etruria, Umbria, Picenum and Latium. They consisted of *asses*, and divisions of the as. (Explained in our second article, on page 197.)

Lot 7. Picenum, Hatria or Hadria, Quincunx Obv., HAT., head issuing from a shell. Rev., a pegasus flying to the right. Exquisitely preserved and patinated, and of great rarity; size, 16. £11.

15. Latium.—As. Obv., beardless head with Phrygian helmet. Rev., same head. Very fine; size, 17½. £6 10s.

31. Latium.—As. Obv., helmeted head of Pallas, full-faced. Rev., bull standing to left, caduceus beneath, and ROMA in the exergue. Size, 19. Another similar, but with L under the bull.

These two pieces, the only two varieties known, were purchased of the Roman dealer Depoletti, who obtained them from the renowned find of Vicarello. The one with the caduceus is in first-rate preservation—the finest coin of the find; the other is not quite so perfect. The great value of all these Italic coins, when fine, is well known. £30 (Bunbury).

Lots 32 to 34 were bronze coins of Apul Luceria, and Venusia.

34. Venusia.—As. Obv., dog's head, to left. Rev., fore-part of a wild boar, to left. Extremely rare, and well preserved; size 18. One, obv., shell; rev., three crescents and YE.; size 9. £10.

Lots 35 to 67 were struck coins in silver and bronze of New Latium, Campania, and Samnium.

35. Alba Novi Latii. Obv., head of Mercury to right, with winged petasus.* Rev., ALBA, winged Gryphon to right. A fine and extra rare diobolus, silver; size 3. £2.

40. Campania. Nola. Obv., laureated head of Apollo to right, and Phœnician legend. Rev., fore-part of the human-faced bull to the right. An apparently unique obolus, fine, and splendidly patinated. Copper; size 4. £2 10s.

50. Campania. Atella. Triens. Obv., head of Jupiter to right, and o o o o. Rev., Oscan legend; fast quadriga to right, and o o o o. Very scarce, fine, and valuable; copper; size 8½. £3 10s.

55. Campania; Marcina. Obolus. Obv., laureated head of Apollo to left. Rev., Oscan legend; dolphin and club. Very fine, and of great rarity. Copper; 4. £6.

Lots 68 to 74 were silver denarii struck during the civil war. They realised high prices.

Lots 75 to 266 consisted of Græco-Italian and Sicilian coins in gold, silver, and copper. From them we select the following:—

82. Apulia. Venusia. Dextans. Obv., bust of Hercules to right, and VE. N. II. Rev., C.A.Q., the Dioscuri on horseback to the right. Fine, and extremely rare. Copper; size 11. £7 7s.

91. Calabria. Tarentum. Drachm. Obv., Taras riding on a dolphin, to the right. Rev., ΦΙΛΙΑΡΧΟΣ, rider to the right, throwing his javelin. Very rare, and in splendid state. Silver; size 4. £5 2s. 6d.

The obverse of this coin represents Taras, the son of Neptune, and the legendary founder of the city, which was called after the name of its founder Taras.

96. Lucania. Metapontum. Didrachm Obv., Hercules naked, with lion's skin head-dress, sacrificing at an altar, and leaning on his club. Rev., META., an ear of wheat. Well preserved; an unpublished variety. Silver; size 6. £8.

The ear of corn, sacred to Ceres, was early adopted by this people, in token of gratitude to that divinity for the fertility of their country.

98. The same. Didrachm. Obv. female head to left, with HOMONOIA. Rev., META., an ear of wheat. Very fine, and of the greatest rarity. Silver; size 5. £10 2s. 6d.

120. Bruttium. Croton. Didrachm. Obv., a tripod between a serpent and an ear of wheat. Rev., KPOTONIATAN, an eagle to the left; in

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* A travelling cap with a broad brim.

ws a branch. A very fine coin of fine style kmanship. Silver; size 5. £6.

l. Bruttium. Rhegium. Tridrachm. Obv., of a lion, full-faced. Rev., RECINON retro e; a calf's head to left. A fine coin of great ty. Silver; size 6. £7 2s. 6d.

The obverse of this piece bears the usual hegian type, and the reverse the Samian type.

133. The same. Tetradrachm. Obv., full-faced head of a lion. Rev., ΡΗΓΙΝΩΝ, laureated head of Apollo to the right. Silver; size 7. In splendid preservation, and of magnificent style. £9 9s.

147. Sicilia. Agrigentum. Obv., two eagles holding in their claws a hare, ΣΤΡΑΤΩΝ. Rev., ΑΓΡΑΓΑΝΤΙΝΩΝ, a quadriga to the left, with horses in strong action; above, a vine branch. Silver; size 7. A very fine and unpublished variety, worthy of a great price. £30.

148. The same. Obv., an eagle to the left, ΑΚΡΑΓΑΝΤΟΣ. Rev. a crab. Very fine. Silver; size 6. £5 5s.

"This city was built upon the river Acragas, so called probably from abounding in crabs, χραγὼν, from which circumstance the crab, being perhaps at an early period made sacred to the river deity, became the principal type of the money of this city, and was never discontinued, either as principal or secondary, among the types of the national coin. The ancient name of the city was the same as that of the river, Acragas, but became eventually Agrigentum, or rather Acragentum. Acragentum was originally built upon Mount Acragas, and the existing ruins near the modern city of Girgenti, attest its ancient extent and splendour. On coins of this city, of the fine period, the obverse is generally an eagle destroying a hare, a type which has been very variously explained."

164. Sicilia. Camarina. Obv., youthful head of Hercules with lion's scalp to left; ΚΑΜΑΡΙΝΑΙΩΝ. Rev., a helmeted charioteer leading his quadriga at full gallop to right, and crowned by Victory; in the exergue two hydriæ or amphoræ. Silver; size 7. Very fine and very rare. £10 15s.

165. The same. Obv., helmet to left on a round shield. Rev. ΚΑΜΑΡΙΝΑ, palmetto with fruit, leaves, leg armour, etc. Silver; size 5. Fine and extremely rare. Another. Obv., bearded head to right, rev., helmet. Silver; size 1½. £15.

167. Sicilia. Catanea. Obv., laureate head of Apollo, adv. between bow and lyre, between the artist's name ΑΓΟΛΛΩΝ. Rev., ΚΑΤΑΝΑΙΩΝ, a charioteer, crowned by Victory, guides a fast quadriga to right, near a pillar; cray-fish beneath. Silver; size 7. Very fine, and rare to excess. £25.

172. Sicilia. Eryx. Silver; size 7. Obv., ΕΡΥΚΙΝΟΝ. The Erycinian Venus seated to the left, on her extended right arm a bird with open wings; Cupid in front, standing. Rev. a charioteer, crowned by Victory, leads a quadriga at full gallop to the right. In beautiful preservation, and of the very highest rarity; it formerly belonged to Dumersan, Raoul-Rochette, then to Rollin, Dupré, and to the present proprietor; unknown in Torremuzza's time; none in the Thomas cabinet. £48.

173. Sicilia. Gela. Silver; size 7. Obv. ΓΕΛΑΣ, human-headed bull to the left, immediately before its face bulrushes springing from the ground (river Gela); in exergue a grain of barley. Rev. a quadriga to the left, the horses in extreme action, wheat beneath, above, an eagle flying to the left. Fine, especially the obverse, and very scarce. £16.

This curious type of a human-headed bull is most likely a personification of the river Gela, which flowed near the city of that name on the south coast of Sicily.

201. Sicilia. Naxus. Silver; size 7. Obv. head of Bacchus (the face has the *genuine* Bacchic expression), crowned with ivy. Rev., ΝΑΞΙΟΝ, full-faced faun resting on a wine-bag, with cantharus* and thyrsus as on gems; ivy branch on his right side. Very fine and rare, of good Sicilian style of work. £13.

205. Sicilia. Segesta. Silver; size 7, Obv. a head of Segesta to right, with broad fillet and reticulum;† wheat beneath. Rev., ΣΕΓΕΣΤΑΙΩΝ, young hunter to right, with conical cap or helmet on his shoulders, secured by a cord, which he holds in his left hand; two dogs at his feet. Extra rare, in magnificent preservation, and of good style of work. £58.

215. Sicilia. Syracusæ. Gold; size 2½. Obv., head of Apollo to left. Rev. ΣΥΡΑΚΟΣΙΩΝ, horse to right on a pedestal. Very rare, very fine, and of very fine style. £32.

216. The same. Gold, size 2. Obv., head of Jupiter-Eleutherius to the right, fulmen (or sceptre) behind. Rev. ΣΩ., Pegasus flying to the right. Very fine, scarce, and valuable. £10 10s.

217. The same. Gold; size 2½. Obv., head of Apollo to left. Rev. ΥΕ (in monogram). A biga to the right, the horses galloping; under them, triscelium. Rare, very fine, and of very fine style. £7 15s.

(*To be continued.*)

EMIGRATION.

A FEW REMARKS ON VICTORIA.

BY F.R.G.S.

IN reply to various correspondents I will attempt to describe clearly, yet briefly, such centres of emigration as at present seem most worthy of notice. Having said a few words concerning New South Wales, it may perhaps be as well to speak in the present paper of its sister colony, Victoria. The accompanying map will give a much better idea of the configuration of the country than any amount of explanation I might crowd into our limited space. It may be, regarded as superfluous information to state that hilly districts are generally pretty well watered, and that mountains have great influence upon the surrounding temperature. Dividing my subject into the three following heads—viz., (1) Agriculture, (2) Manufactures, and (3) Mining, I may say that Agriculture is extending and becoming the staple employment of the colony. "To be well based," says an eminent author, "Victorian agriculture should be grounded on English husbandry, so far as Anglo-Australian cropping and objects are relevant; and on the best warm-climate culture of other countries as to cropping and objects hitherto foreign to English culture, but which the genial climate and the fine soil of Victoria predispose it to produce." This advice has not been thrown away, and I find the rotative system is extensively adopted in the colony. Mixed husbandry is certainly the best for the community, and the safest for the husbandman, because it rarely happens that the 'plough and the pail' or the 'fleece and the vineyard' are despondingly bad at the same time. The Flemings have a proverb, that without forage no cattle; without cattle no manure, and without manure no crops; and there are many recorded instances in which in trying times the profits of one department of an establishment have met the losses of another. Supposing a farm to consist of, say, one-third arable, one-third greensward, and one-third vineyard, the loss sustained by the failure of one of these would be much less than if the whole farm were devoted to the cultivation of that one thing, and a failure occurred. Modern implements are used to a great extent, as may be seen by the perusal of any colonial paper, teeming as it does with lengthy advertisements from the Howards and Ransomes of old England.

The climate of Victoria is well suited to wheat growing. To the remarkable dryness of its weather we may perhaps chiefly ascribe that white and flour-like quality of grain, and thinness of skin, that are the characteristics of the best wheat. In England, it may be remarked, the dry years are always the best for wheat, as the bran is then least in proportion to the flour, while the grain shows its quality by the only true test, its increased weight. It may however be thought that the alternate hot and wet climate is detrimental as a whole to agriculture. Yet it is not so, for the strong sun power, cloudless sky, and the hot wind are features not usually at their full and damaging development until the summer has advanced sufficiently to place the crops beyond danger. The fierce sun and the fiery breath he has kindled in the interior of the country, expend their powers in the most cases harmlessly on fields of stubble; or if they come at an earlier stage upon the farmer, they but quicken his movements to meet an accelerated maturing of his crop. It may, perhaps, be remembered that Victoria took no less than fifteen medals and sixteen honourable mentions in the department of wheat alone at the Great Exhibition. Although the samples of Victorian produce are so good, it has been stated that agricultural pursuits have not always been remunerative. This can very well be explained. As a colony, Victoria, before the "golden era," was almost unnoticed and unimportant. At that time it received an inundation of population; every article was raised to fabulous prices, and a very inadequate supply of land was put into the market for sale by the Government at a time when the country was rapidly expanding its resources, means and population. The combined results of these incidents were the maintaining of a high price for agricultural produce—of course other sources poured into this colony their superabundant produce—land was extensively sold, and the result was a continual decrease in the price of cereals, &c., for several years. A glance at the imports of Victoria will show the extensive trade which has been carried on. For several years, therefore, prices were depressed below the average, but latterly the causes which conduced to this state of affairs has been removed, and the consequence necessarily followed that a more healthy and profitable state of things rose into existence. Another cause again assisted towards this result. The first attempts at farming savoured of extreme laziness and ignorance. The same piece of ground was sown with wheat year after year, at first with excellent results, then fair, muddling, and bad respectively. A different system led, as above, to better times.

During late years the vine has been largely cultivated. Mr. Westgarth says:—"The interior parts of the colony seem most suitable for vines, where the warm sun of summer alternates with a touch of sharp winter's frost. The Murray district is already a scene of yearly vintages, and in conjunction with the district of the Murrumbidgee, has commenced the methodical plan of public auctions of the wine produce." If my memory serves me right, however, a gentleman writing to one of the colonial papers last year, regarding his plantation, stated that on some soils the vines were not over productive, and were liable to numerous "complaints," such as mildew, &c. Though the coast rivers of this colony are neither so deep nor so broad as those of New South Wales, it is skirted and in part traversed in the interior by several of the larger streams of south-eastern Australia. The Murray, Goulbourne, Ovens, and the Hume, in their extent and volume of water, in conjunction with those on the coast, sufficiently supply the colony with water, and leave it little liable to drought. Its remaining large rivers are the Yarra Yarra, on which the town of Melbourne is built, the Glenelg, forming one of the boundaries of the province. The boundaries include an area of about 150,000,000 square acres. Gipp's Land is one of the finest tracts in the province, including more than 300,000 square acres adapted for permanent settlement. Its soil is richly alluvial, its temperature moderate, and adapted to European constitutions, while from its situation in the vicinity of the snowy mountains it is abundantly supplied with water. Another portion of the colony situated between Geelong and Portland Bay may be also noticed for its fertility and the advantages it offers to the occupier Mr. Malcolm says: "I consider that the district of the Lake Colach for about 200 miles is very rich. I do not think there is richer land in any part of the world—it is as good land as ever plough was put into; there are thousands of acres adjoining Lake Colach, clear of timber, and the richest land I ever walked or rode over, well supplied with streams and lakes, one of which is twenty miles in circumference."

Most of the English domestic animals thrive well in Victoria. The sheep especially is very prolific, and the wool annually exported forms a large item in the trade reports. Horses, pigs, poultry, &c., &c., are to be found in large numbers.

The above will give some slight ideas regarding the agriculture of this important colony. If any reader desires further information, I would recommend to his notice a prize essay on the "Agriculture of Victoria," by W. Story, Esq; also Westgarth's "Colony of Victoria;" and intending emigrants should get some late numbers of the Melbourne *Argus*, an excellent colonial paper.

Lastly, I should state that many colonists do not wish emigration to this colony to continue, but an unbiassed mind would say, "Go and prosper."

P.S.—If any reader receives the *Argus* and would not mind, he would confer a favour upon the writer by forwarding it, per the Editor, as I have not seen it for the last few months. I would gladly defray postage.

(*To be continued.*)

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* A tankard or drinking vessel.

† A network cap for confining the hair.

WHITWORTH SCHOLARSHIP EXAMINATION PAPERS.

Subject I.—Practical Plane and Solid Geometry.

Examiner, Professor F. A. Bradley.

(*First Paper.*)

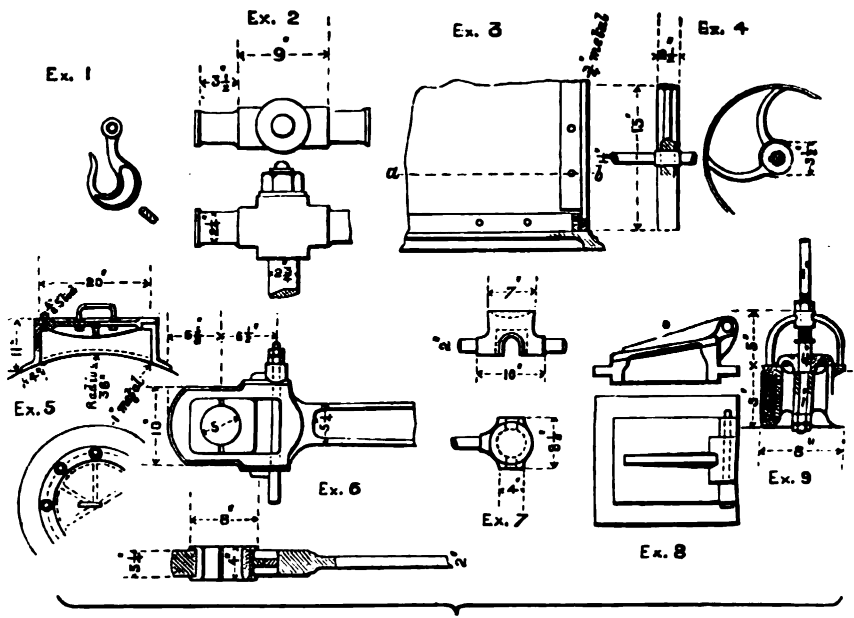
General Instruction.—You are only permitted to answer questions from the elementary paper or from the advanced paper, but not from both. If the rules are not attended to the paper will be cancelled. In all cases the number of the question must be placed before the answer on the worked paper. Three hours are allowed for this examination.

First Stage, or Elementary Examination.

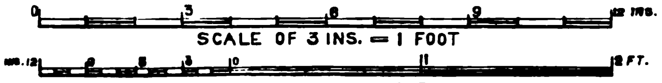
Special Instructions for this Stage.—By well considering the question he is about to attempt the candidate will be able to get all his work, without any crowding or confusion, on the one sheet of drawing-paper given out to him, for he must understand that no second sheet will be allowed him. He is not to attempt more than *eight* questions in this paper, and, to obtain a class, at least *two* of these must be from the solid geometry. The questions in the plane geometry are of equal value. In the solid geometry the relative values are given by the members in brackets. The constructions may be left in pencil provided they are distinct and neat. They must be strictly geometrical, and not the result of calculation or trial. The absence of those lines which would be essential to a correct solution will show that the figure is worthless, however correct the result may appear. Lines parallel or perpendicular to others may be drawn mechanically without showing any construction.

Plane Geometry.—(1) Draw two circles touching one another and a straight line. Radii ·5in. and ·75in. respectively. (2) Find a point P in a line A B (3in. long) produced so that A P : A B as 7 : 4. (3) Draw an equilateral triangle of 3in. side. From a point P in one side ·5in. from the corner, draw a line which shall bisect this triangle. (4) Draw a triangle two of whose angles are 50 deg. and 65 deg., and the radius of the inscribed circle 1in. (5) Draw a square of 2·5in. side, and divide into three equal parts by lines drawn from one corner. (6) Six radii meet in a point O and contain equal angles; OA = 1·1in., OB = 1·3in., OC = 1·5in., OD = 1·5in., OE = 1·4in., OF = 1·2in. Join the points ABC...F, and determine a triangle equal in area to the figure so formed.

Solid Geometry.—(7) The plan of a line is 2in. long and its elevation is 3in. The *projectors* of its extremities are 1in. apart, measured along *xy*. What is its true length and inclination? (6).—(8) The horizontal trace of a plan makes a angle of 30 deg. with *xy*, the vertical trace one of 50 deg. Determine the inclination of the plane and the true angle between the traces (6).—(9) Taking the traces as in the last, in this plane place a line (length at pleasure) inclined at 35 deg., *i.e.*, show the plane and elevation of the line (7).—(10) A pyramid having for its *base* a square 2·5in. side, and its axis 3·25in. long, rests with one *face* on the horizontal plane. Draw its plan, and a sectional elevation on a vertical plane represented by a line bisecting the plan of the axis, and making an angle of 60 deg. with it (6).—(11) Draw the plan of an equilateral triangle of 8in. side, when so held that its corners are at ·9in., 1·6in., 2·5in. respectively above the horizontal plane (5).—(12) Draw the plan of the square pyramid mentioned above when its base is inclined at 47 deg. and one edge of that base at 27 deg. (8).



ELEMENTARY EXAMINATION



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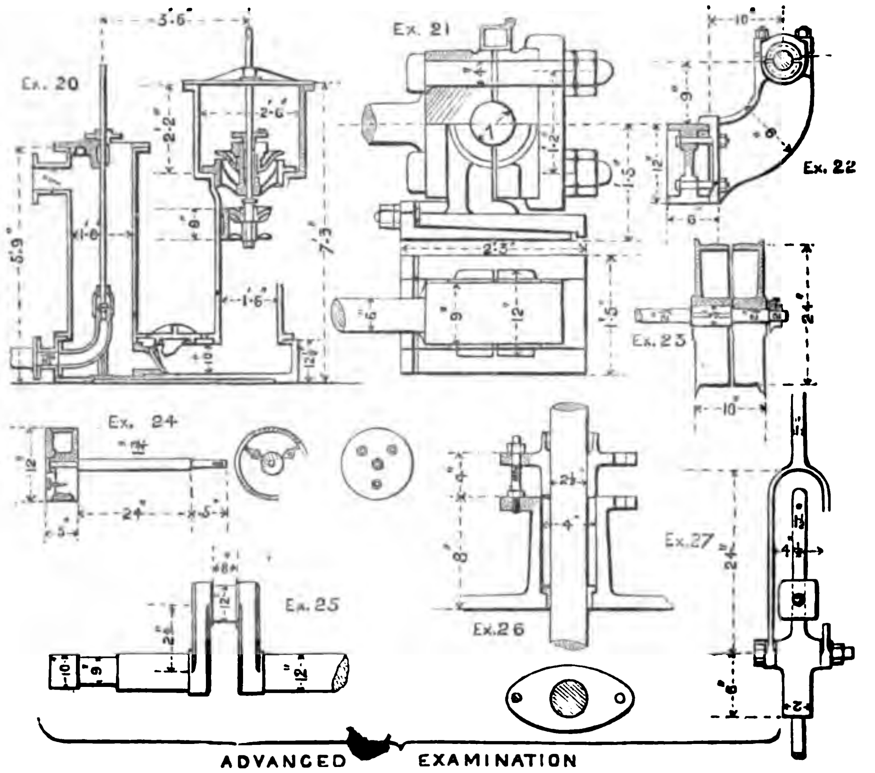


ADVANCED EXAMINATION

Second Stage, or Advanced Examination.

Special Instructions for this Stage (see general instructions on the first page).—By well considering the question he is about to attempt, the candidate will be able to get all his work, without any crowding or confusion, on the one sheet of drawing-paper given out to him, for he must understand that no second sheet will be allowed him. He is not to attempt more than *eight* questions in this paper, and, to obtain a class, at least *three* of these must be from the solid geometry. The relative values of the questions are given by the numbers in brackets attached. The constructions may be left in pencil, provided they are distinct and neat. They must be strictly geometrical, and not the result of calculation or trial. The absence of those lines which would be essential to a correct solution will show that the figure is worthless, however correct the result may appear. Lines parallel or perpendicular to others may be drawn mechanically, without showing any construction.

Plane Geometry.—(21) Construct a regular pentagon whose diagonal shall be 3in. (9).—N.B.—The "diagonal" is from A to C in the figure A B C D E. (22) Divide a square of 3in. side into three equal areas by lines drawn parallel to a diagonal (8).—(23) Draw a triangle whose sides are 2in., 2·5in., and 3in., and an equilateral triangle equal to it in area (10)—(24) Draw an isosceles triangle of 3·5in. area, the vertical angle being 35 deg. (10).—(25) The semi-conjugate diameters of an ellipse are 2·5in. and 1·3in. in length, and contain an angle of 63 deg. Draw the curve and determine its axes (10).—(26) On a certain drawing 1250 yards of real magnitude are represented by 15·5in. Furnish a scale for drawing, and also a "comparative" scale of French metres. 1 metre = 1·0936 yard (10).—N.B.—The English scale may be 500 yards in length.

Solid Geometry.—(27) A point P is 1·3in. above the horizontal plane, 1in. in front of the vertical another Q is 75in. below the *h.p.* and 2·25in. behind the *v.p.* The distance between the projectors measured along *xy* is 2in. Determine the true length and inclination of the line P Q and also its traces (10).—(28) The horizontal trace of a plane makes an angle of 30 deg. with *xy*, the vertical trace one of 60 deg. Determine its inclination and the true angle between its traces [*i.e.*, when the coordinate planes are in their proper position] (10).—(29) Determine the edge of a regular tetrahedron inscribed in a sphere of 3in. diameter. (15).—(30) A right prism, the section of which is an equilateral triangle of 2in. side, is 3in. long. Draw the plan of the prism when one of its faces is inclined at 42 deg. and a long edge of that face at 20 deg. (15).—(31) Determine the traces of three planes which are mutually at right angles, two of them being inclined at 35 deg. and 70 deg. respectively (15).—(32) Draw a circle of 1·25in. radius. This is the plan of a right cone 3·5in. high standing on the horizontal plane. Show the true form of the section of this cone, by a plane whose horizontal trace is 2in. distant from the centre of the plan, and whose inclination is 40 deg. (15).

SUBJECT I.—PRACTICAL PLANE AND SOLID GEOMETRY.

EXAMINER, PROFESSOR F. A. BRADLEY.

(*Second Paper.*)

General Instructions.—You are only permitted to answer questions from the elementary paper or from the advanced paper, but not from both. If the rules are not attended to the paper will be cancelled. In all cases the number of the question must be placed before the answer on the worked paper. Three hours are allowed for this examination.

FIRST STAGE, OR ELEMENTARY EXAMINATION.

Special Instructions for this Stage.—By well considering the question he is about to attempt the candidate will be able to get all his work, without any crowding or confusion, on the one sheet of drawing-paper given out to him, for he must understand that no second sheet will be allowed him. He is not to attempt more than *eight* questions in this paper, and, to obtain a class, at least *two* of these must be from the solid geometry. The questions in the plane geometry are of equal value; in the solid geometry the relative values are given by the numbers in brackets. The constructions may be left in pencil, provided they are distinct and neat. They must be strictly geometrical, and not the result of calculation or trial. The absence of those lines which would be essential to a correct solution will show that the figure is worthless, however correct the result may appear. Lines parallel or perpendicular to others may be drawn mechanically, without showing any construction.

Plane Geometry.—(60) Draw a scale for a drawing where 7·5ft. of real magnitude are represented by 1in. N.B.—The scale must be long enough to measure 50ft. from.—(61) Divide a line AB 3·5″ long in a point P, so that the rectangle contained by AB and AP may be equal to the square upon BP. (62) Draw a triangle whose sides shall be as 2 : 3·5 : 4, and whose circumscribing circle has a radius of 1·5″. (63) Draw a pentagon whose area shall be 5·5 square inches. (64) A circle of 1·25in. radius has its centre 1·5in. distant from a straight line. Draw a circle of 2·25″ radius which shall touch both, but contain the given circle. (65) Draw an isosceles triangle whose base is 2″ and its vertical angle 40 deg., and another twice its area.

Solid Geometry.—(66) Draw the plan and elevation of a point A which is situated above the horizontal plane, 2″ behind the vertical plane, and is 3″ distant from *xy* (6).—(67) A regular tetrahedron (edge 3″) stands with one face on the horizontal plane. Draw its plan, and an elevation on a ground line which makes an angle of 15 deg. with one side of the plan. Show also the *sectional elevation* on a vertical plane which bisects one slant edge, and cuts off one quarter of another (8).—(68) Draw the plan and elevation of a line (length at pleasure) which is inclined at 30 deg. to the horizontal, at 40 deg. to the vertical plane. (69) An hexagonal pyramid (side of base 1·5in., axis 4in.) has one edge of its base horizontal and the plane of that base inclined at 60 deg. Draw its plan, and show the real form of the section made by a horizontal plane bisecting the axis when the solid is so inclined (8).—(70) An isosceles triangle whose vertical angle is 30 deg. and base 2in. revolves upon that base so that the plans of its sides are at right angles. Determine the inclination of the plane of the triangle, and of the sides (7).—(71) Draw the plan of an octahedron of 3in. edge, when two of its diagonals are inclined at 26 deg. and 36 deg. (8).

SECOND STAGE, OR ADVANCED EXAMINATION.

Special Instructions for this Stage (see general instructions on the first page).—By well considering the question he is about to attempt the candidate will be able to get all his work, without any crowding or confusion, on the one sheet of drawing-paper given out to him, for he must understand that no second sheet will be allowed him. He is not to attempt more than *eight* questions in this paper, and, to obtain a class, at least three of these must be from the solid geometry. The relative values of the questions are given by the numbers in brackets attached. The constructions may be left in pencil, provided they are distinct and neat. They must be strictly geometrical, and not the result of calculation or trial. The absence of those lines which would be essential to a correct solution will show that the figure is worthless, however correct the result may appear. Lines parallel or perpendicular to others may be drawn mechanically without showing any construction.

Plane Geometry.—(80) Find by construction $x = \frac{2a}{\sqrt{3}}$, a being 2″ in length, (6).—(81) Divide a line 3·5″ long into two segments so that the area contained by those segments may be 1¼ square inches, (8).—(82) A point P is 1·75″ distant from the centre of a circle of 2·5in. diameter. Draw through P a straight line cutting the circle in Q and R, so that Q R shall be twice P Q (10).—(83) Draw the curve generated by a point on the surface of a disc, and ¼in. from its edge, while the disc rolls along a straight line. Diameter of disc, 2·5in. (10).—(84) A and C are two points 3·25in. apart. B is a third point 1·25in. from A, 2·75in. from B. Given that A and C are the foci of an ellipse, and that B is a point of the curve; draw that curve. Only half need be drawn (10).—(85) Draw a scale of miles $\frac{1}{630000}$ showing furlongs by the diagonal method (10).

Solid Geometry.—(86) One edge of a cube is 2·5in. long, and inclined at 35 deg. A face perpendicular to this edge has one of its diagonals inclined at 25 deg. Draw the plan of the solid, and an elevation on a ground line assumed at pleasure (12).—(87) An oblique pyramid stands on its base, which is a regular hexagon A B C…F of 1·5in. side. V is a vertex. The face V A B is inclined at 75 deg. to the base, V B C at 65 deg., V C D at 60 deg. Draw the plan of the solid, and state its height; also show the inclination of the face V D E (12).—(88) Draw the isometrical projection of a block of wood 3·5in. long, 3in. broad, 1in. thick, with a circular hole of 2·5in. diameter bored through its centre (13).—(89) Draw a circle of 1in. radius, and take a point 2·5in. from its centre. The circle is the plan of a sphere resting on the horizontal plane; the point is the plan of a luminous point 4in. above that plane. Show the shadow of the sphere cast on the horizontal plane by rays of light diverging from the point (15).—(90) A pyramid has for its base a pentagon of 1·25in. side, and its axis is 3in. in length. Draw the plan of the solid when three corners of its base are at heights of ·6in., 1·1in., 1·7in. respectively above the horizontal plane (14).—(91) A right cone whose vertical angle is 40 deg. and axis 3·5in. has the latter inclined at 60 deg. Show a plane tangential to the surface, and having an inclination of 70 deg. (18).

SUBJECT II.—MACHINE CONSTRUCTION AND DRAWING.

EXAMINER, W. CAWTHORNE UNWIN, B. Sc.

General Instructions.—You are only permitted to answer questions from the elementary paper or from the advanced paper, but not from both. If the rules are not attended to the paper will be cancelled. The candidate is expected to prove his knowledge of machinery, as well as his power of drawing neatly to scale. He is therefore to supply details omitted in the sketches, to fill in parts left incomplete, and to indicate by diagonal shading parts cut by planes of section. Where more than one view of the same subject is drawn no credit will be given unless the different views are properly projected one from the other. A little consideration will enable the candidate to arrange all his work on the sheet of paper given out to him; for no second sheet will be allowed. The value attached to each question is shown in brackets after the question, but a full and correct answer to an easy question will secure a larger number of marks than an imperfect answer to a difficult one. If you have not proper scales with you, you may use the scales engraved on the drawing. The dimensions inserted to guide you need not be inserted in your drawing. Four hours are allowed.

FIRST STAGE, OR ELEMENTARY EXAMINATION.

You are only permitted to attempt *five* questions. You may select those from any part of the paper. Read over the general instructions before commencing.

(1) Wrought iron crane hook. Scale, three times that of sketch, (10).—(2) Wrought iron crosshead. Scale, 3in. to the foot (15).—(3) Cast iron water tank. Only a small part of one corner is to be shown, as in the sketch. Draw also, if you can, a section through *a b* of the same part. Scale, 3in. to the foot (15).—(4) Belt pulley. Section and elevation. Complete the elevation of the whole pulley. Scale, 3in. to the foot (20).—(5) Manhole lid and seating. Section and part plan. Complete the plan. Scale, 3in. to the foot (25).—(6) Connecting od end. Elevation and section. Scale, 3in. to the foot (20).—(7) Cast-iron millstone crosshead, or rhind. Elevation and part plan. Complete the plan, and draw, if you can, an end view. Scale, 3in. to the foot (15).—(8) Brass flap valve and seat. Plan and section. Scale, double that of sketch (12).—(9) Brass pump bucket and valve, in section. Draw also, if you can, a plan. Scale, 3in. to the foot (20).

SECOND STAGE, OR ADVANCED EXAMINATION.

You are only to attempt three questions. You may select these from any part of the paper. Read over the general instructions before commencing.

(20) Air pump and condenser, with injection valves, air-pump bucket, and foot and delivery valves, in section. To be drawn to a scale of one inch to the foot (90).—(21) Slipper guide for horizontal engine. Partly in section and partly in elevation, and in plan. Scale, 3in. to the foot (80).—(22) Bracket pedestal. Draw also, if you can, a plan. Scale, 3in. to the foot (30).—(23) Fast and loose pulley. In section. Draw also, if you can, the same view in elevation. Scale, 3in. to the foot (30).—(24) Steam piston. Longitudinal and cross sections, and end view. Scale, 3in. to the foot (25).—(25) Wrought iron crank shaft. Side elevation. Draw, if you can, an end view also. Scale, 1in. to the foot (30).—(26) Stuffing-box and gland. Complete the section and plan. Scale, 3in. to the foot (30).—(27) Crosshead and ends of forked connecting-rod. Scale, 3in. to the foot (25).

HOW TO COLLECT AND STUDY INSECTS.

BY F. G. SANBORN, OF BOSTON, MASS.

ONE can scarcely walk a mile in the country without obtaining some object to grace his cabinet, or observing some fact in natural history to add to his storehouse of mental treasures. It should be borne in mind by the student collector that, notwithstanding he may propose to confined his studies to one order of insects, he should also contract a habit of observing and collecting those of other orders, as well as such small and portable vertebrates and other invertebrates as his opportunities may enable him to capture and preserve. Alcoholic specimens of mammals, birds, fishes, reptiles, mollusks, crustacea, and facts concerning them, are marketable commodities in the exchanges of Science. Especially should this plan be carried out by the collector who may be established for a term of months or years in a region remote from libraries and museums. Such study and investigation in this field as his time permits, will of itself materially enlighten his mind upon the secrets of Nature; and although destitute of books—those records of repeated failures and few successful attempts to unmask Nature's protean face—he may learn the structure, habits, and comparative inteligence of the creatures around him. A subsequent opportunity may occur for him to ascertain, if so disposed, the different technical names imposed upon "Mouse, No. 7," "Bird and Nest, XII," or "Bug, No. 427," and accepted by the scientific world.

Should he care only to acquaint himself with the nomenclature of some limited group or order, and wish to increase his cabinet in that specialty, he will find that he has the powers of a capitalist to invest his miscellaneous collection of specimens and facts in such manner as he may prefer. Thanks to the diversity of tastes implanted in us, there is always some eager specialist—individual or backed by an association—standing ready to give value for, and "work up" this or that portion of such material.

The practice of noting (with *ink* if possible) in a small blank book, or on cards, such facts and observations as he may make or discover, adds immensely to the value of any collection, and cannot be too strongly recommended to the collector. The date of capture of a specimen, of the transformation from the egg, larva, or pupa, of the appearance or disappearance from its usual haunts, and such other items of interest that arise in connection with the specimen, are of importance to the student, and should be therein set down. A small tag or ticket of paper attached to the dry specimen, or of parchment, leather, or soft metal to the alcoholic, and bearing a number corresponding to that in the note-book, renders the information thus obtained available, and sufficiently identities the specimen. As the collector pursues his investigations month after month, he will find his senses becoming educated to a delicacy of touch and fineness of perception that cannot fail to be a source of pride and gratification to him. He whose attention would not at first be diverted to the ragged leaves of a caterpillar-ridden tree will in a few months notice instantly the slight convexity of outline on twig or leaf caused by the presence of a small insect, or the extremity of a branch cleanly cut by a pruner-beetle.

In the course of his observations he will be amused by the imitative shapes and colours of many forms of insect life, and will frequently be deceived by the Curculios, who successfully simulate buds and bits of bark. The caterpillars of some of the moths resemble so closely cylindrical twigs, as many of the Loopers (*Geometridæ*); scales of rough or smooth bark, as the Hag-moth (*Limacodes pithecium*) and the Lappet-moths (*Gastropacha veleda* and *Americana*). Some of the beetles, as the *Crytocephali* and *Histers*, closely resemble seeds, as do certain bugs, among them *Corimelaona*, and the two latter suggest such kinship as to cause them almost invariably to fraternise in the cabinet of the amateur. These singular resemblances are called mimetic forms; and, existing everywhere in nature, even if they have no higher significance and serve no better purpose, educate our perceptive powers to a degree undreamed of by the careless horde of money worshippers. During the active season of the insect year the collector should make it a rule never to stir abroad without a cork-stopped vial half filled with alcohol, for the temporary deposit of beetles, ants, or the larvæ or pupæ of any insects that it may be desirable to preserve in this way. The only insects that are irrecoverably injured by a few days' immersion in pure alcohol are the butterflies and moths. For these a small cork or pith-lined pocket-box, of convenient form, and full 1½ in. in depth, containing a few insect pins of various sizes, is indispensable, and should be a constant companion. Upon a premeditated excursion of a day or more in duration, the collector will naturally provide more extensive means of transportation, such as jars of alcohol, a vial of chloroform, a number of old envelopes a large box slung on side with straps, and a proportionate stock of pins. Some collectors continually carry, in a pocket made for the purpose, a wide-mouthed vial, like a chemist's test-tube, "of the same size all the way up," containing at the bottom a few grains of cyanide of potassium, which is kept in place by a wad of cotton, felt, or thick cloth, neatly pressed down upon it. This prevents the cyanide, which is a deadly poison, from touching or soiling any delicate insect, and allows the powerful vapour to destroy, as it does almost instantly, the life of any insect that may be inclosed in the prepared vial. The permanence of this poison (its virtue enduring for a twelvemonth or more), its cleanliness, and cheapness, render it perhaps the most convenient and desirable "life annihilator." It is, perhaps, unnecessary to mention that the vial should be kept tightly corked, and that the insect should remain therein not much more or less than ten minutes. A vial, 1in. in diameter and 4in. in length, made of strong glass, is the most desirable size. Some collectors carry a small vial of chloroform, through the cork of which passes a very small tube of metal; what is called by jewellers "hollow wire," of minute aperture, is used for this purpose. This instrument is used for conveying a limited quantity of chloroform to the spiracles of the insect, without deluging and damaging much of its plumage, if furnished therewith. Ether, as well as chloroform, is sometimes used in lieu of the cyanide, but it has to be continually supplied from another reservoir. In some countries bruised laurel leaves are placed in the bottom of the vial, or a small packet of them pinned in a corner of the collecting-box, inclosed in a little bag or wisp of loosely-woven cloth, such as lace, book-muslin, &c. All of these poisons act at first only as anæsthetics, or stupifiers, and should be continued in use sufficiently long to destroy vitality, or to prevent th estruggles of the insect; for by these struggles it injures itself, as well as its companions, after being pinned in the collecting box.—*The American Entomologist and Botanist.*

There is, near Grenoble, what guide-books call a burning fountain. Prof. Raoult, who has lately visited this phenomenon, has published a short account of it. It is an emanation of mixed gases. The chief constituent is marsh gas, and there are small quantities of carbonic acid and of olefiant gas.

SCIENCE FOR THE YOUNG.

By the Rev. E. Kernan, Clongowes College.

(*Continued from page 269.*)

CHAPTER III.

§ I.—Forces Applied to a Point.

To have equilibrium there must be at least two forces. From their conditions of equilibrium, that of many forces is easily drawn. Forces (two) may act on a body, *opposite* or *at an angle*.

No. I. **Laws.** These include any number of forces in either of the possible positions. Some laws may appear too self-evident to be mentioned, still they are not the less true laws.

Law I. Two *opposite forces* are in equilibrium when they are equal one to the other. Equilibrium is otherwise impossible.

Law II. Many *opposite forces* are in equilibrium when their algebraical sum is equal to zero. Suppose three forces P Q R, they are in equilibrium when $P + Q - R = 0$. Any number connected by the signs + and − (as they are at one or other side of the body) and reducible to zero, are in equilibrium.

Law III. Two forces *at an angle* cannot be in equilibrium without at least a third. It is not possible that two forces acting at an angle on a body be in equilibrium; the body must move, until they come into a straight line.

Law IV. Two forces *at an angle* may be replaced by a single force, *represented by the diagonal of a parallelogram constructed on the two forces.* The lines which represent the two forces acting here on a body, are supposed to have *each* a length proportionate to the intensity of the force which each represents. When the parallelogram which those lines admit is completed, the diagonal from the point of application represents in *intensity* and *direction* the resultant of the two forces.

Law V. Two forces *at an angle* will be kept in equilibrium by a third force, equal and opposite to their resultant.

Law VI. Many forces in the *same plane* may be reduced by "composition" to two, which can be equilibriated by Law V. Several forces applied to a point can be combined two by two, so as to leave one pair, the resultant of which can be stopped by an equal and opposite force. The whole system is then in equilibrium.

Law VII.—Many forces in *different planes* can be reduced to a resultant, which is equilibriated by Law I. Several forces in different planes and directions can be so combined by one or other of the preceding laws that that there be left but one force.

No. II.—Proofs.

Law I. The body is equally acted upon at both sides; there is no cause to determine motion in one or other direction. As nothing tends to overcome the inertia of the body, it is at rest. Experimentally, Fig. 55. The two forces P and Q acts upon the body A. Their action is effected by the weights *p q*. No matter what these weights, as long as they are equal no effect of motion is seen in A. Raise gently one of the weights at one side; A moves towards the other side. Allow that weight to act again; A remains at rest in the new position. In the Fig. 55, *q* raised, A moved, rests at *b*.

FIG. 55

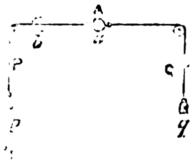
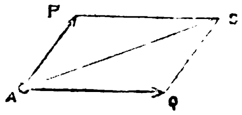


FIG. 56



Law II. As the sum = 0, algebra teaches that the + = − side of the equation. Therefore the forces are in the condition of Law I, for a number of forces, in the same direction, act as one equal to their sum. Experimentally, a number of weights taken at random are divided into two parts, M and N, calculate the sum of each part. If $M - N = 0$, the two parts may be hung to the weights *p q*, Fig. 55, without disturbing equilibrium. If $M - N = n$ (some indefinite quantity) there will be an effect produced on A, it will move at least, if *the differences (n) be considerable.*

Law III. Both forces acting more or less in the same direction, there is nothing to prevent the body from yielding to their joint action. Experimentally, draw down the body A, Fig. 55, let go gently—it is drawn up to the horizontal position; it is not possible, without putting a weight at *(a)*, to have equilibrium at any angle.

Law IV. This law contains the famous proposition known by the title of "The Parallelogram of Forces." Its importance is best evinced by the fact that it may be called the foundation of all mechanical science. Of the parallelogram of forces there are many mathematical proofs, and some experimental. The latter in general refer too much to the dynamical view of the question to be spoken of in statics. The *elementary* mathematical proofs are long, tedious, and not perhaps very satisfactory. But there is a simple yet solid proof based upon a necessary consequence of inertia, which proof will not tax too much the mind or patience of the student. The consequence or principle to be admitted is as follows:—"A force, if allowed to act, must satisfy all its requirements." In plain terms, as before, whatever the force *wants to effect* with regard to any position in space that it must have effected before, it will cease to act. When such has been accomplished, the force is exhausted—has done its work fully. Inertia being a perfect indifference to change of state when the body has acquired motion from a force, it will allow that force to realise all its requirements if no external force can interfere. Therefore the body shall move to such a point in space as will completely exhaust the requirements of the force. With this principle the proof of the *parallelogram of forces* is easy and satisfactory. There are two main points to be proved. First, that the diagonal represents the "direction" which the body would follow if the forces were allowed to act; secondly, that it represents the joint-action or "intensity" of the two forces. The whole argument may be got into three short points.

1. The forces P and Q (Fig. 56) applied to the body A, if allowed to act, must satisfy all their requirements.

The point S of the parallelogram is the only point in space at which the requirements will be satisfied. Therefore the body must be found at S, when the forces have satisfied their requirements.

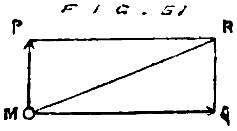
2. The body must have followed the straight line A S (the diagonal) in its passage to the point S, for two points in space are sufficient to determine the direction of a straight line. The starting point A and arrival point B are determined. That the body must take a straight line is evident; first, because the forces are supposed to act but for an instant; secondly, even supposing the action of the forces continuous, their relative proportion must be maintained. Now, instantaneous force is admitted to produce a straight line, and the slightest deviation from the diagonal must destroy the relative proportion of the forces, for nothing exists to make them act otherwise than parallel to their original direction.

3. The line A S must, compared with P and Q, indicate by its length the intensity of their joint action; for, in representing forces by lines, their intensities are shown by length—that is, the distance from the beginning to the end of a line *pictures relatively* the full strength and the complete exhaustion of the forces. Now this is exactly what the diagonal A S exhibits.

To complete this argument, there now remains to be proved one proposition contained in point 1, which, as it is the chief, so it is the longest, in demonstration. Still it is not difficult if taken quietly and by parts. The proposition is: "The point S of the parallelogram is the only point in space at which the requirements can be satisfied." It will be readily admitted that if the point S satisfies the requirements for one position, all the requirements for other positions must be satisfied. For greater simplicity, the lines representing the forces will be taken as the *positions* to be examined; and the three possible sorts of angles which these lines can make (right angle, acute, and obtuse) will make three cases, to be treated separately.

Case I. Right-angle (Fig. 57). The requirement of the force P as regards the position M Q, is to place the body M at a distance from M Q equal to the line M P; for M P being perpendicular on M Q, the length of the force P itself shows the requirement. Now at the point R the body M is at a distance from M Q equal to M P, because (perpendicular between parallels being equal) $QR = MP$; therefore R satisfies the requirement of P. On the other side the require-

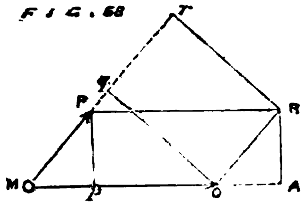
FIG. 57



ments of Q as to the position M P, is to place the body M at a distance from M P equal to M Q for M Q shows the requirement of Q, as M P that of P. Now at R the body is at the distance equal to M Q, as P R = M Q. The point R therefore satisfies the requirements of both P and Q. But there is no other point along the diagonal, along the sides, or in space in general which will satisfy one *or* the other; any point will satisfy these requirements. Various points for instance, along P R will do for P, any point on Q R will do for Q; none will do for *both*, as *along* the diagonal none would do for *either*. Therefore R is the only point which will satisfy the requirements of the two forces.

Case II. Acute angle (Fig. 58). The requirement of the force P as regards the position M Q, is to place the body M at a distance from M Q, equal to P *p*, which shows the requirement being the perpendicular on M Q from the exhaustion point of P. Now at R the body is at the required distance, as R A, the perpendicular from R on the *prolongation* of M Q being equal to P *p*; therefore P is satisfied.

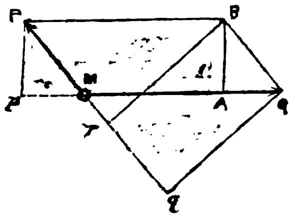
FIG. 58



The requirement of the force Q in regard of the position M P, is to place the body M at a distance from M P equal to Q *q*, the requirement perpendicular of Q. Now at R the body is at the required distance; R *r*, the perpendicular on the *prolongation* of M P, being equal to Q *q*. Again, therefore, R satisfies the requirements of P and Q, and no other point will do so, &c., same reasoning as in Case I.

Case III. Obtuse angle (Fig. 59). The requirement of the force P as to the posti is to place the body M at a distance from M Q equal to P *p*, the perpendicular from the exhaustion of P on to the prolongation of M Q. Now at R the body is at the required distances, R A being equal to P *p*. The requirement of Q as regards M P is to place the body M at a distance from M P equal to Q *q*, the perpendicular from the exhaustion of Q on to M P. Now at R the body is at the required distance, R *r* being equal to Q *q*, therefore R satisfies both P and Q, &c. Finish as in Case I.

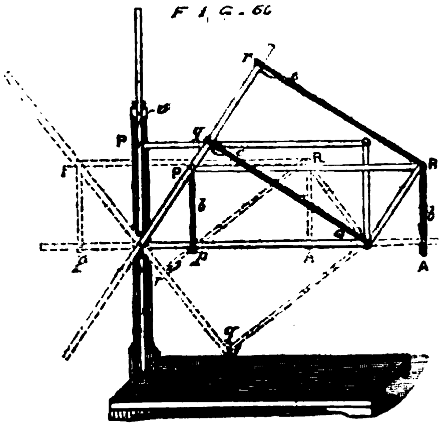
FIG. 59



Following the same train of reasoning, it could be shown that for any position at R the requirements will be fully satisfied. But there is no need of seeking the requirements for other positions, for the points which is necessary for one pair must satisfiy all.

This proof will be firmly imprinted in the mind by drawing lines (forces) at various angles, and looking for the perpendiculars of requirements; let fall, remember, from the end of the lines representing the forces, on to the position chosen. This finding of the perpendiculars is the chief difficulty in the II. and III. Cases; once the general run of the reasoning has been understood. The student may be further helped by a model with rods (Fig. 60), which can be shifted to any of the three positions. The unshaded (white) rods are the forces P and Q, made long to have the prolongations. A pin, *a*, with chain to keep them at the right angle for Case I.; two short black rods *b b* hang from the *top* of the parallelogram. They coincide with P and its parallel in the *first case.* Two long black rods C C, extend from the *end* of the parallelogram and coincide with Q and its parallel in the *first case.* They can be pinned as the forces. Draw pins and shift the whole figure into the acute angle, (this is the chief position *shown;* the right angle is in light lines; the obtuse angle in dotted lines). the small black rods *fall into position* as P *p* and its parallel R A., the long black rods may be raised up to the perpendicular as Q *q* and R *r*, and pinned there. Draw pins and shift to the obtuse angle. The small black rods, fall again into position, as in the dotted figure, and the long ones can be pinned below, as Q *q* and R *r*. The model may be made to range from the most acute to the most obtuse angle.

FIG. 60



(*To be continued.*)

THE SOCIETY OF ARTS ART-WORKMANSHIP COMPETITION FOR 1870-71.

THE Council of the Society of Arts intend in their Art Workmanship competition of next year to suspend for a time the form hitherto adopted in offering prizes for art workmanship, believing the change is likely to be beneficial to the object the Council have at heart, viz., to see the art workmen of the United Kingdom occupying a good position in the coming International Exhibition in comparison with those of other countries.

With this view the Council have decided upon offering a series of rewards for special excellence on the part of all concurring in the satisfactory production of works of industry of the highest character. They consider that they can most effectually ensure their object by offering to manufacturers the highest distinctions they have it in their power to confer, and to workmen liberal money premiums. They desire to obtain, from those who may be willing to compete for the prizes they offer, specimens of art manufacture, which will have to be sent to the society's rooms by the 14th of January, 1871. These will be immediately judged upon their merits, and the premiums enumerated below will be awarded. An endeavour will be made to effect arrangements by means of which every object receiving a premium, or selected for the distinction of being exhibited, will be placed in the coming International Exhibition as a contribution on the part of the Society of Arts, showing the result of recent efforts which have been made to improve art workmanship in this country. The specimens of manufacture sent in in competition for the above rewards and premiums will have affixed to them the name of the designer and of the workmen in each special branch of industry involved in the execution of the work. Every workman will be eligible to receive money premiums proportionate to his merits, and to the degree in which he may have contributed to the successful results of the whole, whilst the manufacturers may receive the gold or silver medals of the society.

The society hope that they may receive objects enabling the judges to award the society's gold medal to manufacturers, and the society's silver medal to manufacturers or designers—accompanied, in the latter case, if the circumstances appear to call for it, with money premiums; and to the art workmen money premiums varying from £3 to £20, and to the extent, in the whole, of £500.

These works may obviously include specimens not only of the taste of the designer, but of the skill of the carver, inlayer, metal worker, chaser, bronzist, engraver, china painter, die sinker, cameo cutter, glass worker, enameller, mosaicist, and other art workmen, either separately or in any combination arranged.

No object involving combined labour for its production will be eligible for reward unless accompanied with the names of all those engaged in its production, to the most meritorious of whom—whether their works may be exhibited in the rooms of the society or in the International Exhibition—every effort will be made by the Council to give publicity and attract attention.

TESTING THE DUTY OF STEAM ENGINES.

AT a recent meeting of the Polytechnic Association of the American Institute, Dr. Van der Weyde gave an explanation of some of the most approved means of testing the duty of steam engines. As the engine may be considered simply as a system of mechanism for changing heat into motion, economy of fuel is the poin most to be considered in any estimate of the utility or working value of a given engine; the questions of first cost and expense of attendance being of comparatively minor consequence. The quantity of fuel required to produce a stated power depends upon the construction of the engine itself, upon the character of the boiler and its furnace, and lastly upon the skill exercised in firing. In estimating the horse-power of an engine, the old plan of multiplying the number of square inches of piston surface by the pressure in pounds per inch in the boiler, and dividing the product by thirty-three thousand, should be ignored; it having been proved fallacious nearly half a century ago. Instead of the steam pressure in the boiler, the steam pressure in the cylinder when the piston is in motion must be taken as the multiplier of the piston area. De Pambour, many years since, in France, demonstrated that the pressure of steam on the moving piston is frequently only a quarter as much as the boiler pressure. This diminution of pressure in the cylinder, as compared with that in the steam-generator, is due partly to bends and impediments in the steam passages, and partly to radiation from the cylinder surface, but in the main to the fact that the steam having to follow the piston is not able to exert its full pressure. From this arises the utility of the indicator showing the steam pressure at all portions of the stroke. For judging a steam engine without regard to the kind of boiler used with it, the weight of steam has until very recently furnished the most practical test, although priming, &c., always makes the apparent evaporation greater than that which really takes place. For trials made on this system, Dr. Van der Weyde gave the following as the rules imperative to be observed, if anything approaching reliable results are to be obtained by this method.

"1st. The water to be measured in tanks, and not by water-meters, which are always unreliable. 2nd. No steam to be used from the boiler, during the trial, for other purposes than for the engine to be tested. 3rd. To let the engine perform a constant well-determined amount of labour during the trial. 4th. The amount of water in the boilers at the end of the experiment should be exactly the same as in the beginning. 5th. When the boilers have blown off salt or muddy water, during the trial, this amount should be ascertained. 6th. The experiments should be very carefully and skilfully performed, and often repeated, in order to eliminate incidental inaccuracies, caused by temperature of the air, variation of water-level, &c."

The objections to the above method, familiar to engineers, may be obviated by a more truly scientific one, which consists in recording the units of heat carried off by the exhaust steam. By simply providing a condensing engine for and specific time with a definite quantity of water as a condensing agent, and noting, by means of a thermometer, the degrees of heat communicated to it by the condensation of the steam, the quantity of heat carried off by the exhaust may be found by a simple calculation. This has very much facilitated the accurate testing of different rates of expansion, &c. The units of heat thus carried off in the exhaust are of course so much abstracted from the force employed to drive the piston, and the less this quantity of heat, other conditions being equal, the more efficient the engine for a given expenditure of fuel. The mode of applying the test is very simple, it being only necessary to place one thermometer in the inlet of water to the condenser and the other at the outlet of the latter. By noting the difference in the temperatures indicated by the two, it remains only to know the quantity of water passed through the condenser per minute, and the results may be readily computed. In testing high pressure or non-condensing engines the same principle is applied, but in a somewhat different manner, the exhaust steam being turned into water in a tank of known capacity, so that the rise in temperature for a given time furnishes, as in the previous instance, the required data of the heat carried from the engine by the exhaust.

SPECTROSCOPIC OBSERVATIONS OF THE SUN.*

BY J. NORMAN LOCKYER, F.R.S.

THE weather has lately been fine enough, and the sun high enough, during my available observation time, to enable me to resume work. The crop of new facts is not so large as it would have been had I been working with a strip of the sun, say fifty miles or a hundred miles wide, instead of one considerably over 1000—indeed, nearer 2000 in width; but in addition to the new facts obtained, I have very largely strengthened my former observations, so that the many hours I have spent in watching phenomena, now perfectly familiar to me, have not been absolutely lost.

The negative results which Dr. Frankland and myself have obtained in our laboratory-work in the matter of the yellow bright line near D, in the spectrum of the chromosphere being a hydrogen line, led me to make a special series of observations on that line, with a view of differentiating it, if possible, from the line C.

It had been remarked, some time ago, by Prof. Zollner, that the yellow line was often less high in a prominence than the C line; this, however, is no evidence (bearing in mind our results with regard to magnesium). The proofs I have now to lay before the Royal Society are of a different order, and are, I take it, conclusive:—

1. With a tangential slit I have seen the yellow line bright below the chromosphere, when the C line has been dark; the two lines being in the same field of view.

2. In the case of a bright prominence over a spot on the disc, the C and F lines have been seen bright, while the yellow line has been invisible.

3. In a high-pressure injection of hydrogen, the motion indicated by change of wave-length has been less in the case of the yellow line than in the case of C and F.

4. In a similar quiescent injection the pressure indicated has been less.

5. In one case the C line was seen long and unbroken, while the yellow line was equally long, but broken.

The circumstance that this line is so rarely seen dark upon the sun makes me suspect a connection between it and the line at 5015 Angstrom, which is also a bright line, and often is seen bright in the chromosphere, and then higher than the sodium and magnesium lines, when they are visible at the same time; and the question arises, must we not attribute these lines to a substance which exists at a higher temperature than those mixed with it, and to one of very great levity? for its absorption-line remains invisible, as a rule, in spot-spectra.

I have been able to make a series of observations on the fine spot which was visible when I commenced them on April 10th, not far from the centre of its path over the disc. At this time, the spot, as I judged by the almost entire absence of indications of general absorption in the penumbral regions, was shallow, and this has happened to many of the spots seen lately. A few hours' observation showed that it was getting deeper apparently, and that the umbræ were enlarging and increasing in number, as if a general down-sinking were taking place; but clouds came over, and the observations were interrupted.

By the next day (April 11) the spot had certainly developed, and now there was a magnificently bright prominence, completely over the darkest mass or umbra, the prominence being fed from the penumbra or very close to it, a fact indicated by greater brilliancy than in the bright C and F lines.

April 12. The prominence was persistent.

April 15. Spot nearing the limb, prominence still persistent over spot. At 11 I saw no prominence of importance on the limb, but about an hour afterwards I was absolutely startled by a prominence not, I think, depending on the spot I have referred to, but certainly near it, more than 2ft. high, showing a tremendous motion towards the eye. There were light clouds, which reflected to me the solar spectrum, and I therefore saw the black C line at the same time. The prominence C line (on which changes of wave-length are not so well visible as in the F line) was only coincident with the absorption-line for a few seconds of arc!

Ten minutes afterwards the thickness of the line towards the right was all the indication of motion I got. In another ten minutes the bright and dark lines were coincident.

And shortly afterwards what motion there was, was towards the red!

I pointed out to the Royal Society, now more than a year ago,* that the largest prominences, as seen at any one time, are not necessarily those in which either the intensest action or the most rapid change is going on. From the observations made on this and the following day, I think that we may divide prominences into two classes:—

1. Those in which great action is going on, lower vapours being injected; in the majority of cases these are not high, they last only a short time—are throbs, and are often renewed, and are not seen so frequently near the sun's poles as near the equator. They often accompany spots, but are not limited to them. These are the intensely bright prominences of the American photographs.

2. Those which are perfectly tranquil, so far as wave-length evidence goes. They are often high, are persistent, and not very bright. These do not, as a rule, accompany spots. These are the "radiance" and dull prominences shown in the American photographs.

I now return to my observations of the spot. On the 16th, the last of the many umbræ was close to the limb, and the most violent action was indicated occasionally. I was working with the C line, and certainly never saw such rapid changes of wave-length before. The motion was chiefly horizontal, or nearly so, and this was probably the reason why, in spite of the great action, the prominences, three or four of which were shut out, never rose very high.

I append some drawings, made, at my request, by an artist, Mr. Holiday, who happened to be with me, and who had never, seen my instrument or the solar spectrum widely dispersed before. I attach great importance to them, as they are the untrained observations of a keen judge of form.

The appearances were at times extraordinary and new to me. The hydrogen shot out rapidly, scintillating as it went, and suddenly here and there the bright line, broad and badly defined, would be pierced, as it were, by a line of intensely brilliant light parallel to the length of the spectrum, and at times the whole prominence spectrum was built up of bright lines so arranged, indicating that the prominence itself was built up of single discharges, shot out from the region near the limb with a velocity sometimes amounting to 100 miles a second. After this had gone on for a time, the prominence mounted, and the cyclonic motion became evident; for away from the sun, as shown in my sketch, the separate masses were travelling away from the eye; then gradually a background of less luminous hydrogen was formed moving with various velocities, and on this background the separate "bombs" (I was working with a vertical spectrum) like exquisitely jewelled ear-rings.

It soon became evident that the region of the chromosphere just behind that in which the prominence arose, was being driven back with a velocity something like 20 miles a second, the back-rush being so local that, with the small image I am unfortunately compelled to use, both the moving and rigid portions were included in the thickness of the slit. I saw the two absorbing--lines overlap.

These observations were of great importance to me; for the rapid action enabled me to put together several phenomena I was perfectly familiar with separately, and see their connected meaning.

They may be summarised as follows, and it will be seen that they teach us much concerning the nature of prominences. When the air is perfectly tranquil in the neighbourhood of a large spot, or, indeed, generally in any part of the disc, we see absorption-lines running along the whole length of the spectrum, crossing the Frauenhofer lines, and they vary in depth of shade and breadth according as we have pore, corrugation, or spot under the corresponding part of the slit—a pore, in fact, is a spot. Here and there, where the spectrum is brightest (where a bright point of facula is under the slit) we suddenly see this appearance—an interesting bright lozenge of light. This I take to be due to bright hydrogen at a greater pressure than ordinary, and this then is the reason of the intensely bright points seen in ranges of faculæ observed near the limb.

The appearance of this lozenge in the spectroscope, which indicates a diminution of pressure round its central portion, is the signal for some, and often all, of the following phenomena:—

1. A thinning and strange variation in the visibility and thickness of the hydrogen absorption-line under observation.

4. If near the limb, this prominence may extend beyond it, and its motion-form will then become more easy of observation. In such cases the motion is cyclonic in the majority of cases, and generally very rapid, and—another feature of a solar storm—the photospheric vapours are torn up with the intensely bright hydrogen, the number of bright lines visible determining the depth from which the vapours are torn, and varying almost directly with the amount of motion indicated.

Here, then, we have, I think, the chain that connects the prominences with the brighter points of the faculæ.

These lozenge-shaped appearances, which were observed close to the spot on the 16th, were accompanied by the "throbs" of the eruption, to which I have before referred; while Mr. Holiday was with me—a space of two hours—there were two outbursts, separated by a space of almost rest, and each outburst consisting of a series of discharges, as I have shown. I subsequently witnessed a third outburst. The phenomena observed on all three were the same in kind.

On this day I was so anxious to watch the various motion-forms of the hydrogen lines, that I did not use the tangential slit. *This I did* the next day (the 17th of April) in the same *region*, when similar eruptions were visible, though the spot was no longer visible.

Judge of my surprise and delight, when upon sweeping along the spectrum, I found hundreds of the Frauenhofer lines beautifully bright at the base of the prominence! ! !

The complication of the chromosphere spectrum was greatest in the regions more refrangible than C, from E to leng past *b*, and near F, and high pressure iron vapour was one of the chief causes of the phenomenon.

I have before stated to the Royal Society that I have seen the chromosphere full of lines; but the fulness then was as emptiness compared with the observation to which I now refer.

A more convincing proof of the theory of the solar constitution, put forward by Dr. Frankland and myself, could scarcely have been furnished. This observation not only endorses all my former work in this direction, but it tends to show the shallowness of the region on which many of the more important solar phenomena take place, as well as its exact locality.

The appearance of the F line, with a tangenial slit at the base of the prominence, included two o the lozenge-shaped brilliant spots to which I have before referred; they were more elongated than usual—an effect of pressure, I hold, greater pressure and therefore greater complication of the chromosphere spectrum; the complication is almost impossible of observation on the disc.

It is noteworthy that in another prominence, on the same side of the sun, although the action was great, the erupted materials were simple, *i.e.*, only sodium and magnesium, and that a moderate alteration of wave-length in these vapours was obvious. Besides these observations on the 17th, I also availed myself of the pureness of the air to examine telescopically the two spots on the disc, which the spetroscope reported tranquil as to up and down rushes. I saw every cloud-dome in their neighbourhood perfectly, and I saw these domes drawn out, by horizontal currents, doubtless, in the penumbræ, while on the floors of the spots, here and there, were similar cloud-masses, the distribution of which varied from time to time, the spectrum of these masses resembling that of their fellows on the general surface of the sun.

I have before stated that the region of a spot comprised by the penumbræ appears to be shallower in the spots I have observed lately (we are now nearing the maximum period of sun spots); I have further to remark that I have evidence that the chromosphere is also shallower than it was in 1868.

I am now making special observations on these two points, as I consider that many important conclusions may be drawn from them.

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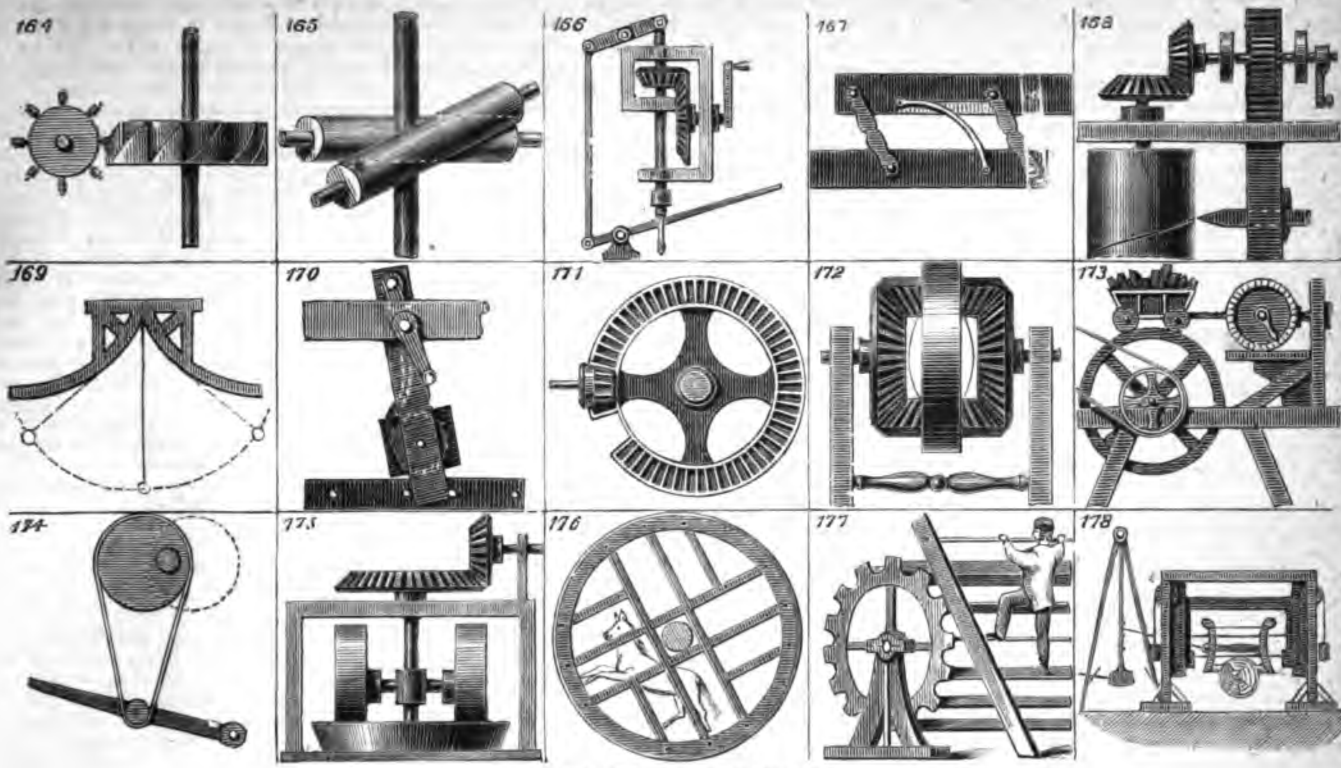
* Read before the Royal Society, May 19.

* Proc. Roy. Soc. 1869, p. 354, Mar. 17.



MECHANICAL MOVEMENTS.

MECHANICAL MOVEMENTS.*

(*Continued from page* 292.)

164. Intermittent rotary motion from continuous rotary motion about an axis at right angles. Small wheel on left is driver; and the friction rollers on its radial studs work against the faces of oblique grooves or projections across the face of the larger wheel, and impart motion thereto.

165. Cylindrical rod arranged between two rollers, the axes of which are oblique to each other. The rotation of the rollers produces both a longitudinal and a rotary motion of the rod.

166. Drilling machine. By the large bevel-gear, rotary motion is given to vertical drill-shaft, which slides through small bevel-gear but is made to turn with it by a feather and groove, and is depressed by treadle connected with upper lever.

167. A parallel ruler with which lines may be drawn at required distances apart without setting out. Lower edge of upper blade has a graduated ivory scale, on which the incidence of the outer edge of the brass arc indicates the width between blades.

168. Describing spiral line on a cylinder. The spur-gear which drives the bevel-gears, and thus gives rotary motion to the cylinder, also gears into the toothed rack, and thereby causes the marking point to traverse from end to end of the cylinder.

169. Cycloidal surfaces, causing pendulum to move in cycloidal curve, rendering oscillations isochronous or equal-timed.

170. Motion for polishing mirrors, the rubbing of which should be varied as much as practicable. The handle turns the crank to which the long bar and attached rachet-wheel are connected. The mirror is secured rigidly to the ratchet-wheel. The long bar, which is guided by pins in the lower rail, has both a longitudinal and an oscillating movement and the ratchetwheel is caused to rotate intermittently by a click operated by an eccentric on the crank-shaft, and hence the mirror has a compound movement.

171. Modification of mangle-wheel motion. The large wheel is toothed on both faces, and an alternating circular motion is produced by the uniform revolution of the pinion, which passes from one side of the wheel to the other through an opening on the left of the figure.

172. White's dynamometer, for determining the amount of power required to give rotary motion to any piece of mechanism. The two horizontal bevel-gears are arranged in a hoop-shaped frame, which revolves freely on the middle of the horizontal shaft, on which there are two vertical bevel-gears gearing to the horizontal ones, one fast and the other loose on the shaft. Suppose the hoop to be held stationary, motion given to either vertical bevel-gear will be imparted through the horizontal gears to the other vertical one; but if the hoop be permitted it will revolve with the vertical gear put in motion, and the amount of power required to hold it stationary will correspond with that transmitted from the first gear, and a band attached to its periphery will indicate that power by the weight required to keep it still.

173. Robert's contrivance for proving that friction of a wheel carriage does not increase with velocity, but only with load. Loaded waggon is supported on surface of large wheel, and connected with indicator constructed with spiral spring, to show force required to keep carriage stationary when large wheel is put in motion. It was found that difference in velocity produced no variation in the indicator, but difference in weight immediately did so.

174. Rotary motion of shaft from treadle by means of an endless band running from a roller on the treadle to an eccentric on the shaft.

175. Pair of edge runners or chasers for crushing or grinding. The axles are connected with vertical shaft, and the wheels or chasers run in an annular pan or trough.

176. Tread-wheel horse-power turned by the weight of an animal attempting to walk up one side of its interior; has been used for driving the paddle-wheels of ferry-boats and other purposes by horses. The turnspit dog used also to be employed in such a wheel in ancient times for turning meat while roasting on a spit.

177. The tread-mill employed in gaols in some countries for exercising criminals condemned to labour, and employed in grinding grain, &c; turned by weight of persons stepping on tread-boards on periphery. This is supposed to be a Chinese invention, and is still used in China for raising water for irrigation.

178. Saw for cutting trees by motion of pendulum, is represented as cutting a lying tree.

(*To be continued.*)

EXHIBITION OF 1871.

THE year 1871 will see the first of a series of annual International Exhibitions, which while formed on such basis as experience gained by the many exhibitions that have been held during the last twenty years has shown to be right and desirable, are yet due to, and actually spring from, the success of the great Universal Exhibition of 1851. The close of that undertaking found the Commissioners incorporated to carry it out possessed of a surplus amounting, in round numbers, to £180,000. This surplus the Commissioners bound themselves by charter to deal with according to the spirit in which the Exhibition had been conceived, and the object for which the public money had been asked for and received—that is, in the encouragement of art and industry. It was therefore invested in such a manner as should render it available, at some future time, for the establishment of permanent exhibitions.

That time has now arrived, and the series that commences next year is therefore the direct result of the Exhibition of 1851, and the Commissioners intend to bear the whole cost and responsibility, without either government money or public guarantee.

Permanent exhibitions must of necessity be established on a different basis than those which are temporary, if they are to be successful. The promoters of the Exhibition of 1851 had no statistics by which they could be guided into the right course of action. The many exhibitions that have, however, been held since in this and other countries have afforded proof that there are certain limits of time, space, and expense which cannot be exceeded without loss and failure. To hold them at any other period than between the months of May and September, is practically to shut out many of the productions of Northern Europe, where the ports are closed by the rigours of winter. The expense of the erection of temporary buildings for decennial exhibitions was constantly increasing, and, with other charges, rendered it necessary for those who undertook their promotion to incur a heavy pecuniary liability, which, coupled with the limits as to the time during which the exhibition could remain open, rendered financial success, at each succeeding exhibition, more difficult of attainment.

Generally, the exhibitions outgrew their limits. For the fulfilment of their legitimate purpose, which was to show from time to time the progress made by art and industry, in connection with the staple manufactures of the country in which they were held, necessitated that a large number of objects should be received, required enormous space for their exhibition, though in themselves possessing but little merit as objects of artistic industry.

With these facts before them, the Commissioners propose, in the first place to make an International Exhibition a permanent institution of the country, giving to the industrial art the same opportunity that is afforded to fine art by the annual exhibitions of the Royal Academy. In the second place, they propose to reduce the area over which the exhibition shall spread itself, by reducing the various industries into groups, and taking certain of these each year, bring the entire industry of the country under review every seven or eight years, fine art being a standing division of the programme. And, in the third place, to restrict the conditions under which exhibits have hitherto been received, by making all articles undergo a preliminary sifting, through appointed committees of selection, thus excluding all works that do not possess sufficient artistic merit to warrant their exhibition, and by the further exclusion of mere masses of natural products.

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* Extracted from a compilation by Mr. H. T. BROWN, Editor of the "American Artisan."

The great aim of the early periodical exhibitions established by the Society of Arts was the closer union of art and industry; this was also the object which H.R.H. the Prince Consort had so much at heart in promoting the first Great Exhibition. The Commissioners now propose, in these permanent exhibitions, to carry on the work of bringing about a closer alliance between artistic design and usefulness of purpose, by, to use their own words, "stimulating the application of the artists' talents, to give beauty and refinement to every description of object of utility."

REVIEWS.

"The Modern Practical Angler: A Complete Guide to Fly-fishing, Bottom-fishing, and Trolling." By H. Cholmondeley-Pennell, Inspector of Fisheries. Author of the "Angler-Naturalist," the "Book of the Pike," &c. London: F. Warne and Co.

We imagine that most of our readers who have any pretensions to be considered fishermen, or who have followed the windings of any of our beautiful streams in search of the pleasure which Angling affords alike to the greatest statesmen as to the meanest kind, will not require to be told that Mr. Pennell is one of our most accomplished anglers, whether in theory or practice. Those who have read his "Book of the Pike" well know the amount of information he has brought to light concerning the habits and peculiarities of the "pirate of the river"—ndeed, so carefully and minutely has he described he life-history of this fish, that he is commonly called the "Father of Pike-fishers." We offer no apology, therefore, for plunging at once nto the mysteries of the craft, convinced that what Mr. Pennell recommends, however novel, is at all events worth trial; and as the holidays are drawing near, we will see what he has to say towards filling the creels of such of our readers as may betake them to the Tweed, the Blackwater, or the Thames.

The author commences his manual by saying that pike and trout, like other mundane creatures, are better educated, or at all events sharper, than their progenitors of the time of Izaak Walton or Dame Juliana Berners, who wrote the "Boke of St. Alban's," published about 1486, wherein the rod is recommended to be of at least some 14ft. long; the "staffe" or butt, measuring a "fadoom (fathom) and a-half," of the thickness of an "arm-grete," or *about as thick as a man's arm*, the joints being bound with long "hopis of yren" (iron hoops). But whether fish are more intelligent, or are simply more timid, from their inability to find in the United Kingdom a mile of water that is not haunted by those tantalising flies that have wrought the doom of so many of their comrades, Mr. Pennell is decidedly and emphatically of opinion that the man who fishes "finest" will be able to show the heaviest creel at the close of a day's sport.

Chapter I. lays down the theory of what a hook should be, describes the various forms of hooks hitherto used, and after pointing out their numerous deficiencies, explains the advantages of Mr. Pennell's pattern, which has all the good qualities of the "sneck" and "sproat-bend," without their drawbacks. It much resembles the "sneck," but with a difference in bend, as well as in the barb and point, and is certainly much stronger, because the strain is distributed, and does not fall on one part. The author has, also, devised a new form of the rather-important "lip-hook," on which depends the proper position of the bait and flight. By leaving the shank of the hook unpolished, and altering the position of the loops so that the line lies close to the hook, he has succeeded in obtaining the requisite ease in shifting, and fixity when required, combined with durability and neatness.

In the matter of spinning tackle Mr. Pennell peaks with no uncertain voice. He unhesiatingly condems the employment of such a number of triangles and hooks, as was formerly the fashion—sometimes no fewer than three to five of the former being used on one flight—and he attributes to them, and to the "crinkling" or "kinking" of the line, the loss of about 50 or 60 per cent. of fish after being struck. Here are his own words:—"These [triangles] were not only useless, but distinctly mischievous, both as regards the spinning of the bait and the basketing of the fish when hooked. Upon the bait they acted by impairing its brilliancy and attractiveness, rendering it flabby and inelastic. Upon the fish they operated only as fulcrums, by which he was enabled to work out of the hold of such hooks as were already fast. The great size and defective bends of many of the hooks used, contributed materially to swell the proportion of losses, as it should be remembered that to strike a No. 20 hook fairly over the barb, requires at least three times the force that is required to strike in a No. 10; and that this disparity is increased when the hooks are used in triangles. A jack, say, has taken a spinning-bait dressed with a flight of three or four of these large triangles, and a sprinkling of single hooks—perhaps 11 or 12 in all. The bait probably lies between his jaws, grasped crosswise, and therefore the points of at least six of these hooks will be pressed by the fish's mouth, whilst the bait also to which they are attached is held firmly in his teeth. The whole of this combined resistance must be overcome—and that at one stroke, and sharply—before a single point can be buried above "the barb."

In the matter of "kinking," Mr. Pennell has inquired into what might be called the science of the subject; and instead of passing his tract through the *centre* of the weight, in which position the lead could not, of course, prevent the line from turning, he fastens the lead to the side of the line, or, at least, in such a position that nearly the whole weight is exerted against the twisting of the line. He recommends that the lead should be varnished with powdered dark-green sealing-wax, mixed with spirits of wine to the consistency of thin treacle. With the lead fixed in this manner *one* really good swivel will be found sufficient, although a double one avoids any hitch that might arise through the single swivel being rusty. Speaking of trolling-lines, the author is decidedly opposed to hair, when used by itself (when a line 80 yards long would cost 25s. or 30s.), or mixed with silk; but recommends the use of what is known as 8-plait dressed silk, of a pale green tint.

For reel-lines for fly-fishing, Mr. Pennell, till within the past twelvemonths, has used the dressed silk; but he has recently tried a line made of spun cotton, which, while much cheaper than the dressed silk, is equally strong and more durable. It is "cable-laid"—*i.e.*, the "ropes" of which the cable is made are twisted the reverse of the strands, and the twisting of the "cable" is the opposite of the "ropes." Mr. Pennell speaks highly of these lines, and says they "answer perfectly, both for fly-fishing and ordinary bottom fishing."

For bottom-fishing and fly-fishing lines gut is to be preferred—the fine, round, natural gut, that is not scraped, and made small artificially, and consequently weaker.

Mr. Pennell next describes the various woods used in the manufacture of rods, and the processes they undergo before they appear as the perfect implement. He prefers as a general rule, rods with ash butts, and middles and tops made of greenhart (? greenheart), and, what will surprise most readers, says, that the difference in weight between rods of solid wood and those made of bamboo, is so trifling, as scarcely to be worthy of consideration:—"I weighed a 12ft. solid ash and greenhart trolling-rod, against one of stout East India bamboo, and the weights were:—solid rod 1lb. 5½oz., hollow rod 1lb. 4oz.; difference, 1½oz." The knots used in fastening lines and hooks are elaborately described, and being illustrated, are made plain to the merest tyro.

It would take a whole chapter to thoroughly examine Mr. Pennell's theory of flies and fly-fishing; and we must be content to state that, instead of expatiating on the allurements and beauties of the "thousand and one" flies to be seen in tackle-shops, he is convinced that six typical ones are all that is necessary for the purposes of the angler, no matter what water he is fishing—three being devoted to salmon and grilse, and three to trout, grayling, &c. Mr. Pennell is opposed to fishing *up-stream*, except when a strong wind is blowing in that direction, and as most experienced anglers are of his way of thinking, there cannot be much doubt that he is correct, especially as this method is found to fail in practice. The author likewise advises—what will be considered rank heresy by some—that in spinning for pike the fisherman should *strike directly he feels a run.* But we have limits to our space, and must conclude by observing that the remaining chapters of Mr. Pennell's book, containing a description of the different varieties of fish, their habits and their haunts, together with the method of angling for them, and the best kinds of tackle to use in endeavouring to achieve their capture. There are also some excellent lithographs, which really represent the fish they are intended for, and there is a coloured frontispiece representing the flies the author considers sufficient for all practical purposes. We may have occasion to refer to this work again, but in the mean time we are confident that while the fisherman who is a proficient in his art will find much to claim his attention, it is a very *vade-mecum* for all tyros who wish to become masters of the "gentle craft."

"Drawing for Carpenters and Joiners, &c., &c." By Ellis A. Davidson. Cassell, Petter, and Galpin.

We have on three previous occasions drawn attention to the very cheap and good technical manuals by Mr. Ellis A. Davidson, recently published by Messrs. Cassell, Petter, and Galpin. The present volume is thoroughly worthy of its predecessor on "Building Construction," and should reach a far wider circle. All of us are, or think ourselves more or less carpenters, and the more or less miserable specimens of the art some amateurs occasionally turn out, should serve to remind them of the necessity of their possessing a book like the one before us. If one thing is more certain than another it is that good execution must be preceded by good design, and a carpenter unable to use his pencil labours under terrible disadvantages. "Drawing," as Mr. Davidson most truly says, "is the language of the workshop more eloquent than words, more rapidly understood, and less liable to be misapprehended." The book is so arranged as to combine linear, freehand, and object drawings each of these branches being again divided and subdivided, and thus in linear drawing, foundations, piles, cofferdams, wooden bridges, roofs, staircases, doors, gates, &c., are made subjects of study. Mouldings, borders, scrolls, &c., are included in the freehand section; whilst under the head of object drawing, a few simple rules of perspective and shading are given, in order to enable the student to draw with some degree of correctness from the subject before him.

"The Second Course of Orthographic Projection being a Consummation of the New Method of Teaching the Science of Mechanical and Engineering Drawing," &c., &c. By William Binns, Ass. I.C.E. London: E. and F. N. Spon, 48, Charing-cross.

The success of the author's elementary treatise on "Orthographic Projection and its Application to Mechanical and Engineering Drawing," confirmed his intention of hereafter publishing a larger and more comprehensive work, although he appears to have delayed it very considerably on account of the pertinacious efforts of "men who have had no practice in the workshop," to "put it down." It would undoubtedly have been a loss to those for whom the publication is intended, had its appearance been altogether prevented. It is an exceedingly useful book, not only for the mechanical draughtsman, who will find in it a perfect encyclopædia of "wrinkles" and dodges to aid him in the easy accomplishment of his work, but by engineers and pattern makers, a considerable portion of the space being devoted to a subject in constant discussion among our readers—the formation of the teeth of wheels. Mr. Binns claims, without materially altering the form of tooth acknowledged to be the best, to have introduced one that shall be uniform, thus avoiding the anomalous practice which still exists in this important branch of mechanical engineering.

Mr. Binns' method of teaching mechanical drawing is now practised in the various art schools of the United Kingdom, and we have little doubt that this record of its publication will be gladly read by many who have been looking expectantly for his "Second Course."

"Hogg's Secret Code for Letters or Telegrams."
G. Hogg, and Co., 122, Fleet-street.

THIS secret code is a more perfect development of that issued two months back on a card by Messrs. Hogg. The present plan saves considerable trouble and time to persons using the code, and an important improvement in the secret notation for figures considerably enhances the value of the system. The chief merit of the code is that its application can be so changed at the will of the sender or receiver that it is impossible for any but themselves to read the message or letter sent. The same message can be written in thousands of different ways—that is to say, that fifty people might telegraph the result of the boat race, and none of them should be able to read the others' messages, though all sent on the same system and in the same words.

LETTERS TO THE EDITOR.

OPTICAL AND SPECTROSCOPICAL.

SIR,—If "O. G." p. 282, can obtain access to an achromatic refractor of Dallmeyer's construction, will direct it to the Moon, and focus carefully on her limb; then if moving the rack tube inwards do not produce a purple fringe to the edge of the image, and screwing it outwards a green one, I can only say that he must be the subject of a peculiar sort of colour blindness. Of course all the outstanding colour is "attributable to the irrationality of the glass employed," but the aim of the optican is always to unite the extreme bright rays; and, in practice, such discs of crown and flint glass are selected as to ensure this union, and at the same time leave the smallest possible amount of secondary spectrum. The effect of over-correction is, in my own case, to give a factitious brilliancy to the image viewed: that of under-correction, to surround everything with a wretched orange fringe, which appears to dull and blunt detail of every description. All the German glasses I have ever seen have been, more or less, over-corrected.

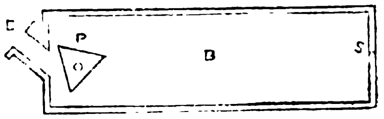
The test of the "Optical Bricklayer," p. 284, is scarcely a crucial one. I think, were I he, that I would repeat it with a watch dial upon which the sun should be shining at the time: or, if he knew exactly what to look for, he might try the reflection of the Evening Sun from the bulb of a thermometer, and see what sort of a figure the artificial star thus produced presented. Still, if small print and the fine lines of an engraving were "well defined, clear and black, without any appearance of mist," his speculum cannot be a bad one under any circumstances, and may be a very excellent one.

"Northern Light," (4063), p. 311, appears to labour under a very curious misapprehension as to what determines the size of the field of view in a telescope; inasmuch as he says, *apropos* of his Gregorian, that "there is a strangely small field, not larger than the field of the eyepiece itself, when detached from the body of the telescope!" Why, of course, this field (*being determined by the size of the stop between the lenses of the eyepiece*) must present the same diameter to the eye, whether the eye-piece be looked through apart from, or in connection with the telescope. As for remedying the defect of which your correspondent complains, it seems to me that, in all probability, his eye-tube is a small one, and of course will only take an eyepiece having lenses of small diameter. These again will not act without a stop between them, and this, *ex necessitate*, must be smaller still. The distance of the lenses apart, has nothing to do with it. In the Huyghenian eyepiece, it is absolutely essential to its achromatism that they be separated by a distance equal to half the sum of their focal lengths. If practicable, an eyepiece of greater diameter with, of course, a larger stop, would give "Northern Light" a field of increased size: but is he quite sure that it would be perfect up to the edge? Depend upon it, the reflector maker had good reason for confining the formation of his image to the central pencils.

I have to thank Mr. Vivian p. 307, for his reference to that wonderful old repertory of information, "Smith's Optics." The mode given of finding the focal length of a concave lens is sufficiently simple, and its reason evident; but still it would require one to think it out before arriving at it. Not so with the second method, given by Mr. Preston, on p. 309, that of combining the lens, whose focus is to be determined, with a convex one of known focus, which ought to have occurred to me merely by the light of nature. Why it did not, it would not be flattering to myself to hint.

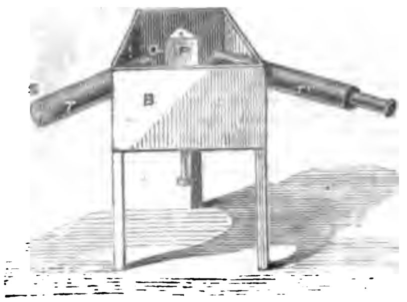
Without giving another paper on the construction of the spectroscope, it may suffice for the present purp os of Mr. H. W. Bishop, (4004), p. 287, if I inform him that the simplest form of spectroscope, if it be worthy of that appellation, with which I am acquainted, is one which I proceed to describe; and which consists merely of a prism at one end of a small box about a foot long, which has a slit at the other end of it about $\frac{1}{80}$in. wide, and a ¼in. in length parallel to the refracting edge of that prism. An eyehole sloped upwards serves to direct the eye to the image of the spectrum. In the annexed section of this affair, B represents the box, S the slit running parallel to the width of the box, P the prism, and E the eyehole. In the case of one which I constructed myself some time ago, I made the slit with two knife edges separable by a fine threaded screw. The knife edges I filed out of the old brass scale off a broken thermometer, and it took me all one afternoon to turn and cut the screw, &c., in the lathe; but this was a needless refinement, as a slit carefully made with a very sharp penknife in a piece of latten brass will answer all the purpose. Particular care should, however, be taken to remove every trace of ruggedness from its edge, as every little excrescence will produce a dark line parallel with the *length* of the spectrum. It is almost needless to add that the box itself must be densely blackened inside. The mode of using this primitive apparatus will be obvious. Directing the slit to the source of light to be examined, the prism is turned round on its axis until the spectrum is plainly seen, and then if we are regarding Sunlight, daylight, or moonlight, several of the most conspicuous of Fraunhöfer's lines (p. 172) will be perceptible enough, with a little attention, to the naked eye. Notably D, E, *b*, F, and G will be apparent like transverse shadings with a lead pencil. An exceedingly slight rotation of the prism on its axis will be essential to obtain the best definition of the individual lines separately, as they are not all precisely in focus at once. When D, the Sodium line (p. 172), is sharply seen, if a common spirit lamp with a pinch of salt on its wick be flashed across the slit, the brilliant yellow line of vapourised Sodium will be superposed on, and entirely obliterate its corresponding dark absorption line in the Solar light: in fact, so universally diffused is Sodium that it is almost impossible to make this experiment without any salt on the lampwick at all, and yet not have this line flash up, as the flame crosses the slit. If instead of viewing Sunlight, either direct or reflected, we look at that of a lamp, we shall get a continuous spectrum, uncrossed by any lines whatever.

FIG. 1



A more elaborate form of instrument on the principle of the one figured on p. 145 may be constructed by the aid of a prism of dense flint glass, (or preferably of a hollow plate glass one, filled with bisulphide of carbon), placed vertically in a wooden box, as represented in the next figure, where B represents the box with the top removed, P the prism and T and T′ two telescopes. The eyepiece of T is removed and replaced by the disc carrying the slit S, this must be accurately in the focus of its object glass O. As in this rough form of spectroscope, it is difficult to devise a means of giving motion to the telescope T′ through the necessary arc, the prism itself P, must turn on its axis. It will be understood that the inclination of the axes of the two telescopes to one another must be at all events approximately such as to give the minimum deviation for the mean ray of the spectrum. The mode of using this instrument will be practically the same as that of employing the form depicted and described on pp. 145 and 148. Any two small achromatic telescopes will suffice for its construction, and a prism being formed of accurately-fitting pieces of plate glass cemented with gelatine (and a very little glycerine), and filled with bisulphide of carbon, will complete the whole thing. Particular care must be taken to free the edges of the glass from grease with some strong alkali, or the gelatine will not hold. The carbon bisulphide is, I think, only about half a crown a pound, and a very few ounces would fill a prism large enough for the spectroscope I am describing.

FIG. 2



Having written which I am confronted by the query of "W. R." p. 306. To him I would say, if he, as a chemist, have any intention of working practically with the spectroscope, let him not attempt to construct what, after all, must be an imperfect piece of apparatus, but go straight to Mr. John Browning, of 111, Minories, London, and he, for five guineas only, will supply him with the form of instrument of which a wood cut has been given in p. 145. "Roscoe's Spectrum Analysis," or his "Elementary Chemistry," published by MacMillan and Co,, London, will give all needful detail to enable your correspondent forthwith to set to work. The rest he will soon succeed in doing for himself. To return, however, to Mr. Bishop, The solutions for the observation of absorption bands ordinarily recommended to beginners are Blood, Madder, Permanganate of Potash, Magenta and Chloride of Uranium. The micro-spectroscope is more particularly adapted to this form of investigation. Iodine is the form of vapour, and (as noticed very many years ago by Sir David Brewster) the red fumes of nitrous acid gas gives strong absorption bands. I confess that the mode of making a "Solution of Sodium" does not occur to me.

So much for the spectroscope itself. With reference to the reiterated request that I should describe the mode by which Mr. Huggins determined the rate of motion of Sirius from the Earth. I will, Sir, having obtained your permission, endeavour at an early date to render this somewhat abstruse subject as apprehensible as I can do, without the aid of mathematics, in the shape of an article.

A FELLOW OF THE ROYAL ASTRONOMICAL SOCIETY.

ASTRONOMICAL.

SIR,—In answer to Mr. Albert P. Holden, (4051), p. 311. I may say that I know of no printed observations of ξ Ursæ Majoris since those of Kaiser in 1863, when he made the distance 2″08; but that the components are certainly much closer than that now. I should be tempted to think from memory of my last peep at them, under 1″8. My Equatoreal clock has taken what the Scotch call "a dour fit" just now, and declines to drive the telescope, or I would make a few micrometrical measurements of the distance and position of the two stars ξ Ursæ, for Mr. Holden's benefit.

With reference to his query about the "Bar Micrometer," I must candidly confess my ignorance of it. I am very familiar with the ordinary spider-line position micrometer, the one I always now employ, and likewise with the double image form of it, and I also know the ring micrometer (which, by the way, is the cheapest form of instrument I am acquainted with), but I never saw a bar micrometer in my life, nor do I know what it means. I suspect, however, that it depends on something the same principle as the ring micrometer, and is used to determine the places of Stars in the heavens differentially. Where, or by whom, may I ask, did Mr. Holden, see or hear it mentioned?

A FELLOW OF THE ROYAL ASTRONOMICAL SOCIETY.

CONGRATULATIONS.

SIR,—Let me add my name to the long list of those who appreciate the efforts you have made to make the ENGLISH MECHANIC thoroughly worthy of its wide circulation. I cannot say that I have been very successful in adding to the number of your subscribers for this simple reason that I find all my friends are already subscribers. I do not say I am glad you are about to absorb the *Scientific Opinion*, for I think it deserved to succeed in establishing itself in public favour. It was well designed and excellently edited, and had not its plan been very coolly appropriated by about the worst edited journal I know of (one which you will doubtless absorb before long) would have been, I imagine, completely successful.

I cannot but congratulate you on the skill with which you manage the Correspondence columns. I do not think it would be by any means wise to rigidly exclude letters from paradoxists, or, generally, from writers who do not very closely attend to those precepts of Montaigne with which you head the Letter columns. But while kindly suffering the weaker brethren to speak, you yet make them feel that there are limits within which they must confine themselves.

No one who has followed the progress of the ENGLISH MECHANIC for the last few months can have failed to recognise a gradual change of tone. Those whose sole object is to impart useful information feel encouraged to use your columns more and more freely; those who mistakenly, but honestly, imagine they have much useful knowledge to impart, are gradually finding their level; and lastly, those who would use your columns to "blare and bellow forth their own stupidity" are steadily discouraged. The result is, that your subscribers can turn with confidence to your pages for sound information on a very wide variety of subjects. I have not lately seen a number of yours in which, quite apart from the set articles, I have failed to find many a good twopenny-worth of useful information on a variety of subjects in which I take interest.

RICHARD A. PROCTOR.

LEIGH'S PLAN FOR CONVEYING RAILWAY TRAINS ACROSS THE STRAITS OF DOVER.

SIR,—In the year 1861, I first conceived the idea o conveying railway trains across the Straits of Dover and took out a patent for it, connected with som other nautical matters. In the following year exhibited my patent ship in London to the Lords o the Admiralty and a number of other scientific gentlemen, including Mr. Scott Russell,* having been introduced to most of them by Rear-Admiral Denman After this I sent my models to the Great Exhibitio of London in that year, and distributed hundreds o lithographs with a printed description of my ne ship, showing how railway trains might be conveye across the Straits of Dover or other narrow seas.

A project has since been formed, I believe, by M John Fowler, for a similar scheme to mine. I wro to Mr. Fowler, stating that although I had a paten and was the first individual to invent the plan, I ha no wish to be an obstruction, but was ready to de with him on suitable terms, or join him in the enterprise. To this letter there was no response. I wro again in January, 1867, and was informed that M Fowler was then in Italy, and that my letter wou be laid before him next month, on his return. I hea no more. On the 17th of February last, I wro again, expressing the same sentiments, but he has n replied.

Mr. Fowler has of course a perfect right to car out any scheme of his own for this object, so long he does not infringe my patent: but why he shou go such a roundabout way to avoid this, if it can shown to be better than his plan, is inconceivabl except on a certain hypothesis, the nature of whic leave my readers to infer.

The public are very little concerned as to who sh have the honour of the scheme, beyond the love of f play; but they are greatly concerned about having t

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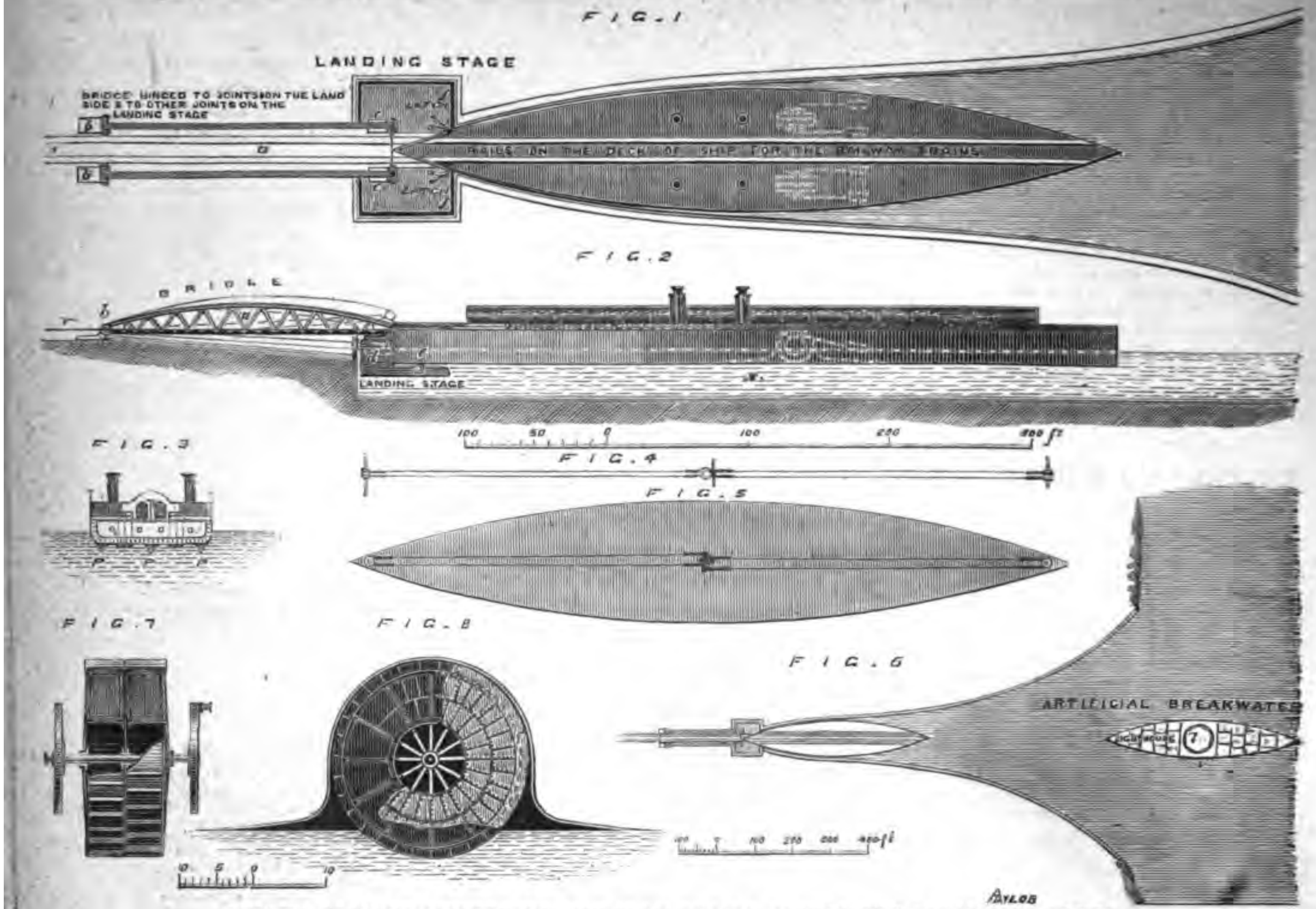
* Since this, Mr. Scott Russell has partly carri this plan out in Switzerland, where a steam ferry established for conveying trains across the Lake Constance. It has also lately been partly carried o in America, by conveying trains across a broad rive



LEIGH'S PLAN OF CONVEYING RAILWAY TRAINS ACROSS THE STRAITS OF DOVER.

best method and accommodation. Now, if it could be shown that Mr. Fowler's plan of shipping and unshipping the trains was better than mine, and his boat steadier, I should have nothing more to say; but I submit it is so much inferior that the public ought not to put up with the loss of time, delay, and inconvenience it would occasion. I also do not think that the plan of boat which Mr. Fowler has shown in *Engineering* and other publications, is the best that can be devised for this object. There appears to be no originality about it. It is merely a large paddle steamer with the wheels outside. How such boats will fare in the Channel in stormy weather will be seen, if they are ever made.

The boat (Figs. 1, 2, and 3) which I have designed for this service will not draw more than seven or eight feet water at most, with train and coal on board, if made without the pontoons *p p p* Fig. 3, and only about twelve feet with them. The paddle-wheels work (as shown) always in smooth water, which, by the peculiar construction of the wheels, is always kept at the outer perhiphery, so as greatly to economise the power given off by the engines. The general principles in the cellular construction of this boat, ensure the greatest possible strength and safety with the least possible weight. It is also calculated for a higher rate of speed than has ever been attained before. The engines are extremely light for the power given off, in consequence of the high velocity of piston traverse which the principle affords, without being too often on their centres. Steam expansion may be carried out to the utmost limit with the greatest convenience, as a very long stroke may be obtained, thereby ensuring an economy in fuel hitherto unknown in marine engines.

It will be seen from the light draught of water and the general plan of entering the harbours, that it will be quite unnecessary to change the present routes *via* Calais, Boulogne, or any other port, as there is a sufficient depth of water at all times. A small island marked *i* on the plan, is thrown out at sea, in front of the harbour. This island is about the size of the train boat, and is formed by filling and sinking a shell boat with concrete. This shell must be made to conform to the depth of water, which, first being moored to its place, must be gradually filled and sunk. The bottom of this shell may be made like a series of arches or tunnels, so that a current of water may flow to prevent the possibility of silting. On this artificial island is placed a lighthouse *l* to guide the train boats into the harbour. The island is so placed that a boat can enter the harbour from either side with equal facility, so that the train boat, before entering from the rough sea, can take the lee side of the island, right or left, according to the weather. By this arrangement the great loss of property and dissatisfaction that would ensue from the desertion of Calais and Boulogne, would be avoided, as the harbours themselves may be formed on the same principle as the island in places where there is not sufficient water at present; and altogether I submit that there would be a vast saving of expense, compared with Mr. Fowler's scheme.

The accompanying plan exhibits sure and perfect connection between the rails on land and those on deck the moment the boat touches the landing stage, as will be seen on reference to Figs. 1 and 2, and in in which *a* is a bridge firmly hinged to fixed supports *b b* on the land side, and to a floating support *c* on the landing stage *d*. The centre of the hinge is in a line with the surface of the rails *r*, and the bridge with its rails is level with the rails on the land and those on deck at half tide. At low and high water respectively the bridge and landing stage assume the position shown in dotted lines. There is an indent in the landing stage *d*, into which the bow of the boat fits. At the bottom of this indent is fixed a roller *e*. The bottom of the boat comes upon this roller on entering, which causes the landing stage to be depressed a little, or the bow of the boat to be raised sufficiently to bring the rails in an exact line, notwithstanding any little inequality that may arise from light or heavy cargo. The moment the bow of the boat enters this indent it is caught and firmly held by the catches *f f*, Fig. 1. When the train is on board these catches are withdrawn, and the boat is at liberty to move off. Thus it will be seen that, when a train arrives, it can be run on to the boat at once, and be carried away without a moment's delay, whatever be the state of the tide. The same in unshipping the trains.

The construction of the ship combines immense strength with the greatest simplicity, reducing shipbuilding to one uniform principle, for large boats especially, being merely a multiplicity of similar parts, cellular below and for some distance above the water line. To sink such a ship from mere accident is impossible, at the same time the expense of construction is reduced to a minimum.

Mr. Leigh's improved plan of steering the boat is as follows:—I place a helm at each end of the ship, making stem and stern alike. These two helms I connect together in such a way that if the front helm is turned in the direction the ship is required to go, an immense pressure of water comes against it; the power derived from this is transferred to the aft helm, which it brings up in the opposite direction like the head and tail of a fish, and the vessel swings round with the greatest ease. The helms being in equilibrum a boy may work them (see Figs. 4 and 5). It is obvious, however, that no helms will be required for boats having detached power, as they will be steered by throttle valves, except in the case of accident to the machinery.

Altogether I am prepared to prove that my plan of boat will be much swifter, steadier, safer, and cost no more than an ordinary boat with outside paddles. I calculate the passage will occupy only fifty minutes in fair weather. I also contend that my plan of entering the harbour, shipping and unshipping trains, will be more efficient, and cost less than the method shown by Mr. Fowler; but of this I leave the public to judge.

EVAN LEIGH, F.S.A., Manchester.

TOURISTS' TRIPS.

SCOTLAND.

SIR,—I was much pleased to see Mr. F. Harwood's letters on "Tours in Ireland." A friend and myself are going for a tour in Scotland, in July, for two or three weeks, and should be glad to see information from someone who has been for about that time. We have "Bradshaw's Railway Handbook for Tourists," Sections 3 and 4, but there are so many places of interest that it is a difficult matter which to choose.

SCOTIA.

DEVON AND CORNWALL.

SIR,—I should like to take a walking tour along the coast of Devon and Cornwall, and there are many others who would do the same if they knew the most economical mode of doing it, and as, no doubt, very many others would be interested in reading hints to walking tourists, and more particularly if geological information be given, I should be glad if someone who has been in this part with stout shoes on, a walking stick in hand, and a knapsack on his shoulders, would give us in as small a compass as convenient, the result of his experience. By-the-way, I think that tourists who are readers of the ENGLISH MECHANIC will not fail to say a good word in favour of our friend and councillor, as they go on their holiday rambles.

COCKNEY.

SCARBOROUGH.

SIR,—As some of your readers take an interest in collecting birds' eggs and shells, I may say Scarborough possesses some rare advantages. Our beautiful and gradually sloping sands are quite attractive to the shell seekers, and remarkable for the number of specimens they produce. We are also highly favoured with a variety of birds, as a proof of this I may state that in the short space of six weeks I have collected fifty specimens of eggs all of which have been taken within a very few miles of Scarborough, among them is the curlew, the sea parrot, kittywakes, razor-bill, guillemotes, cirl buntings, flycatchers, &c., &c. And as for boating and fishing you may enjoy that to your heart's content, thus think how delightful it is to go early in the morning, when the sea is as smooth as glass, taking your shrimp-net, with you, and your box of specimens, enjoy a good bathe, and then after having obtained a good collection, coming back and enjoying a hearty breakfast, of hot rolls, fish, &c. Then the programme for the day is arranged, a visit to the Old Castle, built in the reign of Stephen, by the Earl of Albermale; the walls of the ruin, 9ft. thick; and then standing on such a bold promontory, 300ft. above the level of the sea, the rocks direct beneath you, and here we sit down and rest awhile, watching the Naval Reserve men or the Artillery firing at the target that is anchored off. Then there is Oliver's Mount, 500ft. high, and one mile from the town. We get to the top without any difficulty, and then what a sight breaks on our astonished gaze. Away! away!—as far as the eye can stretch, the waves and the sky seems to touch.

I think I hear some of your readers say, "Oh, yes, this is all very nice, but what a long purse you require for those pleasures." To this I say, "No, not so much as you spend over your pipe or beer; it is within the reach of every working man, this life-giving, soul-renovating enjoyment. The railway expenses by the excursion trains are very low indeed, and the most comfortable lodgings, within three minutes' walk of the sands, can be obtained for the low charge of one shilling a day—that is for bed and use of sitting-room, and cooking and victuals—one shilling clears all; the charge for boarding and lodgings at the hotels is from 6s. 6d. per day. Should any of your readers want any more information I should be most happy to render it.

W. W. **Larkin**, Scarborough.

SUMMER SCIENCE.

Sir,—I am going "to do and exercise" as the lawyers say, the Englishman's grand privilege, in *fact the* privilege of all British subjects, the mainstay of our institutions, &c., *ad lib.*—that is, to grumble. My cause of complaint is this, your paper is too scientific for the time of year. "All work and no play makes Jack a dull boy" saith the proverb, and if those words be studiously thought over during the winter (you can't think in hot weather), they will be found to contain more real knowledge of human nature than many of the voluminous essays that are inflicted on us "poor cusses." Certainly you had a note of a tour in the Western districts of Ireland, but then all your readers are not in the position, or have not the inclination to travel that "side of Jordan." You possess, I suppose, readers in every town of the kingdom; well, let one who is capable of doing so in each town, send you a short note of the ancient buildings, &c., that the town possesses, that are worthy of a visit, so that any of your readers when taking their summer outing, no matter in what direction, may have something to occupy the mind as well as the body, and afterwards call up pleasant recollections, which are more than can be said of poring over plus, minus, &c., this time of the year. Take London. You have, I should say, a few thousand subscribers in this—well, call it city, modern Babylon, or what you like. See what interesting and at the same time picturesque and historical places there are around it. There is Kensington, for example, with its Palace, Lord Holland's Park, &c., while Twickenham, and all up the river, bring recollections to mind of Horace Walpole, Pope, Sheridan, Fox, Burke, &c. Not only would these notes possess a passing interest, but if carefully written and unnecessary verbiage dispensed with, they would possess a lasting value, and, like a thing of beauty, be a joy for ever. If any of our sternly scientific correspondents like to treat the subject in a purely practical manner they might do so with great gain to themselves and their readers. For instance, there is Willesden cage, whence, so tradition sayeth, that noble hero Jack Shepherd escaped (by the way, what a striking picture this would have made for the *Police News!*). Well, that could be treated of in a purely scientific manner, and we might have stated for the benefit of posterity the actual time the hero took to accomplish his feat—in fact, the number of square inches of brick, wood, &c., disturbed, and a calculation of the power of the leverage employed would be very interesting. But let us have no Beardsleyism. Human Science is all very well in the winter, but in the summer let us have the Science of Nature and the mathematics of green fields, rippling waters, and all those other sights and sounds which speak even to the hearts of the most ignorant of Him who clotheth the lily and careth for the sparrow.

A London Subscriber.

["A London Subscriber" is thanked for his suggestion. He will see by reference to our last number that we anticipated him. Perhaps he can do something to promote the cultivation of what he calls "Summer Science," by writing on some of the interesting objects in and about London.—Ed. E. M.]

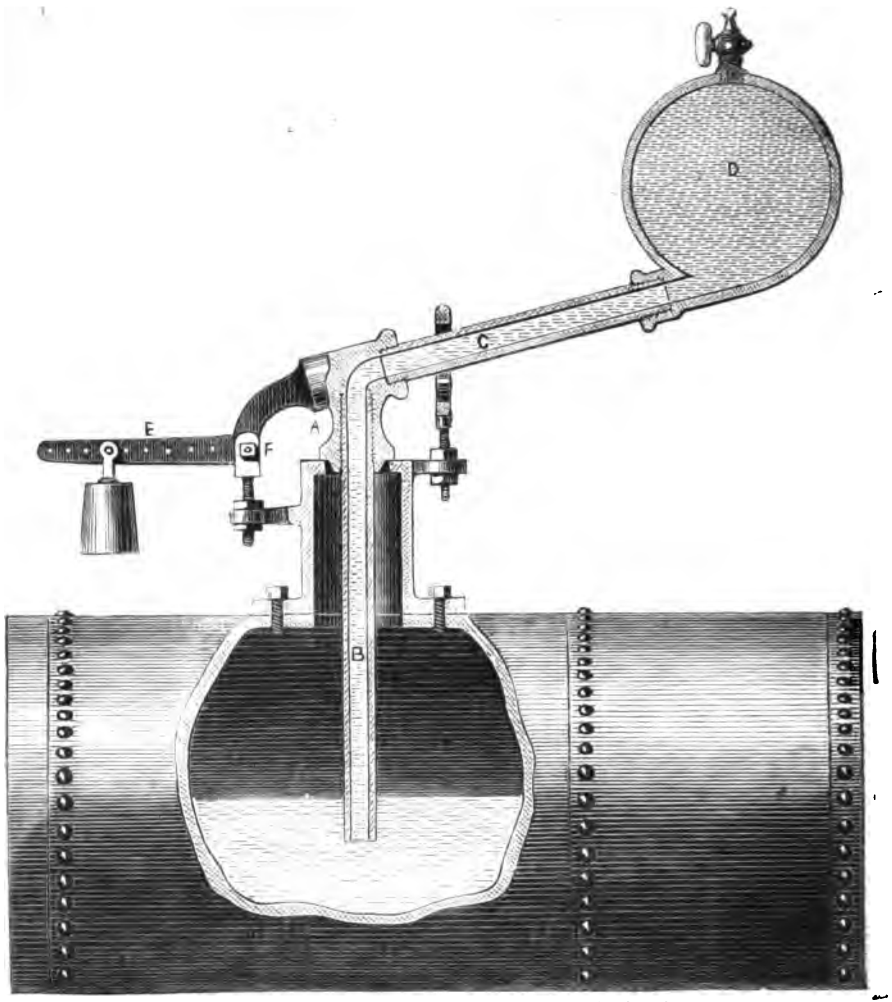
GEOLOGY.

Sir,—I am glad to know that we are going to have a course of letters upon geology. I have travelled in some of the high and lowlands of Hugh Miller, Derbyshire, Matlock Bath, Crich Car, several parts of Ireland—north and south, and in Wales also, but I noticed more "fossils" in West Cumberland than in any of those places to which I have referred.

I don't know anything more interesting and instructing than that of sitting at the mouth of a coal-pit (which the miners are newly sinking), and watching and examining the materials that are brought from below—say 200ft. or 300ft. from the surface. I have done so on many occasions in West Cumberland, where I collected more than a cart-load of fossils. A considerable distance along the coast there is a large space between high and low water mark, from which numerous fragments of fossils are washed up by the action of the sea, which I have often picked up.

Veritas.

LOW-WATER DETECTOR AND SAFETY VALVE.



LOW WATER DETECTOR AND SAFETY VALVE.

Sir,—I extract the following account of an ingenious device combining a low-water detector, alarm, and safety valve, from the *Scientific American*:—The safety valve is made as shown in section at A, with a flat annular face, its upper portion being nearly at right angles with the vertical part, and a tubular opening passes through its entire length.

Into the lower part of the bent tubular opening is screwed the vertical pipe B, and into the upper part the inclined pipe C, having at its outer end the hollow sphere D. The sphere D has a pet cock at the top to allow the efflux of air when the valve is first adjusted to work. On the opposite side of the valve A from the pipe C projects a bent arm E, pivoted at F, and carrying a weight by which the valve can be adjusted to the required pressure. The pipe B descends below the normal water-level, as shown.

In adjusting this valve the pet cock in the sphere D is opened when the air escapes, and the pressure of the steam upon the surface of the water in the boiler causes the water to rise and fill the cavity. The weight upon the arm E is then set to counterpoise the weight of the water to the pressure it is desired to maintain. Any pressure exceeding the required pressure raises the valve and relieves the boiler. It will be also evident that as soon as the water falls below the pipe B, steam will take the place of water in the pipe C and the sphere D, and the valve will then open immediately. The sound of the steam, as it issues from the valve, will give the alarm, or a whistle may be employed if desired.

In this case the valve is opened by both the force of steam and the counterpoise, and a very wide opening being made the discharge of steam will be so copious as to be readily distinguished from the smaller escape due to pressure alone.

P. Humphrey.

AIR PUMP FOR ELECTRIC EXPERIMENTS.

Sir,—With your permission I will endeavour to give "Inductorium," and others, a description of a small air pump I made, and which produces all the experiments he refers to at p. 252 with the induction current; it is so simple and can be got up at a small cost. I send you a sketch. A A, Fig. 1 is the sole plate of cast iron, in one piece, bearing 3 short legs to stand on, and a ¾in. ball in centre screwed; B barrel of pump, G handle of piston and pisten rod, D small cock to equalise pressure where required, also to allow of vapour of liquids or of gases to enter the receiver when exhausted. I use a disc of very thin vulcanised rubber between pump, coil, and receiver, they requiring no luting of any kind to keep them tight, which is of great importance; there are 2 valves E E. What I use is thin vulcanised rubber, or oiled silk will do. Fig. 3 is an enlarged section of valves; the rubber or silk is held upon the aperture with a silk thread wound round the 2 ends of rubber when folded over it; the piston rod is made of brass tube; the under end carries the top valve, the other fixed in bottom of pump; the piston is made with 2 cup leathers, back to back, about 1¼in. depth. As to the vacuum this pump can force, I attached the tube Fig. 2 to plate of pump after a few strokes to shut the small cock, then disconnected it from the pump, opening the cock under water; it filled the tube to about ⅞ of the top, the length of it being 14in. The vacuum is such as to produce Gassiot's Fountain in a satisfactory way. But let me here remark that although this sample pump works very well, I know that there are others that are far superior to it if the cost be no objection. But here it might be as well to state size of coil and battery employed in producing those experiments. The coil contained fully 5lb No. 28 of secondary copper wire; a Grove battery, the platina plate 3 by 1½in. spark in free air ⅝in.; the coil has no insulation, but the cotton covering with a coat of shellac over all, but is wound by beginning at one side of bobbin, which is glass, and filling the under corner first, then up and down till the whole length is filled, thus removing the ends to the greatest distance from each other. Now, Sir, as to the length of spark got from my coil compared with that given last week by "Inductorium," it must be far superior to mine if length of spark without reference to thickness is to decide the point. Having thus far endeavoured to help a brohter I trust in "Inductorum" fulfilling his promise, so that I may lengthen my spark.

FIG. 1

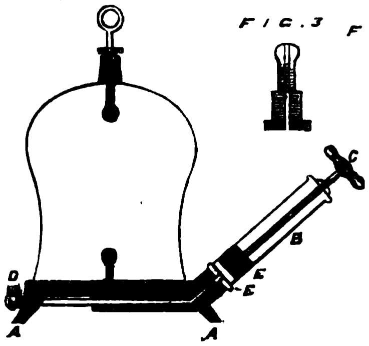


FIG. 3

FIG. 2

At p. 181, "Tangent" gives details of a contact breaker, which, by-the-bye, he thinks will hardly do for experimenting. What does he mean to do with it? I have looked it over but am at a loss to see how it is to work. We were to have a description of a Rhumkorff from him, and I feel hopeful and trustful of hearing soon from him or some one upon this point, it having an important action in the working of all coils.

A. Farquhar.

PHRENOLOGY.

Sir,—In reading over the communication I sent and which you have inserted in the Mechanic, I was much amused by finding lump substituted for bump. I think it must have produced a smile on the countenances of your readers. In reply to what you say as to whether phrenology would enable a person to distinguish between the six different characters mentioned, I think it is too much to expect, for the following reasons:—The preacher might have a phrenological development so varied and comprehensive that he might have made a good engineer or successful merceant, or a clever statesman, or a botanist, and possibly a poet: but owing to the influence of circumstances he becomes a preacher. This being the case, it would not be possible for any person to say what he was. You might as well introduce half-a-dozen men, one a blacksmith, one a joiner, another a painter, and so on, and ask a phrenologist to decide what they all were. A phrenologist would tell on examination whether the person examined had the necessary organisation and development to fit him for becoming an engineer, merchant, preacher, &c., but he must not be blindfolded, as he could not judge of temperament and hereditary organic quality, so necessary to form a correct opinion. It is just as necessary to ascertain the quality of brain as the comparative size of the organs.

You may depend upon it, phrenology is a true science and founded on facts, and if generally understood and acted upon, would be of great service to mankind.

An Inventor and Self-Taught Mechanic.

[Does not our correspondent give up the whole question when he says that "the preacher might have a phrenological development so varied and comprehensive that he might have made a good engineer, or a successful merchant, or a clever statesman, or a botanist, and possibly a poet, but owing to the influences of circumstances he becomes a preacher"? This shows that circumstances determine for him; these circumstances may be education, scenery, climate, society, marriage, or a dozen other things that influence a man's life and character. Our correspondent goes on to say that "it is as necessary to ascertain the quality of the brain as the comparative size of the organs." He must admit that the quality of the brain is also influenced by circumstances such as diet, habits, education, religion &c. But how can he ascertain the exact quality by any particular configuration of the skull?—Ed. E. M.

TRADE AND COMMERCE.

Sir,—Last week I sent you a letter deprecating the discussion of these subjects in the Mechanic. To my great dismay I find that my unfortunate essay has had the contrary effect of producing a column of matter in this week's issue. Although unsuccessful, I am not discouraged, and with your permission will make one more effort to show the inutility of the discussion of so great a subject upon so small a scale.

"Herbert's" letter, being simply a reiteration of his former one, requires little comment. He still insists that the balance of imports over exports is clear profit, but his imaginary cargo does not prove this in the slightest degree. Supposing that through a failure of produce in any one year we were to run short of provisions this would clearly be a loss to us, but by "Herbert's" course of reasoning it would appear to be so much profit, since having to buy our provisions from foreign countries, our imports would exceed our exports to a much greater extent than usual, and the year which was really the most disastrous to the nation would appear to be the most prosperous. It may be objected that the balance would right itself in the course of time, but it is poor consolation to reflect that "it will be all the same a hundred years hence."

Or, to take another case, suppose that through a long course of unexampled prosperity the nation had become so rich that it could retire from business altogether, investing its capital in foreign stocks, and with the dividends purchasing all its requirements from abroad, the country might be turned into a vast flower garden, and produce absolutely nothing of any value. An extension of the volunteer movement would provide brigades of railway engine drivers and porters, brigades of gardeners—unpaid brigades to do all the work, but there would be no exports, and this sort of thing might go on so long as foreign nations paid their dividends and refrained from going to war with us. But all this time the nation would be importing goods, and, as "Herbert" holds that trade is barter, we should be in the happy position of receiving all we required and giving nothing in return. This is taking an extreme case, but the principle holds good in any lesser degree.

All "Herbert's" arguments are based upon the assumption that trade is barter, but he does not attempt to prove it. If he could show that it is a fact, I should agree with all of his deductions.

"Sigma's" letter is a good illustration of the futility of discussing so large a question in your columns, since, in talking of mere buying and selling, it is obvious that we are only skimming the surface of the subject. In spite of Napoleon's saying, we are not a nation of shopkeepers, as that would imply that we simply buy from one foreign country and sell to another, a kind of business which would never make us a prosperous nation, or find employment for our people. In order to flourish, we must manufacture the goods we sell: and to be in a position to do so, we must take care that our workmen have fair play. With this they can very well hold their own, even against foreign workmen, whose ordinary diet is bread and butter. But it is in the power of the foreigner to shut us out of the field by taxing our productions "Sigma" seems to think that this process is an evil only to the country which adopts it. But this is a question which admits of any amount of discussion, for we have no proper data to guide us. We cannot take any one country as an example, for the selfsame nation may at different times oscillate between prosperity and bankruptcy, between extreme activity of trade and stagnation, without any change in its fiscal arrangements.

"Sigma" considers the dulness of trade in the United States to be a proof of the ill effects of Protection; and it is difficult to disagree with him until, by dipping a little deeper into the subject, it becomes apparent that the rapidity with which they are paying off their national debt is an indication of the greatest prosperity. Probably one deduction is as erroneous as the other.

There is little satisfaction to be derived from statistics; for not only are those which are available wanting in accuracy, but, as "Sigma" states in a former letter, they may be made to tell any tale.

I cannot help thinking that "Sigma" somewhat begs the question when he talks about the emigration of our workmen being an advantage to the country. There is little doubt that it is better for them to go, when there is no longer work for them to do, on the same principle that it is sometimes beneficial to a man to have his leg amputated; but surely it is no advantage to them, or to their country, when the necessity to emigrate arises from want of employment, caused by the importation of goods made by foreign workmen, which might happen were our population only one-half of what it is—which might not occur if it were double.

I have not the slightest doubt that free trade would be an unmitigated blessing to this country, but fear that we shall not obtain it so long as foreign nations find that they can close their markets to our goods, and at the same time retain the inestimable advantage of selling us their own manufactures without restriction.

Years ago, when the subject was under discussion, the advocates of one-sided free trade—free-trade half-bound, we may call it—were wont to tell us that if we only threw open our own ports, soon all the world would follow our example. We tried the experiment, and now, twenty years after, comes the answer from America, in the shape of the most prohibitive tariff that was ever imposed.

F. W. M.

VELOCIPEDES.

Sir,—I like to see justice done, and "honour given where honour is due," to every kind contributor of a "brick" in your valued columns, and with this object, I would draw attention to the fact of the designs of the "English" Velocipede, by "A Thinker," (No. 263-4), and also the "Macclesfield Velocipede," by T. Stanley, (page 89, No. 264), being almost (if not quite) identical with the plan invented by Mr. J. Hastings, as described most fully by that gentleman in 1868 (page 55, No. 185), and by a member of the High Peak Velocipede Club, page 537 (No. 206), which is there stated to have been in use "some considerable time," so that unless "A Thinker" and Mr. Stanway, have been asleep, it is difficult to understand how they both could be ignorant of the numerous communications, which Mr. Hastings has kindly given us upon every point and detail of his apparatus, in reply to questions extending through the files of the English Mechanic for two years past.

There is one point, however, in which these later designs fall short of the original one of Mr. Hastings, in which that ingenious gentleman adopts a very simple and excellent plan to counteract the tendency to upset in turning sharply at high speed, by fixing two inclined plates on the front steering axle, by which the machine is inclined inwards upon being turned, which appeared to be a valuable idea.

I am induced to make these remarks, because I observe that Mr. Hastings does not take any notice of this apparent appropriation of his invention in his good-natured letter in reply to the wild theories of Mr. Reveley, (page 184, No. 268.) I quite agree with Mr. Hastings regarding the advantage of small wheels as being better adapted to utilise the muscular action of the legs, which I find will endure a quick and easy effort better than a slower and heavy strain, such as is the case where large wheels are used for driving, while the length of the crane must remain the same. I have used a 4ft.-wheel velocipede for 3 years, upon which I have been long distances, and obtained very high speed on good level roads, but find such large wheels make the machine heavy driving, especially uphill. Upon these points Mr. Hastings has written fully in a quiet, scientific and kindly tone, in pleasing contrast with the wild, and too often impracticable ideas of "would-be" inventors who used to fill up so much of the pages of the English Mechanic a year or two back, but who are now, I am happy to see, no longer allowed space to ventilate their dreams. I, therefore, feel that the subscribers of the English Mechanic are deeply indebted to Mr. Hastings for his communications and kindness and that they do not wish to see his ingenuity forgotten or appropriated by others.

C. D. E.

A CUMBERLAND MINER'S APPEAL.

If "Cumberland Miner" were to try a mask of sheet-metal with eyes, say 2in. or 3in. diameter, of plate glass, or fine copper gauze, and place it not less than 4in. or 5in. from his face, I think it would be some protection. Perhaps, if he tries it he will let us know the results.

Aliquis.

STEAM HAMMERS.

Sir,—I have been a regular subscriber to the "Mechanic, from the commencement, but have never seen any article in on steam hammers. I should feel greatly obliged if any brother reader acquainted with the subject, would give descriptions of the best self-acting principles of the various makers. We have a small hammer in our forge, which we wish to make self-acting, but I am at a loss how to proceed.

I believe Messrs. Massey, of Openshaw, near Manchester, make one of the best, but I am unable to get to see one. A sketch would oblige.

General Mechanic.

SQUARING THE CIRCLE.

Sir,—Mr. Arthur Gearing has produced a very ingenious diagram (page 301) for the purpose of exhibiting a mechanical mode of effecting a solution of this question, in which, however, he entirely overlooks the fact that the base line of his sectors must always be the arc of a circle, and therefore can never be made to form a straight line. Proceeding to describe the process, Mr. Gearing says—"take the half of the circumference of the circle for the length of the parallelogram," now that circumference can only be obtained from the well-known formula, 1 to 3·1415927, &c., *ad infinitum*, therefore his quadrature can only be approximately correct.

The area of a circle is the product of the circumference multiplied by half the radius, and by extracting the square root of that product, you have the side of the equivalent square. I had hoped the squaring of the circle had been long since out of print, but it seems that it is never to die.

Henry W. Reveley, Reading.

SALADS.

Sir,—In last week's number, I am taken to task by "Tautau," for recommending the use of dandelion leaves as a salad. In my communication, I sought to draw the attention of our working friends to the value of many wild plants that were to be obtained without trouble or cost, and that could be used as salads, and I maintain that continental experience justifies the truth of my statement, that many sources of good and cheap food are neglected in this country through ignorance or prejudice. I have no particular partiality for dandelion leaves beyond the unlimited supply to be readily obtained, and the similarity in flavour to lettuce. "Tautau" is wrong in asserting that it is rejected by almost everybody in this country. In my neighbourhood I daily see scores of workmen plucking the leaves of this plant, to render their mid-day and evening meals more palatable. With vinegar, oil, pepper, and dressing, no one can reasonably object to it. The word "beer" was a misprint, it should have been "beet." The seeds of mustard sown with those of the garden cress certainly furnish a good salad known as "mustard and cress." As regards onions, I do not consider them a *recherche* addition to a bowl of salad, on account of their strong flavour affecting the breath; moreover, all alliaceous plants are regarded as "condiments" by our most eminent food authorities.

As our journal largely circulates among the working classes, I think that any information regarding food must prove useful, more especially if attention can be drawn to any members of the vegetable kingdom whose properties are not generally known or recognised; however, with reference to taste, I think we must all agree with Mrs. Partington, that "that is, after all a matter of opinion."

Beta.

SUMMER SKATING.

Sir,—I have just seen your suggestion about summer amusements, exercise, and scientific pursuits, and need scarcely say that I thoroughly agree with it. There is a time for everything, says the wise man. We can set down and read elaborate articles during the long winter months, but during the summer months we want something more "summery," if I can coin a word.

As an inducement for others to send more useful or more scientific matter for the season, I beg to send a scrap on summer skates, I have just taken from an American publication. "To carry the pleasure of winter skating into the midsummer months, has been the aim of numerous projectors, whose fertile brains have brought forth roller skates of varied construction and design. One of these—an American invention—has its stock or foot-rest provided with a toe wheel, a heel wheel, and two middle or side wheels, the latter not having their planes of revolution in line with one another, but are arranged parallel, and on the opposite flanks of a line extending from the centre of the toe wheel to the centre of the heel wheel. The two middle or side wheels are to be so applied to the stock as to be capable of revolving independently of one another."

A Frenchman has invented another device of the same character, but of somewhat different structure, which I find described as follows:—"The leg piece is preferably made of wood, such as ash or oak. The inventor attaches it on the outside of the leg of the wearer, with the pad in contact with the leg a little below the knee by means of a strap, or any other convenient mode of attachment. To the lower part of this leg-piece he attaches, by bolts and nuts, or otherwise, a wrought-iron or steel angle piece, to which he attaches in a similar manner an elastic steel foot piece, slightly raised at its extremities for supporting the foot and the heel of the wearer. Side joggles serve to maintain the foot laterally, and straps to hold it firmly down on the foot piece. The locomotive wheel is hung on a stud attached to the leg piece by a nut; a vertical slot is made through the leg piece where the stud passes, to enable the wearer to regulate within certain limits the height of his foot from the ground, as well as for the purpose of using different-sized wheels, if desired."

W. R. B.

MEDICAL GALVANISM.

Sir,—As a medical galvanist of several years' experience, I beg the favour of a little space in reply to the letter of Mr. Anson, in your last. I have for years manufactured medical coils, and in answer to his theory of intense currents being unsuited for application to the human system, I say, as the result of my experience, that in certain cases an intense current, collected by a (quantity) primary coil is, in those cases, as much an absolute requirement as the same intense current, with the same coil, would, in other inappropriate cases, be an absolute failure. But apart from all difference of opinion respecting the proportion of battery power to coil, and *vice versa*, I am convinced that out of a given number of failures, fully nine-tenths can be traced, not to the inability of the galvanic current to effect the cure; not to the disproportion of battery power to coil, but mainly and simply to misapplication of current. In a good percentage of the above failures, the patients who give up galvanism as not effecting what they have been led to expect (a consequence of which failure is the number of replies "W. A." has received from persons wishing to dispose of their instruments), hold the conducting plates in their hands for a general nervous affection, to the foot or feet for an affection of the knee, and to the spine for an attack of indigestion, and so on for a number of cases, which had the current been properly applied, would soon have made manifest the immense amount of curative property inherent in galvanic currents, medically and properly applied, at present hid under the bushel of medical prejudice and ignorance of proper application. Probably from my signature, "W. A." may recognise me as the sender of a pamphlet on medical galvanism, in answer to the advertisement to which he refers, in which he will find that I advocate the employment of an intense battery (arranged for quantity) and a quantity coil, with an intensity and a quantity regulator, so that any ordinarily gifted person may so regulate the current as to have a preponderance of quantity (over intensity, or the reverse; and should you, Mr. Editor, consider a drawing of a good medical machine worth insertion in your pages, I shall be glad to oblige "W. A.," and perhaps others, and show my estimation of the pages of the English Mechanic, by forwarding one. I agree with "W. A.," in thinking that an immense field is open for the introduction and practice of medical galvanism, and once break down the at present, impenetrable barrier of medical opposition and prejudice, and open the eyes of the profession to the real use and efficacy of a properly-applied current, and I am convinced (in the event of these almost wild improbabilities occurring) that medical galvanism will at once take its stand as a recognised household and popular remedy, but as matters now are, a large proportion of the faculty, whenever they find it in use in a family on which they call in their professional capacity, invariably set their faces against it—in the majority of cases without ever having given it a trial, even in a case of a patient most susceptible to its influence—and if they do not positively demand the discontinuance of its use, they as invariably give their opinion—in answer to the question by the patient, as to its merits—"that it can do no good, and may do harm," which coming from the lips of their professional gentleman, carries an additional weight. This I know has been the verdict in several cases where I have had the pleasure of bringing the patient back to robust health, by the almost surreptitious use of a properly applied current, the physician in the meanwhile chuckling over his supposed cure. I cannot allow these few lines to come to a close, without stating my firm belief and conviction that medical galvanism, united in its proper proportion with the use of proper medicine, is yet destined to be the means of effecting cures which are now either impossible or are of a protracted nature. I shall be glad, Sir, if this letter may have the effect of evoking replies pro and con, but I confess I shall like to see them emanate from pens worthy to treat on so important a subject. I enclose my card.

H. P.

Sir,—Seeing several inquiries in our Mechanic in reference to galvanism as a remedial agent in disease, and having had considerable experience and some success in its application—moreover being confined to my room through a severe accident—it occurred to me that I could do worse than employ the weary hours of my convalescence in (to the best of my ability) instructing my fellow-readers who desire to pursue this interesting branch of science how to proceed therein with good hopes of success.

At the threshold of my subject allow me to make a few remarks upon the subject of therapeutics in general. We most of us adopt and cling to one particular system of medicine, to the exclusion of all others. Having satisfied ourselves that one theory of the healing art is right, we unhesitatingly conclude that every other must be wrong. Having found the system adopted by one set of theorists succeed in certain cases, we condemn every other system.

In this, it appears to me, we are wrong. It seems to me to be the business of an inquiring mind not only to invent theories, but especially to gather facts wherever they may be found; to accept truth, from whatever source it may be presented. Results, as far as they can be ascertained, should be carefully marked and studied. Special conditions should be industriously noted and observed; and from such material theories should be patiently built up.

These remarks apply in a more forcible manner to the healing art than to any other science. In this we can never be certain, in any two experiments, that the conditions are precisely the same. It therefore requires a much more enlarged experience, and far wider and more comprehensive experiments, to enable anyone to form deductions in this than in any other branch of philosophy. The constitutions, the temperaments, the habits, and the physical conditions of patients are so various, that it is impossible, from its effects in one or two cases, to judge of the real character of the remedial agent in every (apparently) similar disease. For instance, in how much mystery is shrouded that very common, yet constantly varying, ailment, catarrh? Who is not acquainted with the philosophy of it? Who is not provided with a remedy for it? from the old woman in the almshouse to the most erudite and intelligent homœopath. And yet, after all the gin and porridge of the sick nurse—the gruel and nitre of the allopath—the drop of camphor of the homœopath—the wet sheet of the hydropath—the composition powder of the Coffinite—the vapour-bath of the herbalist—and the pint-and-a-half of cold water of the teetotaller, how few but what seem to run their course; and how few, with but little care at first, quietly subside! How sometimes, with all our care, they hang about for months; and how again, when sometimes let alone, they seem to die the quicker. Yet who would despise the hot footbath advised by all, or say that the remedies proposed are no remedies at all?

The science of medicine is intimately connected with that of chemistry. Both health and disease consist largely of chemical processes. When the chemistry of disease is better understood, the healing art will have made a large advance. Whatever may be the true system of medicine, if such has yet been discovered, we know that nearly all chemical processes are more or less under the control of electricity or galvanism. Chemical force, as Faraday, in his "Physical Forces," beautifully demonstrates, is convertible into galvanic and magnetic force, and *vice versa*; and we know from experience—at least those of us who have ever held the poles of a large galvanic apparatus—that galvanic force is convertible into, and largely controls, animal or muscular force. Galvanism or electricity is closely associated with nervous activity and life, if it do not actually form the link between spirit and matter. The amount of nervous vitality in the body may be guaged by means of a delicate galvanic pile. Determinable galvanic currents are continually being generated by the chemical processes carried on in the animal economy. Electric currents are constantly circulating throughout the nervous system. The galvanic current is found to possess a specific power over many of the most important functions and secretions of the body. Every throb of the brain, every pulsation of the heart, every twitter of the nerves, is productive of, or connected with, electric excitation. Dr. Reymond has conclusively demonstrated that the muscles and nerves, including the brain and the spinal cord, are endowed during life with an electro-motive force. The electric current flows from the great nerve centres towards the extremities. The strength and intensity of these currents depend upon the state of health or disease of the bodily subject and the amount of vitality possessed. In some forms of disease, as tetanus and epilepsy, the nervous excitement is excessive, and the electricity developed by those parts is beyond the normal quantity or intensity, and requires to be decreased. In other forms of disease, as asphyxia and general debility, the circulating electricity is found to be below the normal amount, and requires to be increased; whilst in still other aspects of disease, a chemical reaction or decomposition should be set up, and a current of great intensity and quantity is requisite.

In nearly all cases galvanism may be applied as a remedial agent without the slightest inconvenience or pain, and is often most successfully used when scarcely perceptible by the senses at all. What is required is a current large in quantity, and of very feeble intensity. Any machine that is not capable of generating very large quantities of the galvanic force will, in ninety-nine cases out of a hundred, be found useless; and such appliances as galvanic belts and chains, which give off but small quantities of galvanic force of very great intensity, in the two former classes of disease, as I have often seen, are liable to become positively mischievous in their effects, though they may occasionally prove beneficial in cases of effusion of matter into the joints, in rheumatism, and similar forms of disease.

The student should therefore provide himself with an apparatus exposing at least from 12 to 30 square feet of metallic surface, and so arranged as to be capable of producing a great variety of effects, from the very feeblest possible current to the strongest of which the machine is capable. He should also be provided with two coils, the one a single helix of thick copper wire, with a bundle of soft iron wires enclosed, and connected with the terminal wires by the usual glass tube and water arrangement, and the other a Rhumkorff's, or similar coil, capable of giving the strongest secondary effects. Some arrangement should also be provided whereby the whole of the cells can have all their positive poles united and attached to one end of the coil, or) terminal wire, and all their negative poles brought together and united with the other wire, instead of being alternated in the usual manner, so as to afford the greatest quantitative effects. Zinc and silver or platinum plates should also be secured, of different sizes, and with insulated knobs, to take the place of the handles, for its more ready application to various parts and organs. It will often be found better, in local application, for the operator to allow the current first to pass through his own body, and then with the moistened knuckles of his free hand to gently rub the affected parts. This mode of application, while more efficacious in some affections, greatly mellows the intensity of the current, and appears to modify it in several other respects.

Electricity and galvanism used in this way, and *cum grano salis*, will be found a powerful agent and assistant to Nature in her efforts for the removal of disease; for, after all, we must ever bear in mind that in every case it is Nature, moved by Nature's God, that works the cure. All that the most skiful physician or the best adapted remedy can do is to remove obstacles and to assist, and will often work wonders when other means have failed. Indeed, if judiciously applied, it seldom fails either to promote a cure or to relieve, and will often (as in the case of obstinate ulcers) give Nature a good start, which she will not fail to follow up to a healthy issue.

Edmund M. T. Tydeman, 10, High-street,
Brighton,

EMIGRATION.

Sir,—In your last issue but one of the English Mechanic I observed, under the head of "Answers to Correspondents," a request that Mr. Rogers would communicate intelligence in connection with emigration to the Western States of America; and as I have not observed any correspondence from a namesake, and having supplied something trifling on the subject before, I naturally suppose I am the person referred to. It is some years since I was in the United States, but I am in communication with some friends there monthly; and anything I write, culled from correspondence with them, is reliable. I had occasion, some few months ago, to make particular inquiries, for a friend who wishes to emigrate. He has a family growing up, who could just be of use to him if he went out; has been educated, and practised for a short time, as a solicitor; has been engaged in farming for some years; could command £1000 to purchase land, &c. He wished to know whether I would recommend him to go to Canada, either Upper or Lower, and from my experience (two years' travelling) of that country, I said certainly not. It is a miserable place—winter too long, all people badly paid, and rich people are not numerous. Most of those who have a little money have earned it so hard, that I have known some who would not trust the best banks in Canada with it, but keep it locked up or hidden in their homes. These are not people to spend much; and where there is not a good circulation of cash, there certainly cannot be an inducement to settle there. Having written to my correspondent in Kentucky (one of the middle States), he replied that the amount of money in that State would be a small thing, the profession was overrun, land very high in price; but the State of Kentucky was one of the best of the middle States. In Nebraska the land is cheap, rich, and yields abundantly. A friend there says he grew beets in his garden, last summer, that would fill a nail keg (a vessel as large as a butter firkin), and that everything grows so in proportion. Wild fruits grow in abundance, and a tremendous emigration is growing on. It is a new State. The capital has recently been removed to Lincoln. An English colony, with which one of our leading members of Parliament is connected, is located near the abovenamed place. The public buildings are now being built. Minnesota is a beautiful State, but cold in winter for any one who likes a warm climate. Middle Tennessee offers many inducements, but is full of Confederate soldiers. A large number of Swiss are settling there. For a man who has a taste for farming, Nebraska in every respect is good. There are a good many tribes of Indians still in this State, who sometimes give some trouble; but they are not so fierce as they were some years ago. However, a border life has its drawbacks as well as its benefits. Land in Nebraska can be bought for from £3 to £6 per acre within about 15 to 20 miles from the splendid city of Omaha. A person buying land should become a naturalised citizen to enable him to hold land in the United States or to practice a profession in courts. Anyone going to any of these States must not expect to find society in the same condition as it is in these old countries, and should go prepared for such change. Sons and daughters must work in and out of doors for some time until they are in a position to hire help. They must milk, feed stock, learn to mow, sow, and reap. Although society is not all first-class, still there are very many first-class people to be found there, especially in the older places. These remarks apply to most of the Western States, and are more peculiarly adapted for those intended to settle on farms, and who have some capital.

Being pressed for time, I must conclude.

S. Rogers.

Sir,—I have just seen the lucubrations of several correspondents in your last two numbers, upon the subject of emigration. Knowing your large circulation compels you to go to press at an early moment, I have determined to write a few lines off-hand. Pray let your readers, and especially those intending to emigrate, beware of the fanciful ideas which may be mooted, and which would prove every square mile under the sun the most suitable for emigrants to occupy. I believe, yes, thoroughly believe, that the colonies possessed by England offer the best spheres to our superabundant population. The tirade of "E. W. J." about *paying* for *fancied* security is all moonshine; you are likely to pay much more in the "*countries* of the *southern* main" for no security at all. Bands of lawless desperadoes go about without let or hindrance in many parts of South America, seeking whom they may devour. The puerility of the authorities is so well known, that every man looks out for himself. "J. G.'s" description of the Argentine and River Plate territory is not to me very pleasing. I do not see how a man would better himself by settling there. But suppose such to be the case, what are his prospects? No roads whereby his superabundant produce may be utilised and money gained. Hunting accoutrements and Guacho life seem best adapted to the territory. The choosing a spot by a navigable river, at least for canoes, is easier said than done. Thus, as J. D. Rogers so excellently describes, we must turn to America; by this I mean the United States. Some of his remarks I protest against--viz., those directed against the English Colonies. Australia is not too distant, neither is New Zealand, Natal, or the Cape—countries possessing a climate as equitable and salubrious as any part of the United States. Then, again, we have Columbia, by no means an insignificant part of the British Empire. Here, then, is enough land to absorb the whole population of the "British Isles," if need be. I admire the energy and self-dependence of the working men at Mile-end, and have no doubt that they will thrive at their new home. But I question if they will find the laws better. Certainly if our Legislature was to take more interest in colonial matters very much more good would be the result. Apathetic, careless, ignorant, to a surprising degree; doing nothing but under compulsion, and even then the least possible work, ignoring the claims of our superabundant population; wasting time in useless squabbling—are a few of the remarks hurled against our Legislature. How true, may be known by consulting an article on England and her Colonies by J. A. Froude, in *Fraser's* for January. I believe Mr. Froude would have no objection to the republication of his article in the columns of the English Mechanic, and if this could be done a great boon would be given to its readers. One or two of his last sentences I make bold to extract. Thus he says:—

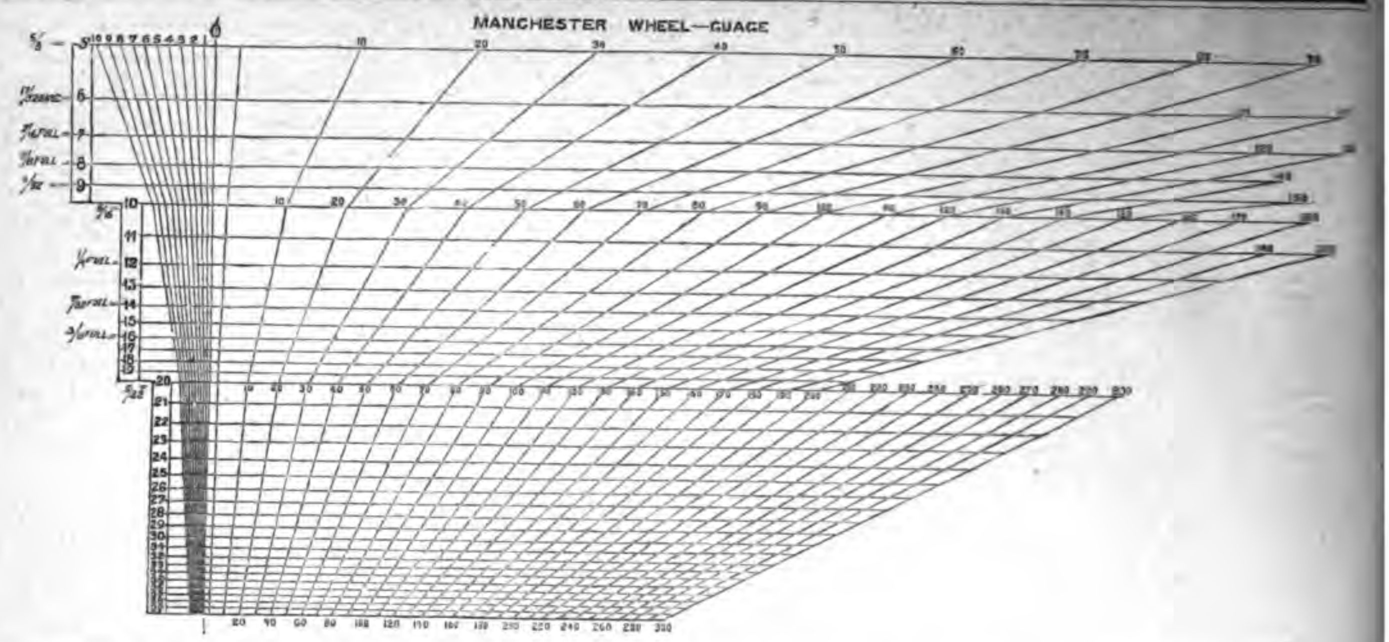
> "That emigration alone can give them permanent relief the working men themselves will ultimately find out. . . . Are we to wait till our own artisans, discovering the hopelessness of the struggle with capital, and exasperated by hunger and neglect, follow in millions also the Irish example, carry their industry where the Irish have carried theirs, and with them the hearts and hopes and sympathies of three-quarters of the English nation! If Mr. Gladstone and Mr, Odger are indifferent, we appeal to Mr. Disraeli. This is one of those imperial concerns which the aristocracy, lifted by fortune above the temptations and necessities of trade, can best afford to weigh with impartiality, &c."

He evidently thoroughly believes in a national system of emigration, in which Government vessels conduct the wayfarer, and Government arms encircle and sustain him till the time has come when he can sustain himself. Of course Government would be no loser in the long run; the first expenditure would easily be recouped by various means which, however, I cannot at present discuss. I Again wish prosperity to the noble workers at Mile-end, a speedy and auspicious departure, and a successful issue in their new sphere!

F.R.G.S.

WHEEL TEETH.

Sir,—In answering a query on the above subject, I had occasion to speak of the Manchester wheel gauge, and attempted to describe it; I now forward for engraving, if you please, what I use in place of the gauge as ordinarily made. As this last is expensive, costing 12s. for about sixteen rows, divided on box wood, and some more for the smaller ones on a brass plate. To use it, say, to ascertain the gauge of any wheel you already have, count the teeth, and place the wheel flat on the gauge where you find the diameter of the wheel covers the same number of equal parts on the scale, as the wheel has teeth. And that line of equal parts is the gauge to work to for any other



number of teeth. You will observe on the gauge, that to the right of the zero line, is a space containing two of the divisions, that there are to the left of the zero, and that quantity is the "addendum," or quantity that the outside of the wheel is bigger than the pitch diameter. So to find diameter of a wheel of 20 on the top scale of all, put one point of your compasses at 20, and measure towards the left as far as the zero, and that will be correct. Or for 25 teeth, measure from 20 past the zero to the number 5, including altogether 27 divisions, and that will be right. And the same for any other scale. It is to be remembered, in making the guage, that the 5 gauge is 5 parts to an inch, and the 10 gauge is 10 to an inch. A piece of the gauge 7in. wide and 6in. high, will be quite enough to show the principle. I must request care in using, as it is the original and only one I have.

J. K. P.

SHORTHAND.

SIR,—Having learnt three systems of shorthand, viz., Mackenzie's, Pittman's. and Lewis', at times sufficiently far apart not to mix one system with another, I have to state in answer to "Hermit" (who, by the, way, puts his question in the unusual form of a letter) on age 255, that, in my opinion, Mackenzie's is not worthy the name of shorthand, Pitman's one of the worst, and the Royal Lewisian system by far the best, beating all others hollow; the first two, I am thankful to say, have long departed from my memory. I have often written 116 words a minute in Lewis's system, and a friend of mine has written more; the most rapid reporters are said to be able to write 250 words a minute in it, but I much doubt any one's ability to do so in such a short time. A gentleman who has used Pitman's system for many years acknowledged, after trial with me, that the system I write (Lewis's) is the clearer and shorter of the two. As Mackenzie's system is now never heard of, there is no occasion to say anything about it. The great fault in Pitman's consists in using the *same* characters when made thick and thin to represent *different* letters; I have heard many writers of Pitman's system acknowledge, and have myself discovered that it is impossible to make any real difference in the thickness of the characters when attempting to write rapidly; the consequence is that unless the shorthand be transcribed while the subject is fresh in the memory it is practically illegible; but the most ridiculous feature in Pitman's is that there are (as nearly as I can remember) six different positions for the vowels and dipthongs, so that when the writer finds it necessary to insert the vowels, as in a proper name, or foreign word, for instance, he has to consider *while he is rapidly writing*, first, what is the proper sign for his particular vowel, and then its proper position—whether it should be at the upper end on the left hand side of the character representing the nearest consonant to the vowel, or at the middle below the character, or at the upper end above the character, or at the lower end on the right hand side of the character, &c., &c., according to the position of the character on the paper; such consideration is almost impossible; rapid writers in Pitman's system are obliged to alter and improve it in this particular. I remember I made out a kind of table to try to remember the different positions. Anything written in Lewis's system can be read, without any difficulty, 20 or 30 years hence, when the subject will have quite escaped the memory—the characters representing the vowels are very simple, and their position is not of the slightest consequence, so long as they are written in the same order, as in longhand; the only awkward character to join to others in this system is that representing *ch*; but another character can easily be substituted. Should "Hermit" wish to constantly write the same sentences—as, for instance, "Your last letter duly received," he can add a character representing the whole of such sentence without causing any confusion; any word may be written as spelled, or as sounded—that is, phonetically; any number of *figures* also are expressed in this system *without taking the pen off the paper*; quite as much time is occupied in making a dot, even, as in writing three or four words in shorthand, because there is no necessity after a little practice to lift the pen from the paper at the end of each word. I was able to write 60 words a-minute after a practice of about one hour a-day for six months, and having kept the dictation for more than two years was able to read it with very little difficulty, although the subject ("Locke on the Ideas") could not enableme to guess at any of it. Forty years of experience have been required to bring this system to its present state of perfection. No disadvantages can attend the knowledge of such a useful accomplishment as shorthand; the many advantages are obvious.

Mr. Pitman's office is at No. 20, Paternoster-row, E.C. Mr. Lewis's is at No. 113, Strand, W.C., where Mr. Lewis will give all information at almost any time. The former gentleman has published a small inexpensive book on his system, and the latter a half-guinea book on his system, which is used in both Houses of Parliament and in the Courts of Law. The Prayer Book and the New Testament may also be had in Lewis's system. I think you will agree with me that only those who can speak from experience ought to express an opinion on the relative values of various systems, no one profits by being told that some one has heard that one particular system is the best.

FRANK W. GRIERSON.

SIR,—Your "Hermit," on page 255, wishes for any information which I can give him, on the merits of shorthand, and of its "different" systems. Five-and-forty years ago I took up Sam Taylor's system, which was published A.D. 1786. I had also Wm. Mavor's, of 1789. This latter I did not follow, for Wm. Harding's came out in 1832 with "Taylor's Improved," which I followed, with some modifications, ever since, examining every novelty as it came out, and comparing its merits with my old adoption—improving it if I could.

Pitman's system is the only one I can call a rival of Taylor's, and that only because of its many admirers. I learned it, tried it for some time, but abandoned it as complex and unsatisfacty. It has but ten characters for twenty letters, to be distinguished from one another by their "thinness" or their "thickness." Taylor's are all unlike, except where you can write one letter for another, as for instance, S for C soft; G for J, or *vice versa*.

I think "Hermit" could write freely from dictation in six months, by an hour's practice a day; and that in half that time, he could keep his diary and note-book, to his great contentment.

I would recommend "The Hermit" to write for the "Phonographic Teacher," 6d., to Mr. Fredk. Pitman, 20, Paternoster-row; "Stenography," by Thompson, 1s., to Mr. Fredk. Warne and Co., Bedford-street, Covent Garden; "Taylor Improved," 8d., to Groomridge and Son, 5, Paternoster-row.—Compare them together, and make himself master of both alphabets and joining tables of these systems. When he comes to the end of that stage, I can tell him more.

MAC D.

SPECULUM TESTING—THE "PHANTOM."—CALLAND'S BATTERY.

SIR,—Thinking it would interest many of our astronomical friends, and having a little forced leisure upon my hands through being invalided by a serious accident, I have endeavoured to epitomise, or, rather, to give in my own language, the substance of methods employed by Mon. Foucault and others for figuring and testing specula independently of stellar observations. These plans were described by Dr. Draper, though not with all the details given below, in a book published in 1864, entitled "On the Construction of a Silvered Glass Telescope, 15½in. Diameter."

For a testing room he chose a long underground apartment, the apertures of which can be closed in order to be as free as possible from vibration and the disturbing effects due to variations of temperature.

For a support a piece of wood somewhat thicker than the mirror, and curved out to fit its periphery, is nailed to the wall about 3ft. from the ground; this is then lined with several thicknesses of blankes, so as to form a pad for the bottom part of the speculum to rest upon, the latter being prevented from falling forward by means of two wooden buttons near the top, which secure it, but so as not to bind it in any way.

Exactly opposite the speculum, and in its centre of curvature, is placed a lamp giving a very strong li the ordinary glass chimney is removed, and one of or tin substituted, having opposite the very brigh part of the flame two holes drilled about the half an inch or more asunder, the one being about 1-500 and the other 1-300th of an inch, or less, in diameter. The smallest hole is the one used in testing, the other merely acting as a finder; these holes must be drilled in the same level, so that when the image of the larger one is obtained, by turning the chimney round a little, the smallest will come in view. Close beside the lamp is placed an eyepiece, magnifying about 39 times, through which the enlarged image of the hole is conveyed to the eye.

If now the speculum be of a perfectly spherical figure, the image of this hole will appear round and distinct, encompassed by diffraction rings. But if its surface be at all irregular the image will be found distorted, or having wings, or it will present some other equally anomalous appearance. The aperture of the speculum can now be stopped off in zones about an inch broad, when, should the form be regular, no alteration of the eye-piece will be necessary to preserve each separate zone in focus.

In judging of a parabolic figure, the longitudinal aberration of such a figure when reflecting rays proceeding from its centre of curvature must be calculated, and the form (or curvature) of the various zones altered by means of local polishers (small polishers varying from 1 to 8 deg. in diameter, made and worked in the usual manner either by hand or machine), until the necessary aberration is obtained. A second test used in conjunction with this one completes the operation of testing. In this test for the eyepiece is substituted an opaque screen, behind which the eye is placed, and the edge of the screen so moved as to shut off nearly all the rays proceeding from the mirror to form the focal image of the small lamp hole; and just when the last rays are departing, an intensely exaggerated view of the figure of the mirror, with all its imperfection in relief of light and shade, will be presented to the eye. But if perfectly spherical the mirror will present to the eye the appearance of an equally lighted plane.

So exceedingly severe is this test that the smallest ruffles or undulations due to the irregularities of hand polishing, but which cannot be detected even by star testing or the most powerful microscope, are made plainly visible.

If the speculum possesses a parabolic or hyperbolic figure, an undulation or gradual rise in the surface of the apparent plane will appear as a zone having its greatest elevation midway between the centre and circumference of the mirror. If the above directions are carefully followed they will be found to afford a valuable criterion to judge of the quality of a mirror. But it requires some amount of practice upon specula of known goodness to be able to figure with great accuracy by it. In the last-named test it is very important to place the screen and the lamp both precisely in the focus of the mirror. This will easily be found by moving them a little to and fro until the shadow named below appears to advance all over the face of the mirror equally.

"The appearance that a trely spherical concave mirror presents is that, when the eye is brought into such a position that it receives the whole pencil of reflected rays, and the opaque screen is gradually drawn across in front of the pupil, the brightness of the surface slowly diminishes, until just as the screen is cutting off the last relic of the cone of rays, the mirror presents a uniform greyish tint, followed by total darkness, and gives to the eye the sensation of a plane."

I will, if desired, describe Dr. Draper's and Mons. Foucault's system of grinding and parbolising. It is spoken very highly of, but will be found rather troublesome. It certainly gives good results on a large glass. It is superior to the method published by the Rev. H. C. Key, and lately so ably detailed by Mr. Purkiss. I do not practise it myself, as I consider my own plan much quicker, and capable of producing a better figure, especially on a small glass. I shall probably recur to this interesting subject in future letters.

Next week I hope to have something to say in favour of the "Phantom" veloce, one of which I have just obtained, but owing to the accident named above have as yet been prevented from taking a "spin" upon it. A better or more thorough-going piece of workmanship throughout I never beheld. I like the appearance of "the wheel and the way" the tires are affixed. It certainly looks capable of doing all that is reported of it. All my friends who have tried it speak highly in its praise.

Edmund M. T. Tydeman, 10, High-st., Brighton,

P.S.—Would "Sigma" oblige me with a description of "Calland's" battery, which I see is stated to involve only one-fourth the expense of a "Daniell's?"

FEED-WATER HEATER.

Sir,—I have read your correspondent's letter, signed "James Baskerville," and beg to thank him for the correction. I wrote my letter to you rather hurriedly. I should have said "within 10° of the heat of the steam issuing from the exhaust." This difference I ascertained by placing a thermometer in the exhaust pipe and in the heated feed water. Passing by the touch of sarcasm in one portion of his letter as a weapon unworthy of a place in a correspondent's armoury, I do not claim an extraordinary saving in the use of this arrangement, as your correspondent seems to suggest; but I do say that my experience warrants my expression when I say that this heater is a very effective appliance. Against your correspondent's figures I beg to place the fact that for two and a-half years before I erected the heater described, my consumption of rough slack was a boat-load every seven weeks on an average, and for over 20 months after the heater was in operation, the same boat-load served always over nine weeks. During both periods, the work performed by the engine and its general condition were the same. The arrangement sketched by your correspondent is no doubt equally effective as that described by myself; but I think the nuisance caused by the noise of condensation of the steam would be a disadvantage, as also the passing of hot water through the pumps.

Llah.

COMMERCE AND TRADE—HIGH MARKETS—WAGES—STRIKES, &c., &c.

Sir,—Having read the very instructive letters of Sigma' and others on 'Commerce and Trade,' I would like to see the subject sifted from the very bottom. I have been a subscriber from the first, and I think the above subject is as important as any. Not many weeks ago the Glasgow joiners were out on strike for the nine hours a day movement, and they have gained. Now, in all future contracts the prices will be higher; then, of course, house proprietors must raise their rents. Now, all other trades, seeing the success of the joiners, will in time try to follow. Now. I would like to have the opinion of some of my fellow-subscribers if 8, or even 9 hours a day, would pay, were it to become the general law?

I have been thinking about the Land question (but not Irish land). My opinion is, if Government were to buy up the whole of the Three Kingdoms, and sublet it in portions to the highest bidders, then the money would return to the national purse, it would reduce taxation, and strike at the root of all discontent.

William Jardine, *Risk-street, Dumbarton.*

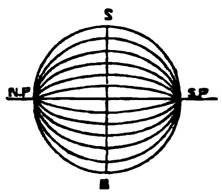
READINGS FROM THE GLOBES.—No. IV.

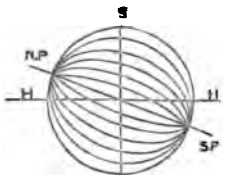
(*Continued from page* 278)

Sir,—It must have occurred to every one, when viewing the sun, what a different appearance he presents at different seasons of the year, sometimes reaching a considerable altitude in the heavens, and at other times being low, and making but a small tour in his daily course. Even an uneducated person cannot but be struck with this property of the sun; but travellers who have visited the torrid and frigid zones must have beheld with still more curious feelings the appearances which he presents in these parts—in the former becoming vertical, and in the latter never setting for days, and even months together. Early observers of the heavens noticed that he did not rise daily in the same point of the compass, but that half of the year he rose more and more northward, and became higher and higher until he had reached his maximum height, and then began to recede, and for another six months of the year to rise more and more southward, and become still lower and lower, and by logical deductions they have been able to form an intelligible theory of the sky, so that anyone can, without much effort, understand

> "Quid tantum Oceano properent se tingere Soles
> Hiberni, vel quæ tardis mora noctibus obstet."
>
> "Why winter's suns to ocean haste away,
> Or what obstructs the nights to make them stay."

It will be our object to show how these different appearances may be readily explained by the globe, and we will begin from the point Aries, when the sun makes a fresh start to pursue his accustomed round. When at this point he is crossing the equinoctial line, and the days and nights are then equal, or 12 hours long, in all latitudes as far as the poles. To represent this by the globes we must place its two poles in the horizon, as it appears in Fig. 1. It will then appear by an inspection of the figure how it is that the days and nights are then equal all over the world; for, let S. E. represent the equator, N. P. the north pole, and S. P. the south pole, round which the world spins. The meridian lines are imaginary lines, contrived by geographers for the purpose of giving a better idea of the revolution of the earth on its axis. In this situation, then, if we count from S towards either pole, we shall find six spaces, each 15° in width, which is equal to half the length of the day in all latitudes. The days will therefore be 12 hours long, and the nights 12 hours long. As the sun is supposed to be in the point Aries, he will be vertical successively to all living at the equator, as they pass under S. At the north and south poles the sun will be just visible on the verge of the horizon, but at all other points his altitude will be exactly equal to the complement of the latitude, because the height of the pole star being equal to the latitude, and the sun being in the equator, it will require these two amounts to make 90°. Thus, at London his meridian altitude will then be 38½°, at St. Petersburg 30°, at New Orleans 60°, and at Quito 90°. Again, owing to the pole of the earth always pointing to the pole in the sky, it does, as it were, shift itself; and moving gradually in three months after, or June 20, the earth presents the same appearance as in Fig. 2. Then it will be summer in the northern hemisphere, and the days will continually increase in length towards the north pole, and consequently the nights diminish. If we count from S towards H, which is supposed to represent the horizon, or boundary of light and darkness, we shall find that at the equator, as before, the day is 12 hours long; but in proportion as any place is distant from that line, so its days increase in length until we come to 23½° of the north pole, or to the boundary of the Frigid Zone. Here we shall find, by counting the meridians, that the half day is 12 hours—that is, that the length of the entire day is 24 hours, as, for instance, in the northern part of Sweden. His meridian altitude will there be 47°, because 23½°, the declination of the sun, added to 23½°, the complement of the latitude, will make that amount. He will then have reached the point where he begins to recede, and at noonday will be vertical to those who dwell under the Tropic of Cancer, and will continue to be so for several days; for it is here that "Sol stat," or is apparently stationary for a short time. By reversing the figure, it will present the appearance of the earth at the winter solstice, when the south pole is turned towards the sun, and the north pole away from it; and the consequence is, that the days continually increase in length in the southern hemisphere, the sun becoming daily higher and higher in the one, and lower and lower in the other, until he has reached his greatest south declination, when his altitude at London will be the complement of the latitude minus the declination, or 38½ — 23½ = 15°. Thus we find that, having only a small arc to pass through in the enlightened hemisphere, his long delay in rising is accounted for by his having a longer tour to take; and when he makes his appearance, it will be as much to the south of the east as during the summer it was to the north of the east. He will then be vertical at noonday to those living under the Tropic of Capricorn, and the reason will be apparent why our antœci have summer when we have winter, and why their day is exactly equal to our night. If, then, we wish to see the position of the earth with regard to the sun at the summer solstice, we must elevate the north pole 23½° above the wooden horizon. But to show its position at the winter solstice, the south pole must be elevated the same number of degrees, when, by turning the globe on its axis, it will be seen that the north pole has entirely lost sight of our golden luminary.





T. S. H.

THE LATHE AND ITS USES.

Sir,—I quite agree with another subscriber of "ours," of this week, respecting patterns for lathe, and have no doubt that, notwithstanding all that has been published, good working drawings to scale, of the most recent pattern, and containing all the improvements that an amateur would be likely to want in a lathe, would be highly prized. It is not enough to see a finished engraving, without the various parts shown in section, &c., and some guide as to relative sizes. There is no journal that can do this better than "ours," even if so well. We don't want to lay out 100 guineas, nor is there any need of one costing a large sum. I would suggest it should have fret saw and vertical drilling apparatus to fit, and work on it, as well as many other appliances that brother amateurs could give "notions" of.

J. F.

DARK LINES IN SOLAR SPECTRUM. TWILIGHT.

Sir,—I wish "Steersman ' (3991) had not required my opinion upon the spectra of the fixed stars, as I would much prefer allowing the spectroscopist to correct his own errors.

There is no doubt the spectra of comets and nebulæ reveal the character of these objects; but as to remote suns, diminished by distance to a point, what can be expected from the spectroscope but evidence of the power their light still possesses of effecting chemical change in our atmosphere?

With reference to the presence of iron in the air, where does "Steersman," imagine the surface matter of the globe comes from? Space is not an empty void.

T. A.

P.S.—I hope Mr. Proctor will pardon my obtuseness but I cannot understand him. There is no such thing in nature as a *crepuscular curve*; for refraction is not concerned in the phenomenon of twilight.

TO TRISECT AN ANGLE.

Sir,—In your impression of the week before last there was an ingenious attempt at the solution of the well-known problem to trisect an angle. The method, however, was only approximate as the locus of the trisected angles would be a curve of the third order, and not a circle. Moreover the method would be rather troublesome in practice.

It led me to investigate the curve which has the property of trisecting all angles drawn from two given points in the manner of the method referred to, and which is, in fact, the place of the apex of all triangles standing on a given base, and having one of the angles at the base three times the other.

The equation to the curve when referred to rectangular co-ordinates is cubic, and has not an encouraging aspect.

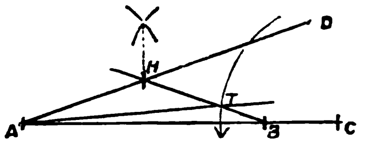
Its polar equation is simpler—

$$r = \frac{a \sin. \frac{\theta}{3}}{\sin. \frac{4}{3} \theta}$$

In its positive branch this curve resembles very remarkably an hyperbola, and this similarity easily led to a practical determination of the radius of curvature at the vertex—namely, at the point which divides the base of the supposed triangle in the proportion of $\frac{3}{4}$ to $\frac{1}{4}$.

This radius of curvature is very nearly $\frac{55}{100}$ of the base, and supplies the following easy and accurate method of trisecting an angle.

The rule should not be applied to an angle greater than about 15°, so that for the trisection of greater angles, three equal arcs must first be taken off, reducing the remainder to an angle within the proper limits.



Let D A C be the angle to be trisected. With any scale, or with dividers make

A V = 15
V B = 5
B C = 6

At B make the angle H B A = D A C. With centre C and distance C V draw the circular arc V T. Join A T. Then will T A C practically trisect D A C.

The theoretical errors will be, approximately, when

	Error.
D A C = 15°	1′
= 6°	1″
= 1°	0

For practice I should recommend from 6° to 10° as the most accurate.

F. C. Penrose.

VELOCIPEDES AND BICYCLES, *VERSUS* STEAM CARRIAGES.

Sir,—I have read, noticed, and examined, with much interest, the thousand-and-one proposals, suggestions, and drawings, made in your paper, respecting the best and easiest mode of self propulsion. Your correspondents' various machines, seem, according to their own account, to go at all speeds, varying from 6 to 30 miles an hour. All the proposed machines would no doubt fulfil the expectations of their inventors, if a journey of 50 miles each way was all down hill, both there and back, but, unfortunately, in a journey both ways, there is just as much up hill as down hill to go. I have never yet been on one of these manumotive engines, but I have seen many of them in the street and on the highways; they all go first-rate down hill, but up hill, or even on a level road, it appears to me to be fatiguing work, and I have come to the conclusion that the whole stock of velocipedes, pedespedes, tricycles, bicycles, and all other pedes and cycles, are up to nothing, when put really to practical work, and particularly in a hilly district. It is useless, then, wasting so much of your valuable space every week in describing these articles. The long and short of it is, we want, and must have, something really useful, practical, and powerful. A steam carriage is what we want, but at present steam carriages are practically useless in consequence of the very many vexatious restrictions placed upon their use by a house full of M.P.'s interested in railways.

It is our duty as English mechanics, to agitate for the repeal of these restrictions, and for the abolition of all toll bars, and never rest satisfied until we have accomplished our object. When such eminent men as Sir Joseph Whitworth are in favour of road locomotion, I think the matter is at least worthy of discussion in your pages. My object in troubling you, is to induce some of your clever contributors to take up the matter in earnest. I think, as mechanics, we ought to take a deep interest in anything that will increase and benefit the iron trade. I am sure I would make every effort to own a steam carriage, were their free use permitted, and I look forward with pleasure to the time when I shall be able to take out my steam carriage, and give my wife and children a pleasant ride into the country, when my day's labour is o'er, or when I can reside a few miles from town, and go to my work in my own carriage. This proposal may seem ridiculous on paper, but we have it within our grasp if we will only go heart and soul into the matter. Then, again, look at the immense benefit it would confer on tradesmen of all classes, builders for instance, who may have twenty men working at a job, three or four miles from their shop. These twenty men each lose one hour of their master's time every morning morning going to the job. Now with a steam carriage, they would go in fifteen minutes, which would be a clear saving of fifteen hours per day to the master. Certainly the coal and the driver's time would cost something, but that would be amply compensated for by the men being fresh and ready for work, instead of being fatigued by a four miles journey. Then, again, very few small tradesmen can afford to keep horses, because they are always eating, whether they are working or not; now a steam carriage would only be consuming when it was working, the consequence would be, every one who could spare the money, would have his own private carriage; this would give a great impetus to the engine trade, and find employment for thousands of our intelligent mechanics, who are being driven out of their native land to seek that employment which is denied them at home. Any objections that our M.P.'s could make or raise, could easily be met, and the public safety secured by using proper precautions, such as limiting the speed of the engine to, say eight miles an hour in towns, and fifteen miles an hour in the country, and by compelling the owner of each carriage to place a speed indicator, and also a water and steam indicator to his boiler, in such positions, that they could be seen distinctly by both himself and the general public outside, who could complain if he violated the law, so as to endanger the public safety. Then again, each carriage should carry a pair of lamps. Coke should be the fuel to be used, so that no black smoke would be emitted; in fact, only let the want of a compact and useful article be felt, and the inventor will step in and supply the want. It would scarcely be advisable to allow lads under, say 18 years of age, to be in charge of them. In conclusion, let me urge your readers to consider the importance of this proposal, and never rest satisfied until we have gained our object. Mr. Allen and his 33,000 brethren of the Amalgamated Engineers, will, I am sure, come to the rescue. The question only wants agitating, and I know of no paper so suitable as the ENGLISH MECHANIC so take the lead in the matter. What a boon it would confer upon commercial travellers with their tons of luggage, to be able to go through the country districts, where there are no railways! It would be to them an immense saving. May I ask you, Mr. Editor, to append the present Act of Parliament on the Use of Steam Carriages, for the benefit of your numerous readers?

A PATTERN MAKER.

["A Pattern Maker" makes some suggestions on steam carriages well worthy of attention, but why condemn "the whole stock of velocipedes," if he has "never been on one of them." He wants a steam carriage "to give his children a pleasant ride into the country," but every one has not a wife and children to take. Possibly at one time there was too much of our space occupied by notions and fads in connection with velocipedes; but for some time past we have only given insertion to practical suggestions and realised facts, and certainly "A Pattern Maker" cannot reasonably object to space being so occupied. —ED. E. M.]

A FOUR-WHEELED VELOCE.

SIR,—I see that you give in your publication considerable attention to velocipede construction. It is an interest subject, and deserving of the space you devote to it. The bicycle seems at present perfected in the "Phantom" veloce, and for all who can ride on a two-wheeled machine there seems to be nothing more to be desired. But there is a large class of people, both young and advanced in years, especially the latter, desirous to make use of this kind of locomotion who cannot or will not adventure themselves on two wheels. I have been thinking that for them there might be a safe and easy-going machine constructed which would be light and swift too, if two bicycles could be mechanically connected so as to make one machine with four wheels, on which two persons could ride abreast. This would be a safe and social way of riding the veloce for the class of people referred to, if our mechanics should pronounce it practicable. The tricycle does not answer the purpose, and is therefore but little patronised. It is possible that you have received suggestions of this kind already, and that they have been satisfactorily disposed of; if so, you will please excuse this communication as in reference to your useful publication I am but

A NEW READER.

AN *ENGLISH MECHANIC* COLONY.

SIR,—I beg to add my testimony to the very able manner in which our MECHANIC is conducted, and the great success it has attained. This is the result of your wise policy of encouraging all your readers to become also contributors. "In the multitude of councillors there is wisdom." Curiously enough, I have known instances, long before the advent of your journal, of similar periodicals starting off with great eclat and success, mainly owing to the primary encouragement of this same feature, but somehow, as soon as the precocious gentleman thought himself safely out of his leading strings, the communications and queries of the life-giving amateurs were pushed from corner to corner, and ultimately to the cover of his precious pages, the effect of which, upon their intrinsic value and on the subscription list, it is needless to describe. It is clear, a journal like yours may be made useful in a thousand ways to its subscribers, which must soon become legion, whatever may be their individual position in society. We can easily gather from its pages, that it represents to a large extent, every grade of education and intelligence, from the inspired philosopher to the humblest mechanic or agriculturist, all ready to yield up the benefit of their special experience to their fellow subscribers. Under these circumstances, it is difficult to conceive almost any object, however important, or however comprehensive in its character, in connection with which your journal could not be of most vital service.

Having noticed some anxious inquiries, from time to time, on the part or individuals desirous of emigrating, it has struck me forcibly, that through the agency of your trustworthy journal, a scheme of colonisation of a superior character could be carried out with very successful results. What is to prevent us at a time when this great question of emigration is forcing itself upon every thoughtful mind, to set to work and form the nucleus of a new and prosperous colony, to be established in some favoured spot of our glorious dependencies, which may, in the course of years, become the happy home of thousands of our surplus population? I can see no reason why this scheme could not be easily carried out by the aid of your liberal pages, and of the able and willing minds which so freely contribute to their contents. Not only so. I believe that a colony formed with such materials as would thus be collected, would be initiated with the advantages of a greater diversity of means, talent, and a more general diffusion of useful intelligence than in almost any previous instance of the kind, thus making a start with all the valuable elements of civilisation at the very outset. I believe now that the attention of Government has been urgently drawn to the subject, terms of a most advantageous character could be made in the way of a grant of land, and other important concessions. If you think, Mr. Editor, that my views are correct on these points, and you think proper to submit them to your readers, with the view of carrying them into practice, I will be glad to correspond with any gentleman competent and willing to become members of a provisional directorate in such a movement, with the view of an interchange of opinion on the subject, after which a permanent directory could be established, in at least one principal seaport in England and another in Scotland, and another in Ireland; and after certain essential arrangements have been made, measures would be taken to make the movement public through the pages of the ENGLISH MECHANIC and other media, with the view of receiving applications for membership, which I trust would reach 1000 at least in a short time. Such a number of colonists, with its combined capital, could, by chartering vessels on its own account, transport itself to the required destination at a very moderate cost, and by the employment of its supposed superior intelligence in the selection of machinery and other appliances, agricultural or otherwise, of the most approved description, it would no doubt succeed in establishing itself with as small a share of discomfort as is possible under similar circumstances.

ALEXANDRA.

[The above letter is written by a strong-handed and clear-headed Scotchman. It may contain the germ of an historical movement; at all events, it has our hearty approval.—ED. E. M.]

COTTON SPINNING.

SIR,—I promised in my last letter to speak further on the subject of drawing boxes; with your permission I will now do so. But first let me say a word or two about the filaments that drawing rollers have to disentangle and draw out. Peradventure, there may be some lads, and even "big 'uns" too, who are not fully aware of the fact that cotton fibres are long tubes, more or less tortuous, and individually of no appreciable strength. That they somewhat resemble the hair of animals, and grow upon the surface of the cotton seeds much in the same manner as hair grows upon the head. Different classes of cotton have different, and to the spinner, very important characteristics—as the average diameter of the fibres of "upland" cotton = $\frac{1}{6000}$ part of an inch, of Sea-Island $\frac{1}{2000}$, of Surat, from $\frac{1}{500}$ to $\frac{1}{2000}$. The process through which the cotton goes after it is "picked" from the seed pods, and previous to its being compressed and packed up for exportation, is a mechanical scutching, for the purpose of tearing off the fibres from the surface of the seed-coat to which they obstinately adhere; and for the further purpose of expelling other extraneous matter from the cotton. How far this process has hitherto been successful, those can tell, to their cost, who have paid from two shillings to two shillings and sixpence per pound for *sand*, seeds, dust, *stones*, *bricks*, &c. However, anyone at all acquainted with cotton spinning knows how utterly impossible it is to tear off the fibres from some portions of the seeds by any amount of scutching, short of one that will be disastrous to their spinning qualities after the cotton has been compressed and felted together, and, especially, is this so with the chief classes from India? When portions of the most common descriptions of cotton come to be examined after being "willowed," "scutched," and "carded," they will be found to consist, not of a mass of single fibres commingled together, but in the mass will be found numberless minute "motes," with a small cluster of fibres adhering to them. The object of the carding process is to eliminate the filaments individually by a combining action, but so tenaciously do these minute clusters adhere together that even the "teeth" of the cards will not separate them without such an arrangement of them as would break the rest of the fibres to pieces. Here let me observe that these minute motes affect the drawing qualities of the cotton very materially; no cotton in which they exist will draw out equally or evenly, but in small patches or clusters which ultimately produce a knotty, uneven thread; because, behind each knot or cluster of fibres there must obviously be a corresponding "thin place," which gives to the yarn the appearance of having been partially cut through. The strength of these thin points, be it observed, is the strength of the yarn. I must further remark that the length of the fibres and the degree of their natural torsion also affect their drawing qualities, inasmuch as they affect, to a great extent, the amount of force with which they resist the quickened motion of the front pair of rollers, or, in other words, inasmuch as they affect the amount of force with which the latter or hind portion of the fibres resist the quickened speed of the front portion. Now it is obvious enough that the amount of this resistance or holding-back force must also depend upon the distance there is betwixt the rollers. If this resistance be too great, the fibres will be broken; if too little, they will draw out in clouds, or irregularly. It follows then, that the medium betwixt these two extremes is the condition that will be most effective in rendering "good work." It may not be amiss, although the thing is self-evident, to say that long twisted fibres offer the greatest resistance in drawing, and short straight ones the least. Another *very important* consideration in this matter is the *speed* at which the fibres are drawn out; for it must be remembered that the rollers do *not* give to the filaments a gradually increasing rate of motion from one speed of travelling to another, but draw them out by a *sudden jerk*, so that the strain upon the fibres caused by a long draught, may be considered as equal to that of a short draught at a correspondingly quick speed. (Let me here refer the lads to the Rev. E. Kernan's "Science for the Young," in this vol., Inertia, page 105). Before I resume the subject, let me remark that this latter *common sense fact plainly demonstrates that no very quick speed of rollers can ever be attained with long draughts*, though it is *not the speed itself that is mischievous*, but the abruptness with which the fibres are jerked from one degree of motion to another. There are but few spinners of any experience who do not know that a very trifling increase of speed often makes the "work" unmanageable. Many things may contribute to this result, but the chief one is the too abrupt jerking of the films between the rollers; and a shorter draught put in operation with the increased speed would be a remedy for the main evil. Now, the "cylinder" of a carding engine travels at a much quicker rate than the "doffer" that "strips" it of the carded filaments; consequently, the filaments cannot be laid upon the surface of the "doffer" longitudinally and parallel, but in a confused mass. In this state they are combed from the "doffer" by the "doffing comb," and made to pass in a continuous web through a funnel-shaped nozzle; and by this means are contracted from the broad web to the form of a flimsy rope. This flimsy rope of fibres has to be drawn out by being passed through various speeds of rollers until its tenuity equals the intended "counts." (The "counts" are the number of hanks there are in a pound weight of the material—840 yards = 1 hank). The "drawing box" rollers have, of necessity, the greatest speed given to them, then, after taking into consideration the above *facts*, and remembering, moreover, that between the first pair of rollers there are often upwards of 40,000,000 of fibres passing through at once, is it at all surprising that the question asked by "Factory Lad" should receive so many different answers. However, "*Factory Lad*," page 231, says, "I find 'Mutual Improvement' comes the nearest to what I have practically found to be the best arrangement working '*fair Dhollera*'—I have my draughts—

$$3{\cdot}41 \times 1{\cdot}75 \times 1{\cdot}17 = 7{\cdot}06."$$

Now, if "*Factory Lad*" is not "running" at a great speed, his arrangement may do.

$$(\text{But } 3{\cdot}41 \times 1{\cdot}75 \times 1{\cdot}17 = 6{\cdot}981975, \text{ not } 7{\cdot}06.)$$

However, it is incomprehensible to me how "Factory Lad's" Surat fibres after being "coaxed" (vide "H. C. S.," page 183) from 1 to 2, should be thereby prepared for being jerked from 2 to 7. "Mutual Improvement," page 230, says he must give me "credit for knowing better than equalising the three draughts." I am afraid I do not deserve the credit; for, seriously, I do believe the arrangement he advises, in these days of "keen" competition, with its concomitant, quick speed of productions, would be all the better for some amount of equalisation. If, however, he thinks differently, I shall not quarrel with him. In a former letter, I said it is a "pennywise and pound foolish" thing to have a draw-box attached to the carding engine for the purpose of adding a considerable amount to the draught of the engine. "Mutual Improvement" says he c[illegible] understand why such is the fact. He further [illegible] it is stated that some of our most successful spinners work them, and asks if I will give my reasons for condemning them. To be sure I will, "M. I.," lad; at the same time, let me say, I do not want any deference to be given to *my opinions*, but I would rather that we should all bear in mind the *fact*, that we may all look at any subject from a different point of view; so that there is not the least necessity for us to "pitch into each other." However, simultaneous with the process of drawing, it is found to be necessary and profitable to put in operation the "doubling" process, in order that the inequalities of the "work" may counteract each other. And, furthermore, in order that as the filaments are drawn out longitudinally and laid parallel to each other, their ends may be properly arranged, one a little advance of the other; in the same order as a builder lays the courses of his bricks, that the joints may be well overlapped. Without this condition, it is impossible to make a good thread; and so fully is this fact recognised that the doubling process is carried out by some manufacturers to the extent of from 80 to 100,000 times. It is a self-evident fact, that as the draught multiplies the length of the yarn or sliver, it also multiplies its defects, unless it is prevented from so doing by doubling. Short draughts and plenty of doubling will produce good, even yarn, that will bear the strain of quick speed—our bulwark against competition. "M. I." may now see why I condemn draw-boxes attached to carding engines for the purpose of adding *a considerable amount* to their draught. I am somewhat puzzled in my attempts to find out by what "preparation" "Harmonious Cotton Spinner" has resolved the major chord of his 1st letter into the minor chord of his 3rd. How does he make his 3rd harmonise with the tenor of the ENGLISH MECHANIC? To give advice is an easy matter, generally speaking, and most people have lots of it to spare—but to give information is a different thing!

E. SLATER, Burnley.

ORGAN PIPES—CLOCK BELL.

SIR,—Having been benefited by the communications of others, I feel bound to give any useful result which I seem myself to have attained. I have taken "Adept's" plan of open wood pipe with the bevelled mouth-piece turned to the inside. But instead of the short sharp bevel I have made a lengthened easy slope, extending about two-thirds up the pipe. I have also bevelled the back to correspond, reducing the wood where it meets the block to the thinness of pasteboard. The space thus gained in the interior I have economised on the outside, making the pipes of less depth, the smaller pipes by one-eighth to three-sixteenths of an inch, and in the middle of the organ by as much as a quarter inch. I find the pipes so treated speak readily, with a clear and pure tone. I think the plan will be appreciated by all who know the value of space on an organ board both for placing pipes and giving them room to speak.

Now will any one help me in another matter? I have a clock with a striking bell like an inverted saucer, about three inches diameter. It strikes a shriller note than I like—flute F on the fifth line. How can I get a deeper tone in the same space? There is room for a bell of more cup-like figure. The bell is nutted on to a central spindle.

T. S. G.

THE PATENT LAWS AND WORKING MEN.

Sir,—I would be glad if you can inform me how I may communicate with the Admiralty. I wish to offer for public trial and use an invention connected with steam marine navigation, which, if successful, will increase the efficiency and economy from 15 to 20 per cent.

You or others may think or say, Why not get a patent? I can only reply, on behalf of myself and hundreds of other fellow working men inventors, that the social and political barriers with which our stupid and selfish lawmakers, and I may add lawbreakers, have been pleased to surround us, render the patent laws a dead letter or a delusion to working men. These laws, no doubt, work well enough for those who are already well to do, but how many workmen, particularly those who happen to be husbands and fathers, are there who are able to save up the required fees, excepting at a sacrifice of all other interests that are near and dear to them? Bitter experience has taught many of us there is very little security or encouragement to the class of patentees who happen to be poor, no matter how valuable their plans may happen to be, whereas the well-to-do patentee can sometimes reap a glorious reward from trifling improvements. I am thankful and grateful for the publication of the English Mechanic, and hope it will spread, until the bond of union, fellowship, and interchange of thought and opinion shall bind together our present isolated brethren into unity sufficiently compact to influence the actions of lawmakers, and wipe out the mockery of justice now existing in the patent laws, as far as the British workman is concerned.

Cyclops.

["Cyclops" may write the Secretary of the Admiralty, Whitehall, London. Let him not be disappointed if he merely receives a stereotyped letter stating his communication has been received. And let him not cast all the blame on the authorities, for they, it is said, are so inundated with suggested improvements and solicitations for experiments that it would be impossible for them to do all that is requested.—Ed. E.M.]

VEGETABLE OILS AND FATS.

Sir,—Complying with your wishes expressed in last number, I give a list of the different oil and fat yielding plants, classified according to the botanical order, with a few particulars. I venture to hope this may prove useful to several readers, and even induce some to send you more elaborate articles on some one of of those products. In many tropical countries the oil seeds are quite lost, and as well as we have yet ground nuts, palm kernels, jesamum, &c., many seeds more could be imported, and afford a new stock to the European market. I give approximately the produce in oil, but this is only an "average," for some writers count the percentage the number of pounds of oil coming from 100lb. of seeds, others the number of litres of oil coming from an hectolitre of seed. Oils are extracted by three different processes—ordinary presses, hydraulic presses, and by means of the sulphuret of carbon. The seeds are sometimes decorticated before the pressing. Oils are then refined by different operations.

As often oils can be mixed with other sorts, several methods have been proposed for detecting the adulteration. I think the simplest is the one proposed by a French chemist—letting fifteen drops of the oil fall upon a piece of glass underlaid with white paper, and a drop sulphuric acid being put on it, a distinctive coloured circle results. The best way of securing the identity is to operate at the same time with an oil of which we are sure and an oil of which we are doubtful, and to compare the reactions.

1.—Palm Order, or Palmaceæ.

Comou (*Ænocarpus Bacaba*), oil employed for lighting and culinary purposes in the province of Para, well suited also for soapmaking.

Patawa (*Ænocarpus Patawa*).

Mocaya or Mucaja (*Acrocomia schlerocarpa*).

Aouara, Kirin nut (*Astrocaryum vulgare*).

Couana (*Astrocaryum aculeata*).

Cohune palm (*Attalea Cohune*).

Maripa (*Schelia maripa*).

Assay, Oleo or Manteiga de, (*Euterpe olaracea*) for lighting; Para.

Rondier (*Livistonia sinensis*), &c., all from the northern part of South America, the West Indies, &c.

Palm nut oil (*Elais guineensis*), called dendê in Brazils, and Caiaué in the province of Amazonas, gathered there, but principally on the west coast of Africa; also existing on eastern Africa, near Lake Tangany Ka; Two sorts of oil are extracted from that nut, a white from the kernel and a yellow from the fruit or sarcocarp. This latter is the well-known palm oil, used for making soap, candles, lubricating machinery, &c. More than 50,000 tons are exported yearly from the coast of Africa. Centre of the palm oil trade is the dangerous and insalubrious "Bonny," or "Bonny river."

Cocoa nut oil (*Cocos nucifera*). The dried pulp is called in India, coprah or copperah. Produce of oil 70 per cent. 10,000 tons imported yearly to England, principally from Ceylon and Cochin, also from the Pacific.

Several palm trees yield also a kind of wax—the Carnauba, the Humboldt palm, &c., but I intend only to mention here the fat or oil-yielding plants. Another time, perhaps, I might give a list of the vegetable waxes.

2.—Nut and Hazel Order, or Corylaceæ.

Nut oil (*Corylus avellana*). 60 per cent., for perfumery.

Beech oil (*Fagus sylvatica*).—France; 12 to 15 per cent.; eatable.

3.—Hemp Ordfr, or Cannabinaceæ.

Hemp oil (*Cannabis sativa*).—10 per cent.; extracted in several countries; seeds exported from Russia, &c., used for soapmaking, &c.

4.—Antidesmaceæ.

Putranjiva, from East Indies (*Putranjira Roxburgi*).

5.—Laurel Order, or Lauraceæ.

Laurel oil (*Laurus nobilis*), extracted from the bay berries imported from the South of Europe; used by veterinarians. It is said to be very good, on account of its smell, for driving away flies, and is employed for that purpose by the butchers in some towns of Switzerland.

Hoerve gadung, Java (*Tetranthera laurifolia*). Hoerve is the Malay name for many laurels.

Japan vegetable tallow (*Litsæa sebifera*, s. *Cylicodaphne sebifera*). The fruits of one tree yield enough tallow to make 500 candles. The laurel oil of British Guiana, called also sassafras oil, attributed by some authors to *Oreodaphne oleifera*, by others to *Nyctanbra cymbarum*, is said to be extracted from the tree nearly in the same manner as maple sugar; it is used in cases of rheumatism. I think it is rather a volatile oil.

6.—Composite Order, or Compositæ.

Ram-till, or Niger seed (*Guizotea oleifera*, Dec., *Verbesina sativa Roxb.*). 20 per cent. India.

Safflower, Koosum (*Carmathus tinctorious*), from India and Egypt; used for burning.

Sunflower (*Helianthus animius*). Germany, Italy, and for culinary purposes.

Madi oil (*Madia sativa*), originally from Chili. Its culture has been attempted, but seems to have failed, in Wurtemburg, France, &c.; yield 1,726 killogrammes of seed per hectare, and 32 kilogrammes of oil per 100 kilogrammes seed. I think it has the great defect that in Europe the seeds of the same plant do not attain their ripeness all at the same epoch, and hence the quality is altered.

7.—Olive Order, or Olivaceæ.

Olive Oil, Provence oil, Florence oil, &c. (*Olea Europæa*), cultivated on the whole basin of the Medditterranean Sea; used for domestic purposes, medicine, preparing cotton for Turkey red dye, oiling wool in cloth manufactures, &c.

8.—Nightshade Order, or Solonaceæ.

Tobacco oil (*Nicotiana tabacum*).

9.—Trumpet Flower Order, or Bignoniaceæ.

Sesamoil (*Sesamusom leiferum*, &c.) Seeds called gingelly, jonjoli, jugoline, jergoline, in different colonies. Benne, in Africa. Oil called Duhn-es-Simsim by the Arabs, nool ennai, Tamoul; mundie noonay, Teloogoo, 45 to 50 per cent. Cultivated in the Levant, Egypt, in the East Indies, in Africa, &c. Used for lighting and culinary purposes.

10.—Sapodilla Order, or Sapotaceæ.

Sapote (*Lucuma manimosa*), tropical countries.

Shea or Cê butter, Galam butter, Bambuk butter (*Bassia parkii*). Tree 40ft. high. Niger region. 49 per cent.

Illipé oil or butter, India; Illipî Yennai, Tamoul *Bassia longifolia*). Used for soap making, burning, and eaten by the poor; wood very good.

Mohwa oil, Yallah oil. Bengal; maurá, Goa (*Bassia latifolia*). For lighting.

Fulwa, Fulwara, India (*Bassia butyracea*).

Djavé, Gaboon (*Bassia sp.*) Eaten.

Noungou, Gaboon (*Bassia noungou*). 56 per cent.

Argan nut, Morocco (*Argania sideroxylon*).

Minusops elengi, &c.

11.—Vine Order, or Ampelideæ.

Grape seed oil (*Vitis vinefera*). Lombardy, &c.; 18 deg.; for burning and soapmaking.

12.—Cornel Order, or Corneæ.

Cornel oil (*Cornus mus*). Europe.

13.—Nutmeg Order, or Myristicaceæ.

Yayamadou ouarichi (*Virzola sibefera*). Abundant in Guiana; deserves attention for candle making.

Combo, Gaboon (*Myristica angloensis*), 72 per cent.

Bicuiba, ucu-uba, Brazil (*Myristica bucuhiba*), used medicinally, and for fabrication of candles.

Rarab, Mayotte (*Myristica sp.*)

Nutmeg butter (*Myristica moschata*), Moluccas.

Poondy seed (*Myristica malabarica*).

4.—Custard Apple Order, or Anonaceæ.

Monodora Grandiflora, Gaboon.

15.—Poppy Order, or Papaveraceæ.

Poppy oil, Œillette oil of the French (*Papaver somniferum*). Cultivated in France; seeds also exported from India; 48 per cent. Two sorts of oils, white and fabric, used for eating, burning, and painting; second sort for soap making,

Prickly poppy, yellow thistle; Shcâl Katta, Bengal (*Argemone mexicana*), East Indies and America.

16.—Crucifer Order, or Crucifereæ.

Colza oil, rape oil, from Summer Colza (*Brassica campestris*), 23 per cent., and winter do. (*B. napus*) 30 per cent. Plant cultivated in Europe, principally in Belgium; seeds also imported from the Black Sea, the Baltic, East India, &c. The oil is used for lubricating machinery, and, after being refined, for turning in lamps. Trade somewhat impaired since the introduction of petroleum.

Ravison seed, from the Black Sea, is a wild sort of colza, often mixed and dusty, yet yielding a good percentage of oil.

Mustard oil (*Sinapis div.*), Europe and India.

Thlaspi (*Thlaspi sp.*), proposed in France, 20 per cent.

Camelini (*Myagrum sativum*), Russia, France, &c.

17'—Capper Order, or Capparideæ.

Hoorhoorya, India; Djoekoet prossot, Java (*Cleome viscosa s. Polonisa viscosa*), very limpid.

18.—Gourd Order, or Cucurbitaceæ.

Bôrall, Senegal: Kurbooz, East Indies (*Cucumis citrullus*), exported from Senegal to France; for culinary purposes and soap making; 30 per cent.

Egusi oil, Abeokuta (*cucumis sp.*)

Abobora, Brazils (*cucumis sp.*)

Momordica, Luffa (*cucumis div.*)

19.—Mallow Order, or Malvaceæ.

Cotton seed oil (*Gossypium div.*). Seeds imported in Europe from Egypt, the United States, &c.; 18 per cent. For burning in lamps and soap making.

Ambarree (*Hibiscus cannabinus*), Sunn-okra, East Indies; Gombochauvre of the French Antilles; Canamo de Senegal of Cuba; Bun Kupasi, of Bengal, &c

Gang-sooreya, Ceylon; tulip tree; Paris-peepul East Indies; Miro, Tahiti; Poo-arasoo, Canarase, (*Thespesia populnea*), medicinal.

Benardin.

(*To be continued.*)

A WORKMAN'S APPEAL.

Sir,—I have been a subscriber to our journal for the past eighteen months, so I think I am entitled to say a word or two about it. Above all the letters that have taken my fancy, there is none like the one on page 187, signed "W. H. J., Plymouth." He says, the English Mechanic is not so much read by intelligent mechanics as by amateurs and scientifically-inclined middle class people. He may find his answer to that by the next few words he writes, where he says, he wishes it had been called "the Scientific Journal"; for true it is that there is seldom anything suited to the wants of the working man, and very little suited for those who have so much time at their disposal, and when it happens to be anything that would really suit the practical mechanic, it is so encumbered by formula and signs that not one in a dozen knows anything about. It is useless to say the English mechanic is a very good scholar, and knows all these things; I say he does not. The exercise of a little common sense will let us see the falsity of such a statement. Having to go to work at the age of fourteen, and work from six in the morning until six at night, he does not find himself in a humour for studying algebra, astronomy, electricity, and such like things. Just take for instance one of our greatest correspondents, "The Harmonious Blacksmith," Who does he write for? Truly not for the class from which he derives his name, as might have been expected, for to my knowledge, he has never wrote one single line for their especial benefit, but he writes for those whom "W. H. J." speaks about, amateurs and harmonium builders, &c. Now if this single correspondent were to write for the benefit of his brother blacks, I think I will not exceed bounds if I say he would have fifty readers where he now has one. But now, after I have my say in the way of grumbling, I may say that I would not miss my Mechanic for all the other journals in print, for although I missed taking it in occasionally at first, I could no more miss taking it in now than I could think of missing my dinner, for I have become quite interested in some of the subjects going on in its pages, "Science for the Young" forming one of its treats; and I am very thankful to see the working drawings of a slide rest in last week's issue which is something after the workshop fashion. I should like to endorse the sentiments of "T. J. O'C.," page 212, and if any of our learned friends would take the matter up, I would try to learn it, and then our journal would become doubly interesting to me. I have tried it from books, but can make nothing of it. In conclusion, I appeal to the "Harmonious Blacksmith" to let his harmonious friends wait a little, and give the blacksmith a turn for once. I have no occasion to inform him that a very great deal of the drawings come out with the French measures on them. If he would give us a short discourse on English and French measures, so that when they get a drawing with millemetres attached they could translate it into English, he would confer a lasting benefit on all practical mechanics, and especially on a brother

Blacksmith.

FROM "URBAN."

Sir,—With reference to "Aqua's" query, Griffin's solutions contain equivalents in grains, in a decigallon. As they are addressed to Mr. Davis, who will attend to them, I shall not answer the rest. Has "F.R.A.S." personally had any experience with bisulphide or amylene prisms for the spectroscope? For many purposes I prefer them to flint glass, With an inch and a quarter spectroscope, I find a train of five are all that can be wanted for chemical purposes.

Urban.

TWO PROBLEMS.

Sir,—The favourable notice that appeared a few weeks ago in the English Mechanic of Mr. Dyer's book of replies to "Parallax" led me to read that book, and to make a number of computations, with a view to give some definite numerical expression to those errors which many people (Mr. Dyer's friend for instance, referred to by him in his introduction) find it difficult either to admit as true, or to prove false Perhaps a few of the results may prove interesting to many readers, without exciting or fostering a spirit of controversy. I submit the following by way of example:—

1. Given $A\,B = 69{\cdot}091$ miles × degrees in S. Let $S\,A\,B$ be a right angle, and the triangle be a plane one. We shall have

$$A\,S = 69{\cdot}091 \tan B \times \text{degrees in } S.$$

If in this we substitute different values of the angle B, and compute the corresponding numerical values of A S, we find every possible value of A S from O when B = O to 3958·6, when B = 89° 59′ 59″. A higher value than this is not possible of the first 5 figures, and this is the value that "Parallax" has assigned to the sun's distance; and this is the sort of computation be made to obtain the distance of the sun S from the earth's surface, A B, supposed to be a plane. The most notable oversight in this matter is that the computation, instead of giving the sun's distance, in reality gives merely the earth's radius, which was assumed to give the 69·091 miles for the length of one degree on its surface.

Let now A be a point in latitude 20° north (near Vera Cruz) on 20th May, the sun's declination being also 20° north, S will be vertical to A at noon. At a point 40° south latitude (near Valdivia, on the west coast of America) S on the same day at noon, will be elevated 30° only, that is B = 30°. Now the sun's diameter to the observers at both A and B, Vera Cruz and Valdivia, subtends an angle of 31′ 40″ on the assumed day. These are matters of every day observation for the last 100 years or more, and therefore may be relied on. Now, continuing the assumption that the triangle is a plane one, compute the value of S B by the formula

$$S\ B = 3958{\cdot}6 \text{ cosec } 30^\circ.$$

It is found = 2 A S = 7917·2 miles = earth's diameter. Hence the sun, to the observer at Valdivia, must subtend an angle = ½ (31′ 40″) by the first law of perspective, see Malton, Book I., which being contrary to observed fact, shows that the assumption of the triangle being a plane one, is erroneous, because every other step in this reasoning is rigorously correct.

2. The triangle formed by great circles through Cape Horn (H), Cape of Good Hope (G), and Port Jackson (J), seems to be less perfectly known than I believed possible in our present state of geographical science. Mr. Dyer, on the authority of respectable chart publishers, gives H G = 3601, G J = 5813, H J = 5470 miles. "Parallax" (who by the way is no authority at all, as he merely gives the even thousands estimated by some unnamed navigator, as having been sailed over), states these distances as follows. H G = 6000, G J = 8000, H J = 8000. But even so I was led, by noticing the differences to be unaccountably great, to compute them from the latitudes and longitudes as given in well known works. I find H G = 4135, G J = 6824, H J = 5831. Will our author of "Readings from the Globes," or some of your mathematical correspondents, be good enough to verify my results? Can it be possible that we are uncertain to the extent of a 1000 miles, of the distances between our three great southern nautical points, and to the extent of 1906 miles in the usual route of circumnavigation?

M. L.

TO MILLERS.

SIR,—Your correspondent, "E. O." (in No. 272 of the ENGLISH MECHANIC), asks for a recipe for filling up the broken joints in his millstones. Four years ago I filled holes in a stone with a composition of alum and red lead. It is in yet, although the wheats that pair of stones have been grinding have been principally hard foreign. The red lead binds the alum, and makes it tough. I always put grease in the ladle with the composition, and melt gently. I try to keep it from boiling. When melted I skim off the grease, and with it the scum of the alum, and then mix in the red lead. But if the joints are well cleaned and wet with water, good plaster of Paris will stand a long time; it does in stones for grinding rice, which is harder than most kinds of wheat.

I beg to suggest to Mr. Smith that he cut holes in the head leather of his bolting cloth, halfway between the existing ones, or remove the loops at the bottom. It would ease the working of the cloth by giving it a lead the same as the brushes of a wire machine usually have. I have tried it, and found it answer. It is no "notion" of mine, but Sir Wm. Fairbairn's, or at least some of his millwrights.

A STONEMAN.

SIR.—Mr. Evans has failed to bring "A Stoneman" to his views on the balance question. However, I think "C. M.'s" letter and John Botting's, pages 226 and 227, leave little more to say on the subject. If "A Stoneman" balances his stones standing, and then starts them up to speed, I think he will perceive that not only will the running disagree with the standing balance, but the difference will be very decided—at least I have proved this by experience, and have yet to learn how the running and standing balance can possibly be the same. Of what use is the standing balance? If a stone be balanced as it works, surely this must be the proper way.

Many thanks to "One Eye" for his answer to my query touching grinding. I note that he thinks 200 revolutions per minute too fast for a 3ft. 4in. stone; but from experience I find that if small stones are not driven fast, they will not do much work. But I should like the opinion of some of our practical brethren on the subject.

SERGIUS.

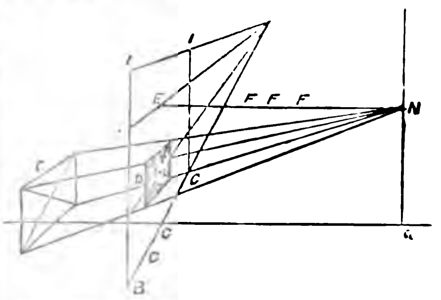
SIR,—After so many remarks from master millers, a few words from a journeyman may not be uninteresting to your readers on the subject of balancing. The great trouble which has often been experienced in balancing causing the necessity, or supposed necessity for a patent balance, I have always found to arise from something else besides the mere difference in weight of portions of the stone. I once had a stone under my care which had a true running balance, and yet always wore down on one side. After trying all the means I could think of to rectify it, I at last tried the crossbar, and found that its centre was slightly out of the centre of the stone, but the short side of the stone was the one which wore the most. After thinking it over, I concluded that the extra leverage which was gained by the wheat under the long side forced it up, and so pressed the other hard on to the bed-stone; but I should like the opinion of some of my dusty brothers upon it.

W. G. M.

PERSPECTIVE.

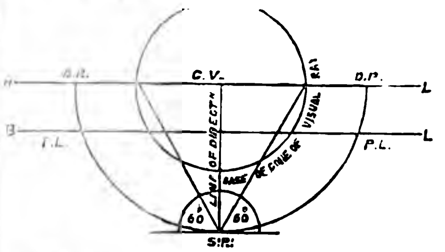
SIR,—Linear perspective is that branch of mathematical science by which we are enabled to represent objects not as they really are, but as they appear to the eye. Let the spectator look down a street of regularly-built houses, of the same size, and he finds as they recede from the eye they appear to become smaller, although they are really all of the same size. If he now changes his position by going to the other end of the street, he will find that by looking towards his previous position the houses that before appeared large are now the smallest, and *vice versa*. Perspective may therefore be said to treat of appearances, while geometry treats of *realities*. A quick student will readily find instances to illustrate the above, which are by far too numerous to insert here. As it is not my intention to use any unnecessary theory, the most careful and thoughtful attention is requested, on that account, to that part which is introduced.

Perspective will be more readily understood if thought of as governed by certain planes. All perspective representations are supposed to be gained on a vertical transparent plane which is between the spectator and the object at which he is looking. This is always at right angles to the direction in which he is looking. This transparent plane is always supposed to be present; in fact, it is inseparable from a perspective drawing, as it is the picture plane. It is represented by the paper on which the drawing is made. The best way to illustrate this is to suppose the transparent vertical plane to be a sheet of glass, standing upright on the ground, the spectator being some twelve or twenty feet from it, and looking at some object or objects on the other side; and could he, with a steady hand, and without moving his eye, trace the objects on the glass, he would have the most perfect perspective representation that could be obtained. Referring to the diagram, B G G G I I is the picture plane, A the station point, N the eye of the spectator, C the object behind the plane, D its representation on it as seen by the spectator.



The ground line, or base line, is formed by the intersection of the picture plane with the ground B G G G. The horizontal line, or horizon, is drawn across the picture plane at the height of the spectator's eye; therefore, if the spectator move up or down, the height of the horizon changes also. But as five feet is the height of an ordinary spectator, it is generally chosen for perspective diagrams. The line of direction F F F is an imaginary line, supposed to be drawn from the spectator's eye to the horizon, so that one end is the spectator's eye N, the other is the point of sight E, or the centre of vision.

The ground plane is the floor of the diagram, always supposed to be horizontal, and extends from the picture line, which is its nearest edge, backwards till lost in the horizon. These two important planes must never be lost sight of in perspective. As the student begins to get familiar with them they had best be known to him as the picture plane P P, and ground plane G P, as it is useless to go further without a pretty good knowledge of these planes and some lines in connection with them. Let the student propose and answer in writing the following questions on the subject:—1. What is the picture plane? 2. What is the ground plane? 3. What is their relative position? 4. What is the nearest edge of the ground plane? 5. How far does that plane extend? 6. What is the line of direction? 7. What governs and determines its length? 8. Say what we find at the ends of it?



All horizontal lines that retire from the spectator vanish to some point on the horizon. Thus, all lines at right angles with the P P vanish to the centre of vision. The points of distance are points on the horizon found by taking the length of the line of direction right and left of the centre of vision. These points are vanishing points for all lines at an angle of 45° with the P P. All other vanishing points must be found; but the two mentioned are always ready.

Every vanishing point is accompanied by its own measuring point, always found by setting off on the opposite side of the C of V on the horizon the distance from the vanishing point to the station point. Thus, the measuring points are the points' distance when the C of V is serving as a vanishing point, but not *vice versa*, as will be seen by the use of the compasses and the rule just given.

The above is of the greatest importance in practice

9. Where do all horizontal lines vanish to? 10. What lines vanish to the C V? 11. Which to the P D? 12. How are the P D's found? 13. What must be done with all other lines (horizontal) at angles other than 90° and 45°? 14. What accompanies every vanishing point? 15. What are the measuring points for lines at 90° to the P P, and how are measuring points found?

The following is a list of abbreviations common in perspective:—C V, centre of vision; D P, distance points; S P, station point; V P, vanishing point; M P, measuring point; H L, horizon line; G L, ground line; P P, picture plane; G P, ground plane; O P, original plane; Vg P, vanishing plane; P L, picture line.

It will be well for the student to get master of the few foregoing hints, and next time we will leave the theory, and begin with a little practice.

J. W. BEDFORD.

MUSIC.

SIR,—I was much pleased to see "Gimel's" remarks in last week's MECHANIC on the subject of old music, and hope, as this subject has been started, we shall have some interesting information concerning the music of the ancients.

Even granting the somewhat doubtful antiquity which "Gimel" assigns to the tune Nas Galan, we have, I think, in the Gregorian tones which are still sung in our churches examples of a much earlier style of music. The first four of these tones were introduced into the service of the Latin Church by Ambrose, who was Bishop of Milan from A.D. 374 to 397; and the means by which they were distinguished seem to indicate a still more remote Hellenic origin: the others were afterwards added by Gregory, who flourished during the 6th century. There are a few tunes in use in modern Jewish synagogues which are *said* to have formed a part of the old Temple service. Though this cannot be proved, and indeed is scarcely probable, there is no doubt that they date back to a very early period.

While on the subject of music, I may perhaps be allowed to say a few words in favour of the tonic sol-fa method of singing, which has lately been referred to in your pages with a contempt which I think is quite unmerited. After some little experience with this and other systems, I am of opinion that it is the best known method of teaching to sing at sight. 1. Because, instead of perplexing the learner with signatures of, perhaps, 3 or 4 flats or sharps, it teaches at once the great principle of key-relationship, or the relation of all the notes of a scale to its tonic, so that a sol-faist can sing a line in A flat just as easily as if it were set in the natural key. 2. Whilst the learner, by the old notation, is going through the hard mechanical drudgery of practising all the intervals of the scale—a task so difficult that many give it up in despair—the sol-faist, by observing the mental effects of the different notes (a knowledge of which is indispensable in the higher branches of the science), is able in a short time to reproduce them at pleasure, and thus to sing at sight. 3. By first teaching the strong notes of the scale—the tonic 3rd and 5th—on which all the others lean, it thoroughly tunes the voice, and prevents that flattening which is so common amongst learners by other systems. 4. By means of the modulator it represents to the eye the exact intervals through which the voice moves in passing from one note to another, and teaches transition in a very clear and simple way. 5. It gives a perfect pictorial idea of time, by mapping out each page into distances proportionate to the actual length of the notes, and distinctly marks the accents, including the secondary or medium accent, for which the old notation has no sign at all! 6. Music can be printed very cheaply in this notation, and thus it is placed within the reach of the poorest.

I could adduce other arguments in favour of this as a system of singing, but my letter is already very long.

J. N. TRAYLER, Pembroke.

CHEMICAL FLORICULTURE AND POMOLOGY.

SIR,—May I ask your numerous readers, and especially Mr. S. Rogers, whether they know of any plants the flowers of which have had their colours changed by the application of chemicals? If they do, will they please state the name of plant, the colour changed, and what it was turned to; also the method of applying the chemicals, and what they were? I think if there is any truth in this theory it would have been turned to account before now. I have not the slightest doubt that I could name several nurserymen and florists who would gladly give £50 for a *blue* dahlia, for instance; and I dare say a *blue* chrysanthemum would find a buyer at a similar price Instances could be enumerated by the score where some particular colour is absent from a genus of plants for which florists would give a good sum, if they could depend on a specimen of that particular colour blooming true.

Again, if it is possible to change the colour of the blooms on a plant by the application of chemicals, might it not also be much easier to change the flavour of, or impart a different aroma to, any particular vegetable or fruit thought worth improving? For instance, if we could impart to the vegetable marrow and the pumpkin the flavour of the peach and the pineapple; or to the turnip and the mangold the taste of the apple and the pear—not to mention bestowing on the potato the aroma of the truffle—what an advance in science would not that be! and what a hero would not the discoverer of the *modus operandi* be considered amongst epicures and gastronomists!

SAUL RYMEA.

PECULIARITY IN EYESIGHT.

SIR,—I think "Blackburn Amateur" is wrong with regard to the peculiarity he mentions. His eyes have adjusted themselves to the focal distance he is accustomed to work at, and the crystalline lens has lost the power of accommodating itself to different foci. It is a parallel case to my own, only in my case objects appear double and misty beyond a certain distance, instead of treble. Short sight is generally supposed to arise from increased convexity of the crystalline lens (and not from the flattening of it, which your correspondent supposes, which would have a contrary effect), and for which concave spectacles are used to correct. In some kinds of employment short sight is rather an advantage than otherwise, such as drawing, engraving, watchmaking, &c. The watchmaker, as is well-known, has to use a convex glass to shorten his vision, which a short-sighted person might dispense with. I am acquainted with a lithographic artist who uses glasses in the streets, but who takes them off to work at the stone. I observe one of your correspondents wishes to know whether the concavo-convex lenses would not be more suitable for this defect than double concave ones. I should like to see this subject ably handled by some of our correspondents who are well versed in optical lore.

J. Hare.

VENTILATION OF BUILDINGS.

Sir,—I beg to explain, for the benefit of Mr. Hastings (page 306) and others, that upward ventilation through the floor was the great mistake made by Dr. Read in ventilating the Houses of Parliament. Upward ventilation through the floor must inevitably carry up with it the odour of shoe leather, either new or old, as well as all the dust and flying dirt brought in from the streets or accumulated on the floor, right up to the breathing organs of the company. Whereas if the fresh air be admitted insensibly through a finely perforated ceiling, it would take the temperature of the air in its downward progress through the room, and at the same time carry down through the floor and out all the unpleasant odours, villanous smells, and flying dirt always present in crowded assemblies.

Henry W. Reveley, Reading.

TOOLS FOR GRINDING OBJECT GLASSES.

Sir,—In almost every number of our inestimable journal we have instructions for making and using telescopes. These instructions are so explicit, and the means apparently so simple that, like Alnaschar, I dream—not of pots, however, but of owning a valuable telescope of my own construction. He demolished the "baseless fabric" of his future grandeur by a kick, while mine is annihilated by remembering that the carrying out of those exhaustive instructions implies the possession of apparatus, the value of which alone would purchase a creditable instrument. A lathe, and skill to use it, are essential for preparing the grinding tools. Now, many amateurs have not these requisites, although from their general aptitude they might be able to grind the lenses, had they the tools already prepared.

Now, to go to a foundry and get them cast, turned, and ground, to the proper curves (supplied in "ours") for the four different surfaces would cost probably as much, as I see 3in. achromatic object glasses advertised for—namely 45s. Were we therefore able to pay for the former, it would be far simpler and more certain of worth for our money, to buy the latter. As this, to many of us, is simply impossible, what I therefore, with your kind permission, wish to propose is, that some kind soul, who has already accomplished the task, should lend us his tools, of course for a consideration, or that some optician should supply us with the discs and the loan of the proper curvature, likewise, of course, for a consideration, for grinding them.

Blackburn Amateur.

THE LATHE.

Sir,—S. Stevens, query 4070, must not look on this present answer to his query as put forward in a spirit of contradiction. I have myself been instrumental in supplying some information on the subject to the readers of the English Mechanic, but have not, as a rule, given dimensions for anything. Many different classes of turners are to be styled "amateurs." There are amateur plain turners, then a step further, eccentric men and oval men, and then your aristocratic rose-engine turners and geometric chuck men, till you come to tools that can only be purchased by the tenscore of pounds. There are other amateurs besides, such as I am one of, who have made lots of chucks and things for doing ornamental scratching, but have scarcely ever turned in wood or ivory anything beyond a few foundry patterns and a cup and ball. Now these classes require and must have very different classes of tools. I think really, as a modification of the last sentence, that the best possible foundation for a man to build on, intending to be an amateur mechanic or turner (ornamental or not), would be one of Whitworth's or Muir's self-acting 5" lathes, or a 6 or 7in. foot lathe, double geared, and made specially light for amateur's use. But here is a first outlay involved of possibly £100 to start with, and that of itself would be enough to make many a would-be amateur pause. And here crops up the money difficulty. Now as to the lathe mentioned by S. Stevens, the design came in the first instance from a gentleman who stands quite in the front of the first rank of amateur machinists, with any quantity of means at his back to produce the best possible result. But lathe making is as much an art as carriage making, and it don't at all follow, because a given maker turns out the best drag in creation, that he is equal to the construction of a dog-cart, and I have been many times reminded, when looking at amateurs' lathes turned out, even by Whitworth, of Mr. Dent's saying, that when engineers make clocks, they forget that they will not have a steam engine to drive them. And in the case of that lathe, the designer had not the time or opportunity of carrying out the inventions of his brain, and the capitalist had not the mechanical ability, so the result was, that a lathe maker had to be called in to complete a machine which I should think would require months of attention and practice to develope the capabilities of. The greatest mistake a beginner can possibly make, is to imagine that he can design his own lathe, or can select suitable patterns from somewhere or other, and have castings made at some foundry or other, and then find some workman who can do the work. He will pay quite as much money, all or most in advance, and then when the work is three-fourths done, and all the money paid, will be called on for a £10 or £20 note to save his work from being seized for arrears of rent, or some such beautiful object. My advice is, if you have experience and money, and want your lathe in a hurry, go to a good maker, and order what you know you want. If you have experience and time, and not much money, I need hardly tell you to do what I do—viz., make everything yourself. If you have not experience, or much money, you had better go without cheap lathes, as they only prove a source of annoyance and vexation, as you get to learn more about what you really wanted.

There are frequently second-hand lathes, some of them of very great value and price too, to be seen at Evans's, in Wardour-street, and at Moseley's and Buck's, of Edgeware-road, and possibly at the other shops of the same name as the last mentioned; and my advice most decidedly is, if you cannot design for yourself, go to a real lathe maker, not dealer, and state what you want. It would be of no use whatever to 999 out of 1000 amateurs to have working drawings of a lathe that costs £1000 to fit up, and people's requirements are so different that if they all knew how to draw no two designs would be alike. I cannot help S. Stevens with sketches of the Saltaire lathe, as I never saw it put together, and only saw a very few detached pieces of it at any time; and as I am not in the ornamental way myself, should not have taken the trouble of examining it if it had all been laid open before me.

J. K. P.

EXTRACTS FROM CORRESPONDENCE.

SQUARING THE CIRCLE.—"Saul Rymea" says:—"The original design of Mr. A. S. Gearing does not, as he seems to imagine, overcome the difficulty of the problem (!). And for this simple reason, that the thick ends of his wedges will form a square edge, they cannot form a circular edge. For as no portion of a circle is a straight line, it follows, as night follows day, that there will be a vacant space between the line of the 'circle' and the centre of the base of each wedge or 'isoceles' triangle. If Mr. Gearing will get a metal circle and endeavour to perfectly fill it with wedges cut according to his diagram he will easily see his mistake. Mr. Elihu Burritt recently made a computation of the amount of time wasted in spelling such words as honour, colour, &c., with a 'u.' I wonder how much has been wasted in attempting to square the circle?"

GLYCERINE AS A SUBSTITUTE FOR OIL.—Henry Page says:—"One is sorry to see in the 'Letters to the Editor' that some pay little attention to the extracts from Montaigne's Essays. A correspondent some time back told us that glycerine was better than oil for machinery and clock work. We have now another stating that litharge mixed with glycerine makes a capital cement for chemical apparatus, and gives us a list of acids, &c., that it will resist. Now, not having the slightest faith in such a mixture, but desirous of putting it to the test, I ground some litharge in glycerine, and put it on glass, where it was well exposed to the air and sun. I find now, after ten or twelve days that it can be easily washed off with a little water, leave alone any acid. This is just what I expected."

BRAZILIAN RAILWAYS.—"Bernardin" says:—I always read with great interest the geographical notes in our English Mechanic. Permit me to make a slight remark on the reply of Mr. T. G. to the query No, 3977. I do not find out how to make correspond his assertion 'no line of railway in the city of Bahia,' and 'the Bahia and San Francisco Railway, some 69 miles long, commences at a pillar and ends at a post.' I extract the following lines from the work 'O Imperio do Brazil na Exposicao Universal em Paris,' Rio de Janeiro, 1867, p. 73:—'Railway of Bahia, English Company.—The part now constructed and delivered to traffic begins *in* the town of Bahia (principia *na* cidade da Bahia) and ends at Alagoinhas, distance 183·5 kilometres (69 miles is only 110·4 kilometres). Perhaps T. G. will have the kindness to throw light on this confused question."

ARTIFICIAL LIMBS.—The *Western Daily Times*, in its observations on the Bath and West of England Society at Taunton, says:—"Nothing in this saloon (Arts and Manufactures), various and valuable as was everything that had yet appeared, would rival as evidence of extraordinary genius and perseverance, the contents of Mr. J. Gillingham's case, of Chard. This gentlemen, yet a young man, and originally a disciple of St. Crispin, has applied himself to the repair of the human understanding to an extent seldom if ever before achieved by an individual starting from his point in life. He describes himself as the inventor of the "Scapular Arm and Dermatopercha Leg," manufacturer of artificial limbs and surgicomechanical appliances, including instruments for diseases of the spine and hip, club foot, fracture and ruptures, and artificial eyes—indeed only give him any portion of the human frame that has life in it, and he will add all the rest. You are not left at liberty to doubt: there they all are, the substitutionary limbs before you, and it needs no assistance from other people's eyes to discover what skill and beautiful workmanship in steel, wood, and other material had been bestowed on their production."

GASES EVOLVED BY RIPE FRUITS.—According to Lechartier and Bellamy, picked fruits—such as apples, cherries, and gooseberries—at first absorb oxygen; afterwards they give off carbonic acid, and in larger volume than the previously-absorbed oxygen. At first the evolution of gas takes place uniformly, afterwards it moderates, and then ceases for a time, and commences again and gives off more gas than during the first period. An increase of temperature promotes the transformation. Whether light has any influence upon the reaction is not stated. From these observations it will appear that it is unsafe to sleep in apartments where much fruit is stored.

REPLIES TO QUERIES.

[3714.]—BOILER.—J. B. Crossley's reply to "One in a Fix," may stop the humming noise made by his boiler, but it will not remedy the evil, which is caused by some irregularity of the flues. I have myself been in a fix with the same complaint. I also tried the perforated plates in front of the ash pit, but found the true remedy in rounding all corners and filling up all spaces where the current of air could by any means form a whirl or eddy, which is the cause of the humming noise complained of. If "One in a Fix" will examine his flues, and get them made as near as possible of one uniform area, and avoid all sharp angles, I have no doubt he will find an improvement, and I shall be glad to see his report.—W. Varley.

[3792.]—SEPARATING CHALK FROM WATER.—If T. Grayling, M.D., will place in his cistern a small sheet of zinc, and one of copper attached at one end by solder—say 9in. square, it will cause a deposit of all the chalk, lime, and also all the animalculæ contained in the water; it sets up an immediate galvanic action. I have used the same for several years.—Nil Desperandum.

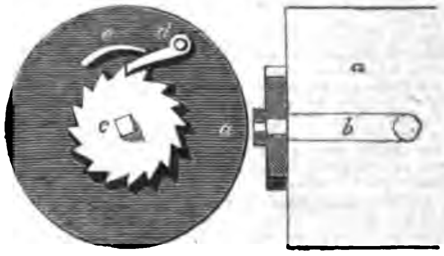
[3800.]—PHOTOGRAPHY.—"Would be Artist" will find this plan answer his requirements. The screen should be covered with white paper, sized and varnished.—Nia Desperandum.

[3803.]—PRIMROSES.—If "J. D. M." wishes to change the colour of his primroses, he should take them out of the soil and plant them in horse-dung, and he will soon get a very different colour. I see, in answer to this question, S. Rogers says that he is willing to give a few hints on hybridising. If he will do so he will greatly oblige.—An Amateur Gardener.

[3895.]—PARASITES IN CANARIES.—Let "Pakeau" scald the cage and everything connected with it in boiling water, as it is the cage not the bird breeds them. 2nd. Let the bird's body (not the head), be folded for a moment in flannel steeped in turpentine, provided *he is tame*. If not so, let cage be touched here and there with turpentine with a quil top. Flour sulphur suspended in flannel bag from the top of cage is a good preventative.—Poor Pipe Cover Maker.

[3913.]—FROM A. STRINGER.—The maker of the velocipede is Thomas Stanway, King-street, Macclesfield, price £7. It is not requisite to send a design for steering a veloce like a boat, because any blacksmith can reverse the steering handle by bringing it under the frame.—A. Stringer.

[3940.]—VELOCE.—"T. T. M." asks for an opinion on his plan for the kind of wheels for his veloce. The following sketch I give, as I have seen it used:—*a* is nave, *b* is axle, works round in nave to be fitted square in *c* ratchet wheel, with thread cut on axle to receive nut to screw on against ratchet-wheel; *d* stop screwed on nave, *e* spring to force stop in teeth.—John Parker.



[3941.]—MARKING INK.—If "Daisy" (page 262) tries a roller made of soft leather or copper-plate blanket-faced with black silk, I think it will get him out of his difficulty; but I am afraid he will not succeed much with ordinary type; its action on the ink, I think he will soon find, destroys the deep black. What he requires is some silver electrotype, which was used a few years back with a patent marking ink, and found to answer very well.—K. T. Z.

[3943.]—BEES.—If the last occupants of the hive died from the severity of the season only, and not from dysentery, "S. W." may safely, and with great advantage, place a swarm in it. The combs of a stock hive very soon become black, but this is of no consequence, though it may be well to cut out a little of the lowest part of the combs. Any mouldy combs, or those filled with old pollen should be carefully removed. "S. W. will find much condensed information in "Manuals for the Many, Bee-keeping," price 4d., at 171, Fleet-street.—R. M.

[3971.]—DISPLACEMENT OF SHIPS.—To work out the displacement of any vessel would take a column of our "voracious journal." The calculations are mostly made by Stirling's (better known as Simpson's) rules. Dr. Woolley's rule is also used; this, though far shorter than, is not quite so accurate as, Stirling's. The whole method of calculation is described, with examples, in Peake's "Naval Architecture," price 3s., published by Virtue and Co., Amen Corner, London; also in "Theoretical and Practical Shipbuilding," edited by Professor Rankine, price (I think) £3 3s.; and in "Naval Architecture," by John Scott Russell, published at 40gs. —F. W. G.

[3972.]—IRON STAINS.—"J. H. P." can take his iron stains out of calico or linen with salts of lemon, which can be obtained at the druggists. The way to do it, is to hold a teaspoon with the convex side up, and place the fabric on that part which is stained; put a small portion of the salt, and rub it with the finger moistened with warm water, the process to be repeated till the spot disappears. This is an old and well-tried recipe. I have seen it practised with success. —J. M.

[3973.]—WATER VELOCIPEDES.—They can be obtained at Boniwell's, Richmond. "J. D." should go and hire one for a short time to see how he likes it. But why not apply the principle to a boat? I can send an illustratien of one served in that manner, if "J. D." would like one.—Semper Paratus.

[Send it.]

[3986.]—CYANIDES.—I do not remember at present where the fullest information on the direct formation or synthesis of cyanides is to be found; but I can tell "J. W." that though the process is very interesting from the scientific point of view, and was particularly so at the time of its discovery, when it was generally believed that organic compounds could only be produced by vital processes, yet it has no practical value, and is not worked, because at the necessary temperature there is such loss by volatilisation that the process is far more expensive than those usually employed; the other bases will act.—Sigma.

[3992.]—THREADS IN ROPES.—I enclose for "One Anxious to Learn" a table of the number of threads in ropes from ½in. circumference up to 12in., which may be implicitly relied on, as it is followed up in all the Government dockyards:—

THREE STRAND SHROUD LAID ROPES.

Size of rope.	Threads in strand.	Threads in rope.	Size of rope.	Threads in strand.	Threads in rope.
½in.	2	6	4½	56	168
¾	3	9	5	69	207
1	4	12	5½	84	252
1¼	5	15	6	100	300
1½	7	21	6½	117	351
1¾	9	27	7	136	408
2	11	33	7½	156	468
2¼	14	42	8	178	534
2½	17	51	8½	201	603
2¾	21	63	9	225	675
3	25	75	9½	251	753
3¼	29	87	10	278	834
3½	34	102	10½	306	918
3¾	39	117	11	336	1608
4	44	132	11½	367	1101
4¼	50	150	12	400	1200

W. H. Laidler.

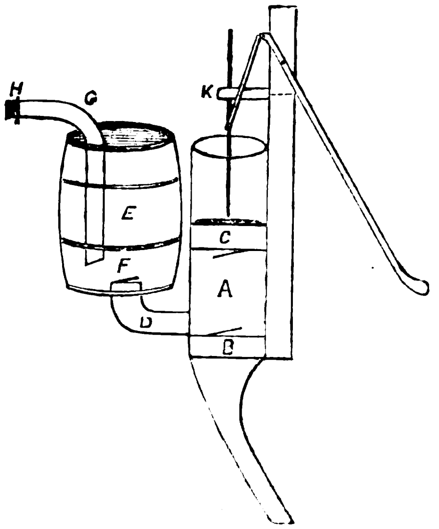
[3996.]—BOOKBINDING.—In answer to "Q., Yorkshire," I should prefer handled letters, as when he has once overcome the difficulty of keeping them perpendicular he will find them much more convenient than the brass type, especially when lettering on a well rounded back, as there is then great difficulty in keeping the letters clear without any slurring. If he wish only to letter on the sides, or for labels, then decidedly the type would be best for him. In answer to his second query, I think he will find the following to be about the usual prices; but as it is now 2 or 3 years since I required to purchase, and I have not the bills handy, I cannot guarantee their correctness:—Cloth, 1s. to 2s. a yard; leather, 1s. per skin—skiver or sheep, 2s. 6d.; roan morocco grain, 4s. 6d. to 5s.; calf, 9s. to 10s. 6d. He will find that the greatest difference in price is caused by grain and colour. —K. T. Z.

[4008.]—GRAINING STUFF.—Vandyke brown in a little beer is the article used for oaken doors; it is termed overgraining.—Semper Paratus.

[4008.]—GRAINING STUFF.—Purchase at the oil shop ½lb. dryers, ½lb. burnt umber ground in oil, 1d. of orange chrome, ½pt. turpentine, ½pt. linseed oil; work up with a knife on a board a handful of dry whitening moistened with oil to a consistency; then add the dryers, umber, and half the orange chrome previously ground up with oil; put all into a pot and thin out with the oil and turps *in equal proportions*. The more oil and turps added the thinner the colour, and then strain the whole through a portion of the leg of an old stocking tied over the pot. For inside work all the oil and turps must be used, as the colour is used very thin.—Barphoogee.

[4008.]—GRAINING STUFF.—The easiest method is called oil graining. Take 2 by measure of boiled linseed oil and 1 of turps; to this must be added patent dryers—a sufficient quantity to make it set in 6 or 8 hours. The quantity of dryers will depend entirely on the time of year. He must now grind up some whitening in turps and mix with it, adding a little at the time; when he finds it beginning to thicken he must rub a little sparingly with his brush on some old paint-work, and draw his graining combs down it. If he finds the comb marks run in, he has not got sufficient whitening; he must keep adding more until he finds, on trial, that the comb marks remain distinct. The whitening is simply put in to make it comb, and not for any other purpose; therefore when you have obtained this do not put in any more, as it only destroys the transparency of the work when finished. Now this is the vehicle for graining oak, either light or middle tint, or old oak. The colours used for tinting the above are raw umber, burnt umber, and vandyke brown. The umbers are good drying colours, but the vandyke is a very bad drying colour. These colours are ground in turps, and are mixed, according to taste, either separately or together. The combs are made of horn, ivory, or steel. The veins of the oak are wiped out with a piece of cloth or leather.—Henry Page.

[4008.]—WATERING GARDEN.—The enclosed rough drawing will, I think, explain to F. H. Jones a cheap method of making a force pump for watering his garden. I have had one in use some time. A, common lead pump; B, valve; C, solid plunge from pump; D, outlet pipe; E, small cask, or any suitable air-tight vessel holding about 6gal.; F, valve; G, outlet pipe, reaching to within about 2in. of the bottom; K, guide for plunge-rod. It can now be used as a common pump by having a union; an india-rubber or any other pipe may be screwed on, and there would be sufficient force to carry a continual stream 60ft. high. The cask, or airtight vessel may be placed at any distance from the pump; a round hole in the bottom, with a piece of stout leather weighted is all that is required for valve.—B. O. Z.



[4017.]—CRICKET BATS.—Willow is the wood used for the blades; when spliced, part wood and part cane is generally used. I should not advise "Stump" to try to make them, as, unless he is a good workman, he will undoubtedly make a mess of it.—Semper Paratus.

[4025.]—HORSE POWER.—The general rule is to multiply together the pressure in pounds on a square inch of the piston, the area of the piston in inches, the length of the stroke in feet, and the number of strokes per minute; the result, divided by 33,000, will give the horse-power; but it is necessary to deduct about 1-10th of the whole as an allowance for friction.—Cuthbert.

[4037, 4038, 4058, 4063.]—MEDICAL COILS.—Being away from home, I cannot refer to past numbers; but some of the questions asked me on this subject have been recently answered, and full particulars given. As to "A Coal Miner's" question, it is very hard to say where fittings can be got, particularly where one does not know his locality; the best directions I can give is, make them, which is easily done by any handy person: thus, for the part carrying the screw an elaborate brass casting may be employed, but is no better than a simple arch formed of sheet brass, on the middle of which a thick piece is soldered for the screw to work through. My own early attempts (and very successful they were, and even with some pretensions to artistic effect) were built out of all kinds of odds and ends; even coat buttons were pressed into service. The pillar to carry the spring may be made of any stout rod, or even of a thick wire, passed up the middle of a piece of wood turned up to shape and fitted with a screw at the end. For medical purposes "R. T." would find the condenser injurious instead of beneficial. It cannot be too plainly understood that for this purpose violent shocks are not desirable, but a full steady flow of mild pulsations. I would advise "Rather Dull" not to use a water regulator; they are nuisances, and interfere with the last-mentioned principle. It is far better to control the force by a commutator throwing different lengths of wire into action, and by either withdrawing the core or covering it with a sliding brass tube. I think "Inductorium" is mistaken in the meaning of terms. If a wire were wound in different directions in its two halves, not the smallest effect would be produced, as one half would act directly opposite to the *other*, and neutralise it. But if we start winding from the middle, it is necessary to wind in what we may call opposite directions in order to make the continuous direction the same, just as it is in the two arms of an electro magnet; so, also, each layer appears in one sense to be in opposite direction to the one above and below it; but electrically it is in the same direction.—Sigma.

[4031.]—LEATHER CUTTING.—TO "J. C."—I consider the screw motion better than rack and pinion for your job. The reason for its going hard is the great diameter of the screw. If it were 1in thick instead of 2 it would be strong enough probably, and take less than half the power to work it. I have investigated this subject mathematically, and have arrived at a result that would astonish most engineers, judging at least from what general practice is. I have not yet been able to try practically whether my theoretical result is correct, but have submitted my calculation to Dr. E. B. Denison, who is a practical as well as a scientific man, and he sees no fallacy in it. I have for some time past intended to send it to the English Mechanic, and shall do so, I hope shortly.—J. K. P.

[4032.]—GRIP CHUCK.—The chuck, as shown, was for a lathe of 5in centre with mandrel not bored up. I have since made one 2in. shorter for a 5½in. lathe, the mandrel of which is bored with a ½in. hole about 6in. deep. Less length would do—say 3in.—J. K. P.

[4033.]—SLIDE REST.—If "J. D. L." will look at my *letter of Oct. 15, last year, headed "Levers or no Levers," he will find a full description of what he requires.*—J. K. P.

[4035.]—ORGANS.—In answer to "J. N.," I beg to inform *him that the sinking of the keys is common, especially in old organs. If he will look at the backfall beam he will most probably find it of oak. The heat of the weather warps this beam, or something immediately connected with it causing the backfalls to rise. The keys drop in proportion t[illegible]* this rise, and the pallets consequently do not *fall* enough [illegible] allow a sufficient supply of wind to the pipes. I played o[illegible] large old organ of 3 rows of keys for many years, which [illegible] to me as good as a thermometer in telling the amount of [illegible] In the summer, if at all hot, not only did the keys fal[illegible] one of the sliders always became immovable. Thi[illegible] owing to the reason above stated, and to the warping [illegible] upper board, which was of oak. The only remedy for [illegible] is to screw up the nuts under the pallet pull-downs. Th[illegible] will raise the keys, but care must be taken if the weather alters to *unscrew* these keys again, or they will be too high, and the pipes belonging to them will most probably speak. The only perfect cure will be to make a new and much stouter backfall beam of dry mahogany, well secured to the bottom of the wind-chest or elsewhere.—Camerton.

[4037.]—WHEELS.—TO "R. T."—The real practical diameter of what is called the "pitch circle" of a wheel is rather more than the distance measured from the bottom of the teeth on one edge to the top of the teeth on the other edge, the trifle that I call "rather more" being the amount cut out between the roots of the teeth to prevent the points of the teeth of the wheel with which it works jamming; and the diameters of wheels of the same set are exactly at their pitch-line, proportioned to the number of teeth; so that if your 120 wheel measured 3in. a little less than half-way down the teeth, then the 30 wheel would be ¾ in diameter at its pitch line; and owing to there being 40 teeth to every inch diameter, would be called No. 40 on the Manchester wheel guage. In the same way No. 10 has 10 teeth to every inch diameter, and No. 12 has 12 to every inch, and so on. Now for the "addendum," as it is called—that is, the amount the teeth project beyond the pitch line. On the Manchester guage this quantity is always one division of the scale on each side of the wheel, or two divisions for the two sides, added to the pitch diameter. Thus, on the 10 guage a 35 wheel will be 35 + 2 = 37-10ths over all; and on the 8 guage a 35 wheel would be $\frac{37}{8} = 4\frac{5}{8}$ diameter; and a 75 wheel on the 20 gauge would be $\frac{77}{20} = 3\frac{7}{20} = 3·85$; and a 63 wheel on the 27 guage would be $\frac{65}{27} = 2\frac{11}{27}$. It is a mere matter of proportion, or what is called a rule of three sum, for finding the pitch diameter; and the rest, which I call the "addendum," is the same for every wheel of the same sized teeth.—J. K. P.

[4047.]—MUSICAL TERMS.—In answer to "J. R. W.," he is evidently not well up in organ stops or the labelling of the stop-handles. The pitch of the principal organ-stops, such as the open diapason, dulciana, claribella, gamba, trumpet, &c., is of what is called 8ft. pitch, because the pipe of these stops to produce CC must be 8ft. long or thereabouts, being a little longer, if the pipe is of small scale, and shorter if of large scale. If you pull out one of the above-named stops, and press down—say fiddle G, you have the fiddle G note, corresponding with the lowest note on the violin. Any stop, then, on the organ or harmonium, which, when drawn, and a given key pressed down, gives you the pitch you expect to get according to the note pressed down in an 8ft. stop, whether it goes through the compass of the instrument or a part of it. The pitch of the human voice and of ordinary instruments, as the piano, violin, flute, clarionet, oboe, bassoon, &c. is 8ft. Now if you pull out the double diapason 16ft., double dulciana 16ft., or bourdon 16ft. (tone), and press down the fiddle G note as before, you will not get the fiddle G tone, but an octave below it. Any stop labelled 16ft., whether it runs through the whole compass of the instrument or a small part of it is called 16ft. pitch, and gives you an octave below the tone you expect to get from a given note. But if you pull out a stop labelled 4ft., say principal or flute, and press down fiddle G, you will not get that note, but an octave above it. If you pull out the 15th, or any stop labelled 2ft., and press down fiddle G key, you will not get that note, but 2 octaves above it. Any stop may or may not go through the whole compass of an instrument; but it is of 16ft., 8ft., 4ft., or 2ft. pitch, as I have explained.—Camerton.

[4055.]—ORGAN PIPES.—In answer to "J. P.," there is no such thing as CCC *open* diapason. CCC is the lowest of the *double* diapason, or bourdon, or any other 16ft. stop. Organ builders first cast the metal, then plane it to the desired thickness. Different organ builders have different thicknesses and scales and weights of wind to correspond. The once noted builder, Green, made his pipes very thin, of small scale, with small weight of wind. His organs were very sweet, but of the chamber organ tone, and wanting in the full, bold, ringing tones of the old Father Smith's organs, the pipes of which, as a rule, were of thick, honest metal, and well blown. An organ builder would cut out many pipes from the same sheet of metal, as he would many wood pipes from the same board. A small scaled pipe will always be longer than a large scaled pipe giving the same note. As to the relative diameters of open diapason, principal, fifteenth, &c., no two organ builders are agreed; but the most sensible notion seems to be this, and it was adopted constantly by the best builder in England, has ever seen:—Make the principal one scale less than the open; the 15th one scale less than the principal; the 22nd one scale less than the 15th; and so on. As to a mixture stop, the relative diameter of the pipes depends entirely upon the character of mixture which is wished to be obtained, whether a full or sharp mixture, cornet, &c. The length of middle C open will be about 2ft.; middle C principal 1ft.; middle C 15th 6in.—Camerton.

[4056.]—ELECTRO MAGNETISM.—"F. N. F.'s" question is somewhat obscure. If I understand it aright, the best position for placing the magnets is in the lines of the radii of the revolving wheel—not as tangents to it, because the whole face is brought into near neighbourhood, while in the latter case only the edges would be so. Of course the cut-off should be so arranged as to stop the current slightly before the armature reaches the position of strongest attraction, in order to demagnetise completely by the time it crosses that position, otherwise there would be a tendency at that point to stop the motion.—Sigma.

[4057.]—GALVANIC BATTERIES.—Neither the manganese or sulphate of lead battery is at all suitable for the purpose indicated; they will neither of them sustain a current of large quantity for any time. My next paper will probably give the information "F. N. F." wishes for.—SIGMA.

[4068.]—PRESERVING FLOWERS.—"G. O. F." must not expose them too much to the influence of light. He will find no difficulty in "laying them out" if he places them carefully on thick absorbent paper, as soon as possible after collecting, and covers them by bending over them, from one corner, another piece of paper so that as he arranges the petals, &c., he presses them into place. Before they get quite dry, he should examine and arrange any parts that are pressed out of the natural position. I have a hortulus siccus consisting of some of the most minute and delicate leaves and flowers, gathered during the past 8 or 10 years, which are as beautiful as when first obtained.—H. E. GODFREY.

[4070.]—THE LATHE.—For answer, see "J. K. P.'s" letter.

NOTES AND QUERIES.

[4082.]—FLUTE.—I have a flute made by Starke, London, which is nearly a whole tone too flat; is there any way to sharpen it? I have tried in town here, and can't get it done. The flute has a very sweet tone, and I am very fond of it so don't wish to change, if possible.—J. T. O'BRIEN.

[4083.]—CLEANING WHITE CORAL.—I have some pieces of coral reef (originally white, I am told) but now very dirty. I have tried to clean them, first by washing them in pure water, then with soap and water. They are still a dirty gray. Will any reader tell me how to get them white, and oblige?—A NEW READER OF THE MECHANIC.

[4084.]—COMET.—Having seen a mention in one of the daily papers of the expected arrival of one of these strange bodies, I should feel much obliged if someone among our astronomical readers would kindly inform me in what constellation search should be made first, and whether it would be likely to be visible to the naked eye?—W. R.

[4085.]—PERRY'S MICROSCOPE.—Will Mr. E. Perry inform me what is the distance between the lens and the object glass, also where the instrument may be obtained?—SALOPIAN.

[4086.]—FITZROY STORM GLASS.—Will any reader publish the formula for making the above?—W. V. YOUNG.

[4087.]—GLASS PAINTING.—Will you let me thank Mr. Ashton very much for the trouble he has taken? The only thing in which I fear failure is the oxide of gold and calcined silver, may I therefore trespass upon your space and his kindness for brief replies to the following:—Where can I procure the above two chemicals purest and cheapest? Does he consider prussiate of potass, indigo, and the earths, burnt umber, sienna, and vandyke brown, permanent; if not, will he kindly set me up with browns and blues?—SABLE.

[4088.]—OBJECT GLASS.—Will someone kindly assist me out of a little difficulty, that is, what distances should the lines be, namely:—

Eyepiece No. 1. ½in. diameter, ½in. focus
" No. 2. 1in. " 3in. "
" No. 3. ½in. " 3½in. "
" No. 4. 1in. " 8in. "

Stops between 1 and 2, 3 and 4. And what distance should there be between 2 and 3, as I have a 3in. achromatic object glass of which I am satisfied with the night power, but in the day power there is a dimness like a glass out of focus?—G. B.

[4089.]—LEVER ESCAPEMENT.—"Nobody" has replied to my question in a sneering, I had almost written, insulting manner; I did not ask for wit, but information. He evidently thinks I knew nothing about what I wrote, and wanted to steal something through the medium of the ENGLISH MECHANIC. Allow me to tell him that I have occasionally seen a lever escapement, and have planted a new one or two, but what I wanted to know was the best way without going far into arithmetic to gauge the "proper dimensions" of the parts of an escapement relative to each other, that is to say, sizes of 'scape wheel and roller, length of lever, place for ruby pin, &c., &c., and the best way readily to get the angle for pallets and lever, and whether the same rules answer for club wheel as pointed tooth escapements. Also in converting a verge or English horizontal into a lever, the best way to do so "supposing the pieces to be already made, for I think nobody would take the trouble to make a lever escapement when it can be bought so cheap rough. The remark—"suits of clothes to fit anybody" was quite uncalled for, as the same gauge or dimensions will answer, proportionably, for all size watches. If "Nobody" cannot, or will not, now answer my question, perhaps, some other practical man will kindly give me the information I ask for.—GRACCHUS.

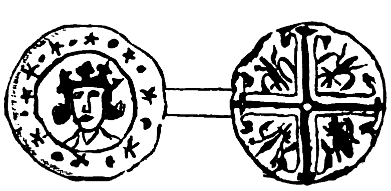
[4090.]—GILDING BATTERY.—I wish to thank "Tangent" for his information (gilding battery) which he sent a few weeks ago, and I have been anxiously looking for the few hints he promised me, as I wish to learn the gilding practically, if possible. I tried with one cell, and followed his instructions—heating the bath to about 60° Fahr, putting a piece of gold on wire from positive pole, and a piece of zinc (as I had no platinum) on the negative wire, but I could get no deposit. Will you tell me where I am still wrong. For the bath I used merely an oz. of cyanide of pottassium to ½ pint of water, and left the battery for seveaal hours. If he wishes to write to me, I will insert my address in the Sale column, or a drawing how to arrange the battery will oblige.—ONE IN A FOG.

[4091.]—PLAN OF CANOE.—I should be glad to take advantage of "Boat Builder's" kind offer to send a plan of a canoe, and to communicate with him direct if he would write to me.—J. F. O'BRIEN, 32, Lord-street, Liverpool.

[4092.]—THE ENGLISH CONCERTINA.—Would our worthy friend "The Harmonious Blacksmith," or some other musical correspondent, kindly explain the merits of an English concertina? Are they really musical instruments, and the best substitutes you can get when circumstances will not allow of a piano or organ?—LOST.

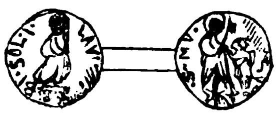
[4093.]—RANGE OF PROJECTILES.—How much rise, or fall, there will be in a plane, on which a cannon is fired, to be equal to 1 degree, on the tangent scale, as I find when practising on a tidal river at a floating target, the range is very much affected by the rise and fall of the tide, which is caused by the elevation of the plane? If the tide is lowering the range increases, and, if, on the other hand, it is rising it decreases in a similar manner. Not having seen the deviation noted, I shall feel obliged by your answer, in one of your papers, as I am a regular subscriber to the MECHANIC. If a stone is ejected from an instrument on a given plane, and at a given angle, it will not go so far as one under similar circumstances from a plane 20ft. higher.—W. KELSALL.

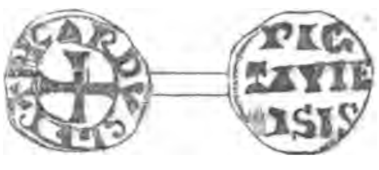
[4094.]—COPPER COIN.—Will any brother reader inform me what this coin is, of which I send you a full-size sketch.



The head is very much like the Edwards, and the coin very thin?—N. T. M.

[4095.]—SILVER COINS.—Would any kind correspondent inform me what the silver coins are of which I enclose full





sized copies; they are thin. The small one has rays apparently issuing from the heads of the figures?—A BEGINNER.

[4096.]—AERATED WATER.—Will any reader give me instructions for constructing an apparatus for making aerated water? It is made by impregnating the water with the gas from sulphuric acid (oil of vitriol) and chalk. I want to know how it is forced in to impregnate the water, &c.?—D. W. L.

[4097.]—A VELOCIPEDE FOR SPORTSMEN.—I have been trying to fix on the best plan for a 3 or 4 wheeled velocipede for carrying two persons, and in addition two dogs, for shooting purposes in winter, or a portable canvas boat for fishing in summer. I live in the west of Ireland, and am surrounded by lakes which are at various distances, and frequently it is not easy to find a comfortable or safe stable to put a horse in. It would therefore be a great boon to me and perhaps to others who are fond of a day's amusement with a rod or gun. Could a really servicable 3 or 4 wheeled velocipede be obtained suited for the above? I should prefer ease in propelling it to speed. I hope some of your clever correspondents may give me some assistance in the matter.—LAND OF THE WEST.

[4098.]—"EMIGRANTS' INQUIRIES.—Will any kind brother reader inform me, how I could emigrate on the cheap to some healthy colony where I could meet with employment in the building trade. I could, if hard pushed, turn my hand to painting, plumbing, masonry, and many other useful branches. Having a wife and family I have not the means to turn out as I would wish.—A HARD-UP WELSH TRADESMAN.

[4099.]—OBSERVATORY.—I want to erect an observatory for a reflecting telescope, like the one described in the "Intellectual Observer" of July, 1864. The chief difficulty will be in getting an ordinary carpenter to make the roof so that it shall turn round easily and smoothly. I intend to cover the roof with felt. If any correspondent has ever built one on this plan, I should be much obliged if he would give me the benefit of his experience? The whole cost, including labour and materials, is said in the "Observer" to be under £11.—ALGOL.

[4100.]—TOOL FOR SWAGING BOLT AND SET SCREWS.—Will some reader inform me how to make a tool for swaging small bolt and set screws?—AMATEUR BLACKSMITH.

[4101.]—DIFFERENCE OF TEMPERATURE BENEATH TREES.—What is the cause of the difference of temperature noticeable in passing under some trees in the summer months. I have often been struck by it, and a few days ago, during a long drive through Herefordshire lanes, about sunset and an hour or so afterwards, the air was quite chill, but whenever I passed under certain trees, a puff of heat in my face was almost startling; indeed, it felt like passing before a fire. I had no means of testing the difference of temperature under the trees and a few yards out, but I am sure it must have been many degrees. I have only noticed the above on summer evenings.—K.

[4102.]—GALVANISM.—Wanted to know best works on medical electricity, and prices of same, and publishers. Also how to make a galvanometer?—T. B.

[4103.]—CLOG IRON MACHINE.—Could any of our readers give a description of one of these machines, so that I may make one?—LANDAMINI.

[4104.]—BEES.—Will "Anon" be kind enough to inform me where I can obtain "Payne's Bee Book," he recommends in MECHANIC of June 10?—A BEE KEEPER.

[4105.]—HALL MARKS.—Will any brother reader kindly inform me where I can procure a book containing the hall marks, so that I might be able to tell the dates of old plate, &c., and about the price of such?—CATSEYE DIAMOND.

[4106.]—GOLD COINS OF EDWARD III.—What is the value of a ½ gold noble of Edward III?—CATSEYE DIAMOND.

[4107.]—KNIFEBOARD.—What is the cork composition fastened on the knifeboard with?—CATSEYE DIAMOND.

[4108.]—WHAT COIN IS THIS?—Brass, about the size of our penny, the inscription Jacobus II, Dei Gratia; rev.: a crown with crossed sceptres, on one side I and the other R. over the crown 1689, XXX, below Aug. I. round the coin, Mag. B.K. Fra et. Hib. Rex.?—CATSEYE DIAMOND.

[4109.]—TELESCOPE CONSTRUCTION.—I shall feel very thankful to anyone who will inform me what is the price of a disc of flint glass, and a disc of crown glass, 6in. diameter, of good quality, at Mr. Chance's, Birmingham, or Powell's, in London? What should be the diameter of my brass tools for working an object glass 6in. in diameter? How can I tell when the glass is ground sufficiently well to commence the polishing; is it possible to grind the surface of the glass sufficiently smooth with finely-washed emery to reflect an image of a star like I can get in working a metallic speculum? Can I employ a coating of black pitch spread on the tool as a polishing bed, or will it be likely to press out at the edges, and so prevent the getting of a true spherical figure; which ought I to employ from among the various other polishing beds which I have heard proposed, such as cloth, linen, alpaca, lute-string, silk, &c.? How long ought a lens, 6in. in diameter to take to be polished, using putty powder?—URANUS.

[4110.]—MAGNETISM.—Allow me to call the attention of your readers to the following as relating to this subject; perhaps "Sigma" will kindly give his opinion. If a wrought iron ring be surrounded with a helix of covered wire, I think it will be admitted that in this case, from its symmetrical form, there is no reason why the magnetism should be more strongly developed in one part than another. If, now, the ring be cut through transversely (without severing the wire) so as to form two horseshoe magnets, it will be found that iron-filings will only adhere around the severed parts, even when the same are pressed firmly together. How can this be explained? The ring with the halves in contact has remained the same as before, with the exception that the cohesion has been destroyed in these parts. Does not this point to an influence that mere severance or destruction of cohesion has on the distribution of magnetism, or on the formation of poles? I cannot see that Ampere's theory throws any light on this case. I have not in my readings observed any mention of the following fact: If one end of the secondary of one of Rhumkorff's coils be insulated and the other end connected to earth; the core, primary wire, and everything in connection with it, battery, &c., takes an electric charge. With a coil giving ¼in. sparks, the battery gave with the above arrangement strong sparks ¼in long. With a large coil a most unpleasant shock would certainly be the result of touching the battery with the arrangement referred to?—S. T. PRESTON.

[4111.]—EMIGRATION—TROPICAL CLIMATE.—Could you or any of your numerous correspondents kindly indicate where I could meet with sound information on the following point: I am desirous of emigrating, but from descent and constitution could succeed only in a tropical climate. I am therefore desirous of learning the price of land and other necessary particulars in Jamaica, Trinidad, and British Guiana.—ORIENS.

[4112.]—GAS METERS.—Will any brother reader be kind enough to give me a description and drawings of the working parts of wet and dry gas meters?—AN INQUIRER.

[4113.]—PHOSPHATE OF LIME.—What is the use of the phosphate of iron arriving in London and in Bristol from Portugal. A few particulars will oblige?—PHOSPHATE.

[4114.]—METRICAL ACT.—I wish to know the date of it, and especially the official proportion of English and French weight?—INQUIRER.

[4115.]—TROPICAL FIBRES.—A work has just been edited on them in England. I shall feel obliged for some particulars on it, where I can get it, price, &c.?—J. C. P., Paris

[4116.]—AN AIR-STRUNG PUMP.—I have for some time been greatly puzzled with a common pump, often improperly called the sucking pump. The pump stands about 50 yards from where it gets its water, and of course there are 50 yards of pipes, with a valve near the end of the pipes. Now, this pump often becomes what is technically called air-strung. The pump does not lose its water, but it is in a manner locked. The fact is, when the pump is in working order one man can work it with ease, but when it is air-strung it is absolutely impossible for two men to work it. I shall feel greatly obliged if you, or any of our excellent correspondents, will kindly explain what it is that causes this pump to become air-strung?—COAL MINER.

[4117.]—BULLION IRON CEMENT.—I should feel obliged if any of our correspondents could tell me of a material called bullion iron cement? I think it is not used to prevent radiation of heat, but to coat the metal of the boiler. I am told it is a heavy yellow powder. I should like to know where I might see any?—R. G. B.

[4118.]—PROBLEM.—"Gimel" will much oblige if he will be so kind as to give a solution to the following problem without the aid of algebra? A gentleman having mortgaged an estate for £2000, at 5 per cent. compound interest, he is now desirous of knowing in what time he shall discharge the said debt and interest by paying the mortgagee £187 yearly?—ALGEBRA.

[4119.]—ANASTATIC PRINTING—POROUS CELLS.—Will any fellow reader kindly inform me whether the zinc used for anastatic printing is prepared in any way; if it is I should be obliged to anyone to tell me the way to do it?—CUTHBERT.

[4120.]—FLY PAPERS.—How are fly papers prepared—I mean papers for catching flies, which disturb us so much at this season of the year?—HAWTHORN.

[4121.]—TO BOTTLE FRUITS.—I wish to know how to bottle fruits such as those done in the clear liquors. Will any reader kindly favour me with the exact process?—SEMPER PARATUS.

[4122.]—DISTILLED WATER.—Will any reader kindly inform me how to distil water on a small scale for photography?—MOSES.

[4123.]—SOLDERING BRASS.—What fluxes are used for soldering brass?—MOSES.

[4124.]—FOLDING STOOL.—Will someone inform me the best principle on which to construct a folding stool for an office desk—one to slide under the desk is what I want. A sketch would oblige?—TIRED LEGS.

[4125.]—SCREW CUTTING.—How could I cut an odd pitch in a screwcutting lathe without using a reversing strap. I have tried to do so by bringing the carriage back to the same place, but find that the tool will not pitch always in the same thread. And also the same information as to the fractional part of a thread?—ANXIOUS.

[4126.]—WALL PAPER.—What is the best material to put on damp walls to keep the paper from being tarnished?—A CONSTANT READER.

ANSWERS TO CORRESPONDENTS.

*** All communications should be addressed to the, Editor of the English Mechanic, 31, Tavistock-street, Covent Garden, W.C.

The following are the initials, &c., of letters to hand up to Friday morning, June 17, and unacknowledged elsewhere :—

G. and S., Rev. H. H. G., A. Q., N, S., Jos. Moore, Hy. Eccles, W. E. E., Sambo, W. C., J. Parnall, D. W., J. H. T., Col. S. B., T. W. T., J. and D., W. B., R. A, Proctor, J. H., H. H., H, W. P. Smith, Paine and Sons, Rev. R. F. D. J., W. P. and Sons, Old Flute, J. K. P., W. H. J. P., Amateur Tinker, Andrew Johnson, Old Paint, Banting, Wm. Airey, R. R., Chemicus, Andrew Wilson, Reineps, A Reader, Rob. Wells, J. R. T., W. B., J. P, G., J. Hamson, Little John, C. J. Eagleton, J. R., J. M. J.

Letters to the Editor.—An unusual number of letters are postponed till next week, including "Emigration," by Saul Rymea; "To Millers," by Thos. Evans; "Bicycles," by Wm. Jackson Pigott; "The Miltonian Bicycle," by Capt. C. D. Campbell, R.N.; "Double Beat Valve," by J. K. P.; "Cotton Spinning," by C. S. B., and Harmonius Cotton Spinner; "A Tour in North Devon," by Devonensis; "Emigration," by Rivet Plater; "Bath Forum Field Sports," by R. P. E.; "Cheap Gas," by C. D. C.; "Specimens of Lathe Turning," by J. H. Morgans, &c.

Edwin Hughes.—The best way is to say what your plan of utilising sewage is. If it is good it will be very likely adopted. Please write with a more legible ink. You can't write too plainly for editors and compositors.

W. and B.—Tickets for the dinner returned. We are adverse to bribing and puffing of all kinds. Giving dinners to "the representatives of the press" is in our estimation a species of bribery.

Grocer wishes to have his thanks recorded to "J. K. P." for his drawings on the throttle valve.

B. J. Williams.—The address of Beck and Co., is Cornhill, London.

J. R. L.—Try again. There is every probability you will be successful next time.

J. H., T. W B. and others.—Mr. Perry's address is, 8, Mount Pleasant, Sherbourne-road, Birmingham.

F.R.A.S.—Mr. D. Wright, of Aberdeen, suggests that a testimonial should be subscribed for, and presented to "A Fellow of the Royal Astronomical Society" for his "unvarying kindness." As the selection of one correspondent from a large number of others, for such an honour might appear invidious, we feel sure that F.R.A.S. would most respectfully decline the offer.

G. Gillingham.—See extract in "Useful Notes." We always like to give an esteemed correspondent a lift if we can honestly do so,

J. H. Morgans, Parklands, with photos of turned work.

W. Pearson and Co.—with description of new lock-stitch sewing machine.

Vencedor.—The journal you mention ceased to appear about two years since.

A. Miller.—The machine was an American invention.

James Eardley.—The report of the Aeronautical Society can be obtained of Hamilton and Co., Paternoster-row, price 1s.

W. S. Greenwood.—Exchanges are paid for, and not inserted gratis as replies to queries.

Medium.—We cannot.

The Sixpenny Sale Column is the only place in which can appear queries sent by "A Bootmaker," "A Reader," "W. Giles."

Cuthbert.—First query inserted. For second, see recent papers on "Electricity."

Barphooger.—Queries asking where various articles can be obtained, can only appear in the "Sixpenny Sale Column."

Charles.—Both your queries have been asked and answered during the time you have subscribed.

Subscriber (Northampton).—Advertisements cannot appear as replies.

Wood Engraver.—See last volume.

A Stonemason.—Yes. We should be glad if you would send us a list. Any sum you can afford.

H. H.—How is it possible to give you any information when you give such meagre particulars? If you describe the picture, say what its subject is, its size, if any initials or marks on it, &c., some of our readers may be able to oblige you.

De Lorraine.—Write the Editor of the *Journal of Horticulture.*

J. Bird.—Find the contents in cubic feet and reduce to gallons. One cubic foot contains (approximately) 6·232 gallons.

Jack Rag.—A book (now advertised in these columns) sold by Mr. Crowther, of Halifax, will give you the information you require, also a book by Mr. Binns (likewise advertised and reviewed in this number).

R, N.—See answer to "Cuthbert."

A Four Years' Subscriber.—You may become a dentist by apprenticing yourself to some member of that trade, and a solicitor by becoming articled to a solicitor for a certain number of years (usually five), and then passing the necessary examinations.

H. C. Davies.—Consult indexes.

R. B.—The "Commissioners of Patents' Journal" will give the information you require.

W. B. D. asks the somewhat curious question, from what town in Great Britain do we receive the largest amount of correspondence? We can't answer exactly, as we have not kept an account.

R. Smith.—A purely commercial query. Advertise.

Veloce.—Your question cannot be answered without seeing the picture.

Pedestrian says, "What a happy suggestion of yours about out-of-door pursuits! The English Mechanic, as it is, is the companion of the workshop and the laboratory. Your suggestion will make it a guide to the rocks, the flowers, in fact, to the surface and crust of the globe, which Mr. Beardsley would degrade by making flat. Is he sure it is the *earth* which is a flat?"

THE *ENGLISH MECHANIC* LIFEBOAT FUND.

Subscriptions to be forwarded to the Editor, at the office 31, Tavistock-street, Covent Garden, W.C.

Amount previously acknowledged	£186	10	7
A Few Friends of Chards, per S. Cooke	0	7	0
Land of the West	1	0	0
Per C. E. Cæsar	0	10	0
Aquarius	0	1	0
C, J. H. C.	0	1	6
B. Edwards	1	0	0
11 o'Clock	0	2	6
	£189	12	7

A Farthing a Week.—Mr. B. Edwards, who sends us a sovereign for the Lifeboat Fund, says: "If every reader of the English Mechanic would put by one farthing a week, and forward the same to you at the end of the year, the boat would soon be afloat."

THE INVENTOR.

APPLICATIONS FOR LETTERS PATENT DURING THE WEEK ENDING JUNE 14, 1870.

1639 L. Rose, 5, Bank, Leith, an improved stopper for bottles

1640 W. Wilson, Manchester, apparatus for manufacturing gas for illuminating and heating from coal oils

1641 W. West, 9, St. Paul's-road, Camden-town, and D. K. West, 7, Lidington-place, Oakley-square, improvements in machinery for pressing cotton and other materials

1642 B. Holt, 14, Savile-row, improvements in horse-shoes and wheels

1643 E. Doughty, 66, Welbeck-terrace, Nottingham, improvements in lace machines

1644 G. T. Bousfield, Loughborough-park, Brixton, improvements in the treatment of slag and other vitreous material.—A communication

1645 J. Morris, Belfast, improvements in machinery for shedding power loom warps

1646 T. Aveling, and H. Rawlinson, Rochester, an improved arrangement of reversing and expansion gear for steam engines

1647 J. Storer, Hammersmith, improvements in fountains

1648 F. Schafer, 6, Golden-square, protecting shop fronts and other parts of buildings against burglarious attempts

1649 W. R. Lake, Southampton-buildings, London, improvements in machinery or apparatus for testing strain or pressure applied to solid bodies, and for other purposes.—A communication

1650 A. Piccaluca, 22, Boulevard Sebastopol, Paris, improvements in apparatus for manufacturing iced syrup or cream, and soda-water beverages

1651 G. Lodge and G. Sheard, Leeds, improvements in steam boiler and other furnaces, fire bars, and flues

1652 H. W. Hammond, Manchester, improvements in cartridges.—A communication

1653 B. Clarke and J. Hughes, Ponkay, improvements in safety cages for mines and shafts

1654 W. Dewhirst, T. Dewhirst, and J. Dewhirst, Bradford, an improved stop motion applicable to machinery or apparatus

1655 E. Green and J. Cadbury, Birmingham, improvements in collar and shirt studs

1656 H. Bollinger, Manchester, improvements in machinery for dividing and condensing fibrous materials on carding engines

1657 W. R. Lake, improvements in printing telegraphic apparatus.—A communication

1658 W. E. Newton, 66, Chancery-lane, improvements in cartridge cases for breech-loading fire-arms.—A communication

1659 T. Greenwood, Leeds, machinery for drawing wool, silk, flax, and other fibrous substances

1660 J. H. Johnson, 47, Lincoln's-inn-fields, improvements in producing light from heavy hydrocarbons.—A communication

1661 G. T. Bousfield, Loughborough-park, Brixton, improvements in woven and knitted fabrics and yarns.—A communication

1662 E. Moss, Winchester House, Old Broad-street, improvements in the manufacture of leather for mill bands.—A communication

1663 W. L. Wrey, United Service Institution, Westminster, improvements in the means of propelling ships and vessels

1664 J. W. Butler, Stonebridge-park, Willesden, W. D. Butler, Princes-street, Hanover-square, and J. Dudbar, Vicarage-road, Camberwell, improvements in machinery or apparatus for supplying coal, cannel, or other substances to gas retorts or ovens, and for withdrawing the same after distillation

1665 J. Scaife, Leeds, an improved packing for pistons, piston rods, and other rods

1666 W. T. Wright, St. Nicholas, Glamorgan, and E. Yorath, Molton, raising and lowering, loading and unloading hay, corn, straw, and other materials

1667 W. Fisken, Stamfordham, Northumberland, and T. R. H. Fisken, Leeds, improvements in machinery for cultivating land by steam or other power

1668 Z. T. Gramme, and E. L. C. d'Ivernois, Paris, improvements in magneto-electric machines

1669 F. W. Webb, Bolton, improvements in ladles for molten metals

1670 C. D. Abel, 20, Southampton-buildings, Chancery-lane improvements in the preparation of corks for rendering them impermeable, and to preserve them from decay.—A communication

1671 O. C. Stone and W. Pridgeon, Odessa, Russia, improvements in apparatus for governing and controlling steam engines

1672 W. Kay, Edinburgh, a new or improved machine for washing and cleansing floors and other surfaces

1673 J. D. Brunton, Leighton-crescent, Kentish-town, improvements in the ventilation of tunnels

1674 C. A. Calvert, Manchester, improvements in the means of checking and indicating the number of passengers carried by an omnibus

1675 W. E. Newton, 66, Chancery-lane, improvements in steam boilers —A communication

1676 P. Spence, Newton Heath, Manchester, improvements in the manufacture of alum

1677 J. H. L. T. Portner, Regent-street, improvements in the construction of cabinets, stands, or receptacles for sewing machines.—A communication

1678 H. R. Fanshawe, 14, Finsbury-place, an improvement in towels, rubbers, and wipers

1679 R. T. Y. Johnson, Stockton-on-Tees, improvements in rotary engines and pumps

1680 J. T. Parlour, Brooklyn, New York, improvements in machinery and in the means employed in connection therewith for raising sunken ships

1681 W. Polson, Paisley, improvements in treating farinaceous substances

1682 B. Hunt, 1, Serle-street, Lincoln's-inn, an improved joint for water, gas, and steam pipes—A communication

1683 W. Bush, Notting-lane, improvements in the construction and arrangement of carriages

1684 J. Walker, Mansell-street, Aldgate, E. Ragon, Cottage-road, Paddington, improvements in the form and construction of ships and floating vessels

1685 T. Greenwood, Leeds, and J. Keats, Leek, improvements in sewing machines

1686 F. G. Fleury, 24, Merrick-square, Southwark, improvements in water waste preventers

1687 W. R. Lake, an improved embroidering attachment for sewing machines.—A communication

1688 J. Combe, Claremont, Leeds, improvements in machinery for winding cops for weft or warp, or other purposes

1689 A. F. Brophy, 42, Redcliffe-road, West Brompton, improvements in staining and ornamenting wood

1690 D. Greig and J. Greig, Edinburgh, a new or improved machine for dressing and separating the fibres of certain fibrous substances, the same being specially applicable for treating rhea or china grass.—A communication

1691 B. J. B. Mills, 35, Southampton-buildings, improvements in steam and other vessels, and in steam engines, steam boilers, and propellers applicable thereto.—A communication

1692 F. W. Granham, and B. Butterfield, Bradford, improvements in muzzles for dogs

1693 R. Punshon, 3, St. Nicholas-buildings, Newcastle-upon-Tyne, showing the local deviation of the mariners' compass in iron and other ships

1694 M. Henry, 166, Fleet-street, improvements in spectacles.—A communication

1695 D. C. Lowber, Church-street, Warrington, improvements in machinery for manufacturing wire ties for securing bales

1696 W. R. Lake, improvements in rudders for vessels.—A communication

1697 E. T. Hughes, 123, Chancery-lane, improved methods of preparing pure carbonate and bicarbonate of soda, and also soda in its crystallised state.—A communication

1698 P. J. Knewstub, 23, Saint James-street, Westminster, improvements in travelling and other bags, cases, and boxes

1699 G. Lewis, Kettering, improvements in reaping or harvesting machines

PATENTS SEALED.

1073 W. R. Lake, improvement in brakes and starting apparatus for railway carriages —A communication

3561 J. Hamilton and R. Paterson, improvements in collapsable casks or vessels for containing fermentable and aerated beverages

3575 R. J. Ransome, J. Dees, and R. C. Rapier, improvements in tramways

3588 H. Cockney and F. C. Cockney, improvements in steam boilers and in the setting thereof

3590 H. Wilson, improvements in machinery for cutting timber into pieces

3591 W. Williams, improvements in subaqueous and tunnel communications

3606 J. Gardner, an improved mode of cutting veneers.—A communication

3617 G. W. Honeyman, an improved preparation for the removal and prevention of incrustation in steam boilers

3673 H. Kinsey, manufacture of surface condensers, hot-water apparatus, and steam boilers, and water heaters for the same

3726 W. Sumner and E. H. Walderstrom, machinery for boring copper and its alloys for making cylinders, rollers, and tubes

3726 W. Sumner and E. H. Waldenstrom, improvements in the manufacture of cylinders, rollers, and tubes of copper and its alloys

3736 A. Upward, J. Bannehr, and the Rev. T. P. Dale, improvements in the manufacture and purification of gas and in the utilization of waste and bye products of gasworks

3759 P. Gledhill, improvements in machinery for cutting coal and other minerals

3589 W. C. Green, improvements in breech-loading fire-arms

3594 J. Turner and J. Turner, improved lubricators for steam engines

3600 P. O. Evans, and H. J. H. King, improvements in apparatus for feeding fibrous materials to carding or other machines

3607 J. Livesey, improvements in street tramways

3613 R. Morton, improvements in refrigerators or apparatus for cooling liquids

3619 N. P. Burgh, an improved double or single acting pump

3624 J. Hamer, improvements in steam engines

3627 J. H. Sams, improvements in seed sowing machines and manure distributors

3628 E. T. Hughes, improvements in wood-moulding and panelling machines.—A communication

3633 J. H. Johnson, improvements in means or apparatus for reducing friction.—A communication

3643 J. A. Buirat, an improved process for producing engraved metallic plates for commercial indications

3668 J. O. Ramsden, improvements in looms

3676 W. L. Wise, an improved instrument for leveling and for measuring angles.—A communication

3679 M. Henry, improvements in the mode of and apparatus for typographical composing and printing.—A communication

3689 A. M. Silber and F. White, improvements in apparatus for indicating time

3702 J. Loader and W. H. Child, improvements in steam-boilers

3703 J. Pritchard and J. Collins, improvements in embroidering or sewing

3706 J. Brooke, an improvement in the manufacture of blankets

3747 F. W. Webb, improvement in mills for rolling and crushing metals

3766 J. O. Butler J. Nichols, and W. Heslop, improvements in the manufacture of tyres and hoops for railway wheels

82 O. Vivier, improvement in means or apparatus for measuring and indicating the distances travelled by vehicles

104 A. V. Newton, improved apparatus for preparing fibrous substances for spinning —A communication

106 A. V. Newton, improvements in machinery for preparing fibres for spinning.—A communication

110 W. P. Chapman, improvement in cases or apparatus for transmitting and exhibiting cut flowers

154 T. P. Balls, improvements in apparatus for moulding and compressing substances for artificial fuel

597 R. S. Norris, improved method of getting coal

911 W. McNabb, improvements in bale hoops and other bands

941 W. McCraw, improvements in photography by processes which combine printing, tinting, and transferring for the production of chromo-photographs

976 J. Shackleton, improvements in utilising exhaust steam

1152 W. R. Lake, improvements in condensers for marine steam engines

1168 B. Farrington, improvements in breech-loading fire-arms

1171 J. R. Clark, machinery for knitting stockings or various other articles

1191 S. D. Tillman, improvements in boilers, air heaters steam condensers

3635 E. Tomlinson, improvements in furnaces for preventing the formation of smoke

3637 W. T. Henley, improvements in protecting telegraph wires and cables

3647 A. R. Stocker, improvements in stoppers for infant's feeding and other bottles

3650 G. Weir and J. Weir, improvements in slide valves

3654 E. A. Inglefield, improvements in hydraulic apparatus to be used on shipboard for utilising the pressure of the external water

3655 J. L. Hancock improvements in apparatus for crushing or breaking bones

3662 W. E. Gedge, an improved system of pessary.—A communication

3663 W. Hargreaves, certain improvements in steam boilers

3664 W. Foulds, improvements in apparatus to promote circulation in steam boilers —A communication

3677 J. Robertson, improvements in machinery for treating and shaping metals

3683 W. Morris, improvements in permanent way of railways and tramways

3699 W. Ferrie, improvements in blast furnaces

3740 S. Dixon, improvements in the manufacture or production of skirts and petticoats

3753 C. Gordon, improvements in the construction of breech-loading fire-arms

3764 H. N. Maynard, improvements in piers or supports for bridges, viaducts, and such like structures

3765 W. Helliwell, J. Helliwell, M. Helliwell, and T. Helliwell, improvements in the construction of bobbins used in machines for spinning, doubling, and twisting

3771 J. R. Wigham, improvements in gas burners for illuminating beacons, buoys, and lighthouses

3782 T. F. France, improvements in the construction of baths and waterclosets

9 C. Drake, improvements in the construction of concrete buildings

24 T. Nuttall and R. Nuttall, certain improvements in the manufacture of counterpanes

The English Mechanic
AND
MIRROR OF SCIENCE AND ART.
FRIDAY, JULY 1, 1870.

MICROSCOPICAL JOTTINGS IN TOWN AND COUNTRY.

No. I.

MICROSCOPISTS have at least this advantage over other devotees of science, that they are independent alike of the seasons, weather, and even of location. Shut an ardent microscopist within the four walls of the dreariest dungeon that ever was, but allow him light and his microscope, and I am certain that he will find both full employment and real enjoyment from the "common objects" around him, even if his imprisonment extend beyond the calendar month. How much more, then, have we who are free to roam, scope for real work? We need not exclaim, as I have heard some who have a fair instrument at their use exclaim, that there is nothing for them to look at; that they are shut within the bounds of a great city, beyond the reach of flowers or pools; or, immured in some village, have no opportunity of purchasing "objects for the microscope."

To these, accepting our Editor's published invite, I beg to dedicate the few rambling notes which, with his permission, I will from time to time publish. I may here premise that my notes shall be simple transcripts of my real home work or my field work. They shall be the chat of a worker to other workers, not treatises to amuse the learned.

We will now take a trip from the fair "and ever faithful" city of the West along the South Western Railway some score miles more or less, to the rising little town by the sea called Seaton, pretty enough, some day to be big enough, but now merely the resort of broad-speaking, honest-looking Zummerset folk, Dorset lassies and their swains, or buxom "Devonshire dumplings," with a few, perhaps, of that species of the genus *homo*, "visitors." The sea tumbles in with a merry though may be a drenching plash. As we stand on the beach, away it stretches before us many a mile, whilst the pixies and the fairies take their morning's bath. To right of us we espy chalk cliffs, Beyond our ken in that direction lies Beer and its land slip. Let us wend our way to the cliffs. As we go, we stumble against a "hideous" cuttle fish. "Frightful creature, pass it by." Gently, fair lady, gently please. There is nothing ugly in nature, bear that in mind, whatever else you forget. That cuttle fish, has in it more than you or I will this day understand—has in it more of beauty than we can now stay to reveal. Let us stay, however, and cut out this canoe-shaped "chalk-like subtance" which lies loosely in the sac within the animal. We will pocket it, pass to the chalk cliff, secure a "lump" of the white "stone" now, but once living shells of wondrous beauty, and gladly return to our workshop at home. Not but that we might pick up as we go a host of waifs and strays sufficient in themselves to find us employment for weeks. Here for example is a mass of chalky substance attached to a piece of "wrack." It is "ugly enough," but take it home, wash it in strong potass, and you will find it is composed of delicate needles of the most delicate transparency. It is only a sponge, but no man could make aught so delicate, so really beautiful. But our cuttle and chalk will more than occupy us for the remainder of the week. We will take the chalk first. Let us powder it carefully, tie it in a coarse cloth and diligently knead it in a running stream. By degrees we get rid of all the white wash and have only a little fine powder left. We remove this from the cloth, carefully dry it, place a "wee tiny" bit on our glass stage plate, moisten it with turpentine, cover it with our thin glass, and magnify it 250 diameters (¼in. objective). Vast numbers of tiny shells come into view, "woven work" shells "wheel shells," and others, showing us conclusively enough that the vast cliffs which guard so much of our coasts, our vast "downs and worlds," are but the vast mausoleum of the past ages. If we wish to reserve them for cabinet objects (and most I trust will so wish) we have merely to place a few on a slide, moisten them with turpentine for a few seconds, and then mount them in Canada balsam in the usual fashion.

Our notes have rambled so far that we must postpone "cuttle" to our next.

W. Pocklington, Hull.

THE WORLD, ITS FORMATION AND ANTIQUITY.

By Arthur Underhill

CHAPTER II.

(*Continued from page* 314.)

WHEN we penetrate the crust of the globe by means of mines or other deep excavations, we find that as we depart from the surface, the temperature becomes greater in proportion to the distance traversed; and from this it has been calculated that at a depth of between thirty and forty miles from the exterior, the heat is so intense as to liquify or fuse the most obdurate material in nature; since then, in all probability the interior of the globe is a mass of molten matter; it must during the immense time which has elapsed since its first creation, have parted with a great quantity of its heat, and therefore must originally have contained a greater amount, than it does at the present time. On this account the most celebrated geologists have thought that the world when it came fresh from its Creator, was a globe of liquid mineral substance. This is of course but a speculation, yet as it is a speculation which is strongly supported by observed facts I have here mentioned it. One argument in its favour is the form which the earth has assumed, namely, that of an oblate spheroid, a form which has resulted from the combination of gravity and centrifugal force, and which it could scarcely have taken, unless such forces had acted upon it when in a state of mobility. This globe, then, after many centuries became sufficiently cooled down, to allow of the solidification of its surface, and thus a thin coating of solid granite was formed, which as the cooling continued became thicker and firmer. At this period, the earth was a vast stony desert, unfitted for any form of animal or vegetable life, both on account of its sterility, and also of the intensity of the temperature at its surface. At length, when it had lost sufficient heat to allow of the existence of water, the aqueous particles in the atmosphere were condensed, and formed a sea of uniform depth covering the whole globe. Then life in humble shapes was produced; the tiny zoophytes and molluscous animals, mere masses of jelly, swarmed in the tepid waters of the ocean, with other elementary forms of creation, which were however the forerunners of nobler species, who in turn should give way to beings better and more exquisite than themselves. Then came a great convulsion, the outside coating of the earth cooling unequally, cracked and split in various places, and the molten substance from within was ejected forth, forming large tracts of land, and throwing up mountain ranges, of which some still exist. Thus the division of the globe into land and water took place; but they were not distributed in the same form as now. Places which are at the present time inhabited countries, busy with the activity of man, and flourishing with all the verdure of a tropical clime, then rested peacefully beneath the ocean, and some of the elevated lands of that epoch, are now the bed of the sea. This change of level has happened even in the memory of man, and at one place the largest ships sail over the towers and steeples of a once flourishing and powerful city.

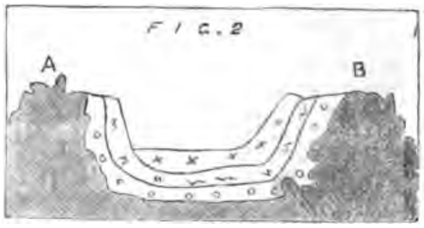
After this convulsion, the sea charged with the debris and detritus, deposited it evenly on its bed; first the heavier portions of matter, then the lighter ones, and thus a succession of strata was formed. At length, after several of such convulsions had taken place, the earth became in a fit state for land animals and birds, which were accordingly created; first in a rude and elementary fashion; huge misshapen lizards, or saurians, as they are called by entomologists and birds, whose wings were but half formed. In these early days of the globe, certain species were not, as now, confined to certain latitudes, but were distributed over the whole earth; thus we find the remains of tropical trees and shrubs in the strata of our own country. It follows, from this, that one even or nearly even climate prevailed, and this is strong evidence in favour of the igneous theory, for the crust must have still retained so much heat as to make the variations of temperature caused by the sun, almost inappreciable; there thus was a general summer over the whole earth. Convulsion followed convulsion, each one causing former lands to subside beneath the sea, and thrusting up new ones, where there was formerly a "waste of water;" destroying all animal and vegetable life, and burying the remains deep in the new strata formed from the ruins of a former world, there to become these fossils which now serve as the historians of their times.

Another creation takes place, and a new, and superior organic world occupies the position of the former one. Again a convulsion, and another creation, and so on through a long period of time; each epoch producing life in forms approximating to the present inhabitants of the globe. As Lucretius says—

> So things by turn increase, by turns decay.
> Like racers, bear the lamp of life, and live,
> And their race done, their lamp to others give.

At length man himself, and the present races of animals and vegetables were formed, and then, for the first time on earth, appeared that mighty attribute of humanity, *reason*.

I have in the foregoing paragraphs, slightly sketched the history of the globe, a history which is proved both by the different races of organic life whose remains are found in the form of fossils, and also by the disturbance and rupture of the strata by the igneous masses which were emitted at each convulsion. That these convulsions did take place at different periods, is proved by the different upheavals of the crust, thus in Fig. 2. The disturbance at A must have taken place before that at B, for when the convulsion at A happened, the top stratum could not have been deposited, for it would have been tilted up with the other strata; but when the upheaval at B took place, it must have been formed, for it was inclined by it, together with the underlying strata. Since, then, this top stratum did not exist when the convulsion at A happened, and did exist when that at B took place it follows, that the convulsion at A was, in point of time, prior to that at B, therefore A and B were the results of two different convulsions.



Since all stratified rocks must have been formed under water, we find that there are certain groups *or systems* of formations. The localities of such systems are by geologists termed *seas*, on account of their having originally been the beds of oceans. Between each convulsion, the sea deposited a system; and thus wherever we find the same system in two places apart from each other, we may rest assured that both were under water at the same period, viz., that of the formation of such system; and wherever we find no traces of such system, we conclude that at the time of the formation of the system, such place was dry land; otherwise we should find a deposit of the system upon it.

As this subject is of great importance in geology, I shall reserve any further explanation of it until my next chapter.

(*To be continued.*)

SCIENCE FOR THE YOUNG.*

By the Rev. C. Kernan, Clongowes College.

(*Continued from page* 319.)

LAW V. By law IV. the two forces tend to have an effect equal to their diagonal. By Law I. a force equal and opposite will keep that diagonal in equilibrium, therefore it will keep the two forces in equilibrium. Experimentally the two forces P and Q, Fig. 61, act upon the body A drawn away, for the moment, to some angle, and held—dotted line—to the base B. Trace a parallelogram, the sides of which (p and q) represent the relative strength of the forces, and the angle at which they act. Measure the diagonal (r), its *length* shows the *force* of the resultant.

Hang to the hook H a weight proportional to the forces P and Q, as the diagonal is proportional to the lines which represent P and Q.

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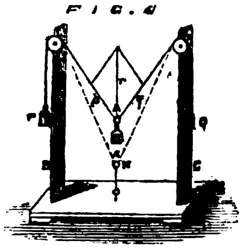
The ring holding the body down may be loosened, the weight R will move to the angle at which it will balance P and Q. For example, suppose P = 8oz. Q = 12oz. Constructing a parallelogram, of which the end and side adjacent are as 8 and 12 (inches for example), and form an angle equal to that of the two forces; the diagonal, say 14in. long, shows that a weight, 14oz., will balance the force P and Q. A useful adjunct to this apparatus is what may be called a *parallelogram-ruler*, Fig. 62. The jointed rod *a a* . . . divided into inches, &c., move to any angle along their diagonal, which, being divided, shows at a glance the *length* of the resultant. The rods may form a parallelogram of any proportions. In experimenting with this ruler, and the apparatus of Fig. 61, the effect of the "obstacles to theory" will present itself to the student for the first time. Two experimental deviations from strict theory will be observed, at least if the apparatus, Fig. 61, be not carefully got up.

FIG. 61



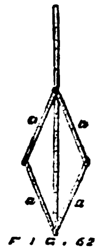


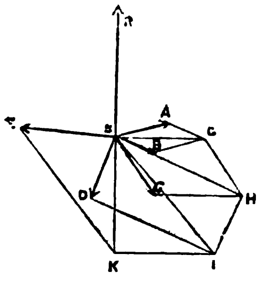
FIG. 62

1. When P and Q are unequal, as in the example, 8 to 12 — R will not rest at equal distances from the two uprights B C; it will move from the middle towards the heavier weight. In that position the diagonal of the ruler cannot lie along the perpendicular, which the hanging weight R will make. Consequently, R should not be able to balance P and Q at the angle of the ruler, because it (R) is not acting straight opposite to the resultant. Notwithstanding, it will be probably found that R does equilibrate P and Q at the angle of the ruler. Strictly, the ruler should be a square, then the resultant would be perpendicular, and R would have its full force. But the "obstacles" diminish the force of P and Q, and thus makes up the deficiency of R in the parallelogram of unequal forces.

2. It will be found that R may be drawn gently down to other and other positions of equilibrium. Here again the obstacles stop somewhat the action of P and Q. Consequently, &c.

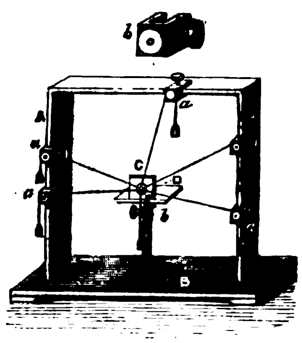
Law VI. Any two forces are combined together, their resultant combined with the next, and so on, until there is but one pair left, the resultant of which being found, is balanced. Thus, in Fig. 63, the five forces A B C D E are compounded; A with B giving the resultant S G; S G with C, resultant S H; S H with D, resultant S I; S I with E, resultant S K, which being balanced by S R, the whole system is in equilibrium.

FIG. 63



For the experimental study of this law, the apparatus, in Fig. 64, will be found very useful. A stout frame A some 4 or 5ft. square on a base B. To the frame can be fixed with screws the little blocks with pullies *a a* . . ., shown (aside) larger at B. Half a doz. or more of these are required. In the centre of the base is a short pillar, which carries a small table, the edge of which just ranges with the groove of the pullies The shaft of the table can be kept raised to any height by a screw. A small clamp *b* serves to fasten various "pieces" to the table.* This apparatus is also useful for the VII Law, and for the applications. For Law VI. clamp the "piece" (*c*)—a square plate of wood—to the table edge, and into the hole put a pin carrying a ring or hollow disc D, with any number of cords. Work out on paper any set of forces in equilibrium. Now dispose the cords over the pullies at the same angles as the forces in the figure, add weights proportional to the forces (lengths of lines), and one weight equal and opposite to their final resultant. The pin may now be removed, the ring will remain at rest. With this apparatus any set of forces in the same plane can be experimentally studied. Any little departure from theory (it never will be much) is to be attributed to the "obstacles."

FIG. 64



Law VII. The law is general, but not to complicate the proof consider but three forces P Q S, Fig. 65. Of these, any two are in the same plane; they then are first combined: say P and Q, resultant A B. Now A B and S are in the same plane; combined their resultant is A C, diagonal of the figure. Were there any more, each new resultant would be combined with the adjacent force, until all were reduced to one. In the present case A C is balanced by adding A R—equal and opposite to A C—which gives equilibrium to the whole system. With the help of moveable pullies on stands, Fig 66, the equilibrium of any combination of forces in various planes can be studied experimentally by means of the apparatus, Fig. 64.

FIG. 65

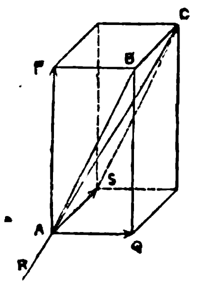
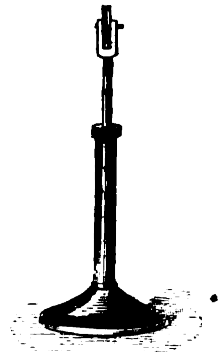


FIG. 66



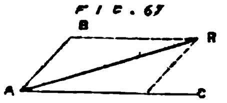
No. III.—Applications. Some of these may appear as not well placed in this point—that they would be better as proofs. But it must be borne in mind that the "Laws" and "Proofs" should be as short as possible. Besides brevity and clarity, obtained by leaving out all conclusions, there is a great danger avoided—the danger to the student of mistaking *deductions* for principles.

App. I—Equal forces. To opposite force in equilibrium equal forces may be added without causing any disturbance. This fact seems too well known to be dignified with the name "an application;" and yet, when used later on in a demonstration, there will be felt, at least at first, an inclination to doubt. Besides the scientific reason of this fact—that the algebrical sum still remains = *o* — gives it a position of scientific dignity.

App. II.—"Obstacles." Already the experimental proofs have begun to show that there are impediments to the *complete* practical execution of theory. These impediments—"obstacles"—cannot be studied with any facility, until the principles of statics have been understood. For the present then, it must be sufficient to know there exist "obstacles" which affect practice more or less, and even in some circumstances completely modify the principles of theory.

App. III.—Decomposition. As forces can be reduced to one by "composition," so may one be replaced by two or many by "decomposition." For this certain data are required; the direction of the *component*, or, at least, the direction of *one*, with its intensity relative to the force to be decomposed. The decomposition is effected by completing the parallelogram according to the data. Let it be required to decompose the force R, Fig. 67, along the direction A B and A C.

FIG. 67



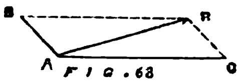
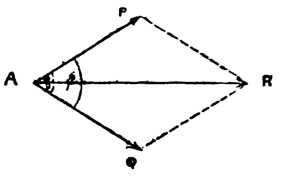


FIG. 68

From R, parallels to the two directions are drawn the portions of the lines A B and A C, cut off are the "components," as they constitute the adjacent sides of a parallelogram, of which R is the diagonal. With one direction only, and the intensity, Fig. 68, represented by A B, join B to R; through A draw a parallel to B R, and from R a parallel to A B. Now, A B and A C are the components for the same evident reason as before. Though important, there is no need of insisting at any length on this point, for in the course of mechanical study, decomposition of forces will occur sufficiently often to make it familiar.

App. IV.—Formulæ. Without any figure or measures, the resultant of two forces, at a given angle, can be known from a simple mathematical formula, which indirectly, therefore, may be called the formula of the equilibrium of two forces

FIG. 69



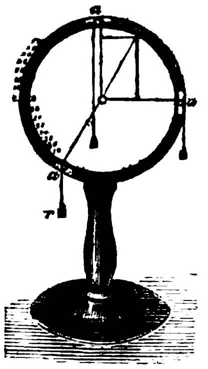
Let P and Q represent two forces, Fig. 69, and ϕ their angle; the formula is

$$R = \sqrt{P^2 \times Q^2 \times 2\,P\,Q\,\text{Cos.}\,\phi}.$$

It will perhaps be better not to distract the mind by showing how this formula is contained in the trigonometrical relations of the lines representing the forces. From this one, other formulæ (having P or Q as the unknown force) may be drawn.

By means of a second formula P and Q can be found when R, α, and β—*i. e.*, the force and the angles of its components are given. In the Fig. 69, let R be the force to be decomposed, α and β the angles of P and Q with R.

FIG. 70



App. V.—Demonstrator. This apparatus, Fig. 70, is specially constructed for "*statical*" *proof* of the parallelogram of forces. A circular slate is set in a rim of brass supported on a foot. The brass rim is graduated in both directions, and carries three small moveable pullies *a a a.* From the centre of the slate any parallelogram is traced, its sides and diagonal measured. A ring with three fine cords is pinned to the centre, and the cords (over the pullies) so placed that they lie along the force-lines, and anti-resultant. Weights proportional to the forces and resultant being hung to the respective cords, the pin may be removed; the ring is in exact equilibrium. So far the apparatus is like in its action that of Fig. 64, but much more delicate. Its speciality , that as it gives the angles, all the deductions from the formulæ of the resultant can be experimentally shown.

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* The clamp is shown at one side that the moving rod (table shaft) may be seen. 'Twill be better to leave the clamp act in the centre of the table.

N.B.—This instrument is only for the laws of equilibrium, the "Static" laws of forces applied to a point. 'Tis useless for "Dynamics," the smallest variation of the action of the forces (weights) changes the angle, and, consequently, the conditions of the force action. Hence, in strict theory, the ring if moved should at once deviate from the original diagonal, along which it should find no point of rest. But in practise, when the angle is *small* and *acute*, the ring will for a short distance follow the diagonal, and with the same apparent forces (weights) will be in equilibrium along that short distance. The reason of this practical result is, that for the short distance the original and new diagonals coincide to the eye, and the anti-resultant has really lost some of its force from the changed directions of the new diagonals, along which it is not fully acting. When the forces act at a right angle, and still more, when they act at an obtuse angle, the ring will deviate at once from the diagonal if the slightest change be mape in any of the forces; *for example, if the weight be gently raised.* It may be added that with acute angles, the "obstacles" have more effect.

(*To be continued.*)

CHAPTERS ON CURIOUS CATERPILLARS.

JULY.

By J. R. S. Clifford.

ONE hears occasionally of persons "going out for wool and coming home shorn"; and insect hunters not a few have gone out for the caterpillar I am going to mention, and if they have not come home "shorn," yet they have returned tired and disappointed, without having obtained the prize they sought. This arises from the circumstance that it is limited to certain localities, and these not extensive, nor is it always to be found even in the spots which it frequents. The Coast or Ground Lackey (*Bombyx castrensis*) is very similar in appearance and in size to the Common Lackey Moth, which, in some seasons, almost strips the hedges, and attracts the notice of bye-passers, being conspicuous by its striped body, and bluish-grey head, with two black spots, which are generally taken for eyes, though not such. The Coast Lackey occurs only, I believe, on the banks of the Thames; it has been taken between Gravesend and Erith, but mostly near the sea-wall, some distance below Gravesend, and in some parts of the Isle of Sheppey. A recent observer remarks that the caterpillars of the Ground Lackey delight to bask in the June and July sunshine, and are not so readily detected at morning or evening. The food-plants are the wild carrot and the sea wormwood, and probably one or two others growing in such places. Mr. Newman discovered that in captivity they would eat the leaves of the pear, poplar, and other trees, if they were moistened with a solution of salt. They have also been brought to maturity on the garden chrysanthemum. In the aspect, generally, as observed, the Coast Lackey caterpillar is like its more frequent relative, being long and hairy, dotted over with black points; along the back runs a broad black stripe, which is interrupted by four orange streaks. The sides of the body are of a bluish gray, through which there passes an orange stripe. The cocoon which is spun by the adult caterpillar is of a compact nature, and formed of silk chiefly, with which is intermingled a sulphur-coloured powder. It is usually attached to a twig. Some speculation has been caused by the name "lackey," and an expositor of this and other popular names fancies that it was applied to the species because the regular stripes resembled the garb in which some livery servants appear! It seems more probable to me that the regular mode in which the caterpillars proceed along the twigs and branches in their peregrinations for food, while they are young, may have suggested some comparison between it and the manner in which the domestics of the upper classes used to march in attendance upon their masters in the "good old times." But this explanation may be thought as fanciful as the preceding. It should be added that until more than half grown these caterpillars live under the protection of a web, spun unitedly, to which they retire at certain times.

In July, the caterpillars of a large and handsome moth, now scarce in England, are adult; sometimes a week or two earlier, in forward seasons. The eggs of the Kentish Glory (*Endromis versicolor*) are laid in regular order on the small twigs of the birch in April by the mother moths. These are yellowish at first, becoming shortly of a brownish tint, and ere the caterpillar emerges the shell ceases to be opaque, and the outline of the caterpillar, about to appear, is seen more or less distinctly. A little colony of these having come out, directly they leave the egg they proceed in what has been called "a line of march," moving towards the tips of the twigs. It is evident that the one which takes the initiative leaves something in his track, by means of which his brethren are enabled to pursue the same path; and a stray caterpillar, should he, by some mischance, get separated from the rest, is very uneasy until he can again "strike a trail." Occasionally, the caterpillars issuing from one batch of eggs will divide into two parties; and should two parties meet by accident, they will unite for a time, subsequently, perhaps, dividing again in their rambles after food. Mr. Gascoyne has pointed out how this caterpillar, in its various stages of growth, escapes, in a measure, from its enemies by the natural disguise with which it is furnished. When young, these little creatures, as they rest on the twigs of the birch in company, very nearly resemble the catkins in appearance. Increasing in size, and scattering about on the tree or shrub, each individual caterpillar, when not eating, rests most frequently with the fore legs raised in the air and the body extended stiffly, looking not unlike a withered or imperfect leaf. The newly-hatched caterpillar of the Kentish Glory gives little promise of its future beauty. It is of a smoky brown, with darker markings, and two yellow crescentic spots behind the head, sprinkled also with minute warts. In the course of five weeks, more or less, it has cast its skin four times, and now appears of good proportions, reminding one somewhat in its appearance of the caterpillars of the Hawk Moths, for it bears a sharp blunt horn on the last segment but one. It is also marked with ten white stripes, which are bordered with green, darker than the ground colour, and a similarly coloured narrow line extends down the back; the horn is white, as also are the spiracles, edged round with black. The head is pale green, with four short white stripes upon it. The cocoon is spun up amongst the herbage, and fastened to a twig, and the insect remains as a chrysalis through the winter. Most of the specimens of the Kentish Glory found in cabinets have either been taken in and about Rannoch, where this moth occurs plentifully, or they are descended from individuals once taken there, having been bred in confinement.

The caterpillar of another stout-bodied moth, which is to be found in several English counties, though not common, is shown in the accompanying figure. This species has received the odd name of the Sprawler (*Pecasia cassinea*), from the odd attitude assumed by this caterpillar when shaken from the tree on which it is feeding. The young caterpillar is not often taken at large. The nearly adult caterpillar, which is beaten from oaks in July, is of nearly uniform thickness, with a slight hump at the anal extremity. The colour of the body is of various shades of green; there is a yellowish white "collar" behind the head, and five narrowish stripes, also white, extend from head to tail; the former is a dull green. When in repose, the caterpillar of the Sprawler rests at full length, grasping tightly the leaf or branch it is decidedly hostile to others, not sparing even its own species. The chrysalis is buried deep in the earth, and the moth appears therefrom in October, and has a partiality for gas-lamps.

A delicate moth which appears partial to the south coast of England is designated by entomologists the Yellow Belle (*Aspilates citraria*), and, like its relative, the Straw Belle, it occasionally flies by day. The caterpillar from which it is produced is full-grown towards the end of this month, and may be got by searching in suitable spots on the wild carrot, the bird's-foot trefoil, and allied plants. It is remarkable as having the whole surface of the body shagreened, and on the last segment it has two longish points extending behind. The genera colour is a dingy white; running from one extremity to the other are a number of narrow brownish stripes, slightly waved; the one passing down the middle of the back is double; the spiracles are a deep brown. The favourite position of the caterpillar when not eating is singular; the claspers are firmly fixed to the twig or leaf, and the head and front segments stretched out, and a little bent. If alarmed, the head is immediately tucked closely in, "in the form of an Ionic volute," and the caterpillar remains motionless until the danger has passed, as it supposes. The chrysalis is placed in a slight cocoon, and is beautifully variegated with stripes and rings of different shades of brown.

Common in certain suburbs of London, and occurring also in various counties of England, is the Waved Umber (*Hemerophila abruptaria*), a moth which is most frequently seen sitting upon palings, where it escapes notice by its greyish brown tints. When examined, the markings are found to be very delicate and numerous. The caterpillar is worth looking for, and if found when young, it is seen to have a beautiful purple stripe along the back, which disappears at the next change of skin. The ground colour is a brown, darker or lighter, and just behind the head is a white ring or collar. The food plant it is most attached to is the lilac, though sometimes feeding on the rose also; it forms a silken cocoon when it is adult, at the juncture of two twigs.

There are several butterfly caterpillars to be found in July. One of these, whose history has not long been elucidated, developes into that pretty and sportive creature, the Duke of Burgundy Fritillary (*Nemeobrus Lucina*), most frequently seen in woodland clearings. The eggs are laid in June, singly or in small patches, on (it is said) the leaves of the cowslip. For about a week after the young caterpillars are hatched they keep to the under side of the leaves, eating only partially through, but beginning to make holes in the leaves; they increase in size, and before long are full grown, and prepare to attach themselves to the stems, to remain chrysalides through the winter. This caterpillar is one of those which are calledovisciform, or woodlouse shaped, being rounded above and flattened beneath, the divisions of the segments strongly marked. The head is pale brown, with black eyes; and it is capable of being entirely withdrawn under the second segment. The body is dingy white, with an obscure stripe above, and on each side a waved stripe, interrupted at the segments; there is also an orange spot on each segment, the spiracles are black. In looking for the caterpillar of the "Duke of Burgundy," it must be remembered that at the slightest alarm it falls from the plant, bending the extremities, which do not, however, touch each other. From its occurrence in the butterfly state in places where the cowslip does not grow, there is a strong probability that the caterpillar may be found also on other plants. In meadows, and on the plants growing about ditches, and the sides of lanes, we may meet with the caterpillar of the pretty Orange Tip Butterfly (*Anthocharis Cardamines*). This feeds in June and July, and would probably be almost as abundant as the common "whites," were it not that many of the caterpillars, ere mature, are destroyed by the mowing of the grass. The plants on which it is found mostly are the Hedge Garlic, the Dame's Cress, the Yellow Rocket, and the Lady's Smock; and in feeding, it gives preference to the seed pods, which it attacks while they are yet small. The back is curiously wrinkled, the wrinkles regularly dividing each segment into portions; and the whole body is covered with minute warts, from each of which there issues a bristle. The colour is green, fading into white on the sides; the legs and claspers are apple-green. The chrysalis remains attached to some stem or stalk through the winter, it is crescent-shaped, and of a greenish brown. In July, by sweeping the grasses which have escaped the scythe, we are very likely to pick up the curious though common caterpillar of the Small Heath (*Chortobius Pamphilus*), the butterfly being frequent in open places throughout the summer. The caterpillar is "dumpy," and has two red points at the tail, having also a smallish head. The colour is green, and there are three white stripes, one down the middle of the back, the others on the sides. The chrysalis is secreted amongst the herbage, and is often placed close to the ground. It is short and thick. There is supposed to be another brood of the caterpillers later in the season, which live through the winter in that state.

ELECTRICITY—ITS THEORY SOURCES AND APPLICATION.

By J. T. SPRAGUE.*

(*Continued from page* 266.)

139. FAURE'S CELL.—Very shortly after the Bunsen's cell was devised, it was proposed to make the carbon hollow, so as to contain the nitric acid, and serve as its own porous cell, and such cells have been a good deal employed in France; this plan is incompatible with the use of gas carbon, as it requires the material to be absorbent, as the first Bunsen carbons were they were made from a mixture of powdered coke or graphite with just so much powdered bituminous coal as, when heated in a retort, would bind it into a solid substance without running or warping; this was afterwards saturated with a strong syrup of sugar, or with coal tar, and after careful drying again carbonised, and by repeating this several times, a very solid and effective carbon is obtained.

Lately a modification of this kind has been introduced and spoken very highly of; the carbon is hollow, composed of the material of plumbago crucibles, in the form and size of a ginger-beer bottle, to which is fitted a stopper. The bottle being filled with nitric acid, this saturates the material, and the gases, not being able to escape, maintain a pressure which forces the acid towards the outer surface. No porous vessel is required, but a strip of gutta percha surrounds the carbon to prevent contact with a cylinder of zinc which surrounds it, and is immersed in a vessel charged with solution of common salt. The conditions of working are therefore similar to those described in Sec. 137, and the action carried on at the expense of the nitric acid. The force of this cell is very considerable, and it is stated to be able to keep ⅜in. thin platinum wire red hot for 12 hours. There is also much less annoyance from the fumes than with Bunsen's, and the inventor claims a very considerable economy of acid.

A cell on short circuit gave 80°, falling gradually to 53° in five hours, when I had to leave it. I also used it for silvering the gauze for the cell described Sec. 118, and after 80 hours' working, during which it kept the galvanometer at about 15°, it gave 68°, on short circuit, showing good constancy and permanence; in fact, as the bottle holds over 4500 grains measure of acid, one charge of strong acid should be equal to some 40 units of work, while for short experiments the capacity should be diminished by putting flint pebbles into the bottle. Under some conditions of working, a flocculent brownish deposit forms in the zinc cell, the nature of which I have not had leisure to examine.

140. ALKALINE NITRATES.—Several of the variations of the nitric acid cell are based on the use of the nitrates of soda or potash in place of nitric acid; nitrate of ammonia, even, has been employed, but as it is expensive and has no sort of compensating advantage, I shall not refer to it. When a solution of these nitrates is mixed with sulphuric acid, a reaction takes place by which the base is divided between the two acids in ratios depending on the relative proportions present; hence results a solution containing a proportion of pure nitric acid which acts in the usual manner, while the remaining nitric acid is only set free as the action of the battery proceeds. Nitrate of soda is by very much the best for several reasons, it is cheaper by the pound, its equivalent is lower, and therefore the said pound does more work, and it is very much more soluble, and therefore, a much more active solution is obtained. It is not, however, generally known that water when fully saturated with one of these salts will still dissolve nearly as much of the other as though it were pure water, and thus the strongest solution is made by dissolving both the salts together. In order to avoid waste it is necessary to know the quantity of salt which will dissolve, which varies very much, according to the temperature. I have, therefore, prepared a table showing how to make the solutions of the nitrates and of bichromate of potash, so as to secure the total effect without waste. The temperature for which it is made is 63° F. and the way to make the solution is to heat the water to about 100°, as solution produces cold, and then allow it to cool and draw off when it reaches 63°, and then add the acid. Column I. gives the name, symbol, and atomic weight; II. the *commercial* equivalent, or electrical unit, allowing for the average impurities; III. the number of the equivalents in 1lb. weight; IV. the specific gravity of the solution at 63°; V. the weight in grains of the salt and the equivalents in 1000 grains *measure*, and VI. the proportionate bulk of oil of vitriol required, this latter being really the number of grains measure necessary for 1000 grains of the solution.

No.	I. Names, Symbols.	II. Units in Grains. Weight.	III. Units in 1lb.	IV. Sp. gr.	V. In 1000 fluid grains. Grains weight.	V. In 1000 fluid grains. Units.	VI. Proportion of acid. Measure.
1	Sulphuric acid. H_2SO_4 98	50	140	1840	1836	37·	·027
2	Nitrate of Potash. KNO_3 101	103	67·9	1169	276·7	2·69	·075
3	Nitrate of Soda. $NaNO_3$ 85	87	80·5	1348	569·2	6·54	·177
4	Same at 100° F. ..	..	..	..	644·4	7·41	·410
5	Mixed nitrates ..	..	..	1436	745·3	8·19	·222
6	Bichromate of Potash $K_2O\,2CrO_3$ 295·2 ..	50	140	1081	117·9	2.163	·087
7	Same for simple cell.	..	..	..	..	..	·115

I have, in this (as I shall in all cases of measurement) taken 1000 fluid grains as the base, because of the convenience of the decimal calculation; the first part of Column V. multiplied by 8·75 gives the grains weight, or by ·00125 the decimal part of a pound required to make one pint of solution, and Column VI. multiplied by 8·75 the grains measure of strong oil of vitriol to be added to it. It is necessary to say that these figures in lines 2, 3, and 5 require to be doubled if acid is not used with the zinc, or this will be dissolved by the nitric acid at greater cost.

This table shows how important it is to attend to the details and proportions in constructing instruments, for column V. shows the amount of work done by equal bulks of these liquids as compared with Column IV. of the nitric acid table, and teaches us that as the solution used diminishes in effective power, we must enlarge the porous cell which contains it; it also enables us to see exactly how much of each excitant we should add to our batteries for any given work we wish to accomplish.

For purposes of comparison, however, I have employed them all in the same cells and under exactly the same conditions as those of the nitric acid, as given p. 266; not to occupy space with unnecessary details I may say, that the action is in all cases much slower than when nitric acid is used, the local action is equally great, the nuisance of the fumes is diminished only because the action is slower, the total amount given off being the same, as the action upon the nitric acid is not altered. As to cost, with nitrate of soda at 3d. per lb. the unit of acid alone costs ·0461, and with nitrate of potash at 4d. ·0666 of a penny, as against ·0393 for the common acid referred to p. 266. It is evident, therefore, that it is only where dearer nitric acid is used that there is any advantage to be gained by the use of nitrates.

141. SLATER'S IRON CELL.—In almost all the forms of battery iron may be used in place of zinc for the dissolving metal, but owing to its lower electromotive force, and other practical reasons, it is seldom employed; however, Mr. Slater (known to our readers as an astronomical instrument maker) has introduced a form of cell which promises to do good service, in which iron as the negative metal is combined with the use of nitrates as the oxidising agent.

Its construction needs no detailed description, as its only difference from the Bunsen is the substitution of iron for zinc, a plate or block of carbon being in the porous cell, which, in this case, ought to be of large dimensions. The cell was described lately in these pages, but not altogether correctly, as now employed. The solution, as described to me by Mr. Slater, is nitrate of soda prepared at 100° Fahr., and with sufficient sulphuric acid added to bring the gravity to between 1400 and 1500. This description is not easy to follow out, and I have tried the proportions as given in line 4 of the table. When the acid is added and the solution cooled, a large quantity of sulphate of soda crystallises out. One equivalent of acid would be 200 to 1000 of solution, and the specific gravity when cold would be about 1441, but this involves the whole of the work being done at the expense of the nitre. I therefore used two equivalents, one to decompose the salt, the other to act on the iron, and this raises the specific gravity to 1568. I tried both solutions under exactly the same circumstances; 500 grains of nitre solution are by the table, line 4, equal to 3·7 units. I obtained a deposit of copper 2·36 units, and a consumption of iron 2·59, the difference being loss by local action, but part of this was loss by rusting after the work was over; allowing 1 unit for action on the iron and ⅔ for supplying the oxygen. We have a work done of 3·9 to 4 units, which is as near 3·7 (the estimated work) as is to be looked for in matters where absolute scientific accuracy is unattainable, or, at all events, only at the cost of great labour for no practical value. With the double equivalent of sulphuric acid, the same quantity of nitre solution gave 3·44 units of copper, leaving still a considerable amount of unexhausted liquid, but the local action was greater than in the first case.

At starting, the outer cell is charged with water, to which is added a small proportion of the solution to render it conducting, and set up the action, which is then kept up by electrolysis and by endosmose, though it is to be observed that the liquid passes somewhat rapidly into the inner cell, the liquid in which stands at a considerably higher level than in the outer; in fact, in my small experimental cell, the liquid rose more than an inch during three hours; the action is maintained by removing a portion of the inner liquid at times, and adding fresh solution, so that there is little waste. The power of this cell is considerable, and its cost so small that it is likely to come into much use where it can be so placed that the fumes from it are not injurious, for though less than in other cases, these are still given off, and render it objectionable in a confined space.

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* "Sigma.

The cost of working this cell may be thus estimated :—

Iron equivalent	28	
Impurities, say	2	
at 1¼d. ÷ 7000	30 =	·0054
2 units sulp. acid at 1¼d. — 7000	100 =	·0171
1 unit nitrate soda at 3d. ÷ 7000	87 =	0·373
		·0,598
Say 10 per cent. loss		·0,060
Cost per unit		·0,668

This is less than half as much more than the Smee with a very much higher force, and about two-thirds that of the ordinary Bunsen at its cheapest.

142. BICHROMATE OF POTASH.—In order to overcome the nuisance of nitrous power, various substances yielding oxygen have been substituted, and this is one of the most commonly employed ; its use in a simple cell system will be referred to afterwards ; at present it is to be considered as used in a porous vessel. The salt may be obtained nearly pure at the price of 8d. per lb. It is not a true twofold acid salt, like bisulphate of potash, and its formula is variously written as $K_2O_1 2Cr$ O_3, or $K_2\ CrO_3\ O_7$ making its atomic weight on the new notation 295·2. Four atoms of sulphuric acid (98 × 4 = 392) unite with this, and the result of the reaction when effected in a battery and completed, is the production of Chrome alum, and 3 atoms of oxygen, the abstraction of which, by the nascent hydrogen set free by the reaction of 3 more atoms of acid upon zinc is the cause of the action considered apart from the preliminary action of the sulphuric acid on the salt itself, which does not affect the ultimate result. Thus

$$\left.\begin{array}{l} K_2Cr_2O_7 + 4H_2SO_4 = 2(KCr, 2SO_4) + 4H_2O + O_3 \\ 3Zyn + 3H_2SO_4 = 3\ Zyn\ SO_4 + \ \ldots\ldots\ 3H_2 \end{array}\right\} 3H_2O$$

In this notation, O = 16, and the electrical unit of oxygen being 8, this quantity of salt is equal to 6 units; that is to say, its own equivalent or unit is 49·2 ; or for convenience, and to allow for impurity, say 50, which quantity requires 66·6 by weight, or 36·3 by measure, of sulphuric acid to effect its own decomposition ; if in the same solution is to be provided the acid to act on the zinc, an additional equivalent is needed, making the quantity for each unit of work 117 grains by weight, or 63 by measure. These last quantities are not very different from the instructions usually given, to use about 3 oz. of bichromate to a pint of water, and add 1 part in 12, or 2 fluid ounces of oil of vitriol, a quantity, which, if it could be worked to exhaustion, would be equal to 26 units of work, including the local action, which is very great.

Owing to the insolubility of the salt, this solution is weak, and therefore a large porous vessel must be used, and perhaps the best way is to make the solution on the second plan, and put salt and water in the zinc cell. There is the same difficulty with this solution in both single and double cell systems ; its action, powerful at first, falls rapidly, simply because, as no gas is given off to disturb it, there is little circulation, and the liquid in contact with the carbon is soon exhausted ; on stirring, the force rises in an instant to its full pitch ; the local action set up by the endosmose of the solution is about the same as with nitric acid, or nearly 20 per cent on the work done (with the simple cell, it may be nearly 100 per cent).

The cost, working in porous cell, according to trials made for the purpose with a solution containing 1·18 units, and doing 828 useful work, was

Bichromate, 58·9 at 9d ÷ =	·0673
Acid 2·8 units	·0249
	·0922
Which, divided by ·828, gives the cost per unit.	1113
Zinc used per unit	293
Total cost	·1406

(*To be continued.*)

ON THE RELATIONS BETWEEN BODY AND MIND.*

LECTURE II.—PART II.

(*Continued from page 295.*)

I PURPOSELY selected for consideration the defective brain of the idiot, because it exhibits an undeniable fault of structure, which is often plainly traceable to evil ancestral influences. When we duly consider this, and reflect that we might, if we chose, arrange a series of human brains which should present a regular gradation from the brain of an ape to that of a well-developed European, are we not fully justified in supposing that like unfavourable ancestral influences may occasion defects in the constitution or composition of the mind-centres which we are quite unable to detect ? We know nothing of the occult molecular movements which are the physical conditions of our mental operations ; we know little or nothing of the chemical changes which accompany them—cannot, in fact, detect the difference between the nerve-element of a brain exhausted by exercise and incapable of further function, and that of a brain re-invigorated by sleep and ready for a day of energetic function; and we know nothing of the intricate connection of nerve-cells in the hemispheres. It is plain, then, that there may be, unknown to us save as guessed from their effects, the most important modifications in the molecular activities of nerve element, changes in its chemical composition, and actual defects in the physical constitution of the nerve-centres. Wherefore, when no appreciable defect is found in the brain of one who has had a strong predisposition to insanity, and has ultimately died insane, it behoves us to forbear a hasty conclusion that it is a perfectly well constituted brain. Close to us, yet inaccessible to our senses, there lies a domain of nature —that of the infinitely little—the operations in which are as much beyond our present ken as are these that take place in the remotest regions of space, to which the eye, with all its aids, cannot yet reach, and of which the mind cannot conceive.

It certainly cannot be disputed that when nothing abnormal whatever might be discoverable in the brains of persons who have a strong hereditary tendency to insanity, they often exhibit characteristic peculiarities in their manner o thought, feeling, and conduct, carrying in their physiognomy, bodily habit, and mental disposition the sure marks of their evil heritage. These marks are, I believe, the outward and visible signs of an inward and invisible peculiarity of cerebral organisation. Here, indeed, we broach a most important inquiry, which has only lately attracted attention—the inquiry, namely, into the physical and mental signs of the degeneracy of the human kind. I do not mean to assert that all persons whose parents or blood relatives have suffered from nervous or mental disease exhibit mental and bodily peculiarities ; some may be well formed bodily and of superior natural intelligence, the hereditary disposition in them not having assumed the character of deterioration of race ; but it admits of no dispute that there is what may be called an insane temperament or neurosis, and that it is marked by peculiarities of mental and bodily conformation. Morel, who was the first to indicate, and has done much to prosecute, this line of inquiry, looks upon an individual so constituted as containing in himself the germs of a morbid variety ; summing up the pathological elements which have been manifested by his ancestors, he represents the first term of a series which, if nothing happen to check the transmission of degenerate elements from generation to generation, ends in the extreme degeneracy of idiocy, and in extinction of the family.

What are the bodily and mental marks of the insane temperament ? That there are such is most certain ; for although the varieties of this temperament cannot yet be described with any precision, no one who accustoms himself to observe closely will fail to be able to say positively, in many instances, whether an insane person, and even a sane person in some instances, comes of an insane family or not. An irregular and unsymmetrical conformation of the head, a want of regularity and harmony of the features, and, as Morel holds, malformations of the external ear, are sometimes observed. Convulsions are apt to occur in early life ; and there are tics, grimaces, or other spasmodic movements of muscles of face, eyelids, or lips afterwards. Stammering and defects of pronunciation are also sometimes signs of the neurosis. In some cases there are peculiarities of the eyes, which, though they may be full and prominent, have a vacillating movement, and a vacantly-abstracted or half-fearful, half-suspicious, and distrustful look. There may, indeed, be something in the eye wonderfully suggestive of the look of an animal. The walk and manner are uncertain, and, though not easily described in words, may be distinctly peculiar. With these bodily traits are associated peculiarities of thought, feeling, and conduct. Without being insane, a person who has the insane neurosis strongly marked is thought to be strange, queer, and not like other persons. He is apt to see things under novel aspects, or to think about them under novel relations, which would not have occurred to an ordinary mortal. Punning on words is, I am inclined to think, sometimes an indication of the temperament. and so also that higher kind of wit which startles us with the use of an idea in a double sense ; of both which aptitudes no better example can be given than that ot Charles Lamb. His case, too, may show that the insane temperament is compatible with, and indeed, it not seldom coexists with, considerable genius. Even those who have it in a more marked form often exhibit remarkable special talents and aptitudes, such as an extraordinary talent for music, or for calculation, or a prodigious memory for details, when they may be little better than imbecile in other things. There is indeed a marked instinctive character in all they think and do; they seem not to need or to be able to reflect upon their own mental states. At one time unduly elated, at another depressed without apparent cause, they are prone to do things differently from the rest of the world; and now and then they do whimsical and seemingly quite purposeless acts, especially under conditions of excitement, when the impulses springing out of the unconsious morbid nature surprise and overpower them. Indeed, the mental balance may be easily upset altogether by any great moral shock, or by the strain of continued anxiety. The effects of alcohol on such persons are in some respects special : it does not make them so much drunk as mad for the time being; and I think it will be found in most, if not all, cases of insanity caused by alcohol that there has been a predisposition to it.

I have sketched generally the features of the insane temperament, but there are really several varieties of it which need to be observed and described. In practice we meet with individuals representing every gradation from the mildest form of the insane temperament down to actual idiocy. These cases ought to be arranged in groups according to their affinities, for until this be done we shall not make much real progress towards exact scientific notions respecting the causation and pathology of insanity. One group might consist of those egotistic beings, having the insane neurosis, who manifest a peculiar morbid suspicion of everything and everybody ; they detect an interested or malicious motive in the most innocent actions of others, always looking out for an evil interpretation ; and even events they regard as in a sort of conspiracy against them. Incapable of altruistic reflection and true sympathies, they live a life of solitude and self-brooding, entrenched within their morbid self-feeling, until the discord between them and the world is so great that there is nothing for it but to count them mad. Another group might be made of those persons of unsound mental temperament who are born with an entire absence of the moral sense, destitute of the possibility even of moral feeling ; they are as truly insensible to the moral relations of life, as deficient in this regard, as a person colour-blind is to certain colours, or as one who is without ear for music is to the finest harmonies of sound. Although there is usually conjoined with this absence of moral sensibility more or less weakness of mind, it does happen in some instances that there is a remarkable acute intellect of the cunning type.

The observations of intelligent prison surgeons are tending more and more to prove that a considerable proportion of criminals are weak-minded or epileptic, or come of families in which insanity, epilepsy, or some other neurosis exist. Mr Thompson, surgeon to the General Prison of Scotland, has gone so far recently to express his conviction that the principal business of prison surgeons must always be with mental defects or diseases; that the diseases and causes of death among prisoners are chiefly of the nervous system ; and, in fine, that the treatment of crime is a branch of psychology. He holds that there is among criminals a distinct and incurable *criminal* class, marked by peculiarly low physical and mental characteristics; that crime is hereditary in the families of criminals belonging to this class; and that this hereditary crime is a disorder of mind, having close relations of nature and descent to epilepsy, dipsomania, insanity, and other forms of degeneracy. Such criminals are really *morbid varieties*, and exhibit often marks of physical degeneration—spinal deformities, stammering, imperfect organs of of speech, club-foot, cleft palate, hare-lip, deafness, paralysis, epilepsy, and scrofula. Moreau relates a striking case, which is of interest as indicating the alliance between morbid or degenerate varieties.

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* Two lectures delivered at the Royal College of Physicians in 1870. By HENRY MAUDSLEY, M.D., F.R.C.P., Professor of Medical Jurisprudence in University College, London.

Mrs. D——, aged thirty-two. Her grandfather kept an inn at the time of the French Revolution, and during the Reign of Terror he had profited by the critical situation in which many nobles of the department found themselves, to get them secretly into his house, where he was believed to have robbed and murdered them. His daughter, who was in his secrets, having quarrelled with him, denounced him to the authorities, but he escaped conviction from want of proofs. She subsequently committed suicide. One of her brothers had nearly murdered her with a knife on one occasion, and another brother hung himself. Her sister was epileptic, imbecile, and paroxysmally violent. Her daughter, the patient, after swimming in the head, noises in the ears, flashes before the eyes, became deranged, fancying that people were plotting against her, purchasing arms and barricading herself in a room, and was finally put in an asylum. Thus there were in different members of this family, crime, melancholia, suicide, eplipsy, and mania. Need we wonder at it? The moral element is an essential part of a complete and sound character; he who is destitute of it, being unquestionably to that extent a defective being, is therefore on the road to, or marks, race degeneracy; and it is not a matter of much wonder that his children should, when better influences do not intervene to check the morbid tendency, exhibit a further degree of degeneracy, and be actual morbid varieties. I think that no one who has studied the causation of insanity will question this mode of production.

I could not, if I would, in the present state of knowledge describe accurately all the characteristics of the insane neurosis, and group according to their affinities the cases testifying to its influence. The chief concern now with its morbid peculiarities is to point out, first, that they mark some inherited fault of brain-organisation; and, secondly, that the cause of such fault is not insanity alone in the parent, but may be other nervous disease, such as hysteria, epilepsy, alcoholism, paralysis, and neuralgia of all kinds. Except in the case of suicidal insanity, it is not usual for the parent to transmit to the child the particular form of mental derangement from which he has suffered: insanity in the parent may be epilepsy in the child, and epilepsy in the parent insanity in the child; and in families where a strong tendency to insanity exists, one member may be insane, another epileptic, a third may suffer from severe neuralgia, and a fourth may commit suicide. The morbid conditions which affect the motor nerve-centres in one generation seem to concentrate themselves sometimes upon the sensory or the ideational centres in another. In truth, nervous disease is a veritable Proteus, disappearing in one form to reappear in another, and, it may be, capriciously skipping one generation to fasten upon the next.

(*To be concluded next week.*)

STRENGTH OF MATERIALS.

By A. Tolhausen, Jun.

(*Continued from page* 200.)

BEFORE leaving the subject of tensive strength, we will discuss a case which frequently occurs in practice, and where the cohesive power of materials is employed in a vessel to resist a bursting or explosive strain arising from the pressure of a fluid within it.

Supposing we had a boiler, pipe, or other vessel, having a square section, as represented in figure, intended to contain a fluid exerting considerable pressure, and the internal pressure acting equally on each part of the casing, then it is obvious that the same would have a tendency to bulge out the sides, as indicated by the dotted lines. After having attained—were the material sufficiently pliable to allow this—a circular section, no farther change of form could be effected, and the amount of the internal pressure might be increased until it attained sufficient magnitude to burst or rend asunder the material.

In the construction of vessels intended to sustain considerable internal pressure, two essential points have to be attained—namely, the maximum of strength with minimum of material, and although a great variety of opinions are held on the subject with regard to boilers, yet mechanical engineers agree that the best form is the circular in section.[*] "In boilers this is the more important, as any increase in the thickness of plates obstructs the transmission of heat, and exposes the rivets as well as the plates to injury on the side exposed to the action of the furnace."

Vessels of large dimensions, such as steam boilers, are made of several pieces of wrought iron rolled into large plates having the required thickness (usually from ¼in. to ¾in. in thickness), according to the magnitude of the work and the amount of pressure which it is intended to sustain.

Mr. Fairbairn says with respect to the process of rolling the plates, that the same gives to the sheets greater tenacity in the direction of their length than in that of their breadth. Mr. Edwin Clarke's[†] experiments, and those made by continental engineers, distinctly contradict that conclusion, but the following results are practically more trustworthy. The relation existing between the ultimate resistance of boiler plate in the direction of fibre, or of that in which the plate is rolled, to that across the fibre, or at right angles to the direction in which the plate was rolled, is as 19·981 to 16·19. Thus rolled plates are stronger in the direction of their fibres—*i.e.*, their length.

These plates are made to overlap each other at the edges, and are fastened together by rivets or round pins of iron, passed red hot through holes provided in the plates, and riveted over so as to form a head.

The riveted joints are generally the weak points in all boilers, as in punching[‡] holes along the edge of a plate the latter becomes weakened to the extent of the sectional area punched out. This was clearly demonstrated by a series of experiments conducted by Mr. Fairbairn[§], and in which the strength of almost every description of riveted joints was determined directly by tearing them asunder. In two different kind of joints—*double and single riveted*—the strengths were found to be in the ratio of the plate as the numbers 100, 70, 56; or plates riveted by the double system appear to retain their position under strain much better than single riveted joints, or that each additional rivet gives an increase of 24 per cent

This led Mr. Fairbairn to further experiments on the best proportions and forms of riveting plates together, and the following table exhibits the same as deduced from practice (all in inches):

Thickness of plate.	Diam. for rivets.	Length of rivet from the head.	Distance of rivets centre to centre.	Depth of lap from single joint.	For double riveted joints add $\frac{2}{3}$ to the depth of lap given for single joints.
·19 = $\frac{1}{16}$	·38	·88	1·25	1·25	
·25 = ¼	·50	1·13	1·50	1·50	
·31 = $\frac{5}{16}$	·63	1·38	1·63	1·88	
·38 = [illegible]	·75	1·63	1·75	2·00	
·50 = [illegible]	·81	2·25	2·00	2·25	
·63 = [illegible]	·94	2·75	2·30	2·75	
·75 = [illegible]	1·13	3·25	3·00	3·25	

Example: Boiler plates of ½in. thickness are to be riveted together. Required the best proportion and best form of the rivets and rivet holes? By table we have ·81 as diameter of rivet, or 13-16th in. (by col. 3), 2·25 as the length of rivet from the head, or 2¼in (by col. 4), the centre of rivet holes to be 2in. apart, (by col. 5 and 6) the depth of lap = 2·25 + = 2·91in. for double joints. The best proportionate quantities are, therefore, ·81, 2·25, 2·0, 2·91, necessary to form the strongest steam or water-tight joints on plates of half an inch thick.

All rivet holes in first-class boiler work ought to be drilled and not punched, and no drifting of holes allowed, although up to the present day many noted engineering establishments still punch the rivet holes, as by so doing a great amount of time is saved when compared to the drilling of each hole by an ordinary drilling machine. The proprietors of the well-known engineering and tool making firm, Colliers and Co., Salford, have invented and patented a multiple drilling machine for drilling boiler, bridge, ship plates, etc., being capable of drilling from 3 to 180 rivet holes at once. The drills in this machine can be adjusted to different distances apart, to suit the widths of plates, or two separate plates or angle irons may be drilled at once. The table brought against the drills is self-acting, and is raised by an hydraulic ram, to ensure the horizontal rise of the same. Drilling machines of the above descriptions may be made for any number of drills, and not only perform their work in equal time to that of the punching machine, but also give greater strength to the plates than by the latter process, and in proportional less time, according to the number of spindles.

Various improvements have been designed to remove—or, at all events, to reduce the defects of the riveted joints, such as covering the joint by a strip of wrought iron, or covering the joint with two covering strips, one on each side of the plate, and an experiment[*] tried in this way showed the tensile strength of the joint to be about equal to the ultimate strength of the plate itself. By welding the plates together (Mr. Bertram's process) the joints prove to be stronger than the ordinary riveted joint.

Having thus shown the proportion existing between the tensile strength of whole and riveted plates, I now proceed to the strength of the plates themselves.

From five of Mr. Fairbairn's experiments the following results were obtained:—

	Mean breaking weight in tons in the direction of the fibre.
Yorkshire plates. . . .	25·77
Derbyshire plates . . .	21·68
Shropshire plates . . .	22·82
Staffordshire plates . . .	19·56

On comparing the strengths of the different irons it appears that the tensile strength in the direction of the fibre is almost the same in Derbyshire and Staffordshire plates, and that Yorkshire plates (Low Moor) are stronger with regard to tension than Staffordshire in the ratio of about 5 to 4.

As stated[†], the ultimate resistance of boiler plate is, on the average per square inch of section

In the direction of the fibre .	19·66 to 20·2tons
Across the same . . .	16·93 to 16·7tons

And the maximum safe passive strain per square inch of

Ordinary boiler plate in line of the rolling .	5tons tension and 5 tons pressure
Puddled steel plates in do.	8tons tension and 20 tons pressure

The last is also the utmost safe limit for cast steel in studs or stay bars, etc., in boiler work.[‡]

All boilers, however, are liable to be exposed to impulsive strains in consequence of sudden evolutions of steam at high pressure, or sudden checking of the discharge by shutting off the regulator, etc., and as the final extension produced by any load or strain, if at once suddenly applied is double that produced by the same load when gradually laid on (passive strain), so the materials of boilers should always be calculated as for impulsive strains[§], and not strained in excess of half the numbers given in the preceding table.

A few simple considerations will enable us to ascertain the amount of strain which the pressure in such vessels throws upon the material of the casing, and hence to compute the strength of material that should be employed in their construction in order that they may sustain a given pressure.

As a cylindrical boiler exposed to severe internal pressure is subjected to two different kinds of bursting—namely, longitudinally, or in the direction of its axis, and along the curved side, we shall first find the conditions that have to be fulfilled, so that 1stly rupture ensues in the direction of the axis, neglecting the end pieces altogether.

Let p = the internal pressure per square inch.
D = the external diameter.

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[*] "Fairbairn's Useful Information for Engineers," I. Series, p. 52.

[†] Account of the Britannia Bridge.

[‡] It is recommended that these shall be drilled.

[§] *Vide* Appendix, No. I., p. IV

[*] See "Fairbairn's Iron Manufacture," p. 210.

[†] *Vide* "Armstrong's Steam Boilers, p. 138.

[‡] "Armstrong's Steam Boilers," p. 138.

[§] Ibid, p. 139

d = the internal diameter.

T = the coefficent of ultimate tensile resistance per square inch of the material (boiler plate).

t = the thickness of plate.

l = length of boiler.

The internal pressure of steam tending to rupture the boiler is, according to our symbols $= d \times l \times p$ (I), and the force keeping the same from bursting may be expressed $= 2\,t\,l\,T$ (II.). Now at the moment of rupture I becomes equal to II. Or

$$d\,l\,p = 2\,l\,l\,T$$

Or

$$t = \frac{d\,p}{2\,T}$$

(III), which gives the thickness of the boiler plates when rupture is about to take place under the steam pressure, p.

II. To find the state of equilibrium between boiler transversely and pressure, the internal pressure on a perpendicular section to the axis, $t = \frac{d^2\,\pi}{4}p$ (3) and force counterbalancing the same may again be written $\pi\,t\,(t + d)\,T$ (6) and when rupture is about to take place 3 must equal 4—That is

$$\frac{\pi\,d^2}{4}p = \pi\,t\,(t + d)\,T$$

Or

$$\frac{d\,p}{4} = t\left\{\frac{t}{d} + 1\right\}T$$

Neglecting $\frac{t}{d}$ as being very small, we have

$$t = \frac{d\,p}{4\,T}\ (5)$$

Thus we see that in cylindrical boilers the strain in line of the axis is always necessarily much less than the circumferential bursting strain; hence the lengthway of the rolled plates should always, as is usual in practice, be placed round the boiler, and not the lengthway of it.

It is obvious that in a boiler having all its plates of the same thickness, if formula III. be applied, we have already worked according to the formula 5, or we have made our vessel sufficiently strong to resist the steam-pressure to which the boiler is to be subjected.

From formula III. we may deduce: To find the bursting pressure of a boiler when the thickness of plates, and diameter of the same are given, for we have

$$p = \frac{2\,l\,T}{d}$$

With the preceeding remarks I intend to close the first chapter, and shall treat the deflection caused by stretching the materials at the end of this treatise.

SECK'S PATENT FIRE-PROOF APPARATUS FOR SMUTTING, CLEANING, AND DECORTICATING GRAIN.

(*Illustrated on page* 348.)

THE great difficulty encountered in the manufacture of flour has hitherto been the separation of the flour from the bran. The means used have more or less failed to accomplish their object. The grain has been submitted to wire brushes, sharp surfaces of stone, corrugated sheet iron, &c., the latter being the more generally used, and revolving cylinders or "robbers" being employed "So long," says Mr. F. Seebohm-Ultzen, the licensee for the united kingdom, in a pamphlet on the improved apparatus we are about to describe, "as the surfaces above-mentioned remain sharp, whenever the grain comes in contact with them it is injured by having its hull cut open. A close inspection of wheat treated in the manner referred to will amply bear out this statement. Such injuries to the grain occasion the premature breaking up of the bran in the process of grinding, and cause it to be largely ground up into flour. But as the hulls of the grains contain a considerable quantity of silicate, the sharpened surfaces are rapidly blunted by the constant rubbing, until at last little or no effect is produced upon the grain by its passage through the machine. Hence it follows that machines based upon this mode of operation have the effect of seriously damaging the grain, until they ultimately become utterly useless, while nevertheless absorbing considerable motive power. In order to partially remedy these serious defects, it is found requisite to employ two or more apparatuses of the expensive construction in question, one at least of which is usually kept sharp; but although they are kept in repair at considerable cost, and involve much trouble, the results of their working are anything but satisfactory."

Mr. Seck, of Frankfort-on-the-Maine, who has devoted himself to the subject for many years, has come to the conclusion that no thoroughly satisfactory result can be attained by direct operation of the machinery against the beard, germ, and wrinkled hull of the grain, but that the desired end can be completely effected by working the grains against one another by means of centrifugal force.

Upon this principle is based the system of which the following is a brief description. The machine (plan and perspective view of which we give) consists of a vertical casing having a number of rings or annular shelves around its interior, and containing a rotating drum provided with vanes which take into the spaces between the rings or shelves. Part of the outer casing is constructed of sheet iron, having perforations through which the currents of air escape into the dust or bran chamber, carrying with them all dust, dirt, bran, &c. By the rotation of the drum the grains are carried round upon the shelves at a velocity of 3000ft. per minute, thus rubbing against each other most effectually. The outlets from one shelf to another are so arranged as to keep the grain under treatment during the required period of from 3 to 4 minutes. The velocity above-mentioned has been determined by ample tests, and adjusted to completely remove all injurious parts, without in any way damaging or heating the grain. As regards wear and tear Mr. Seebohm-Ultzen states that by the working of the grains against one another as described, combined with the peculiar construction of the apparatus, all undue stress upon the various parts of the machine is entirely avoided, in proof of which fact he mentions that a number of machines have been constantly at work for the last five years, without requiring any material repair.

The advantages derived from the use of the machine are said to be:—1. The production of a larger quantity of actual flour. 2. The production of superior qualities of flour, throughout all the numbers. 3. The operations of winnowing and cleaning being both performed in the patent apparatus more perfectly than by any other, the separate machines, which have hitherto been requisite, are almost entirely dispensed with. 4. The flour made from grain cleaned or hulled in the patent apparatus makes a very superior description of bread or biscuit. 5. Any grain which may be affected by smut, damp, the mite, &c., will, after being cleaned or hulled in the patent apparatus, become equal in colour and taste to the best marketable grain. 6. Not even a single grain can escape from the machine without being thoroughly cleaned or hulled. 7. Ten per cent. of wheat, in consequence of any cohesive impurities having previously been removed, can be ground in the same time, thus materially increasing the capability of the respective mills.

ANIMAL MAGNETISM.

DR. JOHN VANSANT has communicated to the American "Journal of Psychological Medicine," the result of some experiments made by him with the magnet on vegetables and animals. He says,—My attention was first particularly directed to the subject of this communication in the winter of 1866, when I observed that a small, magnetized steel rod, the ends of which were finely pointed, if brought carefully in contact with an exquisitely-sensitive blister, that had been accidently produced on one of my fingers by pinching it, gave rise, when the southward pole was applied, to a momentary sharp sensation, and seemed to cause the blister to be more painful after the magnet was removed. When the northward pole was used in the same way, no sensation could be felt at the moment of contact, and after removal the original pain remarkably subsided. Struck by this phenomenon, and yet almost doubting my own sensations, I proceeded to inquire if it were possible to recognize a difference between the two ends of the magnet by means of some organ peculiarly sensitive in its normal condition. On trial, I found that the conjunctival membrane of the eye would indicate by the feeling which pole it was touched with. I could lay with care the sharpened northward end of the magnetic rod on that membrane without pain or winking; but the instant the southward pole was applied, no matter with how much delicacy, there was a sharp sensation and an involuntary slight closing of the eyelid. The effect was faint, but plain. This experiment was repeated on the eye of another person, the same day, with similar results. After this I made numerous experiments with magnets of different forms and powers (though not at any time with very large ones) applied to various parts of the body, and thought I observed a definite set of symptoms arise after every application in the same manner to a given part, provided sufficient time had elapsed between the applications for the organ to resume its ordinary state. Finally, I became convinced of the genuineness of the phenomena, that they were not to be attributed to the imagination, and that they were as regular in their occurrence and quite as persistent as those following the adminstration of any medical substance. But to produce this conviction in others, and especially to give assurance to the broad statement that magnetism has power to affect the functions of living beings, it was very desirable to get some demonstrative evidence that might be apparent to any person, whether sensitive or not, and to a number of persons at the same time, and that should not depend entirely on testimony; in other words, it was necessary to establish the fact by the same kind of evidence that establishes any scientific fact.

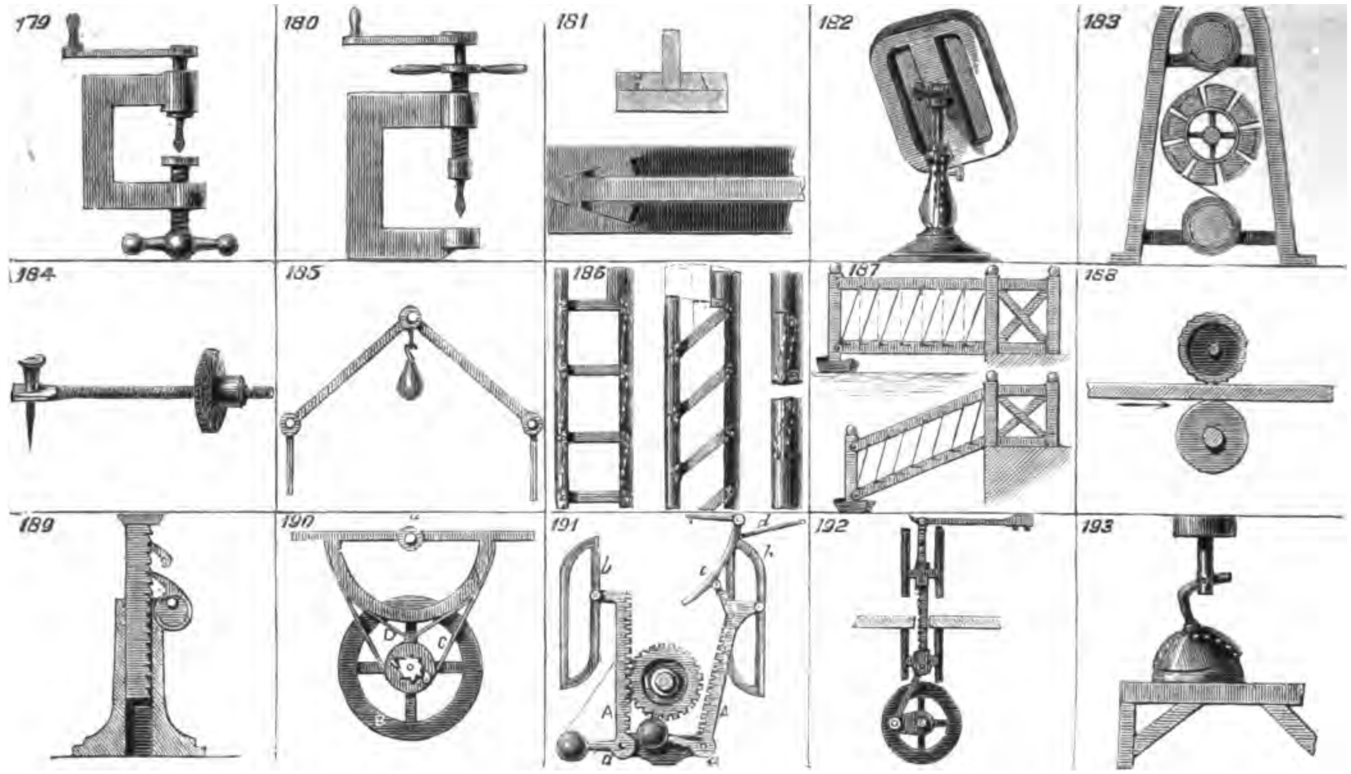
After recording the results of some experiment on vegetables and animals, he made others on human beings, with the following results:—

1.—Mr. J. R., a gentleman of rather delicate organization, had neuralgia in the upper part of one side of his face. I applied the northwards (—) pole of a small bar magnet, not quite capable of lifting half an ounce with one pole, for a few seconds, over the painful place. In about ten minutes he said the pain was increased and more localised. I then applied the southward (+) pole in the same way, and in a few minutes he said the pain had nearly ceased. This gentleman expected to be relieved by the first application.

2.—Mr. M. a strong, unimaginative man, had facial neuralgia of malarial origin. I applied the — pole of the same small magnet last described over the seat of pain for about one minute. In five minutes he complained of the pain being worse. I then made an application of the + pole, and in less than a minute the pain almost subsided. After about an hour there was a recurrence of pain for a short time, but much lessened in intensity. This person, also, was led to expect relief by the first form of application. (I have repeated the above experiments on myself, with similar results.

3.—Mrs. S., a lady of remarkable sensitiveness, but great self-control, was suffering from excruciating neuralgia of the nerves passing out of the left side of the pelvis. The day before I had injected subcutaneously, near the painful place, one-fourth of a grain of sulphate of morphia with effect to produce very great depression of the vital powers, but not to relieve the pain, which continued to be felt during the semi-consciousness that followed. On this occasion, without any knowledge on the part of the lady of what I was doing, I passed slowly, for about ten seconds, over the upper third of the thigh, the — pole of a strongly magnetised steel rod. 4 in. long by one-third of an inch diameter. The effect was surprising. The pain shifted its position, became more diffused and higher up, but was not relieved. A kind of stupor intervened, her respiration was oppressed, a death-like pallor overspread her countenance, her features became contracted, her eyes sunken and half-closed, the heart acted feebly, and the surface of the body was cool and covered by clammy perspiration. The depressing effect much resembled the action of morphia on the previous day, but was even greater. All these symptoms were manifested within a few minutes. After waiting about fifteen minutes I applied the other pole—the + one—for the same length of time to a spot a little below the hip joint, and in a short time new symptoms were manifested. The pain was apparantly increased and more localised, the extremities remained cool, but the perspiration was checked, the breathing was deeper, the eyes closed naturally, and all the signs of depression began to vanish.

In the above instances of disease, the real action of the magnetic force on the economy is not, probably, any greater or more speedy than in health; but when the equilibrium of the vital



MECHANICAL MOVEMENTS.

orces has already been disturbed, there would seem to be less resistance offered than when the perfect balance exists.

Nevertheless, a careful inspection of the groups of symptoms in the subjoined table, which are those capable of being produced by magnetism when applied to the body in health, will show that there is hardly a function of any organ that is not more or less affected, though the action appears to be observable chiefly by its effects on the ganglionic nervous system, and, through that, on the various organs.

MECHANICAL MOVEMENTS.*

(*Continued from page* 321.)

179 and 180. Portable cramp drills. In 179 the feed screw is opposite the drill, and in 180 the drill spindle passes through the centre of the feed-screw.

181. Bowery's joiner's clamp, plan and transverse section, Oblong bed has, at one end, two wedge-formed cheeks, adjacent sides of which lie at an angle to each other, and are dovetailed inward from upper edge to receive two wedges for clamping the piece or pieces of wood to be planed.

182. Adjustable stand for mirrors, etc., by which a glass or other article can be raised or lowered, turned to the right or left, and varied in its inclination. The stem is fitted into a socket of pillar, and secured by a set screw, and the glass is hinged to the stem, and a set screw is applied to the hinge to tighten it. The same thing is used for photographic camera stands.

183. Represents the principal elements of machinery for dressing cloth and warps, consisting of two rollers, from one to the other of which the yarn or cloth is wound, and an interposed cylinder having its periphery either smooth-faced or armed with brushes, teasels, or other contrivances, according to the nature of the work to be done. These elements are used in machines for sizing warps, gig-mills for dressing woollen goods, and in most machines for finishing woven fabrics.

184. Helicograph, or instrument for describing helices. The small wheel, by revolving about the fixed central point, describes a volute or spiral by moving along the screw-threaded axle either way, and transmits the same to drawing paper on which transfer paper is laid with coloured side downward.

185. Contrivance employed in Russia for shutting doors. One pin is fitted to and turns in socket attached to door, and the other is similarly attached to frame. In opening the door, pins are brought together, and weight is raised. Weight closes door by depressing the joint of the toggle toward a straight line, and so widening the space between the pins.

186. Folding library ladder. It is shown open, partly open, and closed; the rounds are pivoted to the side pieces, which are fitted together to form a round pole when closed, the rounds shutting up inside.

187. Self-adjusting step-ladder for wharves at which there are rise and fall of tide. The steps are pivoted at one edge into wooden bars forming spring-pieces, and their other edge is supported by rods suspended from bars forming handrails. The steps remain horizontal whatever position the ladder assumes.

188. Feed-motion of Woodworth's planing machine, a smooth supporting roller, and a toothed top roller.

189. Lifting-jack operated by an eccentric. pawl, and ratchet. The upper pawl is a stop.

190. Device for converting oscillating into rotary motion. The semicircular piece A is attached to a lever which works on a fulcrum *a* and it has attached to it the ends of two bands C and D, which run round two pulleys, loose on the shaft of the fly-wheel B. B and C is open, and band D crossed. The pulleys have attached to them pawls, which engage with two ratchet-wheels fast on the fly-wheel shaft. One pawl acts on its ratchet-wheel when the piece A turns one way, and the other when the said piece turns the other way, and thus a continuous rotary motion of the shaft is obtained.

191. Reciprocating into rotary motion. The weighted racks A A1 are pivoted to the end of a piston-rod, and pins at the end of the said racks work in fixed guide-grooves *b b* in such manner that one rack operates upon the cog-wheel in ascending and the other in descending, and so continuous rotary motion is produced. The elbow lever C and spring *d* are for carrying the pin of the right-hand rack over the upper angle in its guide-groove *b*.

192. Gig-saw, the lower end connected with a crank which works it, and the upper end connected with a spring which keeps it strained without a gate.

(*To be continued.*)

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* Extracted from a compilation by Mr. H. T. BROWN, Editor of the "American Artisan."

So many kinds of steel are now manufactured that an exact and permanent nomenclature for them is needed. Dr. Wedding, of Berlin, has endeavoured to supply the want. He classes all kinds under two heads, "Raw Steel" and "Fine Steel." Of the former he distinguishes five varieties; while fine steel has a much larger number, each of which is named according to its mode of preparation, or after its inventor.

FRICTION IN STEAM CYLINDERS.

BY MR. P. JENSEN.

(*Continued from page* 294.)

HAVING thus briefly glanced at the question of economy of fuel and the best means of effecting it, and having shown that steam lubrication is an indispensable condition, it remains to be seen that steam engines not built on economic principles are benefited by it. There is now scarcely an ordinary engine using tolerably dry steam and cutting off at about ¼ of the stroke but what has some method of lubricating the steam in the cylinder. The ordinary means of lubrication consists of a grease cock on the cylinder, whereby the contents of a cup filled with oil or tallow are occasionally emptied into the steam. The effect of leaving a piston dry for a long time and then injecting a quantity of tallow has often been noticed. The engine instantly takes a start, and materially increases both in speed and power. This goes to prove that lubrication of the steam is good for something. It therefore only remains to be seen which is the best way of lubricating. Shafting is generally lubricated by self-acting means, such as the slow capillary action of a wick, or by the needle lubricator. No one would prefer to empty the contents of the oil cup into the bearing at once, and yet that is precisely what is done in the case of the grease cock on the cylinder, with this difference, that the latter probably detracts far more from the economy of fuel than the former.

The subject of steam lubrication has of late years acquired some prominence, and locomotives are now generally fitted with self-acting means for continuously greasing the steam before it enters the valves. The principle also makes headway with stationary and marine engines. Those who have considered the subject argue that if they can save about 40 per cent. of the tallow that the common grease cock consumes, and at the same time have the additional, and possibly far more important, advantage of diminished friction of wear and tear, why should they not do it? Fifty per cent. of fuel can be saved if engines are properly constructed and a good price paid for them, but to save about 2 per cent. in friction, which means fuel, besides from 30 to 50 per cent. of tallow or oil used for piston and slide valve lubrication, is a far easier matter, and involves an outlay of a mere trifle. We have ingenious governors and heavy fly wheels, and counterweights for the crank and connecting rods to equalise the speed of the engine. Let us not lose sight of a point which may appear trifling, but which in reality has something to do with the steady and even working of the engine as experience has shown. It would be both superfluous and tedious to enumerate all the lubricators proposed or used for greasing the moving parts in the steam cylinder, the more so as all these appliances are now advantageously superseded by lubricators acting on the principle of continuously greasing the steam before it enters the slide valves.

One of the first lubricators (Fig. 1) of this class is that invented by Mr. Ramsbottom, the locomotive superintendent at Crewe. The principle on which it acts is the following:—A swan-neck pipe, being in communication with the steam in the steam pipe, causes a steady flow of steam into a sphere which is filled with tallow to the top of the inner pipe. The steam continually condensing, especially when a current of air is starp against it at high speed, causes it to fall to the bottom as water, because it is heavier than tallow, in the proportion of 5 to 4. A certain amount of tallow is thus continually displaced and forced to overflow into the steam pipe, where it mixes with steam entering the steam cylinders; the steam is thus continually greased. There are no means of regulating this action, but this is not found so very requisite for locomotives. The case is, however, different when we come to apply this lubricator to stationary or marine engines. (Fig. 2.) For such purposes it is necessary to lead the steam to the lubricator through a long pipe in the engine room, that pipe then supplying the necessary condensing surface, or, better still, to place the lubricator in a cool place outside the engine room. The apparatus, however, does not seem very well adapted for engine room purposes, though it answers for locomotives.

The next lubricator is Roscoe's, which acts by condensation of the steam and the consequent displacement of the tallow. It consists of a small hollow vessel with a steam connection on one side, tallow inlet at top, and waste cock at bottom. The opening is surmounted by a metal cup with open top, having a lid for filling the tallow. A bridge across the same, with a screwed hole in it, takes the screwed spindle of a jam valve, which fits a seat in the partition between the lubricator itself and the filling cup. A tube is fixed to the end of the screwed spindle, and reaches to within about 2in. of the bottom of the lubricator. The inventor also claims a peculiar function for the central pipe, for he says that when the engine is running down an incline with the steam shut off, the heat causes the air in the tube to be rarefied, and thus obtain a certain pressure which again forces the tallow into the steam pipe, and thence into the engine. The action of this pipe does not seem very clear. The more natural course seems to be that the whole of the lubricator when steam is shut off, and while running at any speed at all, should get comparatively cold, and the tallow have a decided tendency to stop where it was. However that may be, these lubricators are extensively used on the Midland Railway, and on several others, as well as on many stationary and marine engines, and, the author believes, gives satisfaction. The means of regulation, it will be observed, consists in controlling the amount of steam entering by the screwed jam valve opposite the steam pipe on the apparatus. That the inner pipe, as claimed by the inventor, should prevent the water at the bottom of the apparatus from freezing in the coldest climates, when the engine is at work, seems claiming too much for the very small quantity of air contained in it, which is compressed to a volume of the size of a thimble, if there at all can have no influence on the quantity of water continually entering. The capacity for heat is much larger in water than in air, pound for pound, and the quantity of air contained in the inner tube of a No. 3 lubricator containing about a pint of tallow is only about 1 cubic inch, and with 5 atmosphere pressure only ⅛ of a cubic inch, weighing $\frac{1}{400}$ part of a pound.

The Wilson lubricator has three different tallow levels, each with corresponding ports or holes in the cock and its shell, thus giving three sizes of condensing surface, a means of regulation perhaps sufficient for some cases, but in practice, something cloister is generally required, and that must be attained by throttling the steam inlet through the regulating cock. It acts on the same displacement principle as most of the others in common use. A jam valve with screwed stem serves as blow off. Should the place where it is fixed be too hot, so as not to condense sufficiently fast, a globe is attached to the steam supply pipe, which will afford the requisite condensing surface. This ingenious and simple remedy is not mentioned in Mr. Wilson's patent, and will, no doubt, answer for other lubricators constructed on similar principles when placed in a very hot position. One fault attached to the instrument made with a water guage, is this, that the latter does not at all times indicate the true level. The bottom of the guage is connected to the lower part of the lubricator, but the top is in connection with the steam space above the two lower tallow levels, and any variation in the quantity of tallow and water contained, which, of course, when the instrument works, are continually changing, are not indicated, because the water locks the tallow in the glass, it is only by blowing the glass out and wasting the tallow that the true state of this instrument can be ascertained, as, while the glass shows full tallow, there may be little or none left. This is not an oversight of the inventor's, but is inherent in the construction, because, of the three different tallow levels, the guage only shows when working at the upper one, the one having the smallest condensing surface. In these lubricators a quantity of tallow can be let in at once—namely, all the tallow contained above the centre of the regulating cock, but the instrument then wants refilling again up to its ordinary tallow level.

Clements's lubricator is of simple construction. A pipe from the engine steam pipe conveys steam up through the lubricator, entering from the bottom and discharging over the tallow level, also provided with a cock for regulating the supply of steam to the apparatus, which acts on the displacement principle. Another inside vertical pipe, which must reach to and determine the tallow level, carries the tallow away to the engine steam pipe or slide jacket. This pipe is also provided with means for regulating. The steam is supposed to pass through the tallow and carry it along with it. A gauge glass is provided in the larger sizes. A blow-off cock is provided for discharging the condensed water or foul tallow. These lubricators seem to give satisfaction, and are simple enough; the fitting them on is more troublesome, as they require two steam connections.

A very ingenious lubricator was patented last year by Mr. Schauwecker. It is fixed on the cylinder, and consists of a cup with an outer jacket to keep it warm. A central pipe enters from the bottom and reaches nearly to the top. Near the bottom this pipe is in communication with a capillary pipe or passage too small for the oil to force itself through except when at the latter part of the stroke; the pressure gets lower in the cylinder than in the top of the grease cup, at that moment a small quantity of grease is injected. A filling cup is provided, as in the old fashioned grease cup.

(To be continued.)

EMIGRATION.

A FEW REMARKS ON VICTORIA.—(*Continued.*)

MINING.

BY "F.R.G.S."

HAVING thus hurriedly scanned the agricultural interest of the colony, I now pass to the next portion of my subject. For the purpose of giving information, I have extracted from a Melbourne paper the following epitomised account of the Government mining report for last year. I should, perhaps, warn readers against glowing accounts of the gold fields. Much misery has been caused by a fostered idea that one needs but go to the gold fields and forests; with a very little trouble he finds a nugget and is a rich man. There have been a few such "finds," but the per centage of these lucky individuals, is not more than one in 20,000; or, in other words, it is 20,000 to 1, that any particular man chances to find a rich prize. The best plan to ensure success, is to get permanent employment under a company, say at an average wage of £2 5s., and save all you can, purchasing arable or pasturable land with such savings. The mining population undergoes many hardships, which necessarily detract from the seeming high rate of wages. It may not be generally known that by far the largest portion of the goldfields is in the hands of companies, who are able to extract a larger percentage of gold by means of machinery, &c., than individuals can by their own unaided efforts. It is not the large nuggets that pay, but the regular per centage of gold per ton of earth or quartz. I should advise no one to go to Australia with the intention of proceeding direct to the mining districts.

THE MINERAL STATISTICS FOR 1869.

"The mineral statistics of the colony for 1869 are just issued from the Government Printing Office, and, as compared with 1868, there is a decrease in the export of gold in 1869 of 316,659oz., and, as compared with 1867, a decrease of 92,848oz. This falling off is accounted for on the supposition that all the gold exported is not duly recorded, as it was during the period it paid export duty. The approximate yield in 1869 was 1,544,757oz.; and the figures denoting the yields for 1867 and 1869, drawn from the same sources, scarcely justify the suppositious case put by the Secretary of Mines. During the last quarter of the year, the number of miners employed was 63,787, or less by 871 than the number in the same period of last year. Their average earnings for the year were £79 7s. 8d., against £104 18s. 8d. in 1868; but it is pointed out that the former year was an exceptional one, over 3,00,000oz, of gold having been exported in that year in excess of the year following. The total value of machinery and mining plant on the 31st of December last, was £2,108,660, or a decrease of £41,763 as compared with 1868. Ballarat shows the greatest amount of depreciation under this head, and Castlemaine and Ararat follow. Sandhurst, Beechworth, Gipp's Land, and Maryborough have gained what Ballarat has lost, each showing an advance on the previous year. Held as claims under the bye-laws of the several mining boards, there were at the end of the year nearly 85,000 acres, of which over 20,000 are lying idle under legal protection from encroachment. Under gold mining leases on the same date were held 44,844 acres, or nearly 30,000 acres more than in 1868, which the report states, is evidently from the desire of the miners to obtain some secure hold of the auriferous lands before investing their capital and labour in exploring them. The number of men covenanted to be employed on leased mining lands was 12,647; actually employed, 6889. There is an increase in the goldfields revenue mainly in the item of rents of auriferous lands. The estimated value of claims for the seven great mining divisions on the 31st December, 1869, was £8,539,241, or £330,263 less than in 1868. Taking Ballarat as the largest alluvial field, the value of claims is given at £2,111,569, and Landhurst, as the greatest quartz district, at £2,299,305. Trial quartz crushings, to arrive at an approximate average of the total gold yield from this source, give an average of 10dwt. 9·73grs. per ton. The total cost of timber for mining purposes is given at £563,233, nearly half of which was taken by Ballarat. There were 423 registered companies, representing 1,974,260 shares, and the nominal capital £5,235,229. The lowest wage rate paid to miners was in the Castlemaine division, where it was £1 16s. per week; the highest, £3, was paid in many localities. Rewards are recommended to the full extent for goldfields' discoveries—Godfrey's Creek, £200; Fiddler's Creek, £200; Berlin, £100; Whipstick, £25; and Spring Creek, £300. The report states that it is proposed to extend the examinations now held for mining surveyors to mining managers and mining engineers. No silver ore has been raised during the year, but some of the St. Arnaud and Wood's Point gold was mixed with silver. During the year 200 tons of black sand were exported, together with 14cwt. of tin. The copper mines were not worked during the year, but 10cwt. of the ore were exported; 709 tons sulphide of antimony were raised, of which 417 tons were exported. There were also exported 39 tons of antimony. Of lignite, 230 tons were raised, but no coal. Of flags and slates there were 68 tons, and 21,000 yards of flagging and coreing raised during the year."

N.B.—To navvies and other able-bodied, intending emigrants, a field of employment is just now opened in Victoria, in which good wages may be obtained. I read that tenders for the construction of the first four sections of the north-eastern railway have been accepted at the rate of £5320 per mile. As the work will be commenced immediately, there will be a demand for labour, far in excess of what is at present available in the colony; and should Sir J. M'Cullock succeed with his plan of making thirty miles of railway every year, this demand will be pretty fairly maintained. This should be made a note of by intending emigrants, and the recently published regulations relating to emigrants are just now come into force, having been delayed for some time by the troubled state of the political atmosphere.

Addenda I.—Since writing the commencement of these remarks, I have received statistics relating to the agricultural portion. I find that about 17,000 tons of bread-stuff, wheat, flour, &c., have been exported from the southern portion of Australia since the last harvest.

ASTRONOMICAL NOTES FOR JULY.

BY A FELLOW OF THE ROYAL ASTRONOMICAL SOCIETY.

THE Right Ascension of the Sun at Greenwich Mean Noon on the 1st of July is 6h. 40m. 50·48s. and his North declination 23° 7′ 22″·7. He is consequently in Gemini, to the S.W. of a line joining the stars ε and ζ in that constellation, and about midway between them (*vide* map, Vol. X, p. 494). He souths on the 1st 3m. 29·62s. after mean noon, which is, therefore, the equation of time to be added to that indicated by a sundial or other meridian instrument. The equation is increasing all this month, and amounts on the 31st to 6m. 7·47s. The sun rises in London on the 1st at 3h. 48m., a.m., and sets at 8m. 18s. p.m., and on the last day of the month at 4h. 24m. a.m and 7h. 47m. p.m. respectively. Up to the 20th of July he will never descend 18° below the horizon, even at midnight, so that prior to that date we shall have no real night. He will be in Apogee at 12h. 56m. on the 1st. His period of activity still continuing, his disc will present an interesting spectacle to the telescopic observer.

The Moon will enter her first quarter at ½ past 4 o'clock in the morning of the 6th; be full (and eclipsed) at 10h. 35m. 18s. on the night of the 12th; enter her last quarter at 17 minutes past 2 on the afternoon of the 28, and be new at 11h. 18m. a.m. on the 28th.

The details of the eclipse (to which we have parenthetically referred above) for Greenwich are as follows:—

	H.	M.
First contact with the penumbra, July 12 ..	7	46·0
First contact with the shadow	8	44·6
Beginning of total phase..................	9	44·4
Middle of the eclipse	10	34·2
End of total phase	11	24·0
Last contact with the shadow	12	23·8
Last contact with the penumbra	13	22·4

The Moon will be in conjunction with Saturn at 54 minutes after midnight on the 10th, with Jupiter at 3h. 52m. on the afternoon of the 24th, with Venus at 3h. 39m. on the afternoon of the 25th, and with Mars at 7h. 47m. in the evening of the same day. She will be in conjunction with Uranus at 1h. 27m. on the 27th, and with Mercury at 2h. 21m. on the 28th. It is pretty obvious that the majority of these conjunctions will be rendered invisible by the brilliancy of daylight. The age of the Moon is 2·5 days at noon on the 1st, 3·5 at the same hour on the 2nd, and so on. About 3 o'clock in the morning of the 15th, Libration will bring a portion of her S.W. limb into view, and at 5 o'clock in the afternoon of the 27th a part of her S.E. limb will come into sight from the same cause. Five fixed stars and the planet Saturn will be occulted during the present month. At 38 minutes after midnight on July 10th B A C 5954 will disappear at the Moon's dark limb, and reappear at her bright limb at 13h. 44m. Prior to this reappearance Saturn will be occulted. He will disappear at the dark limb at 13h. 16m. and reappear at the bright limb at 14h. 12m. On the 17th, 30 Piscium will disappear at the bright limb at 10h. 56m. and reappear at the dark limb at 11h. 59m. On the same night, 33 Piscium will disappear at the bright limb 55 minutes after midnight, and reappear at the dark limb at 14h. 9m. At 2h. 50m. in the early morning of the 19th the moon's bright limb will go so near to to 20 Ceti that, although it will not occult it at Greenwich, it *may* from other stations. Finally, on the 30th, the dark limb of the New Moon will occult Leonis at 8h. 56m. in the evening, but she will have set ere its reappearance takes place.

Mercury now is wretchedly situated for observation. He is a morning star up to the 28th, when he is in superior conjunction with the Sun, and of course invisible. Up to this date he is getting smaller and smaller every day. He is travelling through Gemini and Cancer. Venus is also a morning star, southing on the 1st at 18 minutes past 9 in the morning, and on the 31st at 48½ minutes past 9 a.m. She is now gibbous, and not a very interesting telescopic object. She passes from Taurus into Gemini. Mars is in the same region of the Heavens, and scarcely, in any legitimate sense, observable. He too moves out of Taurus into Gemini this month. Jupiter also, in this immediate neighbourhood, is of course a morning star too. He souths at 10h. 6m. a.m. on the 1st, and at 8h. 35m. a.m. on the 31st. Although both Mars and he are unfavourably situated, yet they may be seen just before sunrise. Jupiter continues in Taurus. Saturn is as favourably situated for the investigation of his most remarkable features as he will be for some time to come; southing on the 1st at 10h. 55m. 30s. and on the 31st at 8h. 50m. 18s. He is on the confines of Scorpio and Ophiuchus on the night of the 18th. We have spoken above of his occultation. We propose very shortly to give a detailed description of this marvellous object in these columns. Uranus is quite close to the Sun and utterly invisible. Neptune is a morning star. He continues in Pisces.

A watch should be kept for shooting stars between the 26th and 27th of July; as there seems to be a periodic return of numbers of these bodies at an epoch between the dates referred to.

LETTERS TO THE EDITOR.

[We do not hold ourselves responsible for the opinions of our correspondents. The EDITOR respectfully requests that all communications should be drawn up as briefly as possible.]

*** All communications should be addressed to the EDITOR of the ENGLISH MECHANIC, 31, Tavistock-street, Covent Garden, W.C.

All cheques and Post Office Orders to be made payable to J. PASSMORE EDWARDS.

I would have every one write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that, as to other things, knows no more than what everybody does, and yet to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks: a vice from whence great inconveniences derive their original.—*Montaigne's Essays.*

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PERSONAL.

SIR,—It would be the merest affectation and hypocrisy on my part to pretend that I do not feel extremely flattered by the suggestion made by your correspondent Mr. Wright (on p. 336) to present me with a testimonial; but, at the same time, you are most entirely correct in your surmise that I should at once, and without the smallest hesitation, "respectfully decline the offer."

I am, as you most pertinently point out, only one of many; and it should be borne in mind that, as a sedulous reader of the ENGLISH MECHANIC, I receive—at the very least—quite as much instruction from its perusal as I can possibly impart by any number of communications of my own. To select me, then, as the recipient of a testimonial would be to cast a slight upon other correspondents, all quite as well entitled to it as (and many much better than) myself; and, moreover, as such selection could not be made of the mere abstraction, "F.R.A.S." it would involve the revelation of my identity—a revelation which, on no consideration whatever, could I consent to have made.

Under these circumstances, I am sure that your very kind correspondent will see the impossibility of my acquiescence in a suggestion of which, though, I may legitimately feel proud; but, at the same time, he may accept my assurance of the sincerity of my gratitude, and further of the fact that his appreciation, and that of others, of my very humble efforts to instruct my brother readers, forms the very best and most acceptable testimonial that I could possibly receive.

A FELLOW OF THE ROYAL ASTRONOMICAL SOCIETY.

AN EARNEST APPEAL TO THE READERS OF THE ENGLISH MECHANIC AND ALL OTHERS WHO HAVE THE OPPORTUNITY TO SAVE VALUABLE THINGS FROM DESTRUCTION, —ANCIENT MUSICAL INSTRUMENTS AT SOUTH KENSINGTON AND ELSEWHERE.

SIR,—It seems probable that among the so-called lumber stored away in "unkempt" places, say in old chateaux on the Continent, and in ancient country mansions in Great Britain, there must be a considerable number of musical instruments, which are at once interesting from their antiquity and that insight which the peculiarities of their construction and their capabilities for the rendering of musical performance affords us of the character of the instrumental music of olden times. I have advisedly written a considerable number, rather than a great number, for no doubt the great majority have perished by age, and yet more have been wilfully destroyed. It may seem to the inexperienced that it would be difficult to find a modern Goth who would wilfully destroy works of human art so interesting as musical instruments (excepting in the instance of organs, which the Puritans in Cromwell's time, probably believed with perfect honesty, greatly endangered their eternal salvation; they therefore logically *flattened* and *destroyed* their pipes to *save* their souls), but we ought to allow for the exigences of commercial life, and consider the value of store room. As an example, I may relate, that my old friend, Joseph Kirkman, Esq., who is anything but a Goth, when he succeeded to the old business, found nearly forty harpsichords in store, some of which had been warehoused for more than thirty years, which at the then customary charge of one guinea per annum, amounted to more guineas than they were commercially worth in shillings, so, although he shares with the writer the reproach of being old-fashioned enough to admire the instrument, he literally could not afford room for them any longer, and being quite hopeless of recovering the warehouse charges, he directed most of them to be destroyed. Considering that among them were some of the finest and most modern specimens the firm ever constructed (I believe one bore the date of 1808, and had a compass of six octaves, from C C C to C), I can only wish that it had been my good fortune to have become acquainted with my old friend a year earlier; I would certainly have performed the Christian duty of "saving some from the fire;" indeed, when he came to know me, he much regretted the sacrifice, and said it would have afforded him great pleasure to have given as many of them as would have been accepted, to myself, and any of my friends who—as he was pleased to say—possessed sufficient good taste to appreciate instruments which his father and grandfather had obtained European reputations for the construction of. At a yet later period they are synonymous, a modern Goth (alias a pianoforte maker of my acquaintance) perpetrated a yet less excusable act of Vandalism by the destruction of a most ornate and expensively-constructed harpsichord, which had three ranks of mother of pearl and tortoiseshell keys. In addition to its numerous rows of jacks, whose various plectra caused its strings to utter sounds of greatly [illegible] timbre, it was provided with hammers [illegible] to enable the performer in the language of [illegible] period, to "play piano and forte at pleasure." As in the former instance, I did not know this Goth until after he had perpetrated his wickedness, that like Sir J. Newton's little dog, perhaps we may charitably conclude he little knew the extent of the evil he had done, but when I learned from the sinner's own confession the extent of his iniquity, I am sorry to say there was enough of the Old Adam left in me to cause me (involuntarily) to become at once *savagely* angry and sorrowful. Since then, I have often thought what a valuable addition to the collection of ancient musical instruments in the South Kensington Museum this perhaps unique harpsichord would have been, and lest similar wrong-doing to its destruction should be repeated, I hereby most earnestly appeal to all my fellow readers of the ENGLISH MECHANIC to interpose themselves, and urge all their friends to interpose also, when they hear that any similar sacrifice is about to be perpetrated, and thus "save the innocents" from such an out-Heroding of Herod, so that we ourselves, and our successors, may derive from them that instruction and enjoyment they are capable of affording to us and them, and although myself compelled, by a regard to truth, to plead guilty to the charge of bad taste, in feeling some admiration for that antiquated instrument the harpsichord (of whose capabilities the modern generation of pianoforte players are as completely ignorant as most of them are of the capabilities of the organ and harmonium) I make this appeal, not only in behalf of this one of my many old favourites, but also in behalf of the whole generation of ye ancyent fiddles, flutes, oboes, clarionets, English flutes, &c., &c., not *forgetting ye* dulcimer, ye "clavichordis," ye "payer of clavichordis," ye "manichord," ye "payer of virginals," ye "payer of regals," and all the other multitudinous solo and orchestral wind and "strynged" *instruments* of "ye olden tyme," so interesting for their antiquity, and so remarkable for their variety, I also take this opportunity of appealing to the good feeling *of those* who possess any instruments which *would* add to the wealth of our national collection, to follow the liberal example of Messrs. Broadwood and Messrs. Kirkman, by presenting them to the nation; or at least *the not* less liberal example of Mr. Carl Engel, who has lent sixty instruments from his collection to the museum, including the only example of "ye clavichordis," which is in it. Happy should I be, if *Lord Lytton, or* the Rev. Mr. Spurlong, or the present *possessor of* the virginal sold at the sale of the effects of *Lord Spencer* Chichester, in 1805), or Dr. Rimbault, *could be* induced to lend the virginals now in *their possession*, or that the owner of Queen Anne's spinet, said to be one of the most powerful ever made by Hayward, which was in the possession of Mr. Hawes of the Adelphi-terrace, in 1860, who, I *believe*, yet holds it in trust, under Queen Anne's testamentary direction, for the use of the singing boys of the Chapel Royal —probably they don't learn on it now in these harmonium and pianoforte days, and also can therefore well spare it—the present possessors of Plenius's lyrachord, and Merlin's private harpsichord (if the destructive Goths have spared *them*), *may be* induced to do likewise.

I am happy to say, that it seems very *probable that* the reckless destruction *of works of art of this kind* is not likely to go on at *its former rate*; *since many* have been collected and *deposited* at South Kensington, some of which have been purchased at very liberal prices. That class *of persons* who recognise no value excepting *money* value, are beginning to learn that there is a market for such things, and that they fetch a deal more unbroken than their mere materials are worth. The wildest of destructives becomes remarkably conservative of his chattles when he finds they have what political economists term, "value in exchange," so perhaps those Mosaical brokers—query, is their name derived from broken, the past tense of break?—example, breaker, v. a., one who breaks; broker, one who has broken—who somehow manage to get hold of a good many musical antiquities, may be induced (instead of breaking them up to mend old furniture) to offer them for sale to us collectors, "vel vorth our moniah."

Those who have not yet seen the collection at South Kensington would do well to do so. It comprises some remarkably fine specimens of that class of instruments whose strings are *plucked* by plectra moved by finger-keys. At the head of these stands the spinet by Amabal Die Rossi, of Milan, A.D., 1557, for which the very liberal price of £1200 was given; a sum well worth the consideration of Moses with hair on, and his fellow brokers. This instrument is a remarkable example of the very ornate style of decoration of its time, and is inlaid with no fewer than 1928 precious stones. Besides this, there are many other examples of virginals, spinets, harpsichords, &c., which, however historically interesting, are by no means fair specimens of what they once were as instruments of music, or are capable of being made, if restored to their original condition, which is in most cases a work of no great difficulty; not to mention the great improvement most of them are obviously capable of undergoing, for since the time of their construction, the harpsichord and its congeners have had their tones greatly increased in power, and made capable of rendering sounds whose timbres vary to an extent which probably *none of* these specimens ever possessed what Dr. Johnson would have termed the "potentiality" of doing.

By way of showing what may be done by one by no means clever person, who makes use of his opportunities—*i.e.*, has a habit of "improving the occasion"—the writer will now relate his own experience. When young, "a long time ago," he had the, perhaps questionable, advantage of being rather familiar with the harpsichord, and at a later period he had the good or evil fortune to become the possessor of a remarkably fine specimen, whose condition was *so* perfect that its steel strings were almost as bright as when they left the maker's shop, and scarcely any of its quills were broken, which is a very rare thing indeed. This instrument is an elegant *Spanish mahogany* Kirkman, A.D., 1790, with a beautifully-made mahogany Venetian swell. The writer's common failing, of "not knowing when to leave well alone," but usual desiring to "make well better than well," caused him to be discontented with the instrument's want of power, which, by the way, far surpassed that of any Rucker harpsichord I have yet had the pleasure of hearing. But this characteristic, I believe, was not at all uncommon in harpsichords made by "Abraham et Josephus Kirkman," especially those of their later production, and one dated 1790 is quite a juvenile, although I have been told they did not entirely cease to make harpsichords until nearly twenty years after.

Being, as I before stated, that unhappy individual, a dissatisfied man, I put my harpsichord through a course of experimental improvement. The first thing I did, was to put on some few thicker strings—In those days I fervently believed that the loudness of the sound depended almost wholly on the thickness of the strings, and although experience has modified that opinion to some extent, there is yet a large element of truth in it. My old friend, J. Kirkman, Esq., told me beforehand, that I should get no more tone out of thick strings than from the original thin ones, *i.e.*, about No. 4 steel, but being of the order of St. Thomas the Doubter, I listened and believed not. Glad I am that I was incredulous, for on trying the thick strings, *i.e.*, about No. 7 or 9 steel wire, on middle C, I found the tone, although but little louder, was much improved in quality. Being now, however crotchetty, not quite devoid of common sense, I inferred that to lift a thick string far enough to cause it to utter a loud sound, would require a stronger plectrum than a thin string needed. I therefore borrowed one of the jacks from a low bass note, whose stiff raven's quill put the No. 8 wire into as strong vibrations as the weak crow's quill in the jack belonging to middle C had induced in the original No. 4 or 5 steel wire, but I need hardly add, all the former improvement in the quality of the sound disappeared. The dissatisfied man, wanting not only *louder*, but also more *agreeable* sounds, was by no means quite satisfied with this one experiment, so he went through a course of experiments with plectra, made of a great variety of substances, at the remembrance of which course of experiments he shudders as he writes this. Ultimately, my patience and perseverance—which according to the late Sir Isaac Coffin, are the only things required to do any thing short of a miracle—were rewarded, and I was enabled to produce sounds from my pet instrument varying in timbre from those which the strings uttered when plucked by quills, to those which are produced when the strings of a piano are pulled by the *soft* top of the finger.—N.B. *not* those produced by the finger nail.

Finding that considerably thicker strings than the original ones were required to produce tones of quality and power good enough for the dissatisfied man to put up with—N.B. it is not his nature to be *satisfied* by the tone of any musical instrument whatever, unless Jenny Lind's voice when at its very best, be classed as one, it became needful to strengthen the case or frame, for it would not have endured the additional tension of the thicker strings. It could hardly interest my fellow-readers to describe in detail, how this and other needful improvements were effected, but I may just add that this instrument was rendered at least as powerful (I ought rather to say, considerably more powerful) than any grand piano of the period, 1833, and when its tone was "let out" by opening its beautifully-constructed Spanish mahogany Venetian swell, the proper use of which required some judgment and practice, the instrument was capable of effects in the concert room which harpsichordists, who have heard nothing superior to the ordinary quilled instrument would hardly believe possible with an instrument *termed* a harpsichord..—N.B. It was tried by one who had played on that formerly in the orchestra of Covent Garden Theatre.

Being, in the matter of taking proper care of "ancyent musical instruments, one of the most rigid of conservatives, I kept this harpsichord in my possession until recently, and then gave it to one able to appreciate its quality. It is now the property of your very *practical* correspondent, "W. T." and is, in all essentials, as perfect as when it was used by "ye conducter" at "certaynge consorts of ancyent mvsick," to keep the sometimes rather disorderly fiddlers in order. Were the present owner's time less occupied professionally, I should be tempted to urge him to follow the liberal example of Mr. Carl Engel, and loan it to South Kensington Museum. When there, both he and I might justly be proud of it as an example of what the despised, because ill-understood, harpsichord, is capable of doing. Perhaps then, that portion of the musical public who desire to become acquainted with the toccate of Andrea Gabrielli, also the compositions of Frescobaldi, Scarlatti, old Bach, and Handel, might have the privilege of hearing its present possessor's rendering of their works by the employment of an instrument as far surpassing any harpsichord possessed by those composers as a Broadwood patent iron concert grand surpasses Fulke Greville's humble Italian pianoforte—the first grand piano seen in England, but by no means the first "Hammer Harpsichord" constructed on the Continent.

THE HARMONIOUS BLACKSMITH

HOW THE NATIONAL GALLERY AND BRITISH MUSEUM MIGHT BE LIGHTED WITHOUT RISK OF THEIR DESTRUCTION BY FIRE.

SIR,—The Chancellor of the Exchequer, in the recent debate on the proposed opening of the above institutions during the evening, most truly said that the pictures in the former, and many of the specimens in the latter, could not be replaced if destroyed: and so long as the lighting of those buildings depends on the combustion of coal gas or other fuel, it seems that the risk is too great to be encountered, although, if the precaution were taken to burn the gas in a perfectly close glass (chamber excepting that it must be provided with the means of admitting air and carrying off the products of combustion) that risk would be greatly diminished, and the injurious action on books and pictures which results from the use of gas for illumination might be entirely avoided; also each burner, thus enclosed, would become a very efficient ventilator if air were admitted from the room which is illuminated. That those undulations which are visually perceptible to us as light may be induced, unaccompanied by those slower undulations we perceive as heat, is proved by that *fait accompli*, the electric light at Dungeness. If this can be maintained with sufficient steadiness for the purposes of a beacon, surely it may also be maintained steadily enough to enable us to see pictures and other works of art far better than we can see them by gaslight, which (however it may improve the effect of raw colouring by the Claude Lorraine tone it imparts) has the bad consequence of altering the harmonious colouring of good pictures. The electric light can never be guilty of arson, and if properly diffused by passing through a ground glass screen before falling on a picture, is the nearest approximation to the light of day we can employ to illuminate it. The only valid objection to its use that I know of is, that it is, like most good things, rather costly.

THE HARMONIOUS BLACKSMITH.

"T. A." AND HIS "OBTUSENESS" (?).

SIR,—I owe "T. A." a thousand apologies for using a term he does not understand. He wrote as familiarly about twilight as about light, and I quite forgot that he might be quite as ignorant about the former as he has been at such pains to prove himself about the latter. I trust he will forgive my inadvertence. He will find the words "crepuscular curve" in all respectable treatises on meteorology. They are used to describe the apparent curve forming the boundary of that part of the heavens which is illuminated during twilight. Kämtz calls it "the figure formed by the earth's shadow projected on the higher regions of the atmosphere." I am really very sorry to have led "T. A." to exhibit what he calls his "obtuseness" (I should have used another word); but it is his own fault. When will men learn the folly of talking familiarly about subjects with which they are wholly unacquainted?

RICHARD A. PROCTOR.

ERRATA.

SIR,—There are two noteworthy errata in my paper about comets and meteors. First, the sentence, "I propose only to pass by legitimate reasoning from the known and unknown," should have run "from the known *to the* unknown." Secondly, the words italicised in the following sentence have been accidentally omitted:—"The fact, then, that year after year, as the earth returns to the same part of her orbit, she either always, or commonly, *encounters many meteors*, shows that there must be a system travelling round the sun, and intersecting the earth's orbit in that particular region."

RICHARD A. PROCTOR.

CALLAND'S BATTERY.

SIR,—In reply to Mr. Tydeman, p. 328, I am not acquainted with this cell under this name, but I believe it to be what is called the Gravity Battery. It is not unlike the Minotto without the sand, and I did not remark on it because it is totally useless for any ordinary purpose It must not be subjected to the slightest vibration, and must be constantly worked at an average rate, or it will speedily prove itself a nuisance. It depends solely on the different weight of the liquids for keeping them apart, and no liquids consisting of solutions of different salts in water can be kept from mixing by diffusion. The only way to do so practically is to use a form like that I described as the Meidinger, but without a porous cell, and with the copper consisting of a plate at the bottom, and the zinc of a perforated disc suspended above. Then, by a careful adjustment of the size of the tube from the reservoir to the work, the sulphate of copper would flow out only just as fast as it is required for consumption. The statement of cost quoted only applies to first cost, I suppose, and is, besides, utterly improbable.

SIGMA.

VEGETABLE OILS AND FATS.

(*Continued from page* 3 31.)

SIR,—To resume:—

20.—STERCULIA ORDER, OR STERCULIACEÆ.

Kapok koil.—Silk cotton of the Antilles; Suffed-Semul·Bengal, Guiana, Cuba (*Eriodendron anfractuosum*).

Oddjengé nuts, Stearine nuts, Western Africa (*Heritiera sp.*) The fruits of atoeng-makan (*Heritiera sp.*) are cooked by the Malays with their fish, and are probably also oil-yielding.

Telemboo of Ceylon, Jungle Badam, E.I.; Peenarymarum, Tamoul; Djankang, Java (*Stercalia fœtida*).

Bitter oil, Cabo Verde Islands (*Sterculia sp.*)

21.—CHOCOLATE ORDER, OR BYTTNERIACEÆ.

Cocoa-making butter (*Theobroma cacao*), 50 per cent. Medicine and for soap making.

22.—MALAY CAMPHOR ORDER, OR DIPTEROCARPEÆ.

Lophyra alata, Senegal, 44 per cent. Tree 80ft. high, hard wood.

Ochoco, Western Africa (*Dryobalanops sp.*)

Piney tallow, Hoopada oil, Doop tree g rease (*Vateria indica*) E. I.

Gurjun oil, Burmah (*Dipterocarpus levis*), proposed as a substitute for linseed oil. I doubt ot a resinous oil.

Tangkawang; vegetable tallow of Borneo; minjak tankawan, Malay; Kakowang of the Dynks), excellent lubricating grease; tankayan layer (*Hopea mucrophylla*), taugkawan tongkol (*Hopea splendida*), and several other Hopea.

23.—CLUSIACEÆ.

Galba nut oil, Calaba nut (*Callophyllum Calaba*), extremely abundant in the Antilles. Galba nuts and Bancoul nuts are left rotting on the soil in several of those islands. Galba nut oil is very good for lighting.

Tamanu oil, Ati of Tahiti, Alexandrine laurel, Penna cottay.

Poon seed oil, E.I.; Njamplo ng and Bientanggoor, Java (*Calophyllum inophyllum*), abundant in different islands of Oceania; 44 per cent.; used for lighting in India; good for soap making.

Red Puna, Goa (*Callophylum spurium*).

Nagkasur, E.I., Nagarari, Java (*mesnia ferrea*).

Cocum butter (*Garcinia purpurea*), India.

Gamboge butter (*G. pictoria*).

Madool oil (*G. Echinocarpa*).

24.—OLACINEÆ.

Coula nut, not kola (*Coula edulis*), Western Africa 63 per cent.; eatable oil.

Elozy zegué (*Ximenia Africana*), Gabon; 70 per cent.; for soapmaking. *Ximenia Americana* is existing in Queensland.

Umpeque, Angola (*Ximenia sp.*)

Soump, Senegal; Hingun, Hingoota, India (*Balanites Ægyptiaca*).

22.—ORANGE ORDER, OR AURENTIACEÆ.

Feronia elephantum, India.

26.—GAMBOGE ORDER, OR GUTTIFERÆ.

Butter and tallow tree of Sierra Leone (*Pentadesma butyracea*).

27.—MELIA ORDER, OR MELIACEÆ.

Crab oil of Guiana (*Carapa Guianensis*), used in the colony for burning; also excellent for the hair and for soapmaking; 70 per cent. Wood excellent, and bark good for tanning. Carapa nuts are so common in the district of Cachipour, says the Catalogue of the Products of the French Colonies at the Paris Exhibition, that at the maturity of the fruit the soil is covered with them a foot high to an extent of several kilometres.

Toulocouna oil, tallikoonah oil, Western Africa (*Carapa toulonconna*); 33 per cent.

Margosa, India; Kohomba, Ceylon (*Melia azedarachta*), for soap; 50 per cent.

28.—SOAPWORT ORDER, OR SAPINDACEÆ.

West Indian soap nut (*Sapindus saponaria*), northern part of South America.

East India soap nut (*Sapindus emarginatus*).

29.—RHIZOBOLACEÆ.

Piquia oil, Brazil (*Caryocar Braziliensis*).

Sawarri nut oil, Guiana (*Caryocar comentosum*); excellent eatable oil.

30.—SPURGE ORDER, OR EUPHORBIACEÆ.

Kukui oil, from the Bankoul nuts, Belgaum walnut, candle nut, Lumbang, of Phillipines; Dissee Akrot, E.I.; Africa, E.I., Pacific Ocean (*Aleurites triloba*); also from *A. molucensis* and *A. gabonensis*. 60 per cent.

Castor oil (*Ricinus div.*), E. I., Africa, Brazils, Egypt, &c. Carappato in the Portuguese colonies. Medicine, soap making.

Oleo de mamono do mato, Brazil (*Mala fistuligera*),

Owabe, Guiana (*Omphalia diandra*); 65 per cent., excellent for lubricating machinery.

Physic nut oil, purgueira oil, pinhoes de purga, Brazil; manduby-guacu, do. (*Curcas purgans*), India, Western Africa, the Antilles, &c.; for burning and medicine. Principal centre the Cabo Verde Islands, which export 100,000 hectolitres of seed yearly.

Croton tiglium, E.I., Nappalum, Telegoo; medicine.

Mubango, Angola (*Croton sp.*)

Oleo de Siringa, Brazils (*Siphonia elastica*); good for making hard soaps and printing ink. The *Siphonia elastica* is one of the India-rubber plants.

Aidaleyunnay, India (*Tatropha glauca*).

Kalapa oil, Rottlera butter, E.I. (*Rottlera tinctoria*).

Chinese vegetable tallow (*Stillingia sibefera*), for candle making, &c.

31.—CASHEW NUT ORDER, OR ANACARDIACEÆ.

Cashew nut oil (*Anacardium occidentale*), East and West India.

Lentisk oil (*Pistacia Lentiscus*), Italy; lighting and culinary use.

32.—BURSERACEÆ.

Dika bread, Oba, Gaboon chocolate, &c. (*Irvingia barteri*); 60 per cent.; good for soapmaking, &c.

33.—FLAX ORDER, OR LINEÆ.

Linseed oil (*Linum usatissimum*). Seeds imported from the Baltic and Black Seas, Egypt, India; cultivated in several places in Europe, principally in Belgium and in Russia for the fibre. The extraneous seeds may well serve to discover the origin. Used for soap making, painting, and fabrication of printing ink.

34.—COMBRETACEÆ.

Wild almond (*Terminalia catappa*), East India, West India, Mauritius, &c.

35.—ROSE ORDER, OR ROSACEÆ.

Plum oil (*Prunus domestica*), used in Wurtemburg for burning.

Almond oil (*Amigdalus communis*), South of Europe; medicine and perfumery.

Icaco (*Chrysobalanus icaco*), Antilles and West Africa.

36.—MONKEY POT ORDER, OR LECYTHIDEÆ.

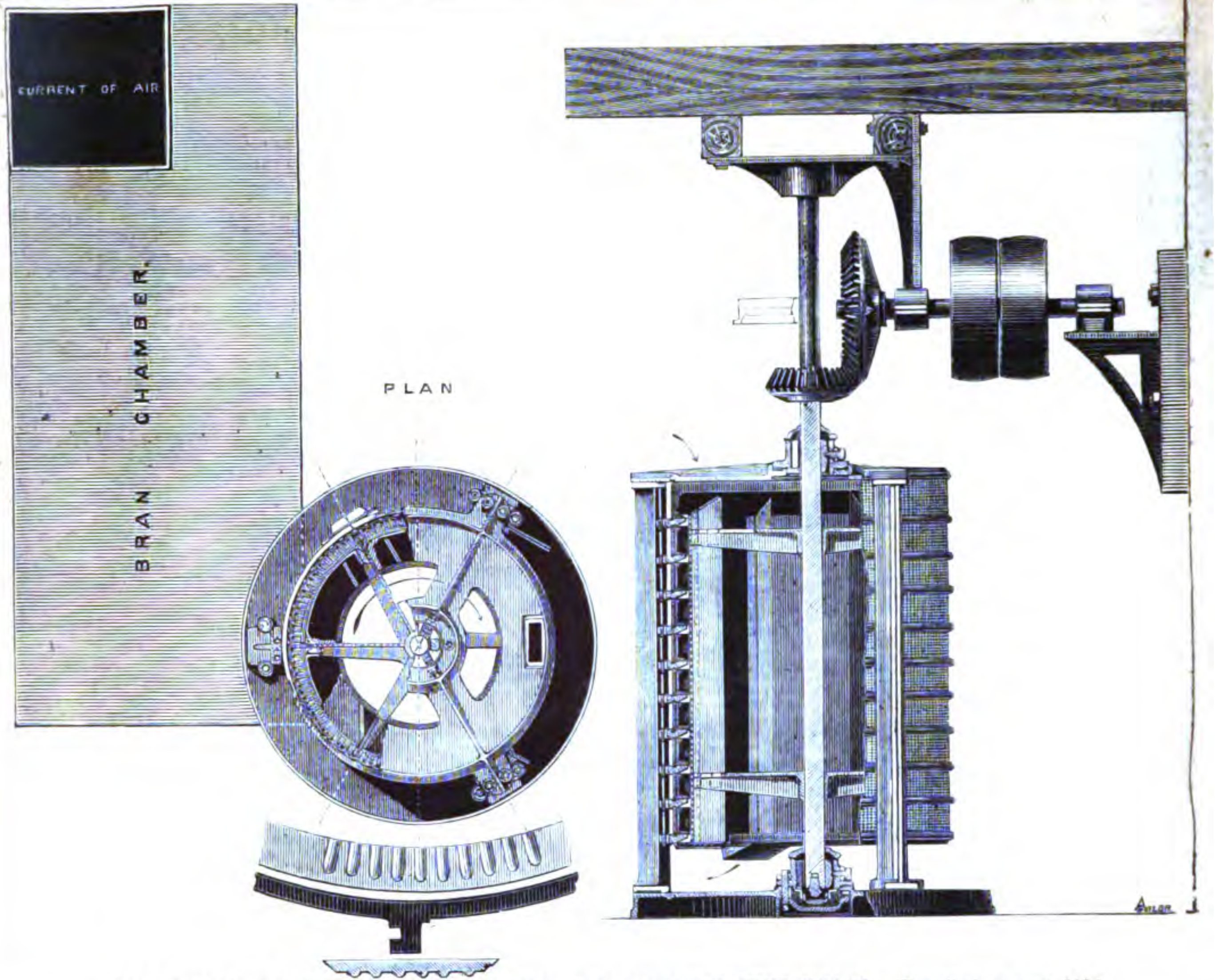
Castanheiro oil, Brazil nut oil (*Bertholletia excelsa*) Sweet oil, excellent for lighting. The Brazil nut forms a great article of exportation from Para to the different European and North American markets. Oil could be furnished to all the industries of the world.

Sapucaya oil, from the seeds of the monkeypoti (*Lecythis ollaria*), &c. Brazil, Guiana, &c.

37.—PEAFLOWER ORDER, OR LEGUMINOSEÆ.

Ground nut oil, Mandobi of Brazils, Katjang tannah of the Javanese; cultivated in all tropical countries. 30 to 40 per cent. Nuts called peanuts and pinots in the U. S.

Pulas, Dak, E .; bastard teak, Jamaica; pulosso



SECK'S PATENT APPARATUS FOR CLEANING AND DECORTICATING GRAIN.—(Described on page 343.)

Java; Nourouk, Mauritius; poukpin, Burmah (*Butea frondosa*).

Pongamia glabra, E.I. Korung oil, India.

Parkia biglanduloso, E. I.; 18 per cent. Also starch-yielding plant.

Ourala, opochala (*Pentaclethra macrophylla*), Gabon, Fernando Po, &c., good for culinary use, lubricating machinery, and soapmaking. 48 per cent.

Oleo de Camaru, Brazil, Tonquin bean (*Dypterix odorata*), perfumery and medicine.

Ben oil (*Moringa pterygosperma*), morunghy yennai, Tamoul; morunga noona, Teloogoo. Plant originally from Syria, introduced in the West Indies, oil very fluid, used by watchmakers and perfumers.

Moringa apteria, Egypt.

Omitted: Chalmogree oil, India (*Gynocardia odorata*) Arnatto Order, or Flacourtiaceæ.

I did not mention a certain number of oils I found quoted in authors without the designations whether they are fat oils or volatile, and which I had not the occasion to examine; of several I could not define the botanical name. Such are the following:—

Nhan-pyai and Nhan-mai, from Moulmein. As we have yennai in Tamoul, noonay in Teloogoo, and unnay in Canarise for oil, I conjecture that "nhan" means oil in Burmese, and that the first is coming from Myet-pyai (*Melastoma malabathricnm*), the second *Cassia sp.*

Kunjee oil, from India. I think sesamum = kunjed being the Persian name for sesamum.

Surgoojah oil, India (*Helianthus annuus*, or sunflower), &c. I might have added many vulgar names, but this would have occupied too much of your valuable space, and my note is already rather too long. Happy shall I be if it should prove useful to some readers of our ENGLISH MECHANIC.

BENARDIN.

P.S.—I intend adding a short supplement in the course of some weeks. Five or six errors crept into my first note, full of foreign names. I beg to correct the following, botanists will easily correct two or three Datin names:—1. Palm order: "Kirin nut" read "Kirlu nut."—5, "Hoerve" read "Hoeroe."—16. "Camelini" read "Cameline."—18. "Bêral" read "Béraff."

B.

(*To be continued.*)

GALWAY, MAYO, AND SLIGO.

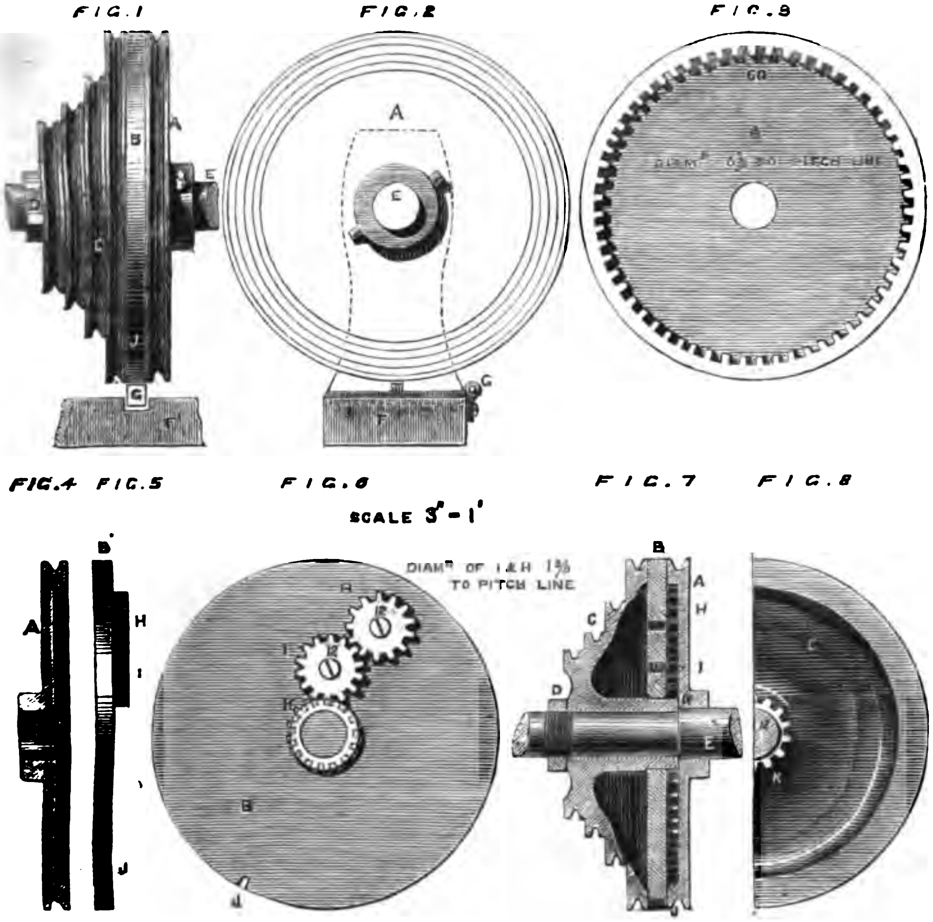
SIR,—The enclosed paragraph, cut from the *Limerick Chronicle* of June 16th, may interest some of your readers about to take a tour through Ireland. I am familiar with some of the places mentioned, and would recommend them, when in Limerick, to visit Castle Connell, Killaloe, Plassey, &c., and then to take the steamer down the lower Shannon to Kilrush and car to Kilkee (8 miles), the coast scenery of which and adjacent places, will amply repay them the trip. They will find excellent accommodation at Moore's, Shannon's, and Walshe's hotels, or at Sampie's, at the east end of the town, a less expensive one. I can recommend the Clare Hotel, or Cruise's, in Limerick. Should they wish to remain any time at Kilkee, I can recommend them to apply to John Roche, a worthy retired coastguard, who will assist them in procuring apartments or lodges. It is rather early for a visit to Killarney; the autumn, when the foliage is changing, is considered the time to see it to advantage.

C. TOWNLEY, The Turret, Ballingarry, Co. Limerick.

"Now that a magnificent touring season is approaching, intending excursionists, whether preparing to buckle on the knapsack and grasp the stout oaken stick solo, or in parties, are anxiously looking out to select an interesting locality as the scene of their rambles. As regards the inhabitants of this locality—of Clare, Limerick, Cork, and Tipperary—the entire south of Ireland has been overdone. There is scarcely a waterfall or a ferny nook, from the Slaney to Dingle Bay, or from Crook Haven to the Shannon, which has not been over and over again invaded by the feet of sight-seers. The beauties of the Blackwater are known to almost every one, and even exquisite Killarney has to be ransacked in search of new scenes of loveliness. It is to be deplored that while Ireland presents so many attractions to the tourist, that people will leave her shores and prefer seeking in Wales and Scotland scenery far less gratifying than can be found at home. Windermere, fascinating as it is, can never compare with the more awful beauties of the Kerry lakes, and nothing that North Britain can show, emulates the grandeur and sublimity of the terrific gorge of the Killeries. Apropos of the Killeries and of that interesting county washed on its southern shore by the bay of Galway, and on the west by Clew and Sligo bays, and which stretches out to the north by Lake Erne, there is no district of such limited extent so fully capable of gratifying the curiosity of the traveller, or of satisfying his utmost cravings after new and beautiful scenery. The counties of Galway, Mayo, and Sligo, have been hitherto almost a *terra incognita* to us southerns. It was so tedious and so expensive to reach their scattered beauties that more time was expended in paying a visit to Lough Corrib and Connemarra, than would bring the tourist through the different points of interest in South Wales. Fortunately all these things are now removed; the opening of the railway communication from Ennis to Athenry, brings within a few hours' run of this city the starting point of as interesting a tour as could possibly be devised. Fortunately, too, the tourist meets facilities along his route which are not to be met with elsewhere. The Midland Great Western Railway Company, in its arrangement as regards time and fare, enters thoroughly into the requirements of the excursionist, and gives every opportunity of conveniencing those who travel along the lines under its control. The knowledge of this fact alone should fill the County Galway and the surrounding counties with tourists during the coming summer months. The trip to be sketched out for the tourist should of course depend upon the time at his command. The picturesque city of Galway should first be reached, and if possible the romantic islands of Arran, abounding in interesting ruins and covered with rare ferns, visited. A sail up Lough Corrib, either as far as Outerard or to the beautiful village of Cong at its northern extremity, must next claim attention. If the former place be stopped at, the visitor can at once proceed through the western highlands and enjoy one of the most delightful drives it is possible to conceive. Ballinahinch, celebrated for its marble quarries; Clifden, for its natural beauties, are successively reached, and a short tramp to the north of Clifden brings the tourist to the pass of the Killeries, one of the most gloomy and terrific pieces of wild scenery, mountain and ocean combined, that the British islands can produce. Clew Bay, with its thousand islets, is marvellously enchanting; and indeed along this stern coast, almost at every headland, some new feature, wild and wonderful, meets the astonished gaze. If time should not permit the tourist to proceed beyond Westport, he can return by rail to Athlone, or, better still, if he can prolong his rambles, he can pursue his course still farther north until he reaches Killala and Sligo, in which case his homeward route should be *via* Mullingar on the Midland Great Western line. This excursion, which includes most that is beautiful in the western highlands, might well be performed in from seven to ten days, and a tourist, who unites with a love of mere scenery, a taste for the beautiful in nature—the ferns which are hidden in wild mountain gorges, the heath which cover hillsides, or the singular geological features which present themselves continually before him—will find himself amply rewarded for his toil and travel."

INTERNALLY-GEARED LATHE.

SIR,—Herewith I forward to you the drawings of my internally-geared lathe:—Fig. 1 represents the pulley and portion of mandrel in side elevation. Fig 2 is a front elevation of the same, and Fig. 7 is a longitudinal section. The letters refer to the same parts in all the figures. A is a gun-metal wheel pinned through the boss on to the mandrel. This wheel, of which Fig. 2 is a front view, has on it five circles of



INTERNALLY GEARED LATHE.

holes—viz., 360, 336, 300, 144, and 96. The other side of it is an internally-cut wheel of 60 teeth. Figs. 3 and 4. This wheel gears into two wheels of 12 teeth, H and I, fitted upon the disc B. Figs. 5 and 6. The pulley C is of cast iron, and is bored to fit the mandrel easily, and is capable of revolution on it. On the projecting part of the neck of the pulley (Fig. 7) there is a plain part turned, over which the cast-iron disc B, is fitted loosely, and beyond this again is a small wheel K, of 12 teeth cast, which gears into the wheel I. D is a fine screwed nut, that binds the whole arrangement together when in single gear, and G is a hinged catch that is fitted into the headstock, and when raised falls into the notch J in the disc B.

The action is as follows:—When in single gear the pulley and all its parts revolve as an ordinary one. the catch G is thrown out, and the nut D is screwed home. When the slow motion is required, the catch G is raised into the notch J, and the nut D is slacked back about 1½ or 2 turns. The lathe cord being upon one of the grooves of the pulley C, revolves it, likewise conveying motion to the wheel K on its neck. This wheel turns wheel I, and I gears into H, which turns the internal wheel A, and so produces the slow motion by the difference of the number of teeth in the wheels K and A, which in this case is as 12 is to 60, or as 1 is to 5. The catch G is likewise very useful for blocking the mandrel stiffly (as in unscrewing a tight chuck); and as any part of it can be brought into position as regards the notch, it can be blocked in any part of its revolution by slacking the nut D.

These drawings form full working drawings, being strictly to scale, 3in. to the foot.

G. W. A.

ASTRONOMICAL.

Sir,—I feel much obliged to "Omicron" for giving the required formula, and could wish him to work out the longitude and latitude of Venus, for noon, 15th March, 1870, by the second—viz.,

$$\text{sin. } \lambda = \text{cos. } \omega \text{ sin. } \delta - \text{sin. } \omega, \text{sin. } \alpha \text{ cos. } \delta$$

$$\text{tan. } l = \text{cos. } \omega \text{ tan. } \alpha + \frac{\text{sin. } \omega \text{ tan. } \delta}{\text{cos. } \alpha}.$$

The operation by five-figure logarithms would be quite sufficient.

The geocentric longitude of Venus computed from Right Ascension 326° 51′·585, and declination 6° 4′ 11″ S. is found by the first formula to be 326° 59′ 47″·9, or 26° 59′ 47″·9 and its latitude 6° 51′ 22″·5 N.

Using the last formula, and the logarithms to five planes only, we obtain the approximate result 26° 59′·8 for the long. and 6° 51′·4 for lat. Please show in the eliminated formula how to distinguish whether the lat. is N. or S.

In the "Astronomical Notes for June" it is stated that the moon will be in conjunction with Mercury at 49m. past 2 a.m on the next morning; "a.m," should have been left out. Mars is in conjunction with Jupiter at 1h. 12m. on the afternoon of the 27th, 7h. 12m. is therefore an error.

There is not given any account of the rising and setting of the planets for this month.

Seeing that astronomers agree to compute from the first point of Aries, why do they not say that Jupiter is in Gemini, Uranus in Cancer, &c., instead of telling us that the former is in Taurus, and the latter in Gemini, &c.

If they intend to adhere to the ancient division of the Heavens, why do they make their computations from the point to be determined by the procession of the Equinoxes'?

G. Firth.

MUSIC.

Sir,—Mr. Traylcr (page 332) has earned the hearty thanks of "our" musical readers, in defending the sol-fa method, which has received some "hard hits" lately in your Answers to Correspondents. I can fully endorse what he has said respecting the advantages of this easy, cheap, and true system, having had the drudgery of teaching by several methods for the last twenty years. Let me state for the benefit of those who wish to sing correctly and easily, that I lately took a class of village boys, from seven to nine years of age, who, without any previous knowledge of music were able to sing ordinary hymn tunes at sight, after six lessons of half an hour's duration. Now if any of our readers can show me a "more excellent way," I shall be most happy to learn, and they will be doing good service to hundreds of others, by making it known in "our" columns. There is just one part of Mr. Trayler's letter, with which my experience will not permit me to agree; he says, that this method will teach pupils to sing in tune better than any other. I have always found that singing out of tune, is the fault of the singer's ear, and cannot be ascribed to any method of teaching. I am of opinion that no amount of practice will cure this evil, so trying and unendurable to a good "ear." I may add, the tonic sol-fa system number its adherents by tens of thousands in all parts of the civilised world—wherever there is competition, it is never in the rear—and is now too firmly established to be shaken by the prejudiced opinions of old notationists.

Musicus.

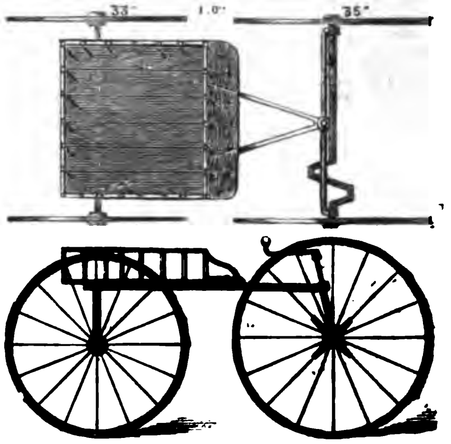
A SUGGESTION.

Sir,—If I, during the summer, go to Cornwall, Wales or Westmoreland, and wish for authentic information regarding the vicinity in which I may find myself, how am I to get it? I doubt not but many of your readers, if I knew them, or they knew me, would be pleased to offer their services, and tell me exactly what I wanted to know. Many others, situated exactly as myself, would gladly hail and reciprocate the kindness thus given. Could not some of your readers give their names and addresses, the time they could receive "calls," &c., thus, "H. B. 4 a.m.," "T. R., 8 a.m., 4 p.m. Any travelling English mechanician calling at these hours, would receive a hearty welcome, trustworthy information regarding lodgings, remarkable places, and general charges.

C. H. W. B.

SPORTSMAN'S VELOCIPEDE.

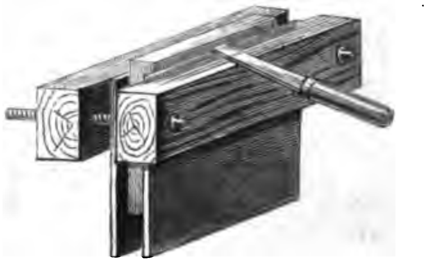
Sir,—If you should think it worth engraving, I enclose a plan and elevation of a velocipede, the best I think, the querist (4097) can have for the purposes he requires. It is four-wheeled, and has a broad seat for two persons to drive direction the front axle. Behind the seat is formed a compartment capable of conveying two dogs, having a boarded floor and enclosed at sides with light open framing. The dogs must be chained to this. The whole is supported on a triangular iron frame, having a socket in front for a steering fork, very similar to that of a bicycle. The cranks are set on an improved plan, which obviates the well known "dead points," and ensures a continual application of power—viz., the cranks for one rider are set crossways with those of the other, as may be seen on elevation. The seat must be well stuffed, and there is no need of springs. A three-wheeler would not answer.



Bicycle Maker.

CUTTING BOOK EDGES, &c.

Sir,—Several of your correspondents write about cutting book edges. I enclose a sketch of how I cut them. It is with a chisel, which when sharp and pressed on the top of the press, will cut them as well as a proper cutting knife could. Will "A. B.," or any other correspondent tell me how to clean dirt, such as finger marks, &c., from the leaves of books before binding?



Joe.

A WORKMAN'S APPEAL.

Sir,—I like the letter under the above heading in your last number, because the writer exercises the Englishman's privilege of growling like a man, and admits his consciousness of the row he is making. Seeing, however, that his requirements range from mathematics without symbols, up to slide-rests of the third order of complication, and considering the great variety of subjects touched on in the letters you publish, it does seem odd that he does not more frequently find something to suit himself. May I ask him if there is any subject that he has ever heard of, about which he wants to know anything, and will not get a prompt answer about in the English Mechanic, from some one or other, if he will only take the trouble to say what he wants? Also, now that he has got the drawing of slide-rest, of what possible use it can be to him? Not to make one by for sale surely? Who would buy it if he did? for although Mr. Evans gets £65 apiece for them, I think one of his would be preferred at even that price by any body wanting one. Also, I wish to refer "Blacksmith" to two letters of the "Harmonious B." in Vol. X., one on forming steel mandrils, and the other on building a lathe under difficulties, and to ask whether such letters are not, as it were, specially for the class to which he belongs, although the information may not be what he individually wanted at the time?

As regards self-teaching, it is one of the most laborious tasks possible, though there are plenty of helps for the purpose published nowadays, without any more being written, and in writing those helps, the difficulty is to make it easy enough; just as in drawing up an examination paper, the difficulty is to keep it down to the level of the knowledge of the pupils, not to puzzle them with hard questions, which some folks look on as evidence of sharpness on the part of the examiner. But that men have taught themselves even high mathematics, was proved by my old tutor, James Hann, of King's College, London, who was once a pitman at Newcastle, and had charge of the winding-engine at the pit-mouth, and worked his sums with chalk on the end of the boiler! and in those days there were very few rudimentary treatises to help any body. He tried astronomy first of all, and when he found he could not understand it from want of knowledge of mathematics, went back to the beginning, and never tired till he had learned it all, and made the best of masters, because, having laboriously gained every step on the road, he was so perfectly grounded in every part of the subject. As to French measures, "Blacksmith" has only to recollect that a millimetre is just about $\frac{1}{25}$ of an inch, so he has only to prick off a scale of 25 to an inch, or more accurately, 100 parts in 3·94in and measure with his rule on that scale, the number of millimetres given. I quite agree with him, that to rush off to some book, and find a formula ready made for the job, and put the valves in for the letters, and stir them up till a result comes out, is not the way to answer a question to the satisfaction of a practical man; and it is the way only too often adopted by certain of your correspondents. It is like copying out a recipe without being able to write "proved" after it.

J. K. P.

A CUMBERLAND MINER'S APPEAL.

SIR,—In answer to "A Cumberland Miner," allow me to suggest two methods of preventing those terrible explosions he mentions:—1st. Go to a clever blacksmith, and get brazed on to the end of the pricker with a slanting splice—a piece of copper a few inches long, so that it will enter the powder, and not the iron end of the pricker; but if the powder is likely to ignite even after the iron pricker that is now in use is drawn sufficiently out to be above the powder, then I suggest (2nd) that a brass tube ⅜in. internal diam., and the proper length (and a piece 3ft. long can be got at Birmingham for about 6d. or 8d.) Have a piece of round rod iron ⅜ diam. driven into it to within an inch of one end, which end may have a piece of brass or copper soldered or brazed into it, and pointed off to imitate the pricker at present in use. With such a pricker, the rammer, if it struck the pricker when the miner was ramming on the powder, would not strike a spark or fire, and the pricker would not bend like copper.

H. W. A. S.

SIR,—Let a "Cumberland Miner" take 1lb. of hog's lard and 2oz. of finely-powdered rosin, mix them at a gentle heat, and when using the pricking rod, smear a piece of paper (such as our MECHANIC is printed on) about 2in. wide, and whatever length the hole may be, twist it with a slight spiral direction round the rod, and place the hole in before tamping, and after the hole is stemmed or tamped, the rod will withdraw with safety. To thoroughly test the above, place a piece of the smeared paper on a piece of flint, and strike with a steel, and it will be found utterly impossible to obtain a spark, where the paper covers the flint.

W. W.

SIR,—As I understand the "Cumberland Miner,' the operation of blasting is as follows?—The hole is drilled in the rock, the powder inserted, the pricker placed in the hole with the point in the powder, the hole is then rammed full of earth, &c., and the pricker withdrawn, leaving a small hole for the insertion of the fuse or straw. The dangerous part of the work is withdrawing the pricker, as it may strike fire from rubbing against the rock.

Now, I have heard it asserted that ramming the hole full is quite unnecessary; that a wooden plug driven into the mouth of the hole is much more effective.

This would appear to be correct according to theory, for it is well known that a gun barrel which would bear very heavy charges of shot, when rammed down on to the powder, may be burst by inserting a cork in the muzzle before firing.

If the "C. M." would try the wooden plug and report the result, it would be interesting to your readers, including

G. H.

SIR,—I have used a copper pricker for five years, and it is very little the worse for wear. We have a silicious grit so full of fire, that to use an iron pricker would be exceedingly dangerous; hence the use of the copper one. My beater or stem-rod is much thicker for an inch at the lower end, with a groove in it made with a round file, to admit the pricker. I preserve the dust that comes out of the hole during boring to stem with it or plate. Having bored the hole, I put what powder I think sufficient into it. Having slightly greased the pricker, I thrust it to the bottom of the powder, and put some paper on it to prevent any fire igniting it. After stemming 6 or 8in., I slightly draw the pricker, and so until the hole is stemmed. Care must be taken to keep the pricker straight in the groove of the beater. Attending to these directions, no accident such as he alludes to need be apprehended.

A YORKSHIRE LEAD MINER.

GOURDS.

SIR,—Your correspondent "Beta" suggests that information regarding food must prove useful, especially if attention can be drawn to any members of the vegetable kingdom, whose properties are not generally known or understood.

Acting on this, I will draw your readers attention to a vegetable, easily grown, and much used on the continent, but scarcely at all in England—I mean the gourd or pumpkin. Its culture is the simplest. On a small heap of manure or leaves, or anything which will give a little bottom heat, sow one or more seeds of the mammoth gourd. This, with an occasional watering, will produce fruit of upwards of 50 or 60 lbs weight. As a proof of this, two were exhibited last year at our local flower show, which grew on the same plant, and weighed respectively 87 and 42 lbs.—129 lbs., from one seed. At another show were exhibited seven which weighed together 413 lbs.

They are most excellent food for man or beast, either in soups, pies, or boiled as a vegetable, and as they are not gathered till ripe, and then hung up in a dry place, and a slice cut out when required, they are useful all through the winter. A packet of seed, price 6d., can be had of Messrs. Sutton, Reading. It is rather late, but I hope some of your readers will try them this season, and state to you the result.

W. M. G.

NORTH OF IRELAND.

SIR,—Having read the letter in your last number, concerning tourists' trips in Ireland, and finding that you are willing to insert further communications on the subject, I beg leave to send you the following.

Donegal is well known as the most picturesque county in the North of Ireland. It is full of high mountains, and small romantic lakes. The Atlantic Ocean on three sides washes its grand and rugged shores, and many beautiful inlets penetrate far inland. As I am perfectly acquainted with the county, I can with confidence recommend the following tour as one that will repay the small time and expense necessary. I suppose a traveller to reach Belfast early in the morning by the steamer from Liverpool, Barrow, or Fleetwood. After rest and breakfast at the Imperial Hotel, proceed about 9 a.m. by the Northern Counties Railway to Portrush. The omnibus of the Antim Arms Hotel, one of the best in the North of Ireland, is waiting at the station. Spend that afternoon in a ramble on the rocky Dromon Head, and on the beach, which is only equalled by two others in Ireland. Next morning visit the Giant's Causeway (by stage from the hotel) and the grand cliffs beyond. Boats are always to be had, but if you object to rough water you can see almost as much by land. Sleep that night also at Portrush. Next morning take a car to Portstewart—3 miles, and there (for I address predestrians) begin your walk, keeping along the shore till you reach the mouth of the River Bann, which you will cross by a ferry. Still keeping by the shore, you will reach Magilligan, which is at the mouth of Lough Foyle. Cross there by ferry-boat to Greencastle—2 miles, and you are in the rugged County of Donegal; walk from Greencastle to Carndonagh, where you ought to spend the third night. Next morning, walk from Carndonagh to Buncrana, ascending Slieve Snaght Mount on your way, which is more than 2000ft. high, and commands a magnificent view. All that day's walk is most picturesque. There is a large and comfortable hotel in Buncrana. Next day take the rail from Buncrana to Fahan, and there cross the beautiful Lough Swilly to Rathmullan, thence by mail cart to Letterkenny, where you would spend the fifth night at Hegarty's Hotel, a very clean and comfortable one. If your time is short you can end your journey here, and go by public stage next morning to Strabane in time for through trains to Belfast and Dublin. But if you have 3 days more, by all means wait, and take a post car from Letterkenny to Glen Beagh, the most beautiful spot in the county. You will also pass Gartan on the way, which is only second in scenery. At the lower end of Glen Beagh dismiss your car, and walk up along the beautiful lake, which is 3 miles long, lying between precipitous rocky mountains. If possible, get an active little boy to guide you across the mountains to the Pison Glen of Dunlewy. While crossing this pass, you will obtain a truly magnificent view. Below you are the Dunlewy lakes, and beyond them Erigal, rising precipitously, the highest mountain in Douegale and in the North of Ireland. Descending, and passing Erigal, make your way to Gweedore Hotel, and spend the 4th night there. After which you can either (1) spend a day at Gweedore, boating, fishing, and ascending Erigal, for which last you should take a guide; or (2) go by mail car to Dunfanaghy and spend a day there, ascending Muckish, or exploring Hornhead; or (3) go by the same mail car through Dunfanaghy to Letterkenny, where your journey will end. Let me add, that if a Sunday should occur in your tour, you will find Portrush or Letterkenny the most agreeable places to spend it in, as they have the most comfortable hotels, the various places of worship close at hand, and the opportunity of pleasant short rambles in vacant hours.

I write without the opportunity of consulting local sources of information, or would add distances, times and fares. Let the intending tourist by all all means procure "The Highlands of Donegal," Murray, an admirable book, written by a native of the county. I shall now only add two hints to travellers, (1) that it is necessary to ascertain particularly where you can get a good bed and breakfast, for Donegal is out of the beaten track for tourists, and you cannot count upon these; and finally, that a weary predestrian can at any small town hire a post car, at 6d. a mile for one, and 8d. for two passengers with a gratuity to the driver of a fourth part of the fare.

H. S. L.

SQUARING THE CIRCLE.

SIR,—In the current number of our journal, is a very funny letter about squaring the circle by practical geometry. If Mr. Arthur Gearing starts with the parallelogram and divides it into cuneiform pieces, as represented, he will not be able to make a circle of them, but a polygon; on the other hand, if he starts with the circle he will not be able to make a parallelogram but a figure with wavy or serrated edges; it puts me in mind of the carpenter's mode of measuring the circumference of a circle by means of a piece of string.

T. COOKE.

SIR,—Mr. Arthur Gearing deserves great credit for his ingenuity, if not for his success, in his elaborate effort (No. 273, p. 301), to solve, even *practically*, the unsolved problem of "squaring the circle." Mr. G.'s diagram presents certainly the nearest *ocular* solution of the great mathematical puzzle. Having arrived at this conclusion, it seems strange that the ingenious discoverer did not attempt to crown his work by connecting his diagram of "practical geometry" with a regular geometrical demonstration, proving the perfect equality of the relative areas of his circle and square. Had he done so he might fairly be entitled to an "Io, Io, triumphe" in the columns of the ENGLISH MECHANIC. It does seem a ruthless act to demolish Mr. Gearing's "practical" or rather *mechanical*, geometrical square, but the interests of science demand it. If a square be "a four-sided figure whose sides are equal, and whose angles are right angles," Mr. G.'s square is really no square at all, for two of its sides are not rectilinear, and, therefore, not equal to their opposite sides; they are a series of *curves*—sections of the circumference of the circle. Mr. G. transforms 36 sectional curve lines into a continuous right line as a side of his square! and he introduces a similar series of curve lines into the area of his square in contact with each other, so that it would appear, even to "ocular demonstration," if correctly drawn, that a series of blank spaces remain unfilled, the consequence is, that the area of the square is considerably larger than that of the circle. Mr. G. attempts to support his demonstration by a reference to the XIV Prop. of the 11th Book of Euclid:—*To describe a square which shall be equal to a given rectilinear figure.* This proposition cannot possibly apply to Mr. Gearing's conversion of his parallelogram (Fig. 2) into a square (No. 3) for the very obvious reason, that his parallelogram is not, and cannot be made into a rectilinear figure, no more than his square, because the sides are composed of 31 curved lines each. Either Mr. G. deceived himself or he was not honest in reducing these curves into straight lines, and in palming a false parallelogram and square upon the readers of the ENGLISH MECHANIC, and in attempting to establish his solution of squaring the circle by an unjustifiable reference to Euclid. It is to be hoped that Mr. Arthur Gearing will be more successful in his next effort "to give an interest in the study of practical geometry by the mere exercise of ingenuity."

WM. ARTHUR DARBY, M.A., F.R.A.S.
Chorlton Hall, Manchester.

COTTON SPINNING.

SIR,—It appears I have succeeded in raising a ghost that is determined not to be laid until the "reason why" has been given. I trust you will kindly excuse me, though I cannot be sorry for it. However, I do believe that a little bit of consideration would have convinced many of my cotton spinning friends, that my first answer to "Factory Lad," was as consistent an answer as, under the circumstances, could be conscientiously given to so simple a question on so important a subject, and one that involves so many considerations. When I answered the question at first, I had a fourfold object in view. The first was to raise this ghost, or the subject, in a manner that would thoroughly disturb it, so that it could not rest again until it had received its due. The second was to show the folly of asking for advice without stating plainly and fully all the circumstances bearing upon the case, and the danger of giving it also. The third was to show the "lads" a stumbling block over which they might easily flounder—"Factory Lad" saw this. My fourth was to call forth answers from other readers, that the subject might be fairly handled, and I had this object still when I gave my second answer. My motive may be open to censure for anything I know but I have papers by me here, in which I have tried to treat of the subject in as simple a manner as I could, to make it comprehensible to the "lads," and, by the way, if any one will try to do this, he will find it no easy matter; neither can it be done in one or two long letters, let alone short ones. I don't know how others find it, certainly, but I have to write, write, and re-write, before I can half satisfy myself that I shall be understood. But this is perhaps owing to my inaptitude, as I am but an entirely self-taught factory lad, barring, that I took all the honours of A. B.-abs by a nine months' half time attendance at a sort of hedge school. I have been driven from my first intention by the very ghost I raised, and this week I am glad to see that "B. W. R." has taken up one part of the subject in much the same way as I intended to do, if others did not. Now I fully made up my mind last week, for "peppering" both "M. J." and H. C. S.," for what I felt to be ungenerous remarks. I cannot see what sense there is in any of us trying to make each other appear as simpletons, whether we do so by garbling or implication, when we are doing our best for each other, and for thousands of others. If "B. W. R." will refer to page 331, at the top of the middle column, he will see that he is mistaken—I hope he will kindly acknowledge. With respect to the two last letters of "H. C. S.," in which he refers to me, I protest, in the words of a country lad, "ageanst ho'din' bulls whoilst other fooaks whollops um." But as soon as he has satisfied me that there is no "chaff" intended in his last letter, I will give it due attention. I may here say, in explanation of what I said about putting the cart before the horse if he intended it to go, that I wished to suggest by what I said, as I thought it was opportune, the vagueness of the word "draw," as it implies something like attraction, whereas mechanical motion is communicated by impulse, or pushing; hence the horse pushes the cart before it by means of the collar on its shoulders, &c. In conclusion, I hope this epistle will do something to appease the wrath of the ghost I have raised, as I raised it with a good intention, but it kicked up a greater floundering than I bargained for, when I considered what little attention the subject of cotton spinning had called forth from correspondents before, and I have been a subscriber from the first number of our paper. "B. W. R." says I appear to have lost one end. I hope he, "H. C. S.," "M. J.," and "Factory Lads," *ad lib.*, will try and prevent me from losing the other end. The "cotton panic" taught above one lesson, and I will give the results of experiments if others will do the same.

E. SLATER, Burnley.

SIR,—Putting aside the preliminary remarks of "B. W. R.," in last week's paper, let us at once come to the question, is it proper, in taking the draught of a carding engine, to begin at the feed rollers? I say yes, and that the rule disputed is correct in that point. "B. W. R." says no; you must begin at the lap rollers, as there is a draught between them and feed rollers. My advice is, begin at the feed, and end at the delivery rollers, except you want to see whether there really *is* a draught between lap and feed rollers. If there is, get it altered at once, as it is a greater evil than it is a benefit to give the slightest strain to a lap. If the rule I give is not correct, then all the authors I have studied are all wrong likewise; for I never found one yet who commenced at the lap rollers to take the draught. And yet they undoubtedly would have done so if they had any idea that there was one; or if they had thought a draught at all necessary.

"B. W. R." is just confounding theory with practice in his analysis of my letter last week. If he does, he will find them (in cotton spinning especially) very awkward fellows to deal with. He forgets we were dealing with the former, not with the latter. But even looking at it in the same light that he does, how does he account for a carding engine working with the same arrangement I quoted, with rollers covered with fillet instead of being fluted? Now, if *mon ami* does "happen to be acquainted with the make of the engines I took my figures from," he must bear in mind that machines do not *always* remain in the same state as that in which they are sent out, especially where there is machine making combined with cotton spinning, as in my case. The particulars I quoted last week were from one of Walker and Hacking's single carding engines, the only one we have. He is wrong in his statement about the length fluted rollers will take up—at least in my case. I am aware it is a common custom to have very deep flutes cut in the feed rollers. Now, ours have not; consequently, there is very little difference between the theoretical and the practical results of the length taken up. In fact, what slight difference there was I got our carder to counteract it last week by nailing thin slabs of wood, ⅛in. thick, round the lap roller, making it same as some of our other (Walker and Hacking's) double cards, the lap rollers of which are 6¼in. diam. $\frac{1\frac{3}{4}}{14} \times \frac{48}{6\frac{1}{4}} = \cdot 90$

In his illustration of the piece of string, does he mean to say that it would bag if it had a support in the middle same as a guide plate to a carding engine? If he will take a piece of string, and hold it tight (not extra tight) between two points 12in. apart, I am afraid that neither he nor anybody else would be able to detect the slightest bag in the middle. Neither would he in a lap at that distance, if it is taken up as it is delivered. The result of what he says last week just amounts to this—that the draught of a carding engine should be taken from feed to delivery rollers, as at first disputed; for if you begin at the wheels on the lap roller, as in my case, it does not alter the theoretical result one jot, and that is what you are dealing with. "B. W. R." says he does not consider his argument answered by what I explained. Well, I cannot help it, but I am happy to say mine is. I am much obliged to him for his kindness in giving me the recipe for size, and also for his information on yarn testers. I heartily endorse all that he puts forth in his first letter, last week, on the draughts in drawing frames, in which he displays his thorough knowledge of the subject. It is really more than I can credit him for with regard to his pet ideas about the indispensable draught between lap and feed rollers.

I now take my leave of this subject (except some more forcible arguments can be brought to bear upon it), as I do not think I should be acting right by keeping up this "simple" matter, when my friend "B. W. R." thinks I ought not to do so.

THE HARMONIOUS COTTON SPINNER.

P.S.—Will "B. W. R." kindly give me his opinion on the yarn tester he mentions—the range of strengths it will indicate, and the principle on which it works?

TO MILLERS.

SIR,—Mr. E. Davis, on page 278, in his description of silk bolters presently in use, asserts that there is not more than one-third of the silk in actual use, the rest being taken up with rails and ribs; this may be the case with some silk bolters, but certainly not all, as the firm of Thomson, Wilson, Weddell, and Parlick, have been putting up silk bolters for the last six or seven years that have none of these cross ribs to which he refers. The rails are 2¼" × 2", and the whole space covered by these rails is not more than 12" in width. The circumference of the bolter is 9' 4"; deducting 12" from 9' 4" leaves 8' 4' of silk for effective use. I have seen one of these bolters 23ft. long, dressing with ease to 6 pair of stones.

AN ONLOOKER.

SIR,—I believe we shall have to take what "A Stoneman" persists in saying touching his "blindness," impracticability &c., to be perfectly true. He says that he is so blind as to be unable to conceive why the respective density of the various materials which composes a millstone should disturb its standing balance, when it becomes to run. One would imagine that enough has been said on the subject to show anyone the reason why; and to illustrate this I suggested that he should try to do so by the aid of Clark and Dunham's patent balance, which I understand he has in his stones. From such suggestion I gather that he understands me to have recommended those balances, which is not the case, though I believe with C. M. that there is no better if properly used. But to a man with his wits about him the same results can be obtained without them. For instance, if John Botting had sunk his balance box deeper, instead of transferring his shot from one box into another, both balances would coincide. I would advise him to try it. The reason for so doing is that it brings the weight within the same horizontal line as the object it has to counteract, and here is the advantage of having the patent, because of its mechanical arrangement; by the aid of which "A Stoneman" says that it is improbable that a stone's standing balance can be disturbed. If he had only given the experiment a practical trial, it would have added considerably towards illuminating his "unenlightened intellect." He seems to think that I ignore a standing balance. Why he should I am at a loss to know. No one is more in its favour than myself, yet in point of utility, I regard it as stated in a previous letter. But while it is possible by mechanical means to possess both, no one would be satisfied with one only, but this cannot be accomplished in any other way than upon the principle stated above, and the best method of driving the stone while balancing is that stated by myself in a previous number of the ENGLISH MECHANIC. As to his stones doing equally good work before he had the patent proves nothing more than that they were in a good balance, which is possible to arrive at without it, as stated above. But "A Stoneman" says that the fault, or cause of the two balances is elsewhere, viz., cogs, irons, faces, &c. Permit me to say, most respectfully, that he is under a very grave delusion if he really believes what the says is true. But to settle the question by practical experiment, once and for ever, let him take a pair of stones from the hands of the makers, and face them as true as they possibly can be. Let the most perfect irons of any kind be put in them, let the bidstone be perfectly level, let the neck and footstep be as tight as they possibly can be, consistent with nonliability to heat. Let the driving wheel and pinion be perfect models of truth; give the runners perfect standing balance, bring it up to its proper speed, and he will find it out of balance while thus running. If not, he will be kind enough to forward the result to the ENGLISH MECHANIC. In his last letter he tells us that he knew stones being allowed to run empty while the mill could be stopped, kicking violently all the time. If such a thing has ever occurred in his presence, I say that both himself and the spoutsman were much to blame. He also says that a different face is the cause of the stones' balance, altering every two or three dressings. Is it not rather a slight deviation in the centre of suspension caused by wear and tear?

THOMAS EVANS.

[We have omitted certain offensive remarks from this letter, which if inserted would have irritated the correspondent alluded to, without producing any corresponding benefit. We are sorry after what we have said that we find it so difficult to discourage personal reflections and unnecessary hard hitting in some of our correspondence.—Ed. E. M.]

COMMERCE AND TRADE.

SIR,—I will add a few more remarks towards the discussion of principles denied by Mr. Jardine, and to endeavour to carry readers' minds somewhat beyond the very narrow bounds to which "F. W. M." would limit them.

I think it can be best done by supposing a case. In France and England there is a party protesting against the Treaty of Commerce as injurious on exactly the grounds taken by "F. W. M." although this treaty is really an approach to the coveted reciprocity; our silk manufacturers and their cotton manufacturers declare they are being ruined by the competition the Treaty has engendered, and the case I intend to suppose is, that these complaints are in both instances correct. Well the narrow view, and that which the interested persons take, is of course that this is an evil to be arrested by some limit to the competition. The wider view is that the buyers in both cases have to be considered, and that all are benefited by obtaining what they want, and that the true remedy is for the unprofitable work to be given up and exchanged for the other; that is to say, the French should make the silk, the English the cotton, and each exchange their surplus for what they require of that which the other can produce best.

Nothing but narrow provincialism, the idea that our own particular spot of earth is of most importance, prevents this truth from being seen and acted on; the narrow view is only a relic of the limited "national" feeling which once made England and Scotland enemies, and at one period saw seven distinct nations in England. The wider view is that which teaches us to regard all mankind as a common brotherhood, each nation really deriving benefit from what benefits the others, instead of the reverse, as is so commonly supposed.

But "F. W. M." and his kindred will say as to our supposed case that the French would like to make all silk, but will not give up their cotton making, but put a fine upon ours to keep it up, and then we must do the same with their silk because otherwise we must pay for their silk in money at a dead loss, and our supposed superseded silk manufacturer must stand idle. Now here it is that people who can see just barely as far as the tips of their noses fall into error. Nothing of the kind would really happen. This energetic and industrious Englishman would simply say to himself, "Well I shall not be quite so stupid as my French friend," he would just make his cotton and send it to India and change it for Cashmere shawls, for which the Parisian ladies would bid him a high price, and with the money paid him for these buy the silk he wanted, and probably put into his pocket a little "profit," our friend the "Harmonious Blacksmith" to the contrary notwithstanding. Of course the case supposed would never happen to any single person as here supposed, but it is what really does happen as far as the national commerce is concerned, and is just what is meant by "Herbert" and others when saying that commerce is really barter, and that taking the average of years the total imports are wholly paid for by the total exports, the higher nominal amount of the former being really the costs of shipment paid abroad and "profit."

Of course "F. W. M." does not look for an answer to such suppositions as those in the early part of his letter; they suppose the nation in the one case a ruined pauper, and in the other a retired gentleman living on his means; both cases quite different from that of an active business-like manufacturer and merchant, which is the actual condition of the case of England.

SIGMA.

MESSRS. CUNNINGHAM & CO.'S IMPROVEMENTS IN OBTAINING MOTIVE POWER.

SIR,—A few weeks ago you described and illustrated in your valuable periodical an invention patented by Messrs. Cunningham, of New Oxford-street, and McCarthy, of Bloomsbury, for obtaining motive power as applicable to the propulsion of wheeled vehicles. Many inventors have laboured under the idea that a large amount of power may be stored up in spiral springs, and a vast deal of trouble and loss has been occasioned by this delusion. That invention seems to me to be thoroughly impracticable, or, as your able correspondent, Henry W. Revely, terms it, "nothing more nor less than perpetual motion." But the fact of its being put forth by gentlemen so well known in the mechanical world as thoroughly acquainted with all its branches, it seems very curious that they should, if such is the case, have fallen into such an error. The value of this invention, if practicable, will doubtless be exceedingly great; yet, not having heard further about it (a proceeding most curious if the invention is perfect), coupled with the aspect of the principles from which it obtains its motive power, when looked at in a scientific view, gives us grave cause to doubt its applicability to the purpose. Perhaps the inventors themselves will come forward and put us right.

I wish your journal every success.

A. SLADE.

AN ENGLISH MECHANIC'S SOCIETY FOR LONDON.

SIR,—My appeal for the establishment of this society, which you kindly inserted in your issue of the 10th inst., has resulted in some half-dozen encouraging replies. As, however, I have reason to think a number of your London readers are expecting something further to appear in your journal, permit me to say that when double the above number of hearty responses have been received, a preliminary meeting shall be convened and further steps taken.

G. G. B., Ripon Lodge, Grove Park, Camberwell.

ANGLES AND TANGENTS.

SIR,—Let me put one word in the discussion between "Hugo" and "Veritas." Have we not

$$\tan. 2A - \frac{2\tan. A}{1-tg^2A} - 2\tan. A\left(\frac{1}{1-tg^2A}\right)?$$

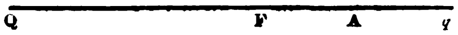
The tangent of twice the angle A is *not equal* to twice the tangent of the angle A. "Veritas" proves that there is always the same relation between the *radius* and the *tangent of a constant angle*, this was not in discussion, I think.

BERNARDIN.

ACCEPTANCE OF GIMEL'S "QUIET CHALLENGE," P. 253.

SIR,—I have a microscope telescope, the object-glass A of which forms an image at q of an object at Q; and the principal focus of the lens is at F.

The relative values of the segments of Q q are



popularly stated in "Brewster's Optics," p. 41, and demonstrated in "Wood's Optics," p. 103: Q F : F A = Q A : q A. I found in using the instrument that there are two positions, and only two, of A between Q and q where equally good images of the object at Q are formed at q. Now Q q = 14·25 and F A = 3·6.

Required from these data, the two positions of A without algebra. I am afraid the detailed solution would trouble the printers, and might be refused space, which is weekly becoming more and more valuable. For the present, therefore, I will merely state, that it becomes a quadratic equation, and the two roots of the unknown quantity, 6 and 7·75, are the answers.

J. STEEL.

SUGAR MILLS.

SIR,—There is one class of machinery which appears to have been entirely overlooked by your numerous correspondents—I refer to sugar mills for extracting the juice from the sugar canes. As this is the time when mills are being made to send to the colonies, in time for the next sugar season, I think it would not be amiss if we now had a little information about them. I believe the only book published on the strength of sugar mills is by Burgh. In it the calculations are all based on the supposition that the length of the roller is equal to twice the diameter; but this, of course, does not happen in the majority of cases in actual practice.

I should like if some of your valued correspondents would give some practical rules for proportioning the different parts, holding-down bolts, roller shafts, &c.: also the pressure required to squeeze the juice out of canes of an average ripeness. Information respecting breakages would also be valuable. As many of your subscribers go out abroad with mills, I am sure they would be delighted with any facts relating to their working, &c. I am myself much interested in them, and should be pleased with any practical hints regarding their manufacture or working.

MACHINATOR.

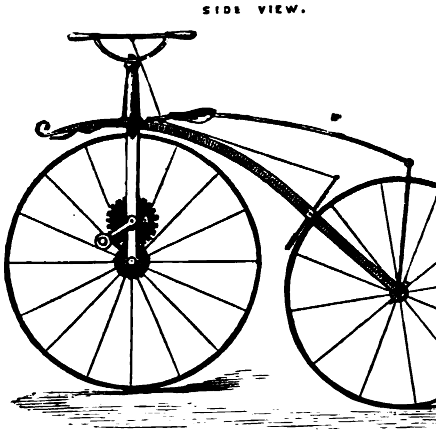
SQUARING THE CIRCLE.

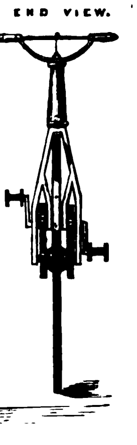
SIR,—The device of your correspondent, Arthur Gearing, for squaring the circle, is ingenious, but it misses the accuracy necessary to a demonstration; for the wedges forming the circle being necessarily curved at the ends, cannot be arranged into a rectangular figure without a "loss of material," which he has evidently omitted from his consideration.

H.

BICYCLE.

SIR,—I beg to enclose you a rough sketch of additions to a bicycle different from any that I have seen in your columns. The advantages of the addition are twofold—firstly, by the addition of the multiplying wheel A the revolution of the driving wheel are doubled without the necessity of moving the feet so fast as formerly; and secondly, by the crank being attached to the wheel A, instead of the wheel B, as is usually the case, the crank is brought nearer to the saddle, which will allow of the driving wheel being made much larger than it is at present; for owing to the average allowed for the length of a man's legs, the distance from the saddle to the cranks must in the present





bicycle be limited to a certain length, or otherwise the driving wheel must be confined to a limited diameter.

I think that if my plan for increasing the speed, and that of Mr. Thomas O. Roberts for steering, were combined, the combination might make a very fast bicycle for a level road.

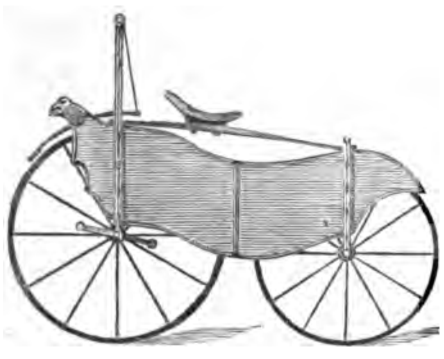
Should you think this sketch and description worthy of being inserted in your columns, your readers are welcome to the idea.

N.B.—Mr. T. O. Roberts' sketch appeared in the number of the MECHANIC for February 12th, 1870.

WM. JACKSON PIGOTT.

THE "MILTONIAN" BICYCLE.

SIR,—Enclosed I send you sketch of a very simple kind of bicycle which I invented last summer, and intended to send it to you then; but I had previously sent a sketch for a spring wheel, and it was not inserted, so that was the reason I did not send the enclosed sketch. But seeing in the last week's issue a bicycle invented by the "Phantom" Veloce and Carriage Wheel Company which was touching on the same principle as mine, I made up my mind to send it.



I can claim some very good features in it:—First, the very simple way in which it is made, as any one that can make a wheel could easily make the rest, with the exception of the ironwork, which is not very much—only the crank, pedals, brake, saddle, &c.—which is not very troublesome to make. Secondly, there is no danger of the legs coming in contact with the wheels, as they are enclosed in a box, which prevents all splashing or dust flying. You will see it steers from the centre, between the two wheels, which are kept together by a hinge joint. The saddle spring can be made of wood or steel, the front end of which would be fixed on an upright pin, so as it could turn, and the back end would be loose, to give freedom for turning. The pedals would be greatly improved if they were covered with indiarubber, which would keep the foot from slipping, and greatly lessen the jolting to the feet. Any other information I will gladly give if required.

A. B. HANDFORD, West Milton, Dorset.

LINK MOTION.

SIR,—I am much obliged to Mr. J. Baskerville for his able way of treating of the link motion. He shows himself however, not very exact on some points of the steam engine viz., lap lead and link motion.

Now if Mr. Baskerville was well versed in link motion, he never would have said what he has, viz.: "that the whole amount of vibration must be communicated to the centre of link." This assertion I must say is not correct, inasmuch as the centre of link is never expected to transmit any motion to the valve; I do not deny that the centre of link does move when at work with the lever at either end notch, but this I do emphatically deny, that the centre of link will vibrate when that centre is in a line with valve spindle and crank shaft, and the diametrical centres are in opposition to each other, no matter at what angles they stand with the crank, because both eccentrics should have one throw, consequently both travel one distance; and at the same speed, but in opposite directions, thereby making the link centre the centre of motion for each end.

Now let me take Mr. Baskerville's supposition viz.: "1⅝in. of lap and ⅛in. lead and multiplying by 2 gives us 3½in." which he "says is the proper amount," but there he is wrong again; because we must have more vibration to open the valve ⅛in. more, making the total 4¼in. in place of 3½in. Now Figs. 1 and 2 will show the position of eccentrics with 1⅝in. lap, ⅛in. lead, take 2⅛in. from 4¼in., of which it is the half, place the eccentric where one half its throw will be expended, with the crank at C, and the port will be closed 1⅝in. or in other words it must be moved forward until the valve is open to ⅛in. for lead, then the eccentric is in the position shown in Fig. 1, E1 which will have to be moved ⅛in. more when the engine is moved in direction of arrow; now if we bring the rod B1 in contact with valve spindle A, the valve will be ⅛ open as lead, but if we bring the rod D1 in contact with valve spindle, we find the valve closed considerably; and to make the rod D1 bring the valve as at B1, we must move the eccentric E, Fig. 1, to E, Fig. 2; thus we see the rods will each give 1⅛in. lead, but the consequence is fearful (perhaps our friend B will explain it to our readers).

Again, Mr. Baskerville says "the belief that the middle of the link has no motion and should, if properly constructed have no motion as I say," now I say again it should *not* when the centre of that link is in centre of valve spindle, and the eccentrics, Mr. Baskerville says they should be; and as they are shown in Fig 3 our friend thinks the 2in. involved by the crossing of rods is communicated to centre of link. Now let me disabuse his mind of so erroneous conception.

Now, for instance, the link being in centre of valve spindle, the rods will vibrate above and below the line of valve spindle A, thereby adjusting and keeping the centre of link as centre motion, and will do so so long as that centre is in centre of valve spindle, but if we bring the rod in contact with spindle, we make that particular rod give motion to the valve until the centre of link is brought to centre of valve spindle, and just the same with rod D, if we stand and watch a link at work, with the lever in the end notch, we shall see the centre of link vibrate; for this reason the centre of link for the time being is not the centre of motion, but the centre of motion will be found about 2in. higher up or lower down if the rod D be in contact, this is caused by what our friend terms the crossing of rods, but principally by that particular rod that is not engaged; being 16in. below the centre line of spindle, thereby receiving all the angles, and causing that end of link to have almost double the vibration, and would make the link into a common lever if the 4¼ of vibration given out by the rod B which throws the centre of motion as shown at 9 Fig. 3. Fig. 1, B1 and D1 shows eccentric rods when lever is in centre notch B3 D3 when at end notches; the same with Fig. 2; the full lines in Fig. 3 represents the rods when the crank is at C B, C D, and C E, respectively.

FIG. 1

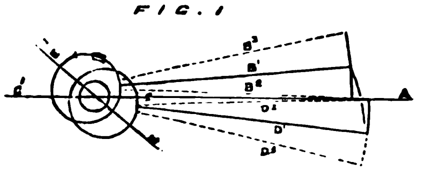


FIG. 2

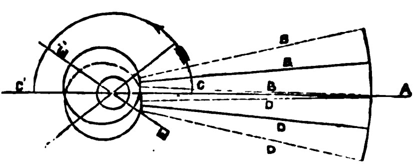
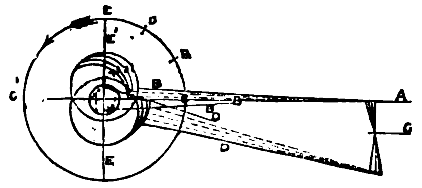


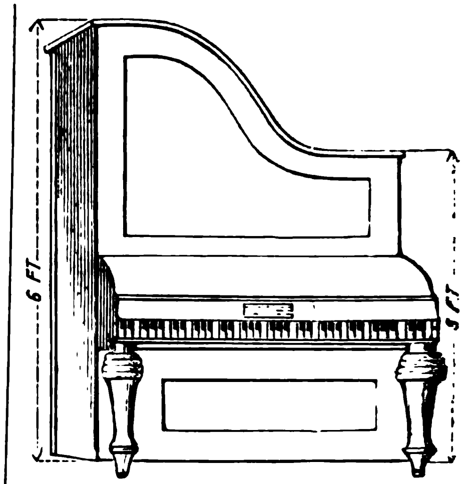
FIG. 3



JAMES HARRISON, Hyde, near Manchester.

STRING SPACE IN THE PIANO.

SIR,—After reading the clear statement of the difficulties in piano construction by your correspondent "W. T." (June 17, page 304) it is very evident that the lowness of the modern pianoforte detracts from its power at least in the bass strings.



Another difficulty is to find a shape of case that is at the same time *saleable* to the general public, and will admit of the greatest length of string.

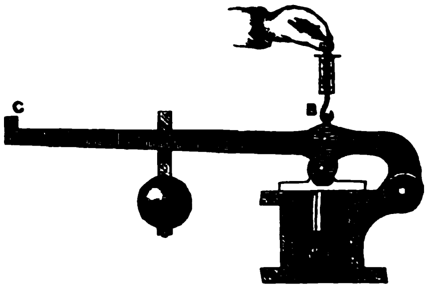
I enclose a sketch I have made bearing these two points in view, which I beg to commend to the attention of "W. T." thinking, if it does not fulfil the one condition of saleability, it would increase the value of the instrument in a musical point of view.

ALEXANDRA.

P.S.—Am I never to have my harmonium of the present with great variety of quality of tone, soft and loud. The harmonium of the future of your correspondent "R. T." justifies its name, and he has never enlightened me on the points inquired about issue of March 18.

BOILER SAFETY VALVES.

SIR.—I read an elaborate account in your No. 272, written by "T. J. O'C.," on the "Safety Valve," and in your No, 273 "J. Howell" gives his theory to calculate the pressure of the same, but in going through the latter, I find there is a mistake in the subtraction. The figures 419, 4910, should be 409, 4910. This throws the remaining part of the calculations wrong. But it strikes me that "Templeton's" way of calculating this valve is much more simple than either of the above, and if you think it worth while to insert it in your columns, I herewith describe it. Take a light line at the centre of valve B, which is 3″ from A, the point of resistance, and hook it on to a Salter's spring balance or steelyard when the valve is connected to the lever, and supposing the weight to be 35lb., this is the effective pressure against the steam at the orifice of the valve, or=5lb. per square inch, the area of valve, and then by adding the weight of a ball, 15lb., which with weight of lever and valve will equal 20lb. to the square inch, and for every 3″ from the point of resistance A, the pressure will be increased 20lb.



FALCON.

READINGS FROM THE GLOBES.—V.

SIR,—In illustrating geographical phenomena by the globes, it is sometimes expedient to consider the earth as stationary, and the stars and sun as revolving round it, but this it is to be understood is done for the sake of illustration and no more, it by no means implies heresy, the party may belong to the orthodox faith, although he makes this supposition. The object in dealing with these questions is to illustrate, not to philosophise, and although astronomers have demonstrated that the sun is the centre of our solar system, and that the stars have a proper motion of their own, it will not at all militate against their conclusions, when, for the sake of illustration we make assertions which seem to contradict them. In the following remarks we shall consider the pole star as immovable, and we shall move the globe in any direction as may best answer our purpose. If Archimedes was unable to move the world, for want of a place on which to fix his machine, we can at least move our miniature globe to suit our convenience. The sphere may be represented under three aspects. (1) the right sphere, (2) the parallel sphere, (3) the oblique sphere; and we shall show the appearance of the sun and stars to those who live in each of them. These aspects of the sphere have particular reference to the pole star and the equator. Where the equator makes right angles with the horizon, as in Fig. 1, there we have a right sphere, and in whatever sign of the Zodiac the sun is shining, whether he has north or south declination, he is always 12 hours above the horizon to places which have no latitude, as Quito, &c. Let the two poles of the globe be placed in the horizon, and we shall have a representation of a right sphere, and the inhabitants of the globe who live in this position of the sphere live under the equinoctial, and, the consequence is, that the pole star being immovable with respect to the earth, this star will be in the northern horizon, and nightly when the firmament is clear, it will be visible to them in the same place, and in fact, these people have much better opportunities of examining the stars, and in consequence of becoming excellent astronomers, than those in higher latitudes, for they have the advantage of being able to examine the whole canopy of the sky in the course of the year, without travelling to other countries for this purpose. All the stars north and south of the equinoctial will in due course appear to them, for as their view extends 90° northward and southward, they will be able to command a view of the whole. Daily, new stars will rise in their east, until the whole tour of the sky is completed, for when the sun is in Aries, (not taking any account of the precession of the equinoxes) the constellation Libra, will be on their meridian at midnight, Taurus Poniatowski will be rising and Orion will have just set, whereas, when the sun is in Libra, Orion will have just risen, and Taurus Poniatowski will be setting. By turning round the celestial globe, from east to west, we shall find that the inhabitants of the equator will lose sight of half the stars for six months. Some of the constellations, those for instance in the equinoctial, as Orion, will perform a large circuit, going round in a vertical circle, but the Great Bear will appear near their northern horizon, performing a small circuit, and the Southern Cross towards the south, the one being nearly opposite to the other. The sun will be vertical to them every six months, and his meridian altitude will never be lower than 66½°—that is, it will be rather higher in altitude than the meridian sun of June in our latitude. Those who live in a parallel sphere, as at the poles, (Fig. 2), will lose sight of the stars for six months, not because they go below their horizon, but because the rays of the sun will prevent them from appearing, and when they do appear they will go round them in parallel circles, the pole star being in their zenith, and even then they will only behold half of the stars in the vast concavities of space, but as a compensation for this, they will be blessed with the sun's rays for six months, he appearing to describe a spiral circle round them. All the other inhabitants of the globe live in what is called an oblique sphere, (Fig. 3), the obliquity increasing more and more as we approach the poles. In an oblique sphere in our hemisphere, the polar star is always at such an altitude above the horizon as is equal to the latitude, and the consequence of living in an oblique sphere is, that the length of day and night constantly varies, the least to those nearest the equator, and the greatest to these nearest the poles. Nearly all the inhabitants therefore of the torrid zone will have an opportunity of seeing most of the stars in the course of the year the noted constellation, the Southern Cross, being visible to all of them. By elevating the pole to the latitude of any place, this will be readily apparent. Thus, London will never see stars beyond 38½° S. latitude, that is, a few degrees below Formelhaut in the Southern Fish, whereas in Australia, the Great Bear will be below the horizon, and invisible. Thus the whole of the globe is visited with an equal share of the sun's rays in the course of the year, and there is nothing hid from the heat thereof the long days of summer, making up for our loss of him during the winter.

FIG. 1

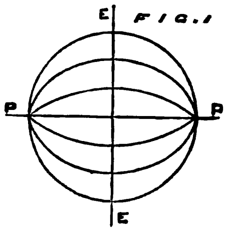


FIG. 2

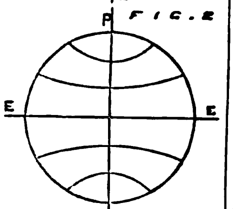
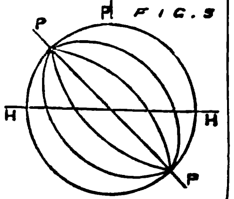


FIG. 3



F. S. H.

P.S. For eclipse read ellipse, in letter 3, p. 278.

WATER ANALYSIS.

SIR,—My attention has recently been drawn to a series of letters in the ENGLISH MECHANIC, on Water Analysis, signed "George E. Davis," "W. R.," and "Urban." "W. R." is anxious for an impartial opinion as to the relative merits of Frankland and Armstrong's method of water analysis, and Wanklyn, Chapman, and Smith's method. As you will perceive by the signature to this letter, I cannot be supposed to give an impartial opinion. I will, however, place before you the points at issue between Messrs. Frankland and Armstrong and ourselves, I must premise that the modification of Dr. Frankland's process, described by Mr. Davis in your pages, will not yield any reliable result unless a multitude of precautions, not hinted at in the letter, be taken. The volume of gas to be measured is so exceedingly small, that if these precautions be omitted, we are certain to obtain as much stray gas as will absolutely vitiate the result. My remarks apply therefore only to the process as described by its authors.

"W. R.," quoting from memory, says that *I* stated that the experimental errors of Frankland's method exceeded the quantities to be estimated. This statement was made by my colleagues and myself, and under considerable restrictions—viz., that the errors on the *published experimental results* of Frankland and Armstrong exceeded the quantities to be estimated. This is a question which anyone possessed of the powers of subtraction and comparison can settle for himself. Of course, the method may have been since greatly improved. It may be that these experimental results do not represent the average error, but there are no other published results on which we could form an opinion. This, therefore, was not a hasty assertion, made in the heat of argument, as "W. R." would imply, but simply an arithmetical fact, as he may convince himself by examining the paper in which the assertion is made in the *Journal of the Chemical Society* for 1868, p. 152, and following. Moreover, this expression was the result of a critical examination of Frankland's method, forced upon us by the extraordinary argument employed by Dr. Frankland—viz., that as his process and our process, when applied to the same water of unknown composition, yield different results, ours is necessarily wrong, and his right.

There are other points in dispute between Messrs. Frankland and Armstrong and ourselves:—First, are nitrates completely decomposed by the treatment recommended by Messrs. Frankland and Armstrong? We assert that they are *not*, and they, on the contrary, assert that they are. Second, is ammonia completely retained by sulphureous acid when its aqueous solution is evaporated with that acid? We assert that it is not so retained, and they imply that it is. Lastly, they operate on the residue obtained after the water has been all evaporated away. We maintain that no method of estimating organic matter in water is valid which necessitates this condition, as the organic matter is liable to be greatly changed, and even in some cases totally to disappear during the evaporation. On these points we have collected many experimental data, all of the simplest kind. Any one, even though he be not much of a chemist, can repeat our experiments; and without in any way wishing to pronounce a decision in the matter myself, I think I may request any of your readers who are prepared to go through the labour of making a water analysis by the method of Messrs. Frankland and Armstrong to devote a few hours to the study of the paper mentioned above, and to a verification, by experiment, of the results mentioned.

A word or two in conclusion on the actual measurement of organic matter contained in water. If one kind of organic matter only existed in water, it would doubtless be desirable to measure it, and would be a very easy thing to do; but the organic matter which exists in water consists of a multitude of different bodies mixed in proportions which vary probably with every source of water supply. Therefore, the actual measurement of organic matter is without interest. But, on the contrary, we hardly know of a virulent organic poison which does not contain nitrogen; and we do not know of a single germ, or egg, or living creature of any kind, which does not contain nitrogen. Therefore, the amount of the nitrogen forms a kind of limiting value beyond which the deflement of the water does not extend. It may not extend so far, but at this present time we are without any means of distinguishing between one variety of nitrogenous organic matter and another. As our method of analysis deals with the nitrogenous organic matter only, and brings out its nitrogen in the form of ammonia, we have called it the "ammonia" method, and not the permanganate, or alkaline permanganate method, as some of your correspondents have done. These latter terms are apt to lead to its being confounded with an older and now exploded method.

ERNEST T. CHAPMAN, 3, Redland-terrace,
Durdham Down, Bristol.

TEMPERING SMALL DRILLS.

SIR,—There have been several queries and answers in your columns on tempering drills, and I presume that "Burslem" (No. 2007) had not observed the several replies previously given on the subject, which, being one of great importance to practical and working mechanics, I beg to add my brick, as it appears that none of the answers allude to a very simple and effectual method of tempering small drills which I learnt from a working watchmaker in 1840, and have *proved* by many years' constant use. It is as follows:—Heat the point of the drill to redness, and plunge it quickly into a lump of common yellow bar soap, and it will be found to be of a fine "straw" temper, and will stand better than if first hardened and then lowered to the required colour in the ordinary manner. The degree of hardness is regulated by the amount of heat applied, also by the nature of the steel. Cast steel requires a lower heat than shear steel or spring steel, but no attention is required to the colours, which is a very great convenience, especially in very small drills, and also at night, when it is often impossible to catch the proper colour in time to ensure a fine cutting edge, and hence there is often serious loss of time (and temper also) to the workman. I have used this method for drills up to ¼ diam., and consider that its value and success result from the fact that the cutting edge is left of higher temper or degree of hardness than the inner particles of the steel, which, of course, are cooled slower than the surface, and consequently drills tempered in this manner will not be found so apt to fly as those treated in the usual way, as described by "A Morayshire Man" (page 235), which leaves the interior of the hardened steel of a higher temper, owing to the reducing heat being applied to the surface. I need hardly add that the temper of the shank of the drill can be regulated by the extent to which the heat is allowed to extend back from the point.

AMATEUR TINKER.

CUTTER BAR.

SIR,—I see I made a mistake in my drawing on p. 285, Fig. 1, in representing the set screws as tapped in the flange of the instrument, they are right in the perspective view.

J. K. P.

THE AERONAUTICAL SOCIETY

SIR,—At a late meeting of this society, reported on p. 295 of your journal the chairman observed that there were no more probable means of obtaining perfect aerostation than the combination of great initial velocity with an aero inclined plane, an idea evidently derived from the fact of a common kite being sustained in the air, when held by the line, in such a manner as to float in an inclined position. It was also suggested, that by fixing an aero plane of oiled silk in an inclined position to a velocipede, a step forward in the right direction might be made. However that suggestion may turn out in regard to actual flying, it is a good one for velocipedes, which if moving with sufficient velocity with the inclined plane attached, would tend to rise from the ground, and thus lessen the friction and fatigue of the driver. In this case the action is somewhat the reverse of the kite, for the carriage produces the wind, while at the same time it holds the inclined plane in the proper position, just as the belly-band holds the kite against the natural wind.

Now a bird flying against a moderate breeze does not move at a much less rate than twenty miles an hour, as may be observed from a train going at that speed. But the velocipede, as now generally constructed, cannot be driven at anything like that rate, for at ten miles an hour only the legs of the driver must make about ninety double strokes per minute, even to attain that speed, an evident impossibility. The "velocifere," however, offers a solution of the difficulty, for it can easily be driven at the rate of twenty or thirty miles an hour, and the oiled silk inclined plane attached, would tend to relieve the driver in some measure from the resistance of the atmosphere, very great at high velocity, by taking off a considerable portion of the weight of the carriage. The suggestion of propellers to act on the air, I believe to be impracticable.

HENRY W. REVELEY, Reading.

ACCUMULATING AND UTILISING POWER.

SIR,—In the vast and rapidly progressing countries bordering on the River Plate, English settlers find one great drawback in the scarcity, often absolute want, of fuel, the cost at any considerable distance from the ports being from £10 to £15 per ton for coal, hence steam (until the plantations now growing, can give the requisite supply of firewood) cannot be employed as motive power. From the level character of the Pampas, water power cannot be got, consequently our only available resources are wind and the countless thousands of bullocks and horses which cover the country. Can any of your ingenious readers suggest a method by which the power of a windmill or horse-roundabout, working, say three days, could be accumulated or stored up in a machine, capable of giving out the whole of the power thus accumulated during the fourth day, for working a set of Fowler's ploughing tackle, pumping water for irrigation, or any other operation requiring more and steadier power than can be got out of the fluctuating action of a windmill, or the equally unsatisfactory work of a horse-roundabout, it being in practice impossible to drive the animals so as to obtain anything approaching what their combined power ought to be. I enclose my address.

RIVER PLATER.

POTATO GROWING.

SIR,—Seeing in the number for June 10 Mr. Wilkins's plan of growing potatoes, I am induced to ask for a small space to present my brother readers with a somewhat similar system, recommended by a first-class gardener in the *Nottingham Guardian*, some little time ago. My lot happens to be cast in a potato producing county, and we are on all sides trying this method, and the plants (despite the unfavourably dry weather) are looking first-rate. His system is to rake the surface of the ground you wish to plant, then lay down (by line) the seed, 1ft. 6in. apart. When the row is complete, draw the soil over the potatoes with a hoe, to the thickness of three or four inches, the next row 3ft. from the first, and so on. Now you see by this plan, the tubers are on a level with the surface of the ground, consequently more under the influence of the atmosphere and sun, which I think is a point gained over Mr. Wilkins's system. The plants, in their growth, do not require the pea sticks, and the yield is set down at 30 tons per acre on the average. Several of us have compared the two systems, and intend trying them side by side another season, and if we are spared, the result shall be known to the readers of the ENGLISH MECHANIC.

BANTING.

MICROSCOPIC CONDENSER, &c.

SIR,—Your correspondent "X. Y. Z." (page 305) seems to be using a very deep Kellner eyepiece as an achromatic condenser. I presume he has removed the cap which covers the eye lens of the eyepiece (that lens being used uppermost). If, when this has been done, the eyepiece still interferes with the movement of the substage, I should recommend him to exchange the Kellner eyepiece for one of somewhat less power and longer focus. An ordinary objective will make a convenient condenser if used with the lower lens next the stage. The objective may be the next lower power to that used in examining the object.

The wedges into which "Arthur Gearing" (page 301) has divided the area of his circle, have, of course, curved lines for their bases, these being small portions of the circumference of the circle; but in the parallelograms the wedges are triangular, the curved bases being replaced by straight lines, necessarily involving some change, however slight, in the area of the wedges, and consequently causing the square to be, at best, of very nearly the same area of the circle, which is evidently no solution of the problem.

W. H. G.

THE THAMES.

SIR,—To those of your readers who can handle an oar or a pair of sculls, I can recommend a week's picnic on the Thames, starting from Oxford and finishing about Richmond, nor is any great skill or strength necessary. I like my ease, and being middle-aged, and having a tendency towards a corporation, prefer the steering, and from a lameness in one arm, cannot stand either hard or long-continued work, yet the above excursion is not difficult for me. It will be observed that my proposal is to come *down* the river. Messrs. Salter of Oxford, and probably the other boat builders, let boats for this voyage, and carry them back by road. The terms are not exorbitant. I paid £2 10s. for the first week, and 10s. per week afterwards for a gig with pair oars, pair sculls, and a small lug sail, the latter being, in their light boats only of use when the wind is, as a lady friend expresses it, "abaft the funnel." The boat may be left at any convenient point where there is a boat yard, or sometimes in charge of the lock-keepers, and from that time the hiring ceases. This is convenient in case of a promising spell of wet weather. The crew should consist of two, three, or four persons. In the two latter cases, one or two should be ladies (of moderate age), but a single voyager, paddling his own canoe, will find it a most enjoyable trip. I went to Oxford, and to Salter, a perfect stranger, and obtained a boat without difficulty, but it would be better to write beforehand, stating what is required.

Now as to board and lodging. There are plenty of inns along the course of the river—and they are really inns—neither hotels nor public houses. They are however, often full, particularly in autumn, and on Saturdays and Sundays at other seasons. When this is the case it is a good plan to leave the boat in charge of a lock-keeper, and walk off to some village a mile or two inland. Very primitive accommodation will thus be met with occasionally, which will give zest to the voyage. It is, however, rather jolly to carry with you the breakfast machinery, including the means of getting hot water, either by a spirit lamp or by a fire of sticks on the bank. Milk can generally be obtained fresh from the cow, and the other materials may be laid in at any village. A railway rug will often be found convenient, particularly if you feel inclined to disregard the popular prejudice against sleeping at night in the open air.

There is a map of the course of the Thames from its source, to its mouth, sold by most booksellers, which is almost a necessity to anyone unacquainted with the river. It shows the position of the locks and inns, and supplies much other useful information—price 2s. or 3s.

If time will allow, a sketch book, a camera, or a fishing rod may be added to the other impedimenta.

R. S.

CHEAP GAS.

SIR,—"Cheap Gas" (3819 No. 269) asks how to reduce his "*Gas Bill*," and "L. M." (page 260 Vol. XII.) tells him that nearly all the plans for carburetting coal gas have proved failures, or at least have been abandoned on account of the difficulties and the absence of the economy anticipated.

Now as the question of cheap gas is a very grave and important one to us all, touching our pockets, our eyes, and our health also, I do not think your readers will wish the subject should be so quietly disposed of in the off-hand manner "L. M." appears to think it ought to be.

He certainly is not well informed upon the real facts and principles involved, and it would have been better had he given his opinions, and then invited those of some of the talented chemists who have contributed such valuable articles in the pages of the ENGLISH MECHANIC.

I have hitherto refrained from offering any reply, hoping that some one more able to do so would have taken up this important and pressing subject, but as a month has nearly passed, and only one correspondent has written in reply, to tell us a very simple and good plan to regulate the flow of gas to the burners, which is very useful as far as it goes, yet the original question of "Cheap Gas" remains unanswered.

I have given some attention to this subject, and have no interested motive, and perhaps a few practical remarks may prove of interest to your readers, and help to ventilate the question more fully, though of course we must be prepared for objections from parties interested in the existing gas companies, whole interests lie in making large gas bills at the least possible outlay in manufacture. Hence there is a constant strife between these interested parties and their customers. On the one hand the gas is kept at the lowest possible illuminating power that the law will permit, and on the other hand bitter complaints come of long bills and high prices.

I do not wish to follow this part of the subject, but only refer to it in order that we may get at the real state of the case, for really cheap gas is good gas, and the question therefore is, how are we to obtain good gas?

"L. M." would wish us to believe that the attempts hitherto made to enrich poor coal gas are not found to be economical, and he tells us of two or three patents, but the real fact is that the number of patented apparatus for this object are nearer one hundred, and are probably all equally without real claims to novelty, being all based upon two well-known facts—viz., that the illuminating power of hydrogen gas entirely dethuds upon the amount of carbon present in its flame.

N—The great affinity of hydrogen gas for the hydromotrn vapour, such as benzole or naptha.

"thatl coal gas is rich in these vapours as it passes municahe retorts, but the gas companies find it expemust ; s.extract a greater part of these condensable of link is and supply their customers with a very low the valve minating gas

move whence was also lowered in proportion, there but this I so much to complain of, perhaps, for link will vibreasons, well known to practical chevalve spindle e have to do with gas as it is, let us centres are in attention to the best plan left us, which what angles the store the illuminating element to the eccentrics should quantity required to give a certain travel one distancay be reduced, and the nature of opposite directions rom the dirty yellow red to clear the centre of motionnot least) less heat and less car-

Now let me takeuric acid fumes discharged into viz.: "1½in. of lap antand hence into our lungs, begives us 3¼in." which he destruction of all property but there he is wrong ase great question therefore is more vibration to open

Dr. Letheby, the great gas analyst, says (in his lecture upon gas lighting) that it can, as follows:—

"Experiments have been made for the purpose of determining the value of the light for the benzole or naphtha consumed, and the results are that every grain of the vapour taken up by a foot of common twelve-candle gas increases its light ten per cent."*

The soundness of the theory being thus established, it only remains to carry it out in a convenient and efficient manner, and for this hundreds of contrivances have been proposed, patented, and discarded, chiefly owing to the fact that the gas in passing over the naphtha always takes up the lighter portion in vapour, and thus the fluid gradually becomes less volatile, and heavy, till at last no more vapour is carried off by the gas at the ordinary temperature, and the illuminating power of the gas is lowered to its former strength, till the vessel is emptied and fresh naphtha added.

But the advantages to be obtained have kept the question before the minds of the scientific world, and latterly there have been plans adopted to avoid the above-stated difficulty. The price, also, of benzole and other products of coal tar is now so much reduced, that the economical carburetting of coal gas can now unquestionably be done with great advantage and success, resulting in a saving of at least 30 per cent nett.

In No. 263, for 8th April, page 64, there is a description and drawing of a very simple and cheap plan for carburetting gas for use in the magic lantern, which will be sufficient to explain the whole process, and which can be made up by anyone wishing to try the experiment himself. Such a bottle apparatus is capable of properly carburetting ten or fifteen feet of gas per hour, and I have used such a rough affair for several years with repeatedly tested results, using the benzole sold at 4s. 6d. per gallon. I found the power of the light increased in an astonishing manner, as given below:—

With common coal gas (pressure $\frac{8}{10}$th.) No. 2 fishtail burner, consuming 3ft. of gas per hour—

Power of light with common gas = 2½ candles.
Do. do. carburetted gas = 7 candles.
Naphtha consumed 1¼ pint per 1000 ft.
Increase of light, 175 per cent.

It is not to be expected that such results could be obtained in ordinary use, but I give these facts to show what can be done by judicious management, and the use of good and small sized burners. If I had used a large sized burner the advantages would not have been so striking (probably not more than 100 per cent.) so that small burners should be used for rich gas, and if more light is required, multiply the number, but do not use larger sized burners than No. 2 or 3.

Having thus given experimental results, I may mention that I believe the best (because the simplest) apparatus I know of is Woodward's patent, of which I enclose a drawing, but I do not wish to use your columns to puff anyone's invention or patent, my object being to prove to your readers that it is practicable to reduce their gas bills, and to lay before them the advantages of carburetting or enriching poor gas.

But there are also dangers to be guarded against, as we all know (or should know) that naphtha is highly inflammable, and requires to be handled and used with the same care as spirits of turpentine, and such other spirits and fluids, therefore in fitting one of these carburetters near the meter, it must be placed so as to be filled by daylight, and a cap and padlock fixed to prevent anyone tampering with it. The fluid is not explosive, and is of such strong smell, that the least leak or escape of gas is instantly detected, which is a very important consideration.

The insurance offices have of course a voice in this matter, and a proper report must be made of the fitting and nature of the apparatus, but as it will require only to be refilled twice or thrice a year in ordinary cases, and to be always done by qualified persons, there will not be any objections made after due and official inspection has been made.

There are other plans for using heavy naphtha, which will require to be heated over each gas burner before it will give off vapour, but these are more adapted for the workshop, factory, or open air, in which they answer very well, but require to be refilled every fortnight or so. In these plans, all difficulty with insurance offices is avoided, and where a working man only rents a room or so, and requires one or two good lights, without outlay, or altering the gas fittings of the house, &c., it would be the best plan to adopt.

Dr. Bowditch, of Wakefield, is the patentee of one of these plans, and a firm in Westminster have another (Kidd's patent), which has been fitted to all the pendant lamps of the new terminus of the Midland Counties Railway, at St. Pancras, but appear expensively made.

In conclusion, I may add that where the size of the burners in use with common gas is not reduced, when the gas is enriched in proportion as the power of light is increased, it is not wonderful that no saving is found to result, nor can the human eye be trusted to judge of the increased light being maintained, for habit so misleads the judgment, that nothing but actual test by photometer can be relied on for proof of the improvement being continued.

I have used carburetted gas in my house for several years, and find the annual saving in gas to be fully maintained at nearly 50 per cent. as at first.

C. D. C.

BATH FORUM RECREATIONS.

SIR,—In your number of June the 17th you invite notices, hints, suggestions, and information on excursions, tours, &c. Enclosed I beg to send you a prospectus of the Bath Free Forum Summer Amusements, which, though not exactly of the character you indicate in your note, may still be interesting to some of your readers who are desirous of promoting pleasant pastimes for summer mornings and evenings. The Bath Free Forum commenced in the beginning of last winter with holding weekly meetings for the free discussion of any local or general questions of importance, and it proved to be such a success that the committee of management, under the efficient presidency of the Rev. J. MacNaught, M.A., decided to do something to entertain the members (and any others willing to join them) during the summer months. With that object in view, they framed the rules of which the enclosed is a copy. In order to prevent any loss that might accrue falling on the committee, or only a few of the more earnest friends of the movement, about one hundred were canvassed, and readily consented to pay 10s., or any portion of 10s., that might be required for that purpose. To purchase the necessary implements, seven gentlemen advanced £10 each as a loan to the society, to be repaid when the subscriptions of members enabled the society to refund it.

The society provides boating on the river, cricketing, football, quoits, croquet, &c. They have three boats, of various sizes, and such other things as may be wanted, according to the number joining. The terms of membership are—5s. for gentlemen, 2s. 6d. for ladies, for the whole of the five summer months, May to September (inclusive), or 1s. per month gentlemen, 6d. ladies. During the first month about 250 joined, and as a result the boats are in constant use during the hours fixed by the committee—*i. e.*, from half-past five to ten in the morning, and five to half-past nine in the evening. On an average, there are about 40 to 50 players at cricket daily, about 30 to 40 croquet, and the other sports are proportionately well patronised, and new members are added to the list daily; so that up to the present time about 150 daily avail themselves of the privileges of the society, and there is every prospect of its being self-supporting, and possibly leaving the boats and other implements of the society a clear profit at the end of the season. In addition to all this, it is intended to arrange excursions for pleasure, scientific, geological, and archæological inquiry, to various places of local or historical interest. At the end of the season I think the committee of management will be able to congratulate themselves in having promoted a good deal of healthful and innocent recreation and enjoyment, cultivated a large amount of social and agreeable intercourse among many who otherwise would have remained strangers, kept many away from the public-house and other places of doubtful amusement, and encouraged and fostered a taste for pursuits of a profitable and educational character.

If any of your readers would like further information as to the working of this society, I shall be pleased to give it them either direct or through the columns of your valuable magazine.

R. P. EDWARDS, Bath.

SHORTHAND.

SIR,—In the multitude of councillors, the wise man said, there is wisdom, and I trust that "Hermit" and any other recluse anxious to obtain a knowledge of the coveted art will be led into the right path. I fully endorse "W.'s" statement respecting Pitman's phonography, and would recommend "Hermit" to obtain "The Reporter's Guide," written by Mr. Reed, one of the best shorthand writers in the world, capable of writing 200 words a minute (if necessary) and read them afterwards; he can get it through a bookseller. I am sorry to say Mr. Grierson has said without proof (at least to me) that Pitman's is the worst system. I deny it, for I learnt Odell's, or Taylor's Improved, but Pitman's is far superior to it. I am between 40 and 50 years old. I was anxious that a son of mine, desirous of being a compositor, should learn shorthand. About three years ago I began to teach him Odell's, but having heard a great deal of Pitman's, I made inquiries about it, and from the recommendations I received in its favour I was determined to master it. I practised with my son for about 12 months, and then I received a teacher's certificate. I can now follow close upon the heels of an ordinary speaker, whilst my son (16 years of age) can write 130 words a minute, and perhaps more at a pinch. Another young man (19), to whom I gave lessons for 12 months, but who had a slight knowledge of it before, is now reporter on a paper published here; and I have a report of his of the re-opening, last week, of a church by the Bishop of Bath and Wells, which occupies two-and-a-half columns of the paper (*Daily News* size). Phonography should not be judged of by the operations of those whose inaptitude would condemn any system, but by that of those who can and do catch and imprison the winged words as they fly. If Mr. G.'s assertion is correct, we must be foolish (I think the noun more appropriate) to follow such a system. But may I ask him what other system can boast of so many admirers as Pitman's, whose devotees are to be reckoned by thousands? What system besides publishes a "Shorthand Magazine," a "Cabinet," a weekly "Phonographer," and a "Phonographic Student," in shorthand, beides the Bible, Prayer Book, and a host of others? "Hermit" will find it unnecessary to purchase different systems and to amalgamate them; it is mere waste of time. Let him get *one* (I recommend Pitman's), and stick to it, bearing in mind that there is no royal road to shorthand. The phonographic motto is, "Practise and Persevere." That which is easily gained is lightly valued. Phonography can be read at any time, if carefully written; and as it has three positions for writing it (for reporting purposes it is unnecesary, except now and then), to insert any vowels, and then generally one is sufficient; whilst half-a-dozen words can be written without taking off the pen.

T. CRIDLAND, Williton, Taunton.

SIR,—In the MECHANIC for the 24th instant there is some correspondence on shorthand, in which Pitman's system is spoken of in disparaging terms; I hope, therefore, you will permit me to say a few words on the other side of the question. I do so on the ground that "those only who can speak from experience ought to express an opinion on the relative values of various systems;" and I think your correspondent, Frank W. Grierson, will admit me among that class when I state that I have written shorthand for nearly 30 years, Pitman's for 24 years, and for the last eight years have taught it extensively in public and private.

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*Lecture upon the Chemistry of Gas Lighting, by HENRY LETHEBY, Esq., M.B., &c. Delivered at Birmingham, before the Society of Gas Engineers, 1865.

Both your correspondents object to Pitman's system because its thin and thick strokes represent *different* letters. Now, this is not exactly true. Pitman's system is based upon the sounds of the English language, and not the letters of the Roman alphabet, and his rule is, similar strokes should represent similar sounds. Thus, he represents *p* and *b* by similar strokes, because of their similarity in sound; so with f and v, *th* in *thin* and *th* in *thine*. It is also possible, nay more, it is easy, to make a difference in the thickness of the strokes when writing rapidly, and so far from being "practically illegible unless the shorthand be transcribed while the subject is fresh in the memory." it is well known that reporters have frequently turned over their note-books to the compositors, who have from them set up the type without the matter being transcribed into longhand; and even lads between 12 and 16 years old have many times set up from my notes, in which I had inserted a few vowel points. But granting, for the sake of argument, that thin and thick strokes are not possible in rapid writing, the principle upon which they are arranged in Pitman precludes the possibility of mistake in reading. I will even grant that a case may occur where the grammatical construction of the sentence would not be a guide to the reader when thin and thick strokes were not observed (such cases are very rare), yet such are the [illegible] sources of phonography, as to variety of outlines, that the emergency would be provided for.

F. W. G.'s next objection is to the vowels. Here again he is in error, which is not remarkable, for he says both Mackenzie and Pitman "have long departed from his memory." There are not, as he asserts, six vowel positions (it would indeed be "ridiculous" if there were), but only three—namely, the beginning, middle, and end of a consonant, and the difficulty which F. G. appears to have felt about placing the vowels would occur to none but the merest tyro. The instruction book is very lucid on this point. The fact that there are thousands of persons in this country and America who are constantly corresponding with each other in Pitman's system, and who prefer it to longhand, both for the ease with which it can be written and read, is sufficient answer to the charge of illegibility.

In conclusion, allow me to say that the daily *Times* employs 19 Parliamentary reporters, 16 of whom write Pitman. These, at any rate, do not find it "complex and unsatisfactory," as your correspondent MacD. did.

SUTCLIFF ROBINSON.

ROCKSALT MINE, NORTHWICH, CHESHIRE.

SIR,—Allow me to give to the readers of your very superior periodical a short account of my visit to the Northwich rocksalt mine, during Whit-week. This special mine, so opened for inspection, is in the occupation of Mr. Stubbs, who every year has it illuminated by upwards of 1,000 candles at one time, so that for the three days it was illuminated this year 10,750 candles were consumed. The number of visitors, chiefly from Manchester and towns around, this year, was 1600, *This is one of the largest salt mines in the valley of the Weaver, and will well repay a visit. Outside there is nothing to distinguish this from any other salt mine. There are the usual appliances for raising the mineral, which is generally, as here, done by two shafts, serving also for the ventilation of the mine.* Down by both these shafts visitors descend in the large kibbles or buckets used for conveying the salt to the surface. These are attached to long, flat ropes wound round a windlass, and worked by a steam engine. The shafts are each about 350ft. deep. The time occupied in the descent is about two minutes. On reaching the bottom the sight is most magnificent. The effect of so many lights, in higher or lower positions on the crystalline walls or massive salt pillars which are left standing to support the roof, is similar to what one might behold in looking down upon a large city when only the thousands of gaslights are seen streaming out into the darkness. The effect is considerably heightened by the many pillars breaking the long line of walls, so that no very great distance can be seen without an interruption, such as would occur from one street crossing another. Thus the long lines of light are everywhere seen in part, now ascending, or else descending, as if the street climbed a hill or descended into a valley.

During the time of inspection, not only may refreshments of all sorts be obtained, but amusements also, for a good band is in attendance, which every now and then sends forth strains of martial or dance music, to the inspiriting notes of which many feet soon begin to thread the mazy dance.

For the instruction of those ignorant of mining operations, a few men are kept working in another part of the mine, showing how, with their drills and other implements, they bore and blast the rocksalt, tearing it from its native bed in great rugged masses. It approaches the terrific when their operation for blasting is completed and the match takes hold on the charge of powder. Reverberation follows reverberation, as if the sides and roof were collapsing, or there was a complete ruin. But the visitor is soon reassured again, for perhaps his eye falls on an illuminated V. R., or a ship, or arch over a pool of water, and the reflection therefrom, or a line of streets in candles.

The capacity of the mine is such that from 5,000 to 10,000 persons might easily be contained. The floor is mostly even, except where the men are working, or have left a hollow which the little water has filled up. But mostly it is dry. It is in this respect a contrast to the world-renowned Wieliezka, which has a chapel, renning stream, fresh water lake, &c.; but on the whole, it is one of the best sights on the Weaver, if not in all Cheshire.

B. W.

LINK MOTION, POINT MOVERS, ECCENTRICS.

SIR,—When reading over my last letter in No. 273, I perceived an error in that part of it which contains my observations on Mr. Harrison's letter on the link motion. In the fourth paragraph I have said, that in the link there spoken of, "4¼in. is the minimum mount of vibration which the middle of the link should have when working, and to obtain that the centres of the eccentrics must be shifted round towards each other to a position 1¼in. in advance of the diameter line upon which they stand at present." Instead of 1¼in. it should be 1⅛in. I do not know whether it is a printer's error or my own mistake, as I kept no copy of that letter, however, it is of no great consequence, as the example then given was only meant as a sort of general illustration of the necessity there exists for motion at the middle of the link, and also of the impossibility of constructing that apparatus so that it shall have no motion at that part.

"Paul Pry" asks, "Do two prime movers ever work in connection, such as a steam engine and a water-wheel, and if so, how is the coupling arranged so that one cannot over-run the other?"

It is very common for steam engines and water-wheels to work in connection, and they do so very harmoniously, and no special coupling is necessary for connecting them, the common coupling being quite sufficient, as under proper management they have no tendency to over-run or drag each other.

Ascertain the least quantity of water which will drive the unloaded water-wheel at the proper speed of the mill, also ascertain the lowest pressure of steam which will work the unloaded engine at the same speed, then all water and all steam over and above these ascertained quantities go to do useful work in driving the mill, and neither over-running nor dragging can take place till either the water or the steam falls below these quantities, neither is a governor to the water-wheel indispensable in procuring harmonious action between the two, for the steam engine governor is quite sufficient for the purpose of governing both. Thus, suppose the water in the pond is slowly rising, more will pass over the sluice into the wheel, and an increase of speed will be the consequence; but the engine governor feels that, and immediately checks it by shutting off some steam. On the contrary, if the level of the water is gradually falling, less will find its way into the wheel, and a reduction of speed will ensue, which is also felt and promptly remedied by the enine-governor admitting more steam to the cylinder.

I do not mean to say that a special governor to the water-wheel would not be an improvement, though not indispensable, and no person need be at the expense of putting up one for that purpose, as the steam engine governor can, by proper appliances, be made to regulate the admission of water to the wheel. "Paul Pry" also asks, "What is the practical method of setting the eccentrics upon the crank-shaft, so that they shall have the required angular advance of the cranks?" and asks me "to select as an example, eccentrics adapted for the link motion?" "Paul" is not the only person, by a good many, who has asked that question in your columns, for I have repeatedly noticed similar enquiries from others for several years past, but I have never met with any replies worth reading, or giving a particle of information of the least use to any person desirous of acquiring a knowledge of that most important branch of practical mechanical engineering.

It is a "big" subject to enter upon so as to treat it properly, and a great deal must be said about it to render it of any practical utility to "Mr. Paul" and the other readers of the ENGLISH MECHANIC, I am willing to go into it with your permission, Mr. Editor, but I caution you beforehand, that I will call for a good deal of your valnable space, and, not a little of your engraver's time for illustrations. It is one of those subjects which cannot be slurred over in a letter or two, but should be properly and inexhaustively treated, or not entered upon at all. I must further inform you, good Mr. Editor, that I will not be satisfied with very minute illustrations, but will respectfully ask you for the full breadth of the page, or at least, the breadth of two columns for my drawings, such as I see you sometimes grant to impossible projects for the impossible purpose of squaring the circle, and also to showy "pictures" of wonderful velocipedes, in which the grand secret is embodied, whereby the power required to drive them diminishes as speed increases, and going up a hill is much less difficult than going down one, and which throw the "seven league boots" of the nursery tale entirely in the shade. However, joking apart, please say if you will make room for a few "practical papers and illustrations on setting the eccentrics and valves of steam engines."

JAMES BASKERVILLE, Manager,
City Foundry, Limerick.

EXTRACTS FROM CORRESPONDENCE.

THE LATHE.—"X. H." says:—"I am much pleased to see the interest that some of my brother readers are taking in the lathe, and I trust that some of our talented contributors will give us working drawings of a first class amateur's lathe. Several of my friends have told me how pleased they have been with S. Stevens' request, No, 4070, in 'Notes and Queries' of last week, and with which I cordially agree. I also trust in our New York friend (page 307) will give us something to work at; I have great expectations from his commuuications."

EMIGRATION.—A Canadian correspondent says:—"It may be information worth knowing at the present time, to know that skilled mechanical labour is far in excess of the demand in Canada at present, and members of clever and industr'ous artisans cannot get employment at their trades here."

TO MICROSCOPISTS.—W. P. says:—"I enclose you a reply to one of the queries in the current ENGLISH MECHANIC. As a microscopist of some considerable experience, I may from time to time be able to solve some of the problems which perplex younger workers, and shall be always glad to do what I can. I am glad to see my old friend, *Scientific Opinion*, is about to amalgamate with you."

PHRENOLOGY.—"J. T." says:— I think, Sir, the foot-notes are often intended to draw information and ideas from our correspondents, and not proofs of scepticism, as many may suppose. You, Sir, have asked our correspondent if he were blindfolded, could he tell who was a merchant, statesman, preacher, botanist, engineer, &c.? but the difficulty being that he could not tell the temperament of each subject he might examine, therefore he could not correctly delineate their character. The temperament is made manifest to the touch as well as to the sight by the fineness and coarseness of the hair, by the softness and hardness of the flesh, &c. But it also may be said that few men rise to eminence but those who have a good temperament and organisation combined. I have no hesitation in saying that, under the manipulation of a good phrenologist, the characters and qualifications of those men might be made manifest, supposing any do not possess a combination of powers; but each one has special qualities in his individual sphere.

REPLIES TO QUERIES.

CUTTING GRANITE.—I have a piece of granite out of which I wish to take a piece an inch square and polish it by hand. Could any brother reader inform me how I can do it?—CHEMICUS.

[3779.]—BOILER SAFETY VALVE.—

$$W = \frac{\pi r^2 l P - \frac{1}{2} L w}{L}$$

whereby πr^2 area of the aperture of the valve; l = distance from fulcrum to centre of valve = 3½in. P = greatest pressure of steam in the boiler = 60lb. per sq. in.; L = length of weight from fulcrum; w = weight of the lever = 7lb. 14oz. Here the area of valve $\pi r^2 = 3{\cdot}1416 \times 1{\cdot}5^2 =$ 7·0686 sq. in. By substituting these values in the above formula we shall obtain the weight that ought to be applied at end of lever. Should "One in Need" require to graduate his scale to obtain less pressure, I will let him know the practical rule. The above formula appears: "Baker's Steam Engine," p. 35.—A. TOLHAUSEN.

[3779.]—BOILER AND SAFETY VALVES.—Our correspondent, Mr. Howell, made a slight mistake in his answer at p. 309. He therein states, first the weight of valve, spindle, and lever, and adds to it the weight of counterpoise weight. Now, I must tell Mr. Howell, that it would not be correct to add the weight of the lever to the counterpoise weight, because the counterpoise weight gives the effective pressure of the lever in a line with the centre of the valve; and, therefore, includes the weight of the lever. Let him read "Jonath's" answer to "O. G.," p. 310., No. 4019, wherein he gives a very beautiful and simple rule, and which will give him all the information he requires.—THOMAS J. O'CONNOR.

[3847.]—HANDRAILING.—If "J. B." will consult Langley Bank's work he will find some useful information. I cannot say whether it is the best extant. I have had Newland's, but do not make much of it, owing to the number of lines which are necessary for the working out of rails as laid down in that work. I have seen another—Jeay's, I think, is the author. A capital small work it is. I believe it is rare in England. There is also old Peter Nicholson's work. It is, however, looked upon now as old and out of date with the times. Of course you will not find the square cut in Nicholson; but he has some capital ideas. Any other information on this important subject I will gladly give.—WREATH.

[3857.]—TO CLEAN SADDLES.—I feel sorry for "Equestrian's" inexpressibles if he has tried the beeswax and turpentine recpie as recommended in No. 272. Let him wash his saddle with soap and water, then sponge all over with old milk, and polish with a soft cloth. If he can apply a little neatsfoot oil where there is no wear it will be all the better; but by a constant application of the milk nothing else will be required.—BANTING.

[3869.]—WEIGHT OF WATER.—"Countryman" must have forgotten that there is 90ft. of rope added to the weight of the water at the bottom of the well.—JOE S.

[3889]—PREPARING CANVAS.—First strain tightly upon frames, then wash with a thin glue; when dry it is painted with a coat of oil colour made of white lead, red lead, linseed oil and turpentine; and afterwards with a second coat, in which the red lead is omitted, and sugar of lead with a little colouring matter substituted.—(Extract from Francis' Dictionary of Recipes.)—JOE S.

[3943]—BEES.—"L. W." may safely hive his swarm in the straw hive if the comb is not more than three years old; if above that age he had better cut out the two middle combs, as the cells in those combs are most used for breeding purposes; therefore the cells are much smaller through their having so many cocoons or linings in them. Each year adds from four to six to their number. I cannot quite understand why he has a box under his straw hive. What motive has an "Oxfordshire Farmer" for sprinkling the combs with sugar, &c.—quite an unnecessary operation, both for the bees as well as their owner? Bees have a great dislike to having their wings clogged with sticky liquid. When bees swarm they always leave the hive with a full supply of honey in their honey-bags—enough for them to subsist on for three days. If "L. W." would hive his in a common straw hive for convenience, and then towards evening when they are all quiet, knock them out on a board or cloth and gently place the box or hive full of comb over them, they will ascend and take possession, when they may be moved to the position they are intended to occupy. A swarm hived into a hive full of comb will be a fortnight or three weeks earlier or forwarder than one placed in an empty hive. I do not think using chloroform as a means of taking hives a good plan. Driving is a much easier method. Thinking some of our readers may benefit by it, I will describe it. Towards evening, or when the bees are in, get an empty pail and invert the hive to be driven in it. Then place above it an empty hive of the same diameter as the lower one, then tie a cloth round the place where the two hives meet, so that none can escape. Then with two stout sticks beat the bottom hive for about ten minutes. The operator will hear by the buzzing sound when most of the bees have ascended. On lifting off the upper hive the bees will be found hanging in a cluster, and there will scarcely be a bee left in the lower hive. The driven bees can be added to any of his weak stocks, which will derive great benefit from the addition. Should "S. W." wish to know how to unite the bees to another stock, I will tell him in my next.—RECNEPS.

[3940.]—THREE WHEELED VELOCE. — "T. T. M." asks for something that I am afraid Andrew Johnson does not supply. Some time ago I was in want of a three-wheeled machine to carry two, and knowing that it would be next to impossible to turn with the two hind wheels fast, hit upon a plan which works admirably. It is altogether different in the back action to anything that has appeared in our MECHANIC these last two years; and if our Editor will allow space I mean to present in a week or two the readers of the MECHANIC with a photograph and description. I will just say for the present that the back wheels are made with a groove inside the nave, against the nave hoop; and then I have a thumb screw-pin to go through the hoops of the nave, then on the axle is rivetted a small piece of flat iron, which is made to work inside the groove of wheel. When the thumb-screw is in the axle cannot pass it, so drives the wheel round when it is required. For one rider take out the pin, and all the wheels are loose. By this method the second man has great power, and still you may cut a figure of 8 with ease, as the pin on the inside wheel falls back from its work and takes it up when going straight. If "T. T. M." is in a hurry, I will furnish him with all particulars if he will give his whereabouts in your Sixpenny Wanted Column. If not, he and others will find a really good and serviceable machine when it is illustrated. The men sit back to back, and the two actions are independent—the first driving, as in the ordinary bicycle, the second by 5in. crank axle.—BANTING.

[4025.]—HORSE POWER.—The ordinary rules for nominal horse power may be expressed as follows:—V = mean velocity of piston, in feet per minute.

D = Diameter of cylinder in inches.
S = Stroke of engine, in feet
H = Horse power of engine

$$H = \frac{D^2 \sqrt[3]{S}}{15{\cdot}6} \text{ for high pressure.}$$

$$D = \sqrt{\frac{15{\cdot}6\,H}{\sqrt[3]{S}}} \qquad V = 128 \sqrt[3]{S}$$

$$H = \frac{D^2\, \sqrt[3]{S}}{47} \text{ for condensing engines.}$$

$$D = \sqrt{\frac{47\,H}{\sqrt[3]{S}}} \qquad V = 128 \sqrt[3]{S}$$

See "Molesworth's Pocket Book of Engineering Formulæ,' page 97.—WM. AIRRY.

[4025.]—HORSE POWER.—The following rule will give "Novice" the indicated horse power of an engine. A = area of piston in square inches; P = average pressure of steam in lbs. per square inch; in cylinder; S = length of stroke in feet; R number of revolutions per minute. $2\dfrac{A\,P\,R\,S}{33000}$ = indicated

STAEM.

[4036.]—BOILER PRESSURE.—From about 40lb. per square inch, upwards.—STAEM.

[4028.]—FLOORING.—The flooring of chambers in Nottinghamshire and Derbyshire were of plaster till boards became so cheap. It is prepared in the following manner for floors:—The stone or gypsum, or plaster, is got in a clay hill extending from Derby to Newark on the south side of the Trent, and only a few miles from the river, and parallel to it. The stone is burnt until red-hot, and then left to cool, it is then thrashed with a flail, the same as corn, until it will pass through a ¾in. sieve; then mix with water until quite soft, as to carry in a bucket. Laid on reed or lath, sets in 12 hours, rubbed off with a stone or trowel next day. The stone is red, yellow, green, and white; the white is ground same as flour, and boiled in open bath and used for covering over plaster images, and by plasterers for settting ceilings and cornices.—A. DOUBLEDAY.

[4033.]—SLIDE REST.—In reply to "J. D. L.," who inquires of me how this is done, the wheel to be cut is bored out, turned upon the edge and placed upon a stud or spindle which is attached to the slide-rest, so that the wheel face may be horizontal, and the middle of the wheel's edge level with the lathe centres. The cutting tool is a grooved steel screw a duplicate of the tangent screw to be used with the wheel. Frequently an ordinary hole or master-trap is used. This is rotated between the lathe centres, and the wheel edge forced against it by the slide screw.—W. H. N.

[4037.]—RULE FOR FINDING THE SIZES OF WHEELS.—"R. T." may proceed thus and find the diameter of his small wheel—30 × 3 = 90 × 4 = 360 quarter inches, which divided by 120 + ¾in., the diameter. "R. T." may see at a glance that 30 is ¼ of 120, therefore the diameter of the small wheel must be ¼ the diameter of the large one. Then to find the pitch of the wheels $\dfrac{3{\cdot}1416 \times 3}{120}$ = ·07854in. pitch of large wheel, and $\dfrac{3{\cdot}1416 \times {\cdot}75 = {\cdot}07854}{30}$ in the pitch of the pinion teeth. When the pitch and No. of teeth are given to find the diameter $\dfrac{{\cdot}07854 \times 120}{3{\cdot}1416}$ = 3in. the diameter.

W. PROUDLOCK.

P. S.—"R. T." will find some useful information on wheel gearing in back numbers of the ENGLISH MECHANIC.

[4037.]—RULE FOR FINDING SIZE OF WHEELS.—"R. T."—In all wheels of uniform pitch the diameters are directly proportional to the number of teeth, but the diameter understood is that of the pitch circle, and not the external circle of the wheel. "R. T." will best comprehend the nature of the pitch circle by supposing two cylinders rolling in contact with each other—say of 3in. and 9in. diameter respectively, it is clear that the smaller one would make exactly three revolutions, whilst the other makes one. Now those cylinders are simply wheels in which the teeth are infinitely small, and the lines of contact are the pitch lines of the wheels. But wheels of this class are not calculated to transmit a great amount of power, nor yet would they transmit motion with the precision necessary in the majority of cases, as in clocks. It is, therefore, necessary to form notches or teeth, which may lay hold of each other so that there may be no slipping, and those teeth are formed by increasing the diameter beyond the primary or pitch line for the points of the teeth, to correspond with which, the space must be deepened to a circle below or within the pitch line. Now the great art of wheel making mainly consists in forming and proportioning the teeth properly. Several systems with those objects in view are in use, the details of which would encroach too much on your space. A simple and good rule is to divide the pitch into 15 equal parts, of which the thickness of the tooth would be 7, the space 8, the length of the tooth 12, of which 5½ parts are above the pitch line, and 6½ below the pitch line. The depth of the tooth may be from 2½ to 3 times the pitch; thickness of rim and arms equal thickness of tooth; thickness of eye equal to pitch. Those references to arms and eye, of course, are only applicable to wheels of a large class. Supposing "R. T.'s" wheel of 120 teeth to be 3in. diameter at pitch line, 120 : 3 : : 30 : ·75, or ¾in. at pitch line for his pinion of 30 teeth; the pitch of those wheels would be about ·078, and the diameter of both would be increased by the increment ·057, or about $\frac{1}{16}$in., so that the diameters would be $3\frac{1}{16}$in. and $\frac{13}{16}$in. respectively. It is very inconvenient to express in figures the pitch of wheels less than ¼in. or ⅜in., and hence they are usually rated so many teeth to each inch in diameter. Thus we have our wheel patterns (invariably engine cut), of 5, 6, 7, 8, 9, 10, 12, 14, 18, teeth to each inch in diameter—a wheel of 8 per in. corresponding nearly to ⅜in. pitch. And trust those remarks may be useful to "R. T." and others.—MATRIX.

[4037.]—RULE FOR FINDING SIZES OF WHEELS.—"R. T." may obtain the relative sizes of wheels by the following rule:—The sum of the number of teeth in the two wheels is to the distance between their centres as the number of teeths in either wheel is to its radius.—STAEM.

[4039.]—BAROMETER TUBES.—In answer to this, I think if he were to fill his tube, and should there be any large air bubbles bring them out by what the French call *Lavement* (that is, pass a large bubble up and down until the rest have been collected by it), then heat the mercury and whilst it is boiling seal the tube close to the end.—J. W. LISTER.

[4040.]—WHEEL-GEARING.—Properly, bevel wheels are made in pairs, and if the teeth were diminished *ad infinitum* they become simply a pair of cones, the two apeces meeting at a point where the axis would intersect, as at A, Fig. 1, the wheels B and C being properly adapted to each other. If it were desired to adapt a larger wheel D to B with the view of changing the velocity, the former must be made of the same angle as the original, this is shown in Fig. 2, where it will be seen the apex of D would reach beyond the intersection of the two axes. Practically, in connection with wheels of small pitch, and where it is often desirable to make considerable changes conveniently, it is quite usual to have what may be called a master bevel and a considerable number of change pinions, and to show what can be done in such a case by a careful manipulation, I will just instance one set in my possession, which answer admirably—viz., a wheel of 60 teeth (7 teeth per inch), for which I have pinions of 20, 22, 24, &c., up to 44 teeth. I may state that the angle of the master wheel was originally made to match the pinion of 32 teeth, which renders the divergence as small as possible. Since those were made I have also made a second master wheel of 50 teeth to match the same set of change pinions, so that nearly 30 different combinations can be got by means of those two wheels. To obtain so large a scope in this way, requires the teeth to be formed with great care, and the principle could not be applied beyond certain narrow limits in connection with wheels of a wide pitch.—MATRIX.

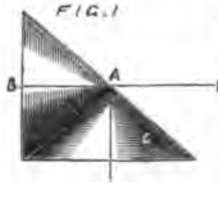


FIG. 1

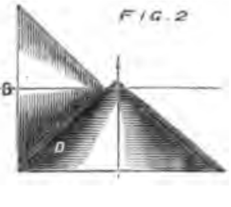
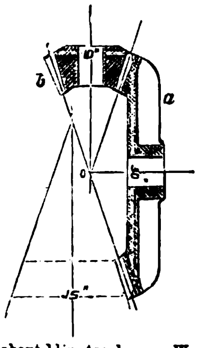


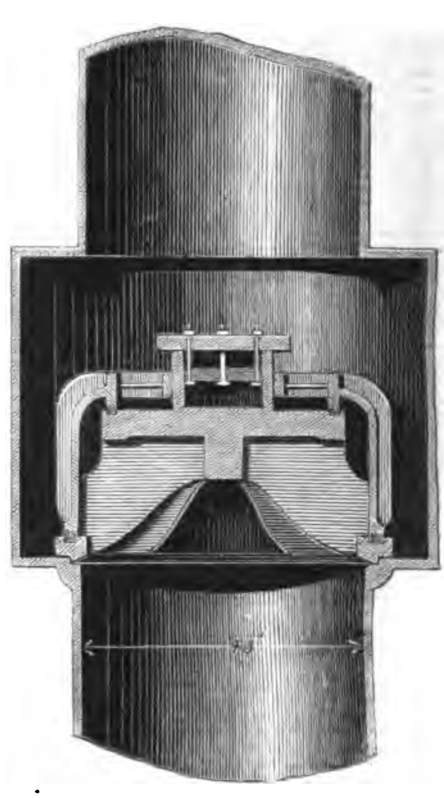
FIG. 2

[4040.]—WHEEL GEARING.—If "Kirby" will inspect the enclosed sketch he will be able to satisfy himself that he cannot gear a larger pinion with his bevel wheel. To construct the wheel *a* and pinion *b* first produce the axis of wheel *a*, and on a line at right angles to it, set off the diameter, which is 30in.; next set off the radius of the pinion whose diameter is 10in., then from this point produce the axis of the pinion, which will cut the axis of the wheel at *o*; now this point must be the common apex of both cones, so that the outer and inner pitch circles shall be proportionate to each other, but to increase the pinion from ⅓ to ½ the size of the wheel we would have the inner diameter of the new pinion about 1½in. too large.—W. PROUDLOCK.



[4041.]—BICYCLE QUERY.—I think that "Lerk's" benzoline lantern will not be of any service without he could with some contrivance suspend on springs, for it is the vibration that causes it to die out; nothing beats the proper composition candle lamp, with spiral spring and rocket. "Lerk" wishes to know which part of the foot is best to use on the treadle. It is a question I have long wished to have proved. I have been a bicycle rider now twelve months (with never such pleasure experienced before), and have tried both with the heel close to the treadle, and with the tread of the foot upon. For my part I ride and prefer the tread upon the treadle; and find less vibration, more use for the calves and ankles, and also reach a larger throw much easier. I am acquainted with a very fanciful rider who always rides with the tread; but he is the only one that ever I saw. I should much like another opinion (if proved) upon the matter.—VELOCE.

[4043.]—CORNISH DOUBLE BEAT VALVE.—In answer to "F, P.," I send drawing of a 43in. valve from a Cornish engine at the East London Waterworks, at Old Ford. The valve itself is like a flat hat, with a hole in the top, and has two seatings, or "beats" as they are called, one round the brim and the other round the inside of the hole in the top. It is prevented rising too high by the plate at top of the guide piece in the middle, which is held on by screw bolts, and it is likewise guided by being bored inside and fitted to the vertical edges of the 8 webs, of which 4 are shown. The top is cast open like a wheel with a large hole in the nave, so that when the valve goes up the water comes out, not only under the lower edge, but also out through the holes in the top. These valves are very good where the lift is high, as the pressure on them acts downwards only on the area of the difference between the outside diameter of the lower beat and the inside of the upper one, and as they are very heavy they sink down the moment the action of the engine stops, which it always does for a longer or shorter time at the end of the stroke, and from their peculiar form they can sink without driving a quantity of water out of their way, as most other valves must, and hence the silence of their action. They do not do so well for short lifts, as then the valves are out of proportion, heavy, compared with the whole work done.—J. K. P.



P.S.—In reading "F. P.'s" query over again, I see he asks for an equilibrium valve, and as there is a steam valve of that name in a Cornish engine, I will describe that also. A Cornish engine is single acting only, and in those with beams the steam comes on the top of the piston only, when the piston gets say ⅓ of the distance down the cylinder, the steam is cut off and acts expansively for the remainder of the distance. That is called the "indoor stroke," because the half of the beam next the steam is indoors, while the other end, at least in Cornwall, goes through a hole in the wall, and is consequently out-of-doors. Now the top and bottom of the cylinder are connected by a pipe closed at top by the equilibrium valve, and as soon as the indoor stroke is completed, the equilibrium valve is opened and a free passage given to the steam from the top to underneath the piston, and the outdoor stroke is made by the descent of a great load attached to the top of the plunger of the pump in waterworks engines, or in deep mines by the weight of the pump rods, which usually weigh several tons, and are sometimes partly balanced at intervals down the pit by great beams like steam engine beams, which work in an excavation made in the side of the pit, and having a great box filled with old metal at the reverse end, and that pulls the piston up again. Direct action or "Bull" engines stand partly over the pit mouth, and the piston rod is attached direct on to the pump rods. Of course in them the steam acts under the piston. The construction of the equilibrium valve is just the same as the pump valve, only has a rod to lift it. I have drawing of cataracts at "F. P.'s" service.—J. K. P.

[4045.]—SPECTACLES.—In answer to "J. R. W.," allow me to say that he has not got his concave spectacles concave enough, or else there is some other defect in his eyes, for if his spectacles were properly chosen he ought to be able to recognise a person 30 yards off, and not 3 yards only. Let him buy a more concave pair of spectacles. As to things looking smaller through concave or shortsighted spectacles, this he must expect, for the fault of shortsighted people's eyes is that they make things look too large, or bring the rays of light to a focus before they reach the retina or back part of the eye. Concave spectacles diminish the apparent size of things, or in other words throw back the focus of the eye to the retina. This apparent smallness of objects seen through concave spectacles will wear off in time, and he will get to take no notice of it. As to his spectacles not being wide enough, he had better see to getting a pair that are wide enough, as he will have to get another pair more concave to suit his short sight; further let him have some bits of wire silver soldered on to the ends of the sides of the new spectacles so that he can bend them to fit the backs of his ears, this is much better than jointed sides to turn behind the ears as the joints wear loose and soon become of no use; I have had mine so made, and they answer better than any other plan I have tried, especially for "J. R. W." who is so short-sighted as to have to wear spectacles constantly. He then can jump and run, and lay down without the spectacles falling off his nose, and, lastly, there would be very little advantage in having plano-concave instead of double-concave glasses, so small as not to counteract other disadvantages.—H. W. A. S.

[4045.]—SPECTACLES.—The object of spectacles is to restore the eye as nearly as possible to its original power. "J. R. W.'s" eyes magnify too much: he requires a concave spectacle to counteract this defect. He says the spectacles he has make objects appear seven-eighths their real size; it is evident they are too concave. Spectacles a little less powerful would remedy this and make his eyes ache.—OPTICS.

[4053.]—DRYING GLUE.—"J. S." must understand that the mere putting of the air in motion will not dry his glue. It is a fact that air of any given temperature, although saturated with moisture (and in that condition, as a matter of course, useless for drying purposes), becomes capable of absorbing additional moisture in proportion as its temperature is raised, so that "J. S." if he wishes to go scientifically to work must have some means of securing a constant influx of air from a comparatively cool medium, heating it on its passage inwards, as much as practicable, then exhaust it, or allow it to escape as near as possible at the opposite extremity of his room. This can either be done by means of a small fan, or by means of an ordinary fire with a good high opening at the chimney—even two or three windows open at the top—or, still better, ventilators, might answer the purpose, assuming that the temperature has been raised considerably before passing into the room. No good will be done without an in and out current of air.—MATRIX.

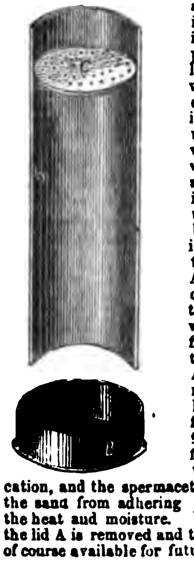
[4054.]—MICROSCOPIC INVESTIGATION WITH POLARISED LIGHT.—I do not think that polarised light will be of any service to "John Barleycorn" in his investigation into the development of the *Torua cerevisiae* or yeast fungus. All that he will require for that purpose will be a good ¼ or ⅛in. and A or B eyepieces with or without a "condenser." Examination of acetic acid is more the work of the chemist than the microscopist, but it is convenient to call the aid of the microscope into requisition sometimes that reactions in *minute* quantities may be observed. For general polariscopic investigation no apparatus can better answer the purpose than a "Nichol" prism below the object as a polariser, and a second prism used above the objective as an analyser. This latter prism may be conveniently made so as to be capable of use in this position or above the eyepiece. But in work I find the former position the preferable one. Want of time prevents my going into detail, but if "John Barleycorn" wishes and the Editor will allow, I will give a few general hints in a week or two.—H. P.

[4061.]—ASSOCIATE OF ARTS DEGREEE.—Every candidate for the title of A. A. must be under 18 years of age on the day of examination. He must pass a preliminary examination in (1) grammar and analysis; (2) English composition; (3) arithmetic, including fractions; (4) geography; (5) the outlines of English history. Failure in any one of these five subjects is absolutely fatal, however high a candidate may stand in the examination I now describe. The other part of the examination is divided into four sections:—A English, B languages, C mathematics, and D science. Every candidate, in addition to the preliminary, must pass in two of the divisions, A, B, C, and D. Each of these divisions is divided into sections, and superior answering in one of these sections, will pass a candidate in the division. Division A is divided into four sections:—(1) English history—a certain period given beforehand. (2) Political Economy; (3) English Literature—certain authors; (4) Geography. Division B: (1) Latin; (2) Greek; (3) French; (4) German. The minimum for division C is four books of Euclid and algebra to quadratic equation inclusive; D (1) Natural Philosophy; (2) Chemistry; (3) Botany; (4) Geology and Mineralogy. Nearly all candidates take division A English, as they are obliged to take history and geography in the preliminary. So that in addition to this, one language, or chemistry; or the minimum of mathematics will pass a candidate. I passed in honours in two divisions. The examination is conducted by the University of Oxford, at various local centres in the country, such as Leeds, Manchester, &c. The fees which I paid amounted to £2.—J. HARRISON, A. A., Bradford.

[4064.]—TURBINE.—"PATTERN MAKER."—A turbine wheel giving out 1 h.p., will require some 35 cubic feet per minute under a head of 20ft. To determine size of pipe, it will be requisite to know the pressure acting upon such column, after which a large per centage must be allowed for friction. A turbine will be more economical and efficient than a steam engine and boiler. Try the North Moor Foundry Company, Oldham, they supply small machines to utilise a town's water. I have just put in Messrs. Spon's (the publishers) hands a thoroughly practical work upon turbines, for the use of all who wish information respecting them.—J. GILLAIRD,

[4066.]—BREWERY.—"Brewer's" temperature is not too low. I pitch my mild ales at 56°, and, as a rule, succeed in getting them quite bright. It is very difficult for one who knows nothing about the position or arrangement of his brewery to give a proper explanation, as there are so many different systems in use, and therefore a great many points at which a wort could be affected. I will not presume to point out to "Brewer" the cause of his ales not clearing (unless I was intimately acquainted with all details concerning his place, and the system he works on). But the mode of procedure I follow, when troubled in any way as he is, may assist him in getting to the bottom of his difficulty, and perhaps discover to him where the evil lies. I examine the water and see if there is anything in it deleterious, then the malt, as to its being thoroughly dry and free from mould, also see that it is properly crushed, not too fine. I am also very careful in washing, using the liquor of a proper heat, say 170° to 168°, taking care always to have the goods falling into the mash tun about 150°; this gives me a tap heat of 144° to 148°, according to the age of the malt (I like it two months old at least). I watch the copper well, and am careful in not raising it to the boil too quick, then a steady and regular boil of 1½ to 2½ hours, according to the hardness of the brewing water and the gravity of the worts, then blow off the steam on the coolers till about 180° or 190°, and do not use too much water in refrigerating, but run regular and not too strong; see to yeast, its freshness, quality, and freedom from all taint or smell; use 1lb. or 1½lb. per barrel for mild; use the tuns or gyles clean and sweet, and free from all mixtures of metal or anything likely to cause the least galvanic action or electric current, then great care is requisite in the working off of the gyle tun, which a long practice can only bring to perfection; taking care not to check too quick or yet raise by any artificial means the heat of gyle, and above all watch the proper attenuating of the worts, bringing them down far enough to prevent secondary action or fermentation. Is the whole brewery thoroughly clean and sweet, if not, wash out and lime at once. These are a few very imperfect jottings and thrown together in a very hurried manner; yet "Brewer" may get some good from them, and I shall be glad to assist him or any other; only to do so with anything like a prospect of success, I must have more particulars. Every *brewer* will understand this.—IZOKS, Edinburgh.

[4067.]—MUSICAL BOX.—The cause of the musical box making the jarring noise he complains of is probably that some of the fine springs underneath the notes are broken off. I have had one or two lately brought me to repair with the same complaint and shall be happy to undertake "Salopian's" if he thinks proper.—E. BARNARD.



[4068.]—PRESERVING FLOWERS.—If "G. O. F." wishes to dry flowers so as to make them resemble everlasting, as in the beautiful bouquets sent over from our German friends, the process is somewhat as follows:—Procure an apparatus which may be made of zinc, and cylindrical in shape, open at both ends, and with a perforated diaphragm (as shown in sketch in section), a cover or lid is also provided for each end. Suppose the box to measure 10in. in length by 4in. diameter. Sufficient very fine silver sand, thoroughly cleaned from dust by frequent washings in water, dried, and well shaken up, whilst in a heated condition with a small quantity of spermaceti, which is held in readiness. The cut flowers are now dropped gently into the box by the end B so to rest upon the diaphragm C, the box being inverted. When filled the lid is replaced at B, and the apparatus turned up, as represented in sketch. After removing the cover A, the cool sand is caused to percolate through the perforations until the whole interstices between the flowers, and also the space above the diaphragm are completely filled. After replacing the lid the apparatus may be placed in an exhausted oven overnight, being careful to have the lid B placed loosely on the top. The sand supports the flowers and preserves the integrity of the petals during the process of dessication, and the spermaceti is evidently intended to prevent the sand from adhering to them through the influence of the heat and moisture. When the dessication is completed the lid A is removed and the sand allowed to escape which is of course available for future operations.—MATRIX.

[4071.]—DRAUGHT IN BOILER.—"Jonath" says the flue of the chimney has been repeatedly swept, but I feel quite sure it does not get thoroughly cleaned. Let "Jonath" mind and see the sweep's machine through the chimney top; in fact he must be sure to see that the flues throughout, from the fire to the chimney top, be thoroughly cleaned with a really good stiff whalebone brush; the inside of tubes or flues makes nothing but what a stiff brush will scrub out; the incrustation inside the boiler has nothing whatever to do with the draught of the flues. I believe some part of the chimney or flues are almost blocked up with soot; let the bottom of the old flue or chimney be bricked up.—ANDREW JOHNSON.

[4078.]—RAILWAY GUARDS' WATCH.—From long practical experience I do not hesitate in stating my belief that *pocket* chronometers are a mistake. "Railway Guard" would find, if he had one, were it ever so good, that if he ran the distance of the length of a train with a chronometer in his pocket that the shaking would cause it to vary seconds, and that it would be some time before it would recover and get back to its rate again. My opinion is that a thoroughly good English lever with about ten holes jewelled and a chronometer balance costing in silver cases £8 to £10 is as good a pocket timekeeper as could be desired. If necessary, I could give "Railway Guard" names and addresses of railway station-masters, clerks and others, who carry these identical watches and from long use have proved them to be thoroughly reliable.—CHRONO.

[4082.]—FLUTE.—If Mr. O'Brien will take my advice, he will keep his flute as it is. The difference in pitch is surely not a fault, and can only be inconvenient if he wants to play with another instrument of the present concert pitch. Nevertheless, if he persists in having it altered, he should apply at Rudall's, Charing-cross. They will tell him whether they can do it, and will give him honest advice in the matter. Further, they will not charge more than some of those needy houses who are ever ready to alter instruments to order, without caring whether they improve or spoil them.—SAUL RYMEA.

[4086.]—FITZROY STORM GLASSES.—These are to be had so cheap that they are hardly worth the trouble of making, and as weather guides they are perfectly useless. I have tried several. I have had one undisturbed in my summer house for two years, but its indications are so wild and contradictory that there is not the slightest dependence upon it, and I only retain it for the barometer attached.—AMATEUR.

[4086.]—FITZROY STORM GLASS.—The composition is two drachms of camphor, half a drachm of nitrate of potassium, half a drachm of chlorate of ammonium, dissolved in about two ounces of absolute alcohol mixed with two ounces of distilled water. To be placed in a glass phial about ten inches long and three-quarters of an inch in diameter, nearly filling the phial, which is to be hermetically sealed.—GIMEL.

[4089.]—READINGS FROM THE GLOBES.—"Gimel" is quite right in his correction. The fact is it ought to be 9¼ instead of 9½, which will bring out 43 miles *nearly*. But the most accurate way is by trigonometry and logarithms, as stated.—T. S. H

[4094.]—COPPER COIN.—The coin of "N. T. M." is one of the common Nuremburg tokens, of which accounts have been given so often in the ENGLISH MECHANIC. It is of no value.—HENRY W. HENFREY, M.N.S., &c., &c.

[4094.]—COPPER COIN.—Is a *counter* or *abbey piece*, struck probably, as Snelling thinks, between 1272 and 1500. "N. T. M." must look into back numbers, where he will find authorities given.—D. T. BATTY.

[4095.]—SILVER COINS.—The second and largest coin of a "Beginner" is a silver *denier* or penny, struck by our King Richard I. for his French kingdom of Poitou. It bears on the *obverse*, a cross patée and RICARDVS REX (Richard, King). *Reverse*, the name PICTAVIENSIS (Poitou) in three lines. This coin is common, and worth about 3s. if in fine preservation. The series, to which this belongs, of coins struck by English princes in France, is termed the Anglo-Gallic; and it includes pieces of Aquitaine, Poitou, Bourdeaux, Calais, Paris, Caen, Tours, Limoges, Antwerp, Bruges, Ghent, Ypres, Tournay, etc., embracing also almost every part of France.—HENRY W. HENFREY, M.N.S., &c., &c.

[4095.]—SILVER COINS.—The largest silver coin is a penny of Richard I. There are no English coins of this king, this coin was coined in Poictou, (Pictairensis on the reverse). They were formerly very rare, but not so now, as hordes have been found. The small coin of no interest Should be glad if "A Beginner" would correspond with me, that I may have his address.—W. NELSON LAST, Bury St. Edmunds.

[4095.]—SILVER COINS.—No. 1 is of a Doge of Venice (Leonard Loredano?); the name is just where the letters are not given: on one side the Saviour and "LAUS TIBISOLI," "praise to Thee alone." Reverse, "S. Mark and the Doge." .... "Dux. S.M.V." .... Doge, S. Mark, Venice. No. 2 I read "KAROLUS REX FR."; rev. PICTAVIENSIS, and think it is of Charles II. King of France, and struck at Poictiers.—BERNARDIN.

[4097.]—A VELOCIPEDE FOR SPORTSMEN.—See reply amongst the letters.

[4100].—SWAGING SCREWS.—If "Amateur Blacksmith" does not want an oliver to forge his set screws and bolts he could easily make some swaging tools. If he wishes to make hexagon heads to his bolts he will require an extra set of tools; but they are inexpensive if he goes the right way about it.—J. M.

[4105.]—HALL MARKS.—The best book on the hall marks is "Hall Marks on Gold and Sliver Plate," by W. Chaffers, F.S.A., 3rd edition, price 3s. 6d., published by J. Davy and Sons, 137, Long Acre, London. It is a most useful book, and gives tables of the date, letters, and marks of every assay office in the United Kingdom, from the earliest period of their use to the present day, with fac-similies, and a mass of valuable informarion.—HENRY W. HENFREY, M.N.S., &c.

[4106.]—GOLD COIN OF EDWARD III.—In asking the value of a quarter-noble of Edward III, I presume that "Casteye Diamond" means one of his fourth issue, in the 21st and following years of his reign, which bears, *obverse*, a tressure (or border) of eight arches pointed with trefoils, containing the royal arms in a beaded shield. EDWARD. DEI. GRA. REX ANGL. (more or less abbreviated). *Reverse*, a tessure of eight arches with fleur-de-lis and lions alternately in the angles, containing a cross fleurée. Sometimes E in the centre. EXAL TABITUR IN GLORIA. Full weight, 30 grains troy. This coin is common; worth 12s. to 15s. Other quarter-nobles of preceding issues are rare, and weigh several grains more. If "C. D.'s" coin weighs more than 30 grs. I should be much obliged if he would kindly send me a sealing-wax impression by post.—HENRY W. HENFREY, Markham House, Brighton.

[4108.]—COIN OR TOKEN.—Is a halfcrown of what is termed "Gun Money," and was coined on account of the exigencies of James the 2nd when in Ireland; crowns, shillings, and sixpences were also struck in the same metal, and bear dates 1689 and 1690. They were coined from old brass guns. For particulars, see "Simon's Essay on Irish Coins." They form a very interesting collection, as they were struck with the name of the month on them, this was struck in August, 1689.—D. T. BATTY, 9, Fennell-street, Manchester.

[4108.]—WHAT COIN IS THIS?—It is a gun money half crown of James II. The following extract is from my "Guide to English Coins," part ii, p. 112:—"When James landed in Ireland in March, 1689, to attempt the recovery of his dominions, he resorted to several expedients to remedy the scarcity of money in that kingdom. First of all, the value of the guinea, as being of easier carriage than the silver money, was raised one-fifth, or 20 per cent., whilst the silver coins were raised no more than one-twelfth, or 8⅓ per cent., and other foreign gold and silver in proportion, that what money he could obtain might go a greater way. However, as all these expedients failed to procure a sufficient supply of money, he coined brass and copper sixpences, which were made current by a proclamation dated June 18th, 1689. Half-crowns and shillings were soon after added; made current by proclamation 27th June. Crown pieces of white metal were ordered to be current on the 21st April, 1690. The half-crowns of copper and brass previously issued, were called in in June, 1690, re-stamped with the die of the crown, and issued at the value of five shillings. The battle of the Boyne, on July 1st, put a stop to these base coinages, which derived their name of "gun-money" from being made of brass cannon, brass and copper kitchen utensils, &c." XXX. signifies thirty pence, the value, and "Aug.' the month when it was coined. The shilling and sixpence are exactly like your correspondent's half-crown, except that they have "XII." or "VI." for the value. Value of all three, 6d. to 1s. each.—HENRY W. HENFREY.

[4118.]—PROBLEM—THE FOLLY OF ALGEBRA.—The question of our friend "Algebra" is just one of those which may well prove how unnecessary is his science itself. His problem is, "A gentleman having mortgaged an estate for £2000 at 5 per cent. compound interest, he is now desirous of knowing in what time he shall discharge the said debt and interest by paying the mortgagee of £187 yearly." Here is "Algebra's" usual flaw. There need not be any compound interest! Compound interest pertains only to such a case as when perhaps a reversion is purchased in advance; or again when nothing is to be paid till a reversion or life-policy becomes available. In such a transaction, no money is paid year by year; there is a lump sum, either at the beginning or at the end. But here the mortgagee gets £187 yearly. The 5 per cent. on £2000 would be only £100. Therefore, any bookkeeper, any solicitor, any accountant, any actuary, would simply take £100 out of the £187, as (regularly) paying the 5 per cent. annual interest. I am well aware that our friend "Algebra" wants the "£2000 at 5 per cent. compound interest" to go on accumulating, in order that there may be a more tortuously big total to be met by the £187. But, there need not be any such accumulation. There *never would be* in plain fact, in the very case supposed. The intended complication is only a riddle for riddle sake; it is mere x, mere algebra, mere gratuitous muddle, mere needless self-mystification. So, to one half of his query, "in what time shall he discharge the said interest?" My reply is, the interest shall be discharged annually, out of the £187. Then, as to the second question, we see there would remain £87 per annum; this would be a sinking fund paid to the mortgagee, and this accordingly ought to fructify at compound interest, say 5 per cent. Thus the awful problem of "Algebra," when popped into the hopper of common sense, comes out in the following simple shape:—How long will £87 at 5 per cent. compound interest take to become £2000? Surely, not even "Algebra" personified will allege that algebra is wanted for such a common-place bit of arithmetic as this, an ordinary interest sum. Five per cent. on £87 will be 87 shillings; add this to £87 and we have £91 7s. This is one year. Then 5 per cent. on £91 7s. will be £4 10s. 4d. Add this to £91, &c. This makes two years. We have only to go on with such augmentation, till we get £2000; and then "Algebra" will know what time it would take. It would be a shorter "time," both amassing and doing, than he seems to think; and I purposely avoid all "fancy" modes of calculation; I go on the most humdrum footing. But we need not pursue the problem, since it is abundantly clear that our friend did not first ask himself whether his own case possessed even possibility. Thanks to his own beclouding algebra, his mind failed to discern that his compound interest not only need not grow where he wants to put it, but also really it would never exist at all in relation to the £2000; of which the superabundant yearly influx of £187 is the proof. In this manner, in the problem of every professed algebraist, there is always some stultifying element, some groundwork fatal to his own platform, so that the hypothesis does not even exhibit verisimilitude. The "problem" is always as if I propounded, Suppose a man had no mouth, and could only drink through his nose? then how many pecks of fried potatoes would he eat? "Eat? you say; how could he eat?" So also our "Algebra's" compound interest is the eating without a mouth. The science (excuse plainness) is all rabbish. The French Institute decreed that phrenology is too vague to be called a science. Algebra is like phrenology; and, if it would not be civil to say they are both humbugs, we may certainly say they are both mistakes. —GIMEL.

[4129].—DISTILLED WATER.—"Moses" may make a cheap and handy apparatus for this purpose by soldering down the lid of a tin saucepan with a hole cut into the top, into which a pipe is firmly fastened. Then he should get a small tub—a butter cask for instance—and bore a hole in the side an inch from the bottom. A few yards of ordinary gas-pipe, with one end passed thoough the hole in the tub, the other luted on to the pipe in the lid, and the remainder coiled up in the tub, will complete a still which I think will answer his purpose. The tube should be filled with cold water (which may require changing now and then), the saucepan three parts full of water put on the fire, something placed at the end of the pipe projecting from the tub to catch the distilled water, and his apparatus will go on with its work without requiring much attention. Of course an old kettle will do as well as a saucepan, and anything that is watertight will answer the purposes of the butter tub.—SAUL RYMEA.

[4123].—SOLDERING.—The proper flux for brass is borax mixed up with Bath metal solder. If the brass is of inferior quality he must use nearly half black solder, which is generally called spelter soda.—J. M.

NOTES AND QUERIES.

[4127.]—MOUNTING CHART.—Would any reader inform me how charts, &c., are mounted on cloth, and the kind of cloth which answers best for the purpose; I have tried several times but owing to the paper expanding and the cloth contracting when wetted, they do not lay quite smooth one on the other? I should also like to know how to varnish charts and drawings. What size and varnish should be used? —CONSTANT READER.

[4128.]—WATCHMAKING.—Will "Nobody," or any kind subscriber kindly inform me how the jewels are fitted to the plates of watches? I know it is the custom of country watchmakers to send their jobs that require new jewels to London and have them fitted; but I should like, if possible, to be able to fit them myself. Another question I should like answered if any brother reader can do so. What am I to do with a watch that has had a magnet applied to its balance; since then it has lost about an hour every day. I have been informed by a friend that if all the steel in the movement is dipped in a liquid prepared for the purpose, and then cleaned in the usual way, it will go as well as ever; but, unfortunately for me, he cannot recollect of what the liquid is composed. Can any reader inform me?—COMPENSATED BALANCE.

[4129.]—FISHERMEN'S NETS.—Would some obliging reader inform me how fishermen make their nets, as I wish to make some for the garden. A small sketch showing how the twine is passed would be of service; also what stuff to make them of to prevent them rotting?—SCOLOPENDRIUM.

[4130.]—FERN CASE.—I asked lately for a design for a Wardian case for ferns and moss, and received a reply, but the design though substantial enough is clumsy and anything but a parlour ornament. Perhaps you would be kind enough to reinsert the query?—SCOLOPENDRIUM.

[4131.]—SUNDIAL.—At what angle should the gnomon of a dial be placed so as to cast no shadow on the longest day at mean noon supposing it to be placed exactly opposite the point in the horizon where the sun first appears on June 21.—W. H. C.

[4132.]—TELESCOPE.—Is it good work for an 8¼in. reflector to pick up Jupiter when only 9° of the sun, and at what distance from the sun ought the same instrument to pick up Mars and Mercury —W. C.

[4133.]—SIDEREAL TIME.—How to set a sidereal clock at exactly sidereal time, and how to test its performance?—W. H. C.

[4134.]—STAINS ON CLOTH.—Will a brother reader kindly inform me if there is anything for removing the red stains from black cloth caused by diluted sulphuric acid or sulphate of copper being spilt on it?—H. A.

[4135.]—STEAMING BOTTLES.—I want a small boiler to steam dirty bottles in a tub. Can any of our readers give me a hint how to plan one that will not cost much, and also state what pressure of steam it will require to boil the water in a tub containing—say 40 gallons?—SIMPLEX.

[4136.]—EGG HATCHING MACHINE.—Would some one of your readers give me the information in detail of how to make an egg hatching machine, with the particulars of the process of working, and oblige?—P. G. M.

[4137.]—BRAZING BAND SAWS.—Will some kind correspondent give me instructions on brazing band saws?—SUBSCRIBER TO NEW VOLUME.

[4138.]—DESIGNS FOR STAMPING TEA TRAYS, &c. —How could I obtain some good designs for the working of stamps by steam such as are used in the Black Country for stamping tea trays, waiters, &c.?—C. D.

[4139.]—STAINS IN VENEER.—Will any brother reader kindly inform me the best way to remove stains from veneering without injuring the wood?—J. B.

[4140.]—FOREIGN CARMINE.—Where is it made, and how?—A. P. S.

[4141.]—ELLIPTOGRAPH.—I have been looking out for some time for an instrument that will describe ellipse, such as is used in isometrical perspective drawing, but have not yet seen a really practical instrument. Could any of your readers inform me if such an instrument has been made that answers the purpose better than drawing lines through points by the hand, or by the compasses from four centres?—THOMAS SMITH.

[4142.]—DYEING WOOLLEN CARPETS.—Can any kind reader inform me if there is a work published that gives in detail the processes of the printing and the dyeing of woollen carpets, &c.?—AMICUS.

[4143.]—POTTERY.—Will someone be so good as to tell me how many degrees of heat are required to bake an ordinary china plate, and to give me the calculation whereby this number is arrived at?—MINNEHAHA.

[4144.]—FIRE CLAY.—Will any fellow reader kindly inform me how to make fire clay and earthenware on a small scale as I wish to make some pipes for water?—AMICUS.

[4145.]—OIL VARNISH.—Will some "brother" kindly inform me of the best known oil varnish for oil paintings of value?—J. S.

[4146.]—BOOKS ON PRINTING.—Would any brother reader tell me where I could procure a good work on printing for young beginners? I know of one, but the price is 7s. 6d. I want something at about 2s.—YOUNG PRINTER.

[4147.]—COIN OR MEDAL.—Will one of your numismatic readers tell me what the following is? It is not quite so large as ½ farthing. Obv.: sinister bust profile of George IV. undraped, laureated legend—Georgius IV. Dei gratia; 1827 under head. Rev.: Britania seated on shield with trident in left hand, right hand on shield, rose, thistle, and shamrock conjointly under. Legend: Britannia Vex. Fid. Def.—ENERGUE.

[4148.]—RAMSBOTTOM'S PISTONS.—I want to know if it is possible to change the rings of Ramsbottom pistons without taking them off the cylinder, and also if it is possible to make the Cornish high pressure valves to work with one face, as the two faces are always getting out of order?—ONE IN NEED.

[4149.]—ELECTRICITY AS A REMEDY FOR EPILEPSY.—I should feel grateful to "W. A." or any of your scientific correspondents informing me if electricity is a remedy for epilepsy, as I have been suffering from it 5 years, and am tired of doctors, besides having lost a good deal of my hard earnings, and received no benefit?—T. M.

[4150.]—BOILER FEEDING.—Can any correspondent tell me of any method of getting water into a boiler containing compressed air without the use of a pump? A speedy and intelligible answer will greatly oblige?—AMICUS.

[4151.]—BOTANICAL QUERY.—Will some botanist kindly tell me which of the *Orchideæ* is the following. It answers in most particulars to the description of the "Orchis ustulata," only great stress is laid in botany books on its dwarf growth, whereas my orchis is decidedly tall. Sepals dark purple forming a helmet, including the two small petals, lip white, spotted with purple, deeply 3-cleft; spur, short; bracts, about half as long as the germ, upper ones, purple; spike, oblong, rather crowded; root knots, two; leaves, green, lower ones, broad and egg-shaped; height, from 8 to 10 or 12in.; *Habitat*, meadows in North Yorkshire.—E. M. P.

[4152.]—MANUFACTURING GAS FROM VEGETABLE SUBSTANCES.—Can any of your very numerous correspondents tell me where I can find an account of the method of making gas for illuminating purposes from waste vegetable and oily matters. I am informed that Paris is partially lighted with such gas; but I cannot learn how to make it. I wish to learn the method thoroughly in order to practise it abroad in the wilds of South America where I am going. If it be an English patent, I would, of course, willingly pay for permission to use it.—DIEGO USON.

[4153.]—COLOURING WIRE.—Will any kind reader inform me if there is any fluid by which I can coat, or stain iron wire a dark straw or brass colour; also, what is used for colouring pins?—A. E. O.

[4154.]—ENGRAVED STEEL PLATE.—I have a valuable steel plate which, after having had some copies printed, I wish to preserve for future use. Will some correspondent tell me how to prevent its rusting, &c.? It has been returned from the printer's slightly covered with wax.—H. W. H.

[4155.]—PHOTOGRAPHIC AND DISSOLVING VIEWS. —Could any of our friends who understand optics assist me? I want a half-plate lens for taking photos., and a magic lantern. Is it possible to have the two combined in one lense with a 4½in. condenser? Could any of our kind friends inform me where I could get the lenses, and their cost, and if it is really possible to have the two perfect lenses combined in one?—A SUBSCRIBER.

[4156.]—BOOK ON WATERWHEELS.—I shall be obliged if any of our fellow readers can refer me to a good practical modern work on the construction of waterwheels, in either the English, French, or German languages?—AQUARIUS.

[4157.]—REED ORGAN.—Having read the various articles by our talented contributors upon the pipe and reed organs and harmoniums, I have come to the conclusion to build one of these, and as I have not the room at my disposal for a pipe organ, I have thought of a reed organ, the (free) reeds of which I would enclose in short pipes. I want 2 manuals and 8 rows of reeds, the stops, I should like being double diapason 16ft., flute 8, fifre 4, bassoon 8, hautbois 8, flute 8, clarion 4. Should the pipes be circular, or would any difference be made in sound by making them the shape of the reed frame, and what would be the sizes and modifications required for the various stops, also, should the reeds be fixed at an angle with the axis of the pipe, or laid horizontally within it. Would tho "H. B." oblige by giving small diagram of tuning-screw action in Myers Eolophons, and could I apply it to the pipes, Also, about what size would the sound board require to be, as I intend to follow "An Adept's" instructions in the woodwork." If "H. B.," "Eleve," or any of our talented writers would favour me with their advice, they would greatly oblige. J. C. P.

[4158.]—WATER PUMP.—Will any brother subscriber give a rule for finding the number of gallons a pump will lift per min., having a 10in. steam cylinder, a 8in. ram, 10in. stroke, making 20 strokes per min.—ONE IN NEED.

[4159.]—VINEGAR.—Will any reader give a recipe for making vinegar for pickling, and how much malt would it take to the gallon.—E. H.

[4160.]—KILLING MOTHS, &c.—Will any brother reader inform me if there is any liquid to be obtained, that will take the life of moths, flies, &c., without impairing their beauty? If nothing of the kind can be had, what is the quickest and best plan of taking the life of insects intended for preservation.—J. C. S.

[4161.]—REFRIGERATOR.—Will some brother worker assist me in my troubles? I want to have some means of keeping ice, for say three days at a time, and believe the only way is to keep it is in a refrigerator; can anybody explain the principle and how made?—CHICO.

[4162.]—STRENGTHENING STEEL WIRE.—Will any kindly-disposed wire worker tell me how I can strengthen hard drawn plated or steel wire from 30 to 40 guage.—ANON.

[4163.]—LEAD STICKING TO STEEL.—How can I prevent the lead sticking to steel when hardened in it.—ANON.

[4164.]—SLITS IN STEEL GUAGES.—How are the very fine slits cut in steel guages?—ANON.

[4165.]—ASTRONOMICAL.—Will any of your astronomical friends give me a plain and easy formula to convert heliocentric longitude and lattitude in geocentric?—T. ROUND, Handsworth.

[4166.]—SCRATCHED OBJECT GLASS.—I have an object glass belonging to a telescope, which is rendered useless by having a number of scratches on it. Will some of your kind readers inform me how they can be removed? If it is necessary to grind and polish it again, how is this done, and what tools would be required?—E. G.

[4167.]—EMIGRATION.—Will Mr. R. Smith, or any other brother reader, kindly inform me where I can obtain, the best work on the cultivation of Indian corn and other American farm produce, and also the best work giving the latest and most reliable description of the United States generally, and the newer States in particular, naming the publisher and price in each case?—KANSAS EMIGRANT.

[4168.]—THE VALUE OF A TESTRIL.—Will Mr. Henfrey inform me the exact value of a Testril? The coin is mentioned by Thakespeare in "Twelfth Night," Act II, scene III.—B.

[4169.]—RUSTED JOINTS.—Can any brother subscriber favour me with how to make a rusted joint?—AMO VONIS.

[4170.]—SMOKE BURNING.—I should be much obliged to any subscriber who could give me a few hints about the construction of smoke burners in a steam boat the amount of air-heating surface, &c.?—ENGINEER IN A FOG

[4171.]—CHEMICAL.—Will one of our ever obliging chemical servants kindly inform me how I may convert MnSO4 into Mn2O3. My object being to make manganic sulphate by this means?—MANGANIC OXIDE.

[4172.]—BORING BAR.—How is a boring bar supported in order to bore out the brasses (while in their places) in two standards, so as to have them true with each other.—UNPRACTICAL.

[4173.]—CLEANING GALVANISED VESSELS.—On behalf of one of the gentler sex, I ask is there any means of cleaning a galvanised vessel used for washing? When the clothes are being boiled, a kind of scum attaches itself to the clothes and is almost immovable.

[4174.]—GEOLOGY.—An eye witness to the sinking of a coalpit in west Cumberland. Materials were brought to the surface from below, slate and shale in abundance, with distinct traces of vegetable matter, such as leaves, and even stone fruit, but changed or petrified. At a depth of 240 feet from the surface the miners came upon two trees, as they expressed them "Like two gate posts," which were brought to the surface in fragments, but not a trace of the woody fibres could I discover, except the internal fluting and the bark apparently changed into coal. Perhaps some of your numerous correspondents could solve this problem, How long is it since those two trees first grew that were found 240 feet below the surface?—VERITAS.

[4175.]—OLIVER CROMWELL SHILLING.—What is it worth? A sixpence fetched about £20 a few years back at E. Christies —CODFREY.

[4176.]—CALLAND'S GRAVITY BATTERY.—Will "Sigma" or some other correspondent give me a description of Calland's gravity battery mentioned in No. 273, folio 298, and also state the length of wire to be wound on the pendulum of Bright's electric clock, described in Vol. IV., folio 396? JOHN DAVIES.

[4177.]—BEES AND BEEKEEPING.—Would "Anon" ("Replies to Queries" No. 3943) kindly inform me of whom Payne's "Bee Book" may be had, and the price; and could he tell me whether an entrance hole should be made in a duplet, or whether the bees should enter through a lower hive? Could he tell me also the proper size for glasses to set over duplets, and how long they may be taken?—APIATOR.

[4178.]—MALLEABLE CAST IRON.—Will any of my brother readers inform me if there is a work published on malleable cast iron? Any information will be thankfully received?—CASTOR.

[4179.]—CRAYON DRAWINGS.—Will any subscriber kindly inform me how to use coloured crayons, how to lay on the colour, when to use the stump, and if when finished to wash it over with anything?—WISHART.

[4180.]—A NEW COMET.—I read the following in a Brussels paper:—"Dr. Winnecke, of Carlsruhe, has just discovered a new comet, which is only telescopic. This comet is situated on the east of the sun, above the constellation of the Pisces. It can be observed only after midnight, and a low power will show it. It has the appearance of a nebula, whose diameter was 1-12th of the moon's on the 29th of May last. The movement of this comet seems to be in a plane nearly perpendicular to the celestial equator, as its movement in declination is ten times greater than its movement in right ascension. On the 29th of May its movement in declination was a semi-diameter of the moon. This comet has no tail for the present." I anxiously waited for the last number of the ENGLISH MECHANIC to see more details about this comet; but no allusion is made to it. Has any of our astronomical friends seen it?—FOREIGNER.

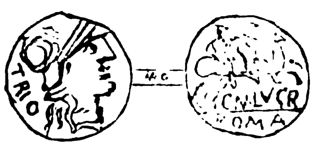
[4181.]—CALCULATION OF BOILER PRESSURE—Would some one name to me an engineer's book that would give me the method of calculating correctly the pressure on boilers by size of valve, and length of lever and weight of ball, as there must be above one way of calculating; for instance "One in Need" proposes a question and gets a weight of 56lb. from one, and 67lb. 10oz. from another, and 58lb. 184 deg. from another as the weight to be placed at the end of lever,—THROTTLE VALVE.

[4182.]—MARKING BOILER PLATES.—Any reader who may be acquainted with the practical methods of marking the templates for boiler plates will greatly favour me by explaining how it is done, giving any simple rules and constructions for drawing the various lines which may occur to him. As an example, he could take the case of a Cornish boiler having the shell plates cylindrical, and the flue plates conical, and also carrying a dome on the top. There will, in this case, I suppose, be four templates, viz., two for the shell, one for the dome, and one for the flue.—TEMPLATE.

[4183.]—CHARCOAL BISCUITS.—Can any of your readers oblige me with a good recipe for making charcoal biscuits?—F. C. R.

[4184.]—LATHE WORK.—If some knowing one at work would answer these questions I should feel obliged:—How are these two beautiful ivory cups turned in case B. No. 26 in the Kensington Museum; is it by the swash plate? I bought in Switzerland at a little shop in the mountains from a wood carver, a match box. From the finish and the mouldings, it had been done in a lathe. But how? He would not tell me, but said it was very difficult. This I do not believe, or he would have charged more for it, neither was he a man who could invest in an expensive machine; so I know it was simple. The cross section is a flat oval, with a moulding turned at each end, and the lid fits to perfection. The inside is simple enough in the eccentric chuck; but the outside beats me. I see in last number, June 10, a lathe for sale with eccentric chuck, with quadrants. What are quadrants to a chuck; and what is the principle of Lowe's medallion cutter?—J. P. G.

[4185.]—SILVER COIN.—Will some numismatic reader kindly inform me whose the coin is of which I enclose full-sized copy? It is, I believe, a Roman denarius, rather thick, and of pure silver. Is it rare?—H. R. G.



[4186.]—SHEATHING IRON SHIPS WITH COPPER.—With reference to No. 2466, page 140 of present volume, may I ask "Patience and Perseverance," or any other willing to oblige me with the information, who is the patentee or inventor of the plan for covering ships' bottoms with a thick coating of some adhesive material painted on hot, and copper in minute particles, dredged on and rolled to make a smooth surface; also, how long is it since this composition was first tested or made public. Any information on the subject will much oblige?—J. M——o.

[4187.]—STEAM CARRIAGES.—TO G. PREW.—Would G. Prew, whose steam carriage is illustrated in last week's paper be kind enough to favour his fellow readers with a more minute description of it, especially the boiler?—LITTLE JOHN.

[4188.]—SOFTENING ASH TIMBER.—I want to bend some ash timber 2in. square; boiling or steaming does not make it soft enough. Would any of our chemical writers inform me if anything could be put in the boiling water that would make the timber softer?—J. L. B.

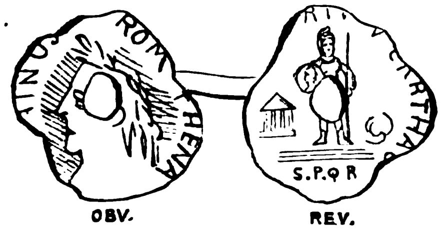
[4189.]—CONDENSER.—I should feel greatly indebted to "Sigma" if he would have the goodness to inform me what size of condenser I ought to make for a coil of the following dimensions:—Iron core 6in. × ¾in., 3 layers of primary wire and 21 layers of secondary, half No. 30 and half No. 32; No. 30 wire being wound on first, and then No. 32. If he would also tell me what size of Bunsen battery would be suitable, I should be still more indebted to him?—ELECTRON.

[4190.]—EMIGRATION TO THE CAPE AND WEST INDIES.—I shall be glad to know what advantages the Cape, or any of the islands in the West Indies—Jamaica or Trinidad—offer to an intending colonist? I see Mr. Rogers proposes Kansas as a suitable place for emigrants. Will he kindly inform us if the Government of that State is thoroughly united and settled, and whether there is anything to be feared from the Indians who occupy its western portion?—R. R.

[4191.]—DOG MUZZLE.—Will some brother reader tell me through our MECHANIC how to make a wire dog muzzle? I hear of them being made so that the animal can drink and not bite. As hydrophobia is just now very prevalent, and as the doctors tell us the ordinary leather muzzle tends to increase it. I think the subject is worthy of the attention of my fellow readers.—BUNTING.

[4192.]—CUTTING GRANITE.—I have a piece of granite out of which I wish to take a piece an inch square, and polish it by hand. Could any brother reader inform me how I can do it?—CHEMICUS.

[4193.]—COINS.—Can you or any of my brother readers inform me in your valuable paper what the two following coins are:—No. 1. Obv., a crowned bust to left, legend, "Isabella Def. Fid.;" rev., a crown between two laurel branches, legend, "Hispanola, Brazil, 1770." I enclose drawing of the other.—ONE WHO WANTS TO KNOW.



[4194].—PHOTOGRAPHY—STAINS, &c.—May I ask some kind subscriber to inform me how to take out stains of pyrogallic acid and silver? I am constantly sprinkling my clothes with the intensifying solution above-named. May I also ask our kind Editor to encourage as much as he can articles on photography, as I am sure there are many amateur photographers who read the MECHANIC, and thoroughly enjoy the articles on photography.—W. G. C.

[4195].—SENSITIVE FLAMES.—Will you or any of my fellow readers be kind enough to give me some information with regard to the properties of the sensitive flame, and the apparatus requisite for producing it.—F. W.

[4196].—CEMENT FOR FASTENING BRASS CAPS TO BOTTLES.—Will any of my brother readers answer the following? What is the best cement for fastening brass caps on glass bottles so as to stand washing?—NEW SUBSCRIBER.

[4197].—WARMING BY MEANS OF HOT WATER.—What is the cause of the rushing and jumping noise in the hot pipe from boiler to the (cistern hot) circulating principle? Why does it not rise as the water heats in the boiler instead of going in pushes? Also, which is the best principle, the circulating or the pressure? A little information will oblige.—A NEW SUBSCRIBER.

[4198].—GAS STOVES.—In the ENGLISH MECHANIC for June 3 I saw the particulars of a gas stove for cooking purposes. Would "A Dentist" kindly inform, through the MECHANIC, if the gas stove would bake bread; if it would I should like to purchase one with four cooking burners, as by the description given it seems to be the very stove for economy, cleanliness, and adaptability for housewifes generally.—GEORGE.

[4199].—IRRIGATION.—Can any of your numerous correspondents recommend a plan for irrigating a meadow? The top part, five acres, is quite a yard or more from the top of river. Which is the best way to get the water up this yard, as I am disposed to irrigate it if the expense would not be too much. Is there a practical person amongst your readers who would give an estimate of what it would cost, and if not too much I should be glad to have it done.—GEORGE.

[4200].—PRECIPITATING COCHINEAL.—Will some reader tell me what chemical besides bichloride of tin will precipitate cochineal. Bichrolide of tin is too expensive and unmanageable. I should also be much obliged by information respecting the modt of obtaining a dark (or darkish) green precipitate. Arseniate of potash and nitrate only gives a very light, almost white, green, under my hand.—B. A.

[4201].—RED LEAD.—Can any one impart to me the means of preserving (ready mixed) red lead for making steam tight joints in a soft state. Hitherto I have kept it in water, but it always got hard in a few days.—STAEM.

[4202].—BALANCING LOCOMOTIVES.—Would one of your practical readers inform me of a good rule for balancing a four or six-coupled locomotive. The rule I have been working to is not to be depended upon.—STAEM.

USEFUL AND SCIENTIFIC NOTES.

THE ROLLER BARROW.—The peculiarity of this ingenious invention is, that it causes no unsightly scores or marks upon lawns or walks in wet weather, when the use of the ordinary wheelbarrow is a source of constant disfigurement. It is easily worked by a boy, though it can be rendered of any weight desired by filling it up with ballast, the load being discharged at once by tipping the handle. It is very serviceable for bedding out plants, carrying away cut grass or turf, gathering up leaves, or when manuring the ground. The roller barrow is equally adapted for grass lands where horses and carts cannot be employed, and for croquet lawns, being always sufficiently light to be managed in case of need by a lady. It is in use at the Crystal Palace, Kensington, and other gardens, where its handy qualities have rendered it a permanent favourite.

LIGHT IN RELATION TO OPTICAL INSTRUMENTS.—At the usual weekly meeting of the Birmingham Natural History and Microscopical Society on the 31st ult., Mr. C. J. Woodward, B. Sc., read a paper on "Light in Relation to Optical Instruments." He commenced by observing that in order to understand the manner in which light is propagated, the transmission of force by waves must be understood, and especially the transmission of vibration by the atmosphere. According to the accepted hypothesis, light is propogated in a manner analogous to that of sound. The medium, ether, receiving the pulsations of a luminous body, transfers them to the retina of the eye, and thus produces in us the sensation of light. The ether waves are themselves invisible; a so-called beam of light being invisible except there be haze or dust to intercept it. The constitution of a luminous body, as an assemblage of luminous points, was explained and illustrated. The law of inverse squares, and its application in determining the relative brightness of two lights, was illustrated by several experiments. A statement of the laws governing the reflection, of light concluded the paper.

GLASS NEEDLE-CASES.—The following is a description of a needle-case that would appear to possess more neatness and compactness than most devices of the kind. A tube is used of glass, opaque, white, opal, lavender, turquoise, black, or other colour. The inventor draws with the blow-pipe a long point at every three inches of the tube. He separates the lengths, and with the flame of the blow-pipe melts down the point, forming a nib as a finish at bottom of case. He then grinds the other end flat, and smooths in flame; a pad of cork is pushed to the bottom of the case to receive the points of needles or other articles. He then places the articles inside, and finishes with a peculiar metal spring, slide, scoop, and cap in one.

PRESENCE OF MANGANESE IN MILK AND IN BLOOD.—The presence of manganese, as an essential constituent of milk and blood (human, as well as animal), has been known for about 20 years past, but M. Pollacci gives in a French scientific journal some particulars about the method of detection of this metal in the two animal fluids referred to, of which milk contains this metal in the largest proportion; the milk is first evaporated (300 grms. are taken) to the constituency of a paste; this is carbonised by heat in a platinum crucible; the charcoal thus obtained is pulverised, and next completely incinerated; the ash is triturated in an agate mortar and lixiviated with water, in order to eliminate the salts soluble therein, especially chlorides; the residue is treated with very pure nitric acid, and the solution thus obtained is evaporated to dryness and calcined in a test tube; after cooling, a few drops of nitric acid are added, and the contents of the tube again boiled; next, a few grains of puce-coloured oxide of lead are added, and the liquid again boiled; a more or less deeply purplish-coloured liquid appears on leaving the tube at rest for a short time, which is due to the formation of permanganic acid. No quantitative researches have, as yet, been made by the author.

TINNING OF IRON WITHOUT THE AID OF HEAT.—The chief point of interest in this matter is, that the tinning of iron in the cold cannot succeed at all, unless the bath used for that purpose contains, in solution or suspended, an organic substance like starch or glucose, although no precise scientific explanation of this indispensable condition has been hitherto given; the *breveté* employs the following bath—To 100 litres of water are added 3 kilos. of rye meal; this mixture is boiled for half an hour, and next filtered through cloth; to the clear but thickish liquid are added 106 kilos. of pyrophosphate of soda, 17 kilos. of protochloride of tin in crystals (so-called tin-salt), 67 kilos. of of neutral protochloride of tin, 100 to 120 grms. of sulphuric acid; this liquid is placed in well made wooden troughs, and serves more especially for the tinning of iron and steel wire (previously polished) for the use of carding machines. When instead of the two salts of tin just named, cyanide of silver and cyanide of potassium are taken, the iron is perfectly silvered.—COSMOS.

DECREASE OF THE RAINFALL IN FRANCE.—S. Meunier states that it appears more and more certain that the annual quantity of rain in France is rapidly decreasing; the cause is attributed to the cutting down of forests, and to the fact that no sufficient care is taken to keep the mountains well covered with suitable vegetation, so as to enable their soil to grow trees in abundance.

TELEGRAPHIC IMPROVEMENT.—The *American Telegrapher* describes a valuable improvement in relay magnets, by W. W. Smith, of Cincinnati, Ohio. The improvement consists in arranging the connections of a relay so that the main circuit is divided, one half passing through each helix, and uniting again on the opposite side, instead of having the conducting wire of the two spools continuous, as in the usual manner. It will be seen upon a moment's reflection, that, by changing the connections of a magnet of the usual form, and arranging them upon Mr. Smith's plan, that the total resistance will be reduced ¼ of the original amount, while the two helices will exert their magnetic influence in conjunction upon the soft iron cores, as usual.

TOBACCO AND ITS ADULTERATIONS.—According to John C. Draper, who contributes an able article, against the use of tobacco, to the *Galaxy*, for June, the adulteration of tobacco varies greatly with the character of the preparation. In that intended for chewing, it consists chiefly of molasses or common salt, rarely of leaves of other plants. In cigars and cut tobacco for smoking it is by no means common, and consists usually of hay, paper, or leaves of the dock, rhubarb, cabbage, elm, and oak, all of which are, comparatively speaking, harmless. In snuff, on the contrary, adulteration is very common, and the substances used are, in many cases, exceedingly injurious, including such articles as chromate of lead, bichromate of potash, powdered glass, and different kinds of ochers or oxides of iron. The latter are nearly always found in the Scotch snuffs, and rarely occur in the Welsh and Irish.

REWARDS TO INVENTORS.—Amongst recent Parliamentary papers issued, is one which gives copies of reports and correspondence as to the rewards to inventors proposed in the army estimates for the current financial year. These rewards are as follow:—A grant of £100 to Mr. C. F. Guthrie for an ingenious and efficient rolling-bridge applicable to defensive works. It is proposed to pay the sum of £500 to Mr. S. A. Goddard for his improvements in breech-loading cannon. In the case of Mr. Parsons, who alleged that the Palliser gun was really invented by him, the matter has been referred to Mr. Gregory, the president of the Institute of Civil Engineers. The Treasury has sanctioned a grant of £500 to Commander Colomb, as a final reward on account of his signals for naval and military use. The Treasury has also resolved to ask Parliament for £1700, to be granted to the representatives of the late Jacob Snider, for his invention of breech-loading rifles.

EMIGRATION.—Private letters from Melbourne represent the labour market as much overstocked, although immigration is still encouraged by a large party. The fact is that Victoria is at the present moment passing through a severe crisis. Mining property has become greatly depreciated in value, partly from the natural exhaustion of the works which have been long in operation, and partly from the numerous instances of fraud in the so-called "auriferous discoveries," and the country has now been so thoroughly "prospected," that it is hardly likely that any rich deposit will remain unrevealed.

ANSWERS TO CORRESPONDENTS.

⁂ All communications should be addressed to the, EDITOR of the ENGLISH MECHANIC, 31, Tavistock-street, Covent Garden, W.C.

The following are the initials, &c., of letters to hand up to Friday morning, June 24, and unacknowledged elsewhere :—

H. Larkin, W. Richardson, J. H. T., Col. J. R., W. K., H. Dolan, R. Biddle, C. Smith, J. F., Rev. G. G., W. B., W. H. W., J. Crowther, J. Peters, W. Moor, jun. ; Right Rev. T. L., Veritas, W. Clarke, J. C. F. K., E. T., J. Halley, The Harmonious Blacksmith, Rev. E. Kernan, A Practical Man, W. R. Birt, J. H. J., Wm. Johnson, J. H., A. Tolhausen, Jet, J. B., Peregrine, T. H. S., A. B. C. D.. T. N., E. Perry, A. P., Llah, W. A., Veritas, G. E. J., W. Morton, T. J. O. C., Alex. Forbes, Jas. Leigh, Ch. Rabache, J. H., W. Current, W. B. J., W. B. C., J. Gillott.

HITHERTO, during summer time, there has been a marked falling off in our correspondence. It is not so this season. In fact, the number of our correspondents—and we can never have too many of them—is increasing. This is the best sign of the growing nterest felt in the ENGLISH MECHANIC. Mr. Batty, of Fennell-street, Manchester, in a letter just received, says :—"The ENGLISH MECHANIC is becoming quite an institution of the country." So the Loudon postmen think, who have to bring hourly to our office large bundles of letters. We have had to provide them an extra fee when the "Christmas Box" fund is collected. We have had to postpone this week F. R. A. S.'s communication on The Light of the Stars, Mr. Proctor on Meteors, Algebra by Gimel, Brazilian Railways by J. G., Comets by W. F. Dunning, To Millers by F. Davis, Hydrostatic Weighing Machine by A. B. Duckham, three letters on Music and Musical Instruments by Harmonious Blacksmith, The Sun's Parallax by Hugo, letters on Trade and Commerce, Lunar Actinity by W. R. Best, The Herne Knitting Machine by a Practical Man, Practical Hints to Millers, Cotton Spinning, Bicycle Riding by S. James, &c., &c.

TOURISTS' TRIPS.—Our invitation for information for tourists has been most liberally responded to—in fact, to such an extent that we cannot insert all the letters on the subject which have reached us. We did not want exactly glowing descriptions of beautiful scenery, over which some of our correspondents have gone into raptures, but districts pointed out and objects described which would be particularly interesting to scientific tourists. Devoniensis is thanked for his description of Barnstaple, J. J. McCartey for his North Wales, A Mechanic for his description of same district, and A. Crofts for his particulars of Dover.

ALFRED MILLEDGE.—No stamps enclosed.

ULSTER.—One of the best remedies for tender feet this time of the year, is to wash them daily, or twice daily.

E.W.—We cannot afford space for an illustrated notice, of a bicycle, in order to elicit opinion thereon. E. W. must be a very inattentive reader of the ENGLISH MECHANIC for many years past, or he would not have sent such a thing.

G. M. Rather too speculative for our columns.

J. E. KEY.—We cannot inform you.

J. W. R.—We read your letter and threw it aside, and the following day we read it and threw it aside a second time. It contained some good information, and some equally good criticism ; but it was vitiated by incivilities towards another correspondent, and, therefore, rejected. Though men may differ, there is no reason why they should not credit each other with good intentions, and treat each as gentlemen, and particularly when they enter on scientific matters, and have no selfish interest to promote.

J. W.—You should always put the drawing on a separate sheet of paper from that on which the description appears, as we like to send the description to the printer, and the drawing to the engraver simultaneously.

J. WAREHAM must consult indexes.

The Sixpenny Sale Column is the only place in which can appear queries sent by James Levesque, A. D., and D.P.M.

H. LOCKE.—No stamps. Exchange not inserted.

JAMES LIGHT.—Yes.

TATIUS.—The rubbings of the coin you send are not plain enough for our engraver. It is best to send sketches.

F. N. B.—See back numbers.

T. TADE.—Your suggestion is impracticable.

E. BONCER.—We cannot, as we do not know either your capabilities or position.

F. W.—First part of query inserted. For second, see recent back numbers.

H. DOLAN (Leeds).—The stamps were duly received and the numbers forwarded to the only address you gave—viz., "Leeds." They were returned through the Post Office, the Leeds postmen not being able to find you. Your second letter only contains the same vague address. Please send your exact address and eight stamps for the re-postage of the numbers. You have given yourself, us, and the Post-Office a deal of unnecessary trouble.

J. BRADBURY.—We cannot say. Try S. and B. Solomons, Albemarle-street.

CROYDE.—We cannot.

BLACKSMITH (Ontario). With every wish to oblige you, we *dare* not allow you to ask for the information through our pages. The eye is far too sensitive to be treated by unskilled persons. Let your boy see a medical man at once and don't tamper with his eyes yourself.

A WORKMAN'S APPEAL.—"The Harmonious Blacksmith" has written us in reply to a "Blacksmith's" complaint in a letter, under the above heading in our last number, that he (the "Harmonious Blacksmith,") does not write enough on subjects of interest his to "brother blacks." The "H. B." has no desire to benefit any one class as such, but wishes he were "privileged to suggest means for benefiting all classes." If any fellow-correspondent "does him the honour to think that he can keep him to any lawful knowledge he may command his help." Our own pages bear witness that this is no mere idle offer, and we think that a "Blacksmith" was jus 'a trifle unreasonable and incorrect, when he complained that the "H. B." wrote on nothing but musical instruments. He *has* written on many other things and has never withheld any information asked of him, which was in his power to give. It should be mentioned, however, that he is only half a "Blacksmith" and very "Harmonious hence he doubtless possesses more information (the fruit of long experience) on musical subjects than some others.

THE ENGLISH MECHANIC.—Mr. R. A. Proctor says :—"The ENGLISH MECHANIC will grow to be, if it is not already, the most powerful scientific organ in England. There are some ill-natured remarks about it in the *Astronomical Register* for the current month. It would be utterly absurd to mulct the ENGLISH MECHANIC of the best parts of its power by a too rigid exclusion of all but strictly scientific matter." We noticed the remarks referred to, but took no notice of them on account of the insignificance of the journal named. It does not circulate as many dozens as the ENGLISH MECHANIC circulates thousands. The information it contains is very stale and very dear, as a shilling part contains about as much information as four of our pages.

G. F. S. thinks the idea of connecting two bicycles, and making a four-wheel veloce, as suggested by a new reader, last week, a happy one.

C. G. R.—You ask too much. It is not fair that our generous correspondents should also be asked to communicate information through the Post Office.

H. CHILDS.—When built send a drawing.

W. E. SEDGLEY.—Two other letters on shorthand, all taking your side, are inserted this week.

J. DODSHON.—We don't know the address.

J. W CASTLY.—See answer to W. E. Sedgley.

GEO. FREEMAN.—See answer to G. F. S.

INDUCTORIUM.—Next week.

J. A. T.—See answer to C. G. R.

P. W. G.—No doubt you have been taken in. The advertisement shall not be inserted again. No one, if we can help it, shall use our advertisement columns for dishonest purposes. Now the horse is gone, no doubt P. W. G. will close the stable door. Be more careful in future.

JOHN JEFFREY.—We do not send receipts privately for love or money. The query column is open to you.

J. HAMSON.—Thanks for suggestion about indices.

G. F. S. says he has discovered a new motive power which would, provided it could be applied, achieve wonders ; but he has not the means to patent it. Has G. F. S. tested the discovery by experiments? If he is certain, let him communicate with some capitalist of knwn honesty, and in all probability he will not be denied. Trust begets trust.

JOHN A. LEY.—What blocks do you want ?

TRADE AND COMMERCE.—Received letters from Fact Collector, Percy Johnson, F. W. M., and Foreign Clerk.

ROWLAND A. ELLIOTT, of St. Helen's, sends his congratulations on the improvements in the ENGLISH MECHANIC.

G. M. LITTLE.—The tourist trip given is not sufficiently detailed. The same correspondent says that Adept again appears in print ; he hopes he will favour him with a reply to his query (3837) respecting organ pipes.

J. D. MORGANS.—Please send description to accompany engravings, which are prepared.

C. H. W. B.—The continuation of Mathematics came to hand.

W. H. HUNT.—You should take no notice of Isaac W. Wolfe. He made so many blunders, and wrote about matters on which he knew nothing, that as a correspondent we simply had to show him the door. We refused to insert any more of his letters, and have several by us unused at the present time. So to revenge himself, he abuses us elsewhere. Let him do so if it affords him any amusement ; he cannot possibly hurt us. The journal in which he writes has become the receptacle of our rejected correspondence.

THE *ENGLISH MECHANIC* LIFEBOAT FUND.

Subscriptions to be forwarded to the Editor, at the office, 31, Tavistock-street, Covent Garden, W.C.

	£	s.	d.
Amount previously acknowledged	£189	12	7
J. Baxter	0	1	0
R. S.	0	1	0
H. Childs, Blandford	0	2	0
H. C. B.	0	0	6
P. B. McG.		2	6
	£189	19	7

THE INVENTOR.

APPLICATIONS FOR LETTERS PATENT DURING THE WEEK ENDING JUNE 20, 1870.

1700 R. Blackbee, Dalston, improvements in surgical instruments known as specula

1701 H. Hammond, Manchester, an improved apparatus for mixing soils and chemical manures.—A communication

1702 W. Moore, Preston, improvements in securing bolts and nuts

1703 W. A. Chandler, 79, Sun-street, Bishopsgate-street, London, improvements in railway and other carriage wheels

1704 A. Ford, 21, Elgin-crescent, an improved method of applying moisture and heat, medicated or otherwise, to the animal frame

1705 G. Wells, 12, North-street, Westminster, apparatus for ventilating ships and for extinguishing fires on board same.—A communication

1706 B. G. Sloper, Northfleet, improvements in the treatment of sewage

1707 G. Weir, Glasgow, and J. Weir, Liverpool, improvements in slide valves

1708 A. V. Newton, 66, Chancery-lane, an improved mode of forming bats of wool for felting purposes.—A communication

1709 J. H. Johnson, apparatus for pressing and forming heels for boots and shoes.—A communication

1710 F. Dupuy, Bayonne, an improved anti-hemorrhoidal apparatus or anti-hemorrhoidal plate

1711 C. H. Perman, improvements in coal vases

1712 A. B. Berard, 21, Avenue Montaigne, Paris, improvements in the manufacture and fusion of cast iron

1713 H. Law, 15, Essex-street, Strand, improvements in apparatus for the supply of water to waterclosets

1714 M. Jacob, Maida Hill, improvements in the means or apparatus employed for retaining the windows of railway carriages.

1715 R. Miller, Gartcosh, improvements in the manufacture of clay or earthenware pipes

1716 J. H. Johnson, improvements in the treatment and in the employment of certain animal substances to be used as fertilizing agents.—A communication

1717 J. Fossard, improved bellows for lighting fires

1718 W. J. Hopkins, Worcester, improvements in the construction of roofs and sides of houses

1719 W. Gadd, and J. Moore, Manchester, manufacturer, improvements in looms for weaving

1720 H. B. Fox, Oxton, improvements in Venetian blinds

1721 W. A. Clayton, Birkenhead, improved combinations of screw propellers and steering apparatus.

1722 B. C. Rolls, Chatham, Ontario, Canada, harmoniums and other reed instruments of music.—A communication

1723 J. Swain, Oldham, improvements in the construction of furnaces for the manufacture of iron and steel

1724 W. R. Lake, Southampton-buildings, improvements in steel washers.—A communication

1725 J. H. Brierley, 58, Aldermanbury, improvements in the ornamenting of fastenings for braces

1726 W. E. Newton, improvements in paint brushes.—A communication

1726 W. E. Newton, improvements in machinery for binding wrapping, and forming cigars.—A communication

1727 B. P. Weatherdon, 77, Chancery-lane, an improved machine for breaking stones.—A communication

1729 H. H. Kromschroeder, 99, Camden-street, Camden-town, and W. P. Randall, 9, Dorset-street, Vauxhall-bridge-road, improvements in gas meters.

1730 G. S. Fleming, 148, Drury-lane, a cork, stopper, or plug

1731 W. Hadfield, Manchester, improvements in looms for weaving

1732 G. Farmer, Summer-lane, Birmingham, improvements in machinery for the indenting of iron for shoe-heel tips

1733 C. Joseph, south-place, Kennington-park, improvements in gas burners.—A communication

1734 J. E. Lee, Oughtibridge, near Sheffield, improvements in the manufacture of tilt and forge hammer heads, and in hurst and tail hoops

1735 W. B. Smith, Tucking-mill, Cornwall, an improved casing for Bickford's safety fuze

1736 C. A. Bluemel, York-street, Globe-road, improvements in walking-sticks and in sticks or handles for umbrellas, parasols, and sunshades

1737 H. E. Newton, improvements applicable to looms for weaving.—A communication

1738 J. A. Lindblad, Sheffield, improvements in bottles or flasks, and an improved device for uncorking said bottles or flasks

1739 W. Ambler and B. Jowett, Bradford, a self-acting indicator or machine for showing the times of trains

1740 G. O. Wray, Heatholm, improvements in fastenings for boxes, wine cases, and other articles

1741 T. Greenwood and J. Fabian, Hoxton, an improvement in billiard and bagatelle cues

1742 H. Bessemer, Queen-street-place, improvements in steam vessels and sailing vessels, for the purpose of lessening the motion of certain parts thereof, and for lessening or preventing sea-sickness

1743 L. A. Ritterbandt, 40, Eastbourne-terrace, Hyde-park, improvements in the manufacture of peat charcoal

1744 C. M. Campbell, Stoke-upon-Trent, improvements in the manufacture of mosaic plaques or slabs

1745 Sir J. Whitworth, improvements in fire-arms and ordnance, and in rifled projectiles and machinery for the manufacture of the same

1746 T. J. Smith, 166, Fleet-street, improvements in producing caustic soda and caustic potash.—A communication

1747 B. Partridge, Smethwick, improvements in axle-boxes and in means of securing the same upon the axle

1748 A. M. Clark, 53, Chancery-lane, improvements in bells and in the mode of hanging the same.—A communication

1749 A. S. Stocker, Thomas-street, Horsleydown, improvements in bottles and stoppers and other articles to be employed therewith

1750 T. J. Smith, 166, Fleet-street, improvements in treating copper pyrites.—A communication

1751 W. E. Gedge, 11, Wellington-street, Strand, improvements in machinery for cutting corks.—A communication

1752 J. O. Ewing and J. J. Coleman, Glasgow, improvements in treating or preparing certain lubricating oils

1753 J. J. Lundy, Leith, an improved compound for the lubrication of wool and other similar animal material in their processes of manufacture

1754 R. J. B. Mills, 35, Southampton-buildings, improvements in doffing and dividing apparatus applicable to continuous cards.—A communication

1755 A. M. Clark, 53, Chancery-lane, improvements in apparatus for raising sunken bodies, and in the mode of operating the same.—A communication

1756 C. D. Abel, 20, Southampton-buildings, a new or improved mode of and apparatus for testing the quality of the malleable metals and alloys.—A communication

1757 L. Heim, 15, King's-road, Islington, improvements in blacking for boots, shoes, and other articles

1758 J. de Weweirne, Ghent, improvements in dyeing

PATENTS SEALED.

3684 F. T. Hughes, garment for sanitary purposes.—A communication

3685 J. Wild, Rochdale, improvements in the manufacture of pile fabrics

3691 G. C. Fraser, improved means of disinfecting or drying clothes, bedding, &c.

3692 H. M. Marsden, improvements in the manufacture of sheep shears

3694 W. E. Gedge, a self-acting apparatus for preventing accidents from steam machinery.—A communication

3696 J. Martin, fabrics and materials repellent of water, and in apparatus therefor

3712 R. Turner, improvements in machinery for preparing, twisting, or spinning cotton and other fibrous materials

3733 W. H. Baxter, improvements in machinery or apparatus for weighing or measuring corn

3736 F. F. Benvenuti, an improved feeding inkstand

86 R. D. Dwyer, an improved mode of roofing buildings

98 W. E. Newton, improvements in the manufacture of sugar.—A communication

103 H. E. Newton, improvements in billiard-table cushions.—A communication

172 G. H. Gossip, improvements in the manufacture of umbrellas and parasols

291 C. W. Fuller, improvements in the construction of bottles intended to contain aerated and other liquids

374 J. Tenwick, improvements in holding fingers used in reaping or mowing machines, or other machines of like character

551 W. E. Newton, improvements in windmills.—A communication

631 A. V. Newton, improvements in fluid meters.—A communication

640 W. E. Gedge, an improved apparatus for subcutaneous extractions and injections.—A communication

735 J. Dunnachie, improvements in stoves for drying bricks and other articles in pottery

819 G. W. Fox, improvements in the treatment of cod-liver, castor, and other medicinal oils

962 A. Ody, improvements in weighing machines

1006 W. Iesty, improvements in compositions for coating ships' bottoms and other like purposes

1008 W. Simpson and A Gardner, engines worked by steam or other motive power

1141 W. Brown, improvements in the construction of thrust blocks, plummer blocks, and such like mechanism used in steam ships

1252 W. R. Lake, an improved valve or stop-cock.—A communication

3711 W. McKenzie, T. McKenzie, and J. McKenzie, improvements in apparatus for sharpening the cutters of mowing machines.—A communication

3728 R. Thomas, a new or improved apparatus for propelling steam ships

3731 J. Hargreaves and T. Robinson, improvements in the treatment of pyrites and in obtaining products therefrom

3735 T. G. McDiarmid, improvements in the rig of ships and vessels

3741 S. Walker and B. Holt, improvements in steam pumping engines

3744 N. Grew, improvements in apparatus for measuring the weight or volume of water or other fluid supplied to steam boilers or other vessels.—A communication

3761 B. G. Herrmann, improvements in the separation of metals

3775 J. H. Johnson, improvements in the production of cast-iron, iron, and steel.—A communication

106 A. V. Newton, an improved knitting machine.—A communication

233 W. G. R. Penley, improvements in pipes for smoking tobacco

236 W. E. Newton, improvements in preparing surfaces for skating in all seasons.—A communication

238 J. B. Alliott and A. H. Sellers, improvements in the construction of axle-boxes for railway, tramway, and other similar engines, carriages and trucks

407 W. R. Lake, improvements in spring seats and bed bottoms.—A communication

510 F. C. Hills, improvements in the manufacture of gas

816 T. Keely, improvements in the manufacture of looped fabrics

834 A. A. Newton, improvements in manufacturing barrels and other round vessels of wood.—A communication

908 J. S. Davies and W. B. Yates, improvements in looms for weaving

1082 . Joseph, improvements in filters.—A communication

1107 E. De La Rue, improvements in croquet mallets

1134 W. R. Lake, improvements in reversible butt hinges.—A communication

The English Mechanic

AND

MIRROR OF SCIENCE AND ART.

FRIDAY, JULY 8, 1870.

ANNOUNCEMENT.

THE following is the publishers' announcement in the last number of *Scientific Opinion*:—

"74, Great Queen Street, London, W.C.
29th June, 1870.

"This week's issue of *Scientific Opinion* comletes its third volume, and brings the existence f this publication, in its present form and under ts original Editor, to a close. The proprietorhip and conduct of *Scientific Opinion* have now assed into other hands, and this journal will enceforth be incorporated with THE ENGLISH MECHANIC AND MIRROR OF SCIENCE, an illustrated reekly periodical of great popularity, and one njoying a very large circulation.

"Correspondents in all future communiations are therefore requested to observe the hange of address, and to note that the day of publication is altered from Wednesday to Friday in each week.

"Subscribers will continue to receive *Scientific Opinion* in its altered form in completion of their prepayments; and it is hoped they will find increased inducements, in the more extended scope of THE ENGLISH MECHANIC AND MIRROR OF SCIENCE, to renew the patronage originally acorded to *Scientific Opinion*.

"Books for Review, Advertisements, &c., &c., should henceforth be addressed respectively to he Editor and Publisher, at the Office, No. 31, Tavistock Street, Covent Garden, London, W.C."

THE FLIGHT OF A STAR.

BY A FELLOW OF THE ROYAL ASTRONOMICAL SOCIETY.

WE have, on a former occasion, referred to the fact that our great English philosopher, Mr. William Huggins, F.R.S., has succeeded, by the aid of the spectroscope, in determining not only that the most brilliant star in our heavens (Sirius) is travelling away from the earth, but even, within very narrow limits of error, the rate in miles per second at which that glorious luminary is winging its stupendous flight through the depths of space. Since then several communications have been addressed to the ENGLISH MECHANIC, containing the expression of a wish for more definite information on this subject than the bare reference above alluded to affords. We now, therefore, propose to endeavour to give some notion of the *principles* on which Mr. Huggins's very extraordinary results have been arrived at. We cannot hope to do any more; and even to effect this in an intelligible way, debarred as we are from the use of mathematics, will tax all our powers of popularizing a very abstruse subject, and all those of attention on the part of the reader of this article.

In the acquisition of knowledge in any fresh branch of physics, or in the pursuit of any novel form of scientific investigation, more or less intimacy with other branches of science must be, of necessity, presupposed; and it would simplify our task exceedingly if we could legitimately assume the acquaintance of the student with the undulatory theory of light. Inasmuch, however, as we are writing for those who may have been debarred, by want of time or opportunity, from the chance of familiarizing themselves with this special subject, we must, in the outset, give such a short exposition of its leading features as to render what is to follow intelligible. A careful re-perusal of our series of articles on "What Stripes the Sunbeam" will, further, be essential to its proper understanding.

In treating of the dispersion of light by means of a prism (on p. 145), we merely enunciated the fact of such dispersion without making any attempt to theorize upon the subject. It now, however, behoves us to say something of the nature and constitution of light itself.

We derive, then, the notion of what we call light from the impression on the eye caused by the undulations in a medium which apparently pervades all space, and which has been called—not very appropriately—the luminiferous ether. Be this medium what it may, this much is certain, that each ray of light travels through space by absolutely equal and regular steps or vibrations. The number of these in any given ray is perfectly measurable and invariable, but is different for different rays; so that, in point of fact, we can identify any given ray by the length of its vibrations, steps, oscillations, or whatever we may call them. Now, although the *number of vibrations* performed in a second by the luminiferous ether varies, as we have intimated, for each colour, yet, in vacuo, the actual *velocity* of all rays is equal; so that white light has been happily compared to a crowd of men and children all running at precisely the same rate but with steps of various lengths, the shortness of the children's steps being compensated for by their frequency. Of the equality of this velocity of all the differently-coloured rays, we have evidence from the everyday observation of astronomers that the aberration of all these rays is identical. We have spoken, on page 120 of our last volume, of the eclipses of Jupiter's satellites, and a little reflection will show that if, say, the violet rays *travelled* quicker than the red, when the satellite plunged into the shadow of the planet it would change colour, fading out from white to red through the various colours of the spectrum, the red rays being the last perceptible, as the last to reach the earth. For the same reason the satellite ought to appear violet or blue at the commencement of its reappearance. As a matter of fact we know that it retains its white colour up to the instant of becoming invisible, and emerges from the planet's shadow again without presenting a tinge or tint of any kind.

Unwilling as we are to encumber the student with more detail than is absolutely necessary for the comprehension of this somewhat difficult subject, we shall abstain from any description of the manner in which the length of the various undulations, their number in an inch, and the number of them which are performed in a second, have been ascertained. A tolerably accurate table of these data (at all events, as a differential one) will be found on page 35. It will be more to our present purpose to examine the bearing which they have upon the matter which we have undertaken to discuss.

Well, then, as we have said above, light of all colours or degrees of refrangibility travels at identically the same rate *in vacuo*. But suppose that a ray of white light falls upon a prism (p. 145) how will that affect its rate or mode of motion? In this way: it will be retarded, or the rate of propagation of the undulatory motion will be diminished. In other words, the progress of the ray will be slower in any refracting medium than in vacuo. And besides, our prism, in refracting the rays unequally, really retards them unequally, delaying the violet the most and the red the least; so that the latter travel the fastest and the former the slowest, intermediate colours progressing at intermediate rates.

It is almost unnecessary to add that all that we have said with reference to the visible rays of the spectrum, applies equally to the dark lines crossing it (Fig. 5, p. 172), and that the rate, length, and frequency of the vibrations necessary to produce light of their precise refrangibility, are susceptible of mathematical determination with all conceivable accuracy. This, as will be seen in the sequel, is a point of the utmost importance. Assuming this to be all clear to the mind of the reader, we now proceed to derive an illustration from a wholly different branch of science—acoustics; for, although sound is propagated through the air at the rate only of 1,090 feet in a second, and light travels at least 900,000 times as fast, yet the circumstance of their both having their origin in undulatory movement—albeit of very different media—enables us to employ one of these effects to explain the other. The waves, then, of the deepest note of an organ pipe audible (as a musical sound and not a mere noise) are about 64 feet in length, and occur some seventeen times in a second; these we may conceive to be analogous to red light. The length of the waves of a cricket's chirp are certainly less than an inch long, and between 30,000 and 40,000 of them are formed in the same interval; we may imagine these to correspond with the violet rays. Now, in saying this, we have assumed both the source of sound and the ear of the auditor to be stationary. A very little consideration will show that, if either of them be in motion, the resulting sound will be modified. For, suppose that a note is being sounded on a horn such as to induce 440 vibrations or waves in the air in a second of time, if we approach the trumpeter at a rate bearing anything like an appreciable proportion to that at which the sound is travelling, more of these waves will reach the ear in a second, and the pitch of the note will rise; if, on the contrary, we travel away from our imaginary musician with any considerable velocity, the waves of sound will have to overtake us; fewer of them will reach us in a second, and the pitch of the note will fall. M. Buys Ballot, between twenty and thirty years ago, experimented on this subject on a railway in Holland; and his experiments were subsequently repeated in this country by Mr. Scott Russell, who brought them under the notice of the British Association for the Advancement of Science in 1848. Both M. Ballot and Mr. Russell found that the whistle of a rapidly-approaching train sounds a higher note than when the train is stationary, and as it recedes from the listener it sounds a lower note. We believe that in the case of some experiments with a moving train and a stationary observer this difference amounted to a semitone; and that, when the auditor was himself travelling in a train which met and passed the one whose whistle was blowing, the resulting sound differed a whole note from that yielded by the same whistle when both the locomotive and the experimenter were standing still.

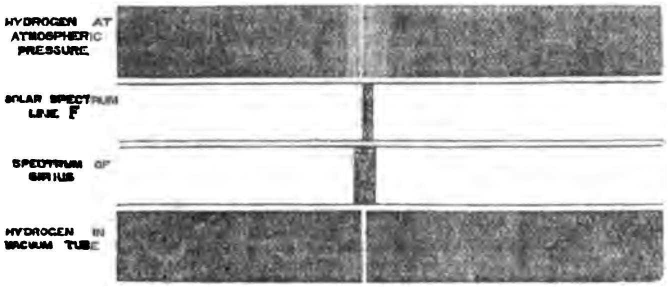
All this may assist us in comprehending how motion, towards or from any luminiferous body—if such motion be sufficiently great to bear a measurable proportion to the velocity of light—may either exalt or depress the refrangibility of the rays which reach the spectator, and so shift the rays—*and, of course, the dark lines*—either up towards the violet end or down towards the red end of the spectrum, according as we are approaching to or receding from the source of light.

One more consideration will help us in the apprehension of a point of detail in Mr. Huggins's very wonderful researches, and that consideration is this. Throughout our papers on "What Stripes the Sunbeam," we have tacitly assumed—without, however, anywhere actually asserting—that the bright spectral lines of various incandescent vapours are not only invariable in position under all circumstances, but also in thickness, we having purposely suppressed all reference to the fact that the *breadth* of the lines is affected by the *density* of the gas. To take an example, of which we shall now very soon make use, the line F (p. 172) is very sensibly expanded when hydrogen at the ordinary atmospheric pressure is employed instead of that in an ordinary vacuum tube, with which comparisons are usually made. The reason of our former reticence on this and other minor points had its origin in our indisposition to overload a subject already sufficiently complicated with a quantity of detail which could only tend to distract the attention of the reader who might be labouring to master its fundamental principles.

Assuming the student, then, to have grasped the idea that in travelling with any considerable velocity towards a source of light, we meet more waves of that light in a second, and so in effect increase their refrangibility—and that, on the other hand, in receding with sufficient rapidity from the luminiferous body, we diminish the number of vibrations or undulations which reach us, and so degrade their refrangibility—we are now prepared to follow the details of Mr. Huggins's observations and to appreciate their results.

Sirius is a star which, from its great brilliancy and the marked distinctness and intensity of the four lines in its spectrum, early attracted his attention, and to which he has devoted a large amount of consideration. Owing, however, to its proximity to the horizon, anything like measurement of its spectrum is confined to a period of about an hour on each side of the meridian; and, in fact, the extraordinary difficulty of making any measurement at all of lines which fluctuate with the undulations of the atmosphere, can only be appreciated by those who have themselves examined a star, having much south declination, with the spectroscope. From this point we had better let Mr. Huggins speak for himself.

"As it was obviously impossible," he says, "to determine with the required accuracy the coincidence of the line of Sirius when the much broader band of hydrogen at the ordinary pressure was compared with it, I employed a vacuum tube fixed before the object glass. In all these obser-



vations the slit used was as narrow as possible. . . . The line from the spark appeared, in comparison, very narrow; not more than about one-fifth of the width of the line of Sirius. When the battery circuit was completed, the line of hydrogen could be distinctly seen upon the dark line of Sirius. The observation of the comparison of the lines was made many times; and I am certain that the narrow line of hydrogen, though it appeared projected on the dark line in Sirius, did not coincide with the middle of the line, but crossed it at a distance from the middle which may be represented by saying that the want of coincidence was *apparently* equal to about one-third or one-fourth of the interval separating the components of the double line D. I was unable to measure directly the distance between the centre of the line of hydrogen and that of the line in the spectrum of Sirius, but several very careful estimations, by means of the micrometer, give a value for that distance of 0·040 of the micrometer head. This value is probably not in error by so much as its eighth part." After giving an account of many carefully conducted experiments, to prove that it was really the line F of hydrogen which he was observing in Sirius, Mr. Huggins proceeds:—

"From these observations it may, I think, be concluded that the substance in Sirius which produces the strong lines is really hydrogen, as was stated by Dr. Miller and myself in our former paper. Further, that the aggregate result of the motions of the star and earth in space, at the time when the observations were made, was to degrade the refrangibility of the line in Sirius by an amount corresponding to 0·040 of the micrometer screw. Now the value of the wave-lengths of 0·01 division of the micrometer at the position of F is 0·02725 millionth of a millimetre. The total degradation of refrangibility observed amounts to 0·109 millionth of a millimetre. If the velocity of light be taken at 185,000 miles per second, and the wave-length of F at 486·5 millionths of a millimetre (Ångström's is 486·52, Ditscheiner's 486·49), the observed alteration in period of the line in Sirius will indicate a motion of recession existing between the earth and the star of 41·4 miles per second.

Of this motion a part is due to the earth's motion in space. As the earth moves round the sun in the plane of the ecliptic, it is changing the direction of its motion at every instant. There are two positions, separated by 180°, when the effect of the earth's motion is a maximum—namely, when it is moving in the direction of the visual ray, either towards or from the star. At two other positions in its orbit, at 90° from the former positions, the earth's motion is at right angles to the direction of the light from the star, and therefore has no influence on its refrangibility. . . . That portion of the earth's resolved motion which is in the direction of the visual ray, and which alone has to be considered in this investigation, may be obtained from the following formula:—

"Earth's motion towards star $= v, \cos \lambda, \sin (l - l')$.

"Where v is the earth's velocity, l the earth's longitude, l' the star's longitude, and λ the star's latitude.

"At the time when the estimate of the amount of alteration of period of the line of Sirius was made, the earth was moving from the star with the velocity of about twelve miles per second. *There remains unaccounted-for a motion of recession from the earth amounting to 29·4 miles per second, which we appear to be entitled to attribute to Sirius.*"

Such, in the words of their great discoverer, is an account of the astounding results arrived at by the employment of a few glass prisms and a narrow slit. It seems to us to require no addition on our part to render the principles on which those results depend apprehensible to every one who will take the trouble to read it carefully through. Two aids, however, to its comprehension, it may possibly be expedient to supply. The first is the information that the millimetre mentioned above is 0·03937 of an English inch; the second consists of a diagram showing the slight degradation of refrangibility of line F in Sirius. With these, and a careful perusal of what has preceded them, we would fain hope that the student may have no difficulty in perfectly realizing the mode in which have been ascertained both the direction and velocity of the Flight of a Star.

THE WORLD: ITS FORMATION AND ANTIQUITY.

By Arthur Underhill.

(*Continued from page* 337.)

Chapter III.

SINCE the débris, waste, or dregs of each convulsion were deposited in regular strata over every part of the earth which might at that period be submerged or under water, and since each such deposition always partook of a nature different to any preceding or succeeding one, it follows that strata are always found in the order of time of their deposition; that is to say, that the older formations are always beneath the later ones. Thus the carboniferous system was deposited before the oolitic system, and if you should search the whole world you would never find the coal above the oolite. To make it plainer, suppose several systems represented by the numbers 1, 2, 3, 4, to have been deposited in the same order—viz., first 1, then 2, then 3, and then 4, we should in such a case never find them in a reversed or inverted order, as 2, 1, 3, 4, or 1, 3, 4, 2, &c; although from local disturbances of the crust we might frequently find some of the intermediate strata absent; as 1, 3, 4, or 2, 4, or 3, 4, or, perhaps, 4 alone, or 1 alone, resting on some igneous rock. The knowledge of this fact is very useful in the arts, for if we knew what formations are upon or near the surface, we can tell accurately that certain rocks will be absent in that locality, and so save the expense of a useless search for them. For instance, if we should discover (referring to our former example) No. 3 at the surface, we should never think of looking for No. 4 *there*, although we might find numbers 1 and 2. In consequence of this fact, geologists have classified rocks in order of superposition, and the list appended to this chapter exhibits this order. They are placed primarily in five classes, called respectively, primary, transition, secondary, tertiary, and superficial formations. These classes are subdivided into systems, and these again into strata. The division into classes has been made, because all the systems in each class bear a certain resemblance to each other, both in conformation, and fossils or organic remains. Thus the superficial accumulations consist of surface soil, mud, gravel deposited at the mouths of rivers, and diluvium or drift erratic blocks, and contains remains of present animals, including man. The tertiary class (or that immediately below the superficial) consists of marls, clays, crag (or half-formed limestone), and thin strata of sand, and contains fossils of animals and plants of a bygone period. The secondary class is formed of large beds of clay, chalk, shale, coal, limestone, sandstone, and ironstone, containing fossils of plants and saurians (or big lizards). The transition class is composed of strata of limestone, sandstone, and shales, having very few fossils, and those of an exceedingly low organization. The primary class is formed of vast beds of slate, quartz, gneiss, crystalline limestone or marble, and is wholly destitute of fossils. As it may interest my readers to inspect for themselves some of the different systems and classes which are found in our own country, I may mention that in and around London, and from thence as far as the Humber, and including all the eastern counties, the tertiary deposits are found. In Buckingham, Hertford and Bedford, the chalk system occurs. In Shropshire, the old red sandstone; in Northampton, the oolitic; the Cambrian, mica schist, and gneiss, in the mountainous counties; and the new red sandstone, and carboniferous (coal-bearing) systems, in Staffordshire and Leicestershire.

In my next chapter I shall describe the superficial accumulations.

LIST OF ROCKS IN ORDER OF SUPERPOSITION.

Recent or Superficial Accumulations.

Surface Soil.—Earth and decomposed organic remains.

Alluvium.—Gravel, &c., deposited at the mouths of rivers.

Diluvium.—Drift, boulders and blocks.

Tertiary.

Pleiocene (more recent).—Sand, pebbles, clay, &c., containing sea-shells of species approximating to the present.

Meiocene (less recent).—Limestones and clays containing salt and fresh water shells.

Eocene (beginning of recent).—Thick strata of clay, containing marine shells, beds of limestone, with fossil land and amphibious extinct animals and vegetables.

Secondary.

Chalk, or Cretaceous.—Chalk with flints, chalk without flints, chalky marl, green sand.

Oolitic, or Jurassic.—Thick strata of clay, yellow sands, and iron ore, clayey sandstone, Portland stone, Kimmeridge clay, Oxford clay, Forrest marble, great oolite, Fullers' earth, inferior oolite, upper lias, marlstone, lower lias.

New Red Sandstone.—Red sandstone, variegated with blue, yellow, and red; contains gypsum and rock-salt, magnesian limestone and dolomite.

Carboniferous.—Coal, slate, and sandstone alternately with ironstone, clay and peestone; millstone grit, coarse sandstone, and slatey clay, mountain limestone and lead ore.

Devonian, or Old Red Sandstone.—Red and brown sandstones, and conglomerate marl and limestone of a dull red colour.

Silurian.—Thick beds of sandstone, limestone and slate.

Clay-slate.—Slate and dark limestone.

Primary or Metamorphic.

Mica Schist.—Mica, slate, quartz, marble, &c.

Gneiss.—Gneiss and quartz alternately with crystalline limestone, and mica schist.

(*To be continued.*)

COMETS AND METEORS.

By Richard A. Proctor, B.A., F.R.A.S.,
Author of "Other Worlds than Ours," &c.

(*Continued from page* 313.)

IT had been noticed that many meteors seemed to enter our atmosphere with a velocity far exceeding that which would be due to bodies travelling in nearly circular orbits around the sun. The observations on which this conclusion had been founded were, indeed, not wholly satisfactory, because it was a matter of extreme difficulty to *time* the motions of the meteors athwar the heavens. It was comparatively easy for tw observers, at stations far apart, to take observations of the same meteor so accurately that it actual path through our atmosphere could be determined; but to ascertain exactly how man seconds it occupied in traversing that path wa by no means so easy. The suddenness with whic a shooting star appears, the short duration of it visibility, and the necessity of noting very accurately its apparent path among the stars, all ten to make the determination of the actual numbe of seconds occupied by the meteor in swoopin athwart the heavens a matter of extreme difficulty. Yet observations had been made whi indicated, as I have said, a velocity far great than that which would be found in the case meteors travelling in a nearly circular pa around the sun. We know what that veloci would be: a body at the same mean distance fr the sun as our earth, would travel with the sa mean velocity, or at the rate of some 18 miles a second. Such a body coming full tilt again the earth, would traverse our atmosphere at t rate of 36 miles per second. But, as a matter fact, it was found that some meteors travelle a rate considerably exceeding this—even, when they were not directly encountering earth.

Now, if this had been accepted as actu proved, there would have been only one exp nation of the phenomenon. We know so su what velocities can be generated by the s attractive influence under such and such circ stances, that whenever we find a body mo with a given velocity in any given part o solar system, we know forthwith what i range of its path, from what distances i come, and to what distances it will pass aw It may seem that in the present instance problem must be complicated by the effects of earth's attraction; but in reality the earth ca largely affect the motions of these bodies. the earth were allowed an all but infinite per to attract a meteor from an all but infinite tance, the meteor would finally reach the ear with a velocity of barely six miles per second. will be conceived, therefore, how relatively sm must be the part of any meteor's velocity due terrestrial influence, when these bodies come swooping down upon the earth's atmosphere with a sun-generated velocity of nearly 24 or 25 miles per second, often superadded to the earth's velocity of 18 miles per second.

What could be gathered, then, from the great observed velocity of meteors would be inevitably this, that these bodies before reaching the earth had been travelling on paths far wider in range than the earth's orbit—that the aphelia (that is, the points of their orbit farthest from the sun) lay far out beyond the orbits of Jupiter and Saturn, perhaps even beyond the orbits of Uranus and Neptune.

But what amazing results would follow from this! It would no longer be possible to regard meteor systems as in any way associated with the earth's orbit. We should no longer be able to regard the earth's encounter with even a single meteor system as otherwise than a most wonderful coincidence, unless we concluded that besides that meteor system there were millions on millions of systems which lie altogether clear of her path. And remembering that she encounters many systems, we should have to abandon the belief that a wonderful coincidence was in question, and be forced to conclude that there must be countless millions of meteoric systems.

We shall see presently that the evidence is in reality even stronger than we are here supposing; but I do not hesitate to say that with no further evidence than the great observed velocity of meteors we should be led inevitably to the amazing inference that the solar scheme is crowded with meteoric systems. *This inference would even then be no mere theory, but a legitimate conclusion from the evidence.*

The occurrence of annual meteoric displays had convinced all reasoning minds that the meteors are cosmical bodies travelling on planetary orbits around the sun. The matter was in effect certain, though it was often spoken of as a theory, even by astronomers capable of appreciating the sound evidence on which it rested. Another law of periodicity was to lead to a further and even more important advance in our knowledge respecting meteors. It was found that one of the best recognised meteor systems—that which produces the November star shower—waxed and waned in splendour within a period of about the third part of a century. In other words, there was a rich part of the meteoric stream which returned to a particular position in the solar system once in about 33¼ years. But whether it returned in reality only once in that period, or oftener, was not certain. If it had come back to the same position, but during another month than November, we could have known nothing about it, for the earth would have been "in another place." Astronomers were disposed to believe, in fact, that it *did* return several times in the course of the period of 33¼ years; for they could not believe that this rich region travelled out into space upon the enormous orbit corresponding to a revolution having so long a period. They imagined that it returned to the place where the earth's orbit crosses the meteor track in about a year and a 33rd part, or in about a year less a 33rd part, and so came there at epochs passing round the circle of the months, either forwards or backwards, until after about 33 years the complete circuit had been formed, and so the display was renewed.

I shall now show how this view was shown by the great mathematician Adams to be unfounded, and the much more surprising results established—that the members of the November meteor system have a period of 33¼ years, and travel out into space beyond the orbit of distant Uranus.

From the laws of gravitation it follows that when once the period in which a body travels round the sun is determined, the velocity of the body at any given distance from the sun is also known, let the *figure* of the body's path be what it may. So that the astronomer could determine with what actual velocity the November meteors enter the earth's atmosphere on any given assumption as to their period. This known, he could, by very simple processes of calculation, determine from the apparent direction of the meteor's motion as they enter our atmosphere, what is the actual direction in which they are moving at that part of their path round the sun.

And thus it became possible to determine, on each of the above assumptions, what is the actual path traversed by the November meteors. But then, given their path, we know what forces come into play to sway their path into new positions. And if their path thus changes, the place where the earth encounters them must change also. In other words, although in one year the earth might cross the track of the meteors on or about November 13, yet a long time after the path would have so changed that the earth would not encounter the meteors on that date, but somewhat earlier or somewhat later.

Now astronomers might have waited for many years before they would have been able to verify the occurrence of such a change—but, fortunately, we have records of the occurrence of the November shower in long past years; so that all that was necessary was to compare the dates of those showers with the date on which the shower now takes place. The earliest recorded occurrence of star-shower belonging to what we now call the November system, took place on October 12, A.D. 902, (or in the new style on October 18); and, by comparing this with the date on which the shower now occurs (making due allowance for that peculiar motion of the earth's axis which causes the precession of the equinoxes), it appeared that the place where the earth encounters the meteors is steadily shifting forwards by about half a minute of arc in each year, so that a complete revolution of the place of encounter could be effected in about 30 × 360 or 10,800 years.*

But when Professor Adams—for the problem is one calculated to tax the highest powers even of mathematicians of his standing—came to examine the effects which the planets could produce on the meteoric paths, he found that this change of position was not accounted for on any of the assumptions mentioned above. It became clear that the meteors are subject to disturbing attractions of a more effective character. In other words, it seemed as though the meteors must travel out into regions where the giant planets, Jupiter and Saturn, or even Uranus and Neptune, are capable of exerting more influence than they can exert on bodies travelling always near the earth's orbit.

It was an obvious consideration that, this being so, the real period of the meteors is, probably, that same period—33¼ years or so—which separates the recurrence of marked meteoric displays belonging to this system. For with a period of 33¼ years, a body which along one part of its path crosses the earth's orbit, would along the opposite path be far out in space, even beyond the orbit of distant Uranus.

The calculation of the motions of bodies travelling in such orbits is by no means an easy matter. Astronomers, though they often have to deal with the motions of bodies in very eccentric orbits, yet are seldom required to follow those bodies along the whole course of such orbits, or to trace out those processes of change which affect the position and figure of the paths of such bodies.

It happened, fortunately for science, that a method devised long ago by the eminent German astronomer Gauss was available for the solution of this difficult problem. Adapting this method with singular skill to the requirements of the problem before him, Adams found that the changes affecting the meteor's orbit are most satisfactorily accounted for on the supposition that the meteors really travel out into space along the eccentric orbit which corresponds to the period of 33¼ years.

No doubt therefore remained, in the minds of any who were capable of appreciating the evidence, that the path of the November meteors really carries them beyond the orbit of Uranus, or more than nineteen times farther from the sun than our earth is.

But, in the meantime, other and very remarkable evidence had been adduced which, at the same time, confirmed this result and proved that the August meteors also are travelling on an orbit yet more eccentric than that of the November meteor system.

The Italian astronomer Schiaparelli had been led to notice that the bright comet of 1862 passed close by the earth's orbit at a point lying very near the spot where she encounters the August meteors. Now that comet travelled in a very eccentric path, having a period variously estimated at from 126 to 145 years, but undoubtedly very long. It occurred to Schiaparelli to inquire whether, on the supposition that the August meteors travel on an orbit of like eccentricity, their calculated path would lie near that of the comet. It will be understood that the meteors might cross the earth's orbit in a million different directions, not one of which would correspond to a path placed like the comet's—though of like figure. So that the odds were enormously against such a coincidence as Schiaparelli looked for, supposing there were no real association between the meteors and the comet. Now it appeared that the path of the meteors (on the supposition mentioned) accords most closely with the comet's path—so far, at least, as the parts of both paths near the sun were considered.* The conclusion is obvious: an enormous weight of probability favours the belief that the coincidence is not accidental, but that, in some way (even now not fully understood), the meteor system and the comet are associated together.

But astronomers have a liking for certainty. I am inclined, indeed, to say that they have too great a liking for certainty, inasmuch as they often neglect evidence which, though founded on the laws of probability, is yet overwhelmingly strong. At any rate, in this instance, it is certain that very little confidence would have been placed in the researches of Schiaparelli, had not a very surprising confirmation been detected shortly after his results were promulgated.

If the August meteors have their family comet, why not the November meteors also? And as the actual figure of the meteor orbit was known in this instance—which was not the case with the August meteors when Schiaparelli began his researches—there was here a means of proving definitely that meteors and comets are associated, if only a comet could be found which travels along that particular route in space which the November meteors traverse.

But no bright comets were found which could be associated with the November meteors, and at first the search for faint ones was unsuccessful. By one of those extraordinary coincidences, however, with which the history of science has familiarized us, a telescopic comet had but a few months before been detected by Tempel, the orbit of which (only calculated a few week before Adams completed his labours) was found† to correspond very closely—or rather, in effect, *exactly*—with the track of the November meteors.

Thus quite a new light was thrown upon the nature of these wonderful meteor systems. I pass over the later researches, which have shown that other well-known periodical meteor systems are either associated with known comets or travel in orbits demonstrably eccentric. The two instances above dealt with are quite sufficient to establish the important conclusion that the meteor systems are not in any way limited to the neighbourhood of the earth's orbit, but extend far out into space along orbits of the most eccentric figure.

The consequences of this result are most striking, and have hitherto not received a tithe of the attention which they merit.

(*To be continued.*)

MICROSCOPICAL JOTTINGS IN TOWN AND COUNTRY.

No. II.

WE may now attempt the examination of our piece of cuttlebone, or as the learned call it, Sepiostaire. We will commence by dividing the "bone" into halves across the axis with a stout knife. With a keen razor we can now cut with perfect ease very thin sections of the bone, and placing one of these on our stage, we find that the bone consists of a great number of thin plates, separated from each other by vertical laminæ of excessive delicacy, which wind in and about, reflecting upon themselves at intervals, so as to form a better support for the plates. Many have described these sinuous laminæ as "pillars," but their true character is easily discoverable if we make a careful horizontal section, removing the "calcareous plate," so that the tops of the so-called pillars may be seen. As "opaques," these sections, when mounted on a black background, are very beautiful; but many persons prefer to mount vertical sections in balsam, in order that they may be viewed as polariscope objects. The number of beautiful slides that may be obtained from one piece of sepiostaire would surprise the novice. The outer horny case of the bone requires a different treatment, and would hardly be adapted to the hands of a beginner.

Before we leave, for a time at least, the sea-side, we will glance at a few other objects that I have secured at different periods. We may begin with Polyzoa. The different species of Flustra (sea-mats, &c.), found on all our coasts furnish very good objects for the microscope of moderate power—and be it understood that I shall speak of nothing which a £3 3s. instrument will not show well, with the exception of polarizing, which would entail £1 10s. more. These must be carefully washed with fresh water, and then mounted either as "opaques," or in section as "transparents," in balsam. I have one slide—a *Flustra foliacea*, found at Hornsea, Yorks—which comes out grandly by polarized light. This Flustra is composed of small oblong cells; the base membrane of this is seen studded with a vast number of beautifully coloured crosses, which "rotate" with the prism below the stage, when that is rotated.

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* The real period is somewhat longer.

* It is not to be therefore understood that the coincidence is not equally close for the whole of the two paths. But where we only have the opportunity of observing the part of a body's path which lies close by the sun, we are not able (unless very many and very exact observations have been made, or unless the body has appeared more than once, so that we know its period) to determine very accurately the figure of the very remote parts of the path.

† By Dr. Peters of Altona.

A parasitic Flustra, common on sea weeds, also furnishes a very pretty object for the inch objective. Of corallines, such as the "sickle," our shores commonly have an abundance; and these well mounted as opaques are not to be despised. Amongst the waifs of the shore we may generally find some very transparent crabshells, so transparent that they may be mounted "as they are," in balsam, and submitted to examination. We shall find in them certain "wheel crystals" of lime, which are noteworthy as revealing to us one stage in shell construction. These two are splendid polariscope objects. The skin of the prawn affords better specimens of these circular crystals, but generally these must be got at the shops, and can hardly come into the category of sea-side objects. The sea hedgehog, or Echinus, is tolerably well known to most of our readers; yet probably few of them have paid it the attention that it deserves. Let us take one from our miscellaneous gatherings and give it a look over. The "Aristotle's lantern," being the jaws of the creature, may first attract our notice. The teeth which compose the jaw are five in number, and each "tooth has somewhat the form of that of the front of a rodent, save that its concave side is strengthened by a projecting keel, so that a transverse section presents the appearance of '⊥.'" The tooth itself is composed of carbonate of lime, and is in structure essentially the same as the shell; the keel is composed of "cylindrical rods of carbonate of lime, having club-shaped extremities," and the "concave side of the tooth is coated with a firmer layer," which some have likened to the "enamel" of the teeth of vertebrata. These teeth are furnished with delicate serrations, visible by the aid of the pocket lens, and the whole apparatus is interesting in the extreme. Around the jaws are a number of calcareous plates, easily removable, and to be mounted in balsam. These are interesting, inasmuch as they give a ready view of the structure of the shell and of the teeth. As polariscope objects, they too are good. The "spines" require to be sectioned, but though interesting, are not in our British species very remarkable.—H. P.

THE ACTION OF THE JAWS AND THE PHARYNX IN DROWNING.

IT is well known to most persons that by contracting the muscles of the jaws, the pharynx, and the roof of the palate, it is possible to prevent the entrance of air into the bronchi, and we are enabled to plunge beneath the surface of the water, and remain there for some appreciable time. But it is not generally understood that, in the case of drowning animals, nature adopts this same method without effort on the part of the individual. Dr. A. De Labordette, after making numerous experiments on animals, believes that the contraction of the jaws, far from being a sign of death, shows rather the continuance of life; and he is strengthened in his conclusion by the fact that the Humane Society men, and all persons who have rescued and restored drowning persons, are agreed in declaring the existence of the contraction of the jaws. If we analyze the sensation which is experienced when we fall into water, we remember that we suffered for some time a violent constraint in the throat. We may swallow but not breathe, and when we come out of the water we still preserve for a long time the sensation of contraction and constriction of the throat. Let any cause or agent intervene to threaten the respiratory function in its physiological conditions, the sensitive disturbance which the pneumogastric nerve receives from it instantly causes the motor nerves—the spinal, hypoglossal, and the laryngeal nerves—to enter into action, and immediately the muscles of the mouth, of the back of the throat, and of the larynx, &c., contract, and shut out the access of any other agent than the atmospheric air.

If an animal whilst plunged under water, is prevented from coming to the surface to breathe, at the end of a minute and a half it will appear to be quite dead, and the jaws will be firmly contracted. By keeping the mouth open, and causing movements to be executed similar to those which are produced in the act of respiration, the animal will recover life in proportion as the air penetrates into the lungs.

Dr. De Labordette tried this experiment on twelve animals of the same age and species (viz., rats), with the following results:—nine were restored, three died. But by prolonging the stay under water to two or three minutes, the limbs by degrees spread out, and the jaws were no longer contracted. Of twelve animals which had been immersed from two to three minutes, Dr. De Labordette, not without difficulty, restored only three: the others died.

The stiffness which follows death cannot be confounded with that which is produced in the subject whose stay under water has lasted only some moments. In the latter case, with subjects restored to life, the rigidity is the result of the contraction of the muscles; in the other case it is due to the *rigor mortis*. Section of the medulla oblongata causes the first species of contraction to give way, but is without effect in the case of *rigor mortis*. Eight animals presenting, after a short immersion in water, a strong contraction of the jaws, were submitted by M. Legros and Dr. De Labordette to section of the medulla oblongata, and immediately the contraction disappeared.

The attempts to recover a drowned man from the state of apparent death ought to be so much the more persevering as the fact of the persistence of the contraction of the jaws is almost tantamount to a certainty of seeing them crowned with success. If, unfortunately, life is extinct, we have a sure sign of the inutility of any attempt at resuscitation in the spontaneous unclosing of the teeth and the opening of the mouth.

SCIENCE FOR THE YOUNG.

By the Rev. E. Kernan, Clongowes College.

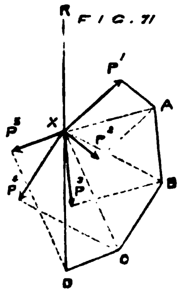
(*Continued from page* 339.)

Appendix VI.

Polygon of Forces.

IN determining by *composition* the equilibrium of any system of forces, there is formed a polygon, which begins with one of the forces, continues by *parallels* equal to the other forces *in order*, and is closed by the final resultant. In Fig. 71, P^1 P^2 P^3 P^4 P^5, are a number of forces acting on the point X. Combining P^1 and P^2, there is produced the side P^1 A, parallel to P^2. Continuing the combinations as in Law VI., there is produced: A B parallel to P^3, B C parallel to P^4, C D parallel to P^5, and D X closes the polygon. For equilibrium R X, a force equal and opposite to C X, is added. Therefore, this system of forces in equilibrium is represented by the polygon P A B C D X. Its sides being equal and parallel *in order* to the six balanced forces, show their relative intensities and direction. Such is the meaning of the "Polygon of Forces."

FIG. 71

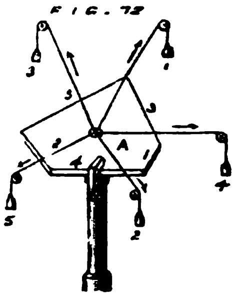


It does not signify, then, that the forces *form* a polygon, but they may be *represented* by a polygon, the sides of which show their direction and relative magnitude. It may be found enounced in other words, but these do not convey anything really different from what has been just stated.

For experiment, the theorem is reversed, "forces of relative magnitude, as the sides of a given polygon, are in equilibrium when acting upon a point if they be disposed *in order* parallel to the sides which represent their magnitudes."

In the polygon A, Fig. 72, the sides are to one and other as 4, 2, 5, 3, 1. This polygon (of wood) being clamped on to the table of the apparatus in Fig. 64, cords are disposed, Fig. 72 (from a ring, D, held by a pin to the wood), parallel to the sides of the polygon, by means of the pulleys, on the frame.* Weights proportional, as 4, 1, 3, 5, 2, are hung to the cords which are parallel to the sides, 4, 2, &c.;* when the last weight is hooked on, the pin may be withdrawn: the ring will not move. The student may exercise himself with this apparatus by taking a number of forces (weights) at random. Let them settle into equilibrium. Now draw a polygon with sides parallel (*in order*) to the forces. Measure the sides of the polygon; their lengths will be found proportional to one another as the forces to which they are parallel. For the truth of the polygon of forces, it is not necessary that all the forces act in the same plane. This point may be said to belong more strictly to the next application.

FIG. 72



Sub-Appendix.

Strain.—Disposition of Forces.

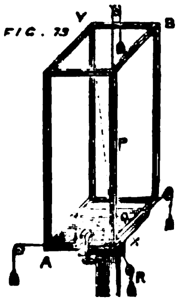
It may sometimes be of great importance to know what amount of strain is exerted in certain directions in which circumstances require that the forces keeping a body in equilibrium should act. A polygon of the forces at once shows their *relative strength of action* on the body. The absolute value of one force being known, that of the others can be calculated. Again, a number of known forces are at command, it is required to know how they should be placed to hold a body at rest. A polygon with sides *as the forces*, will show the direction each force should have.

Appendix VII.

"Parallelopiped of Forces."

As a polygon represents the *equilibrium of a* number of forces in (more or less) *the same plane*, so a solid figure with its diagonal represents a number of forces in several planes. The solid figure thus built upon the forces is called the "Parallelopiped of Forces." The three sides of Fig. 73 are sufficient to give a good general notion of this important theorem. The forces P Q S, acting on a body at X, are represented in direction and in magnitude by the sides of the *solid figure. A frame such as shown is clamped upon the table of Fig. 64 as the* polygon in Fig. 72. Cords, with proportional weights, are disposed along the sides of the frame, Fig. 73. The diagonal—the dotted line, XX—shows the resultant. Add the force R, equal and opposite to the diagonal—the body at X is in equilibrium.†

FIG. 73

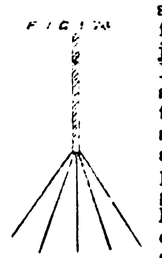


Sub-Appendix I.

Practical Questions.

Some interesting facts, and some most important matters of every day utility, depend upon the principle contained in the parallelopiped of forces. Were the subject not too difficult, these practical questions should be *studied* separately. For the present little more than the indication of them can be given. I. Bellringers.—Large heavy bells require a number of men to make them swing. To one large rope coming from the handle of the bell are joined a set of smaller ropes, Fig. 74*aa*. How the men should stand, how pull, where the stronger, where the weaker should be placed, &c., can be all calculated by the parallelopiped of forces. II. Ships' rigging.—The general strain being known, it can be fairly calculated where the greatest strength must be in the rigging, how the various stays should be placed, &c. On the contrary, when, in case of storm, it may be required to "cut away," principles of calculation will show where to cut, that the source of danger be removed with all speed. III. Moorings.—The safety of all floating bodies

FIG. 74



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* The frame is omitted in the present figure, and the pulleys are nearer than they should be if the whole apparatus were given.

* The figures *at the weights* show the lines to which the forces are parallel. Thus, 1 shows that the line is parallel to the side of which the length is *one*, &c. &c.

† Frames of any solid figure, acute angle, &c. &c., may be used as the rectangular frame of Fig. 73.

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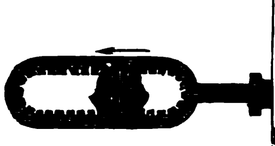

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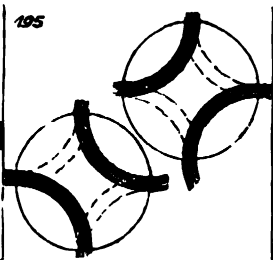

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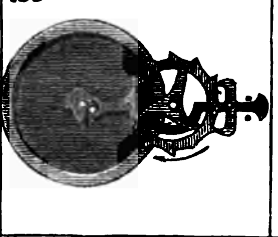

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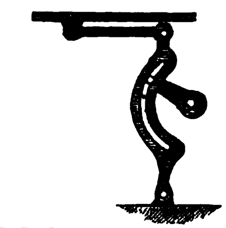

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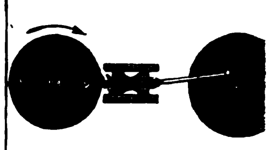

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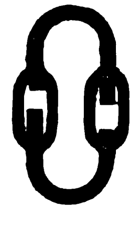

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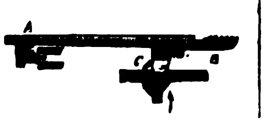

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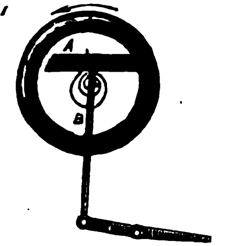

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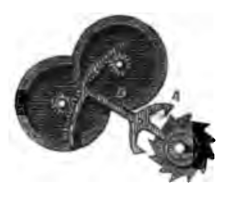

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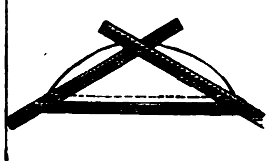

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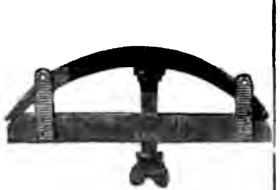

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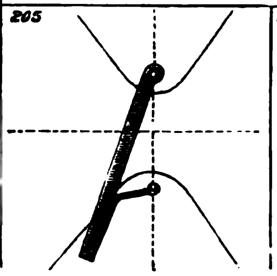

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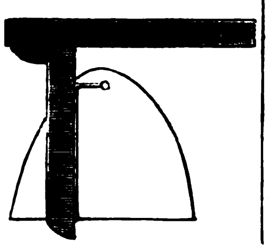

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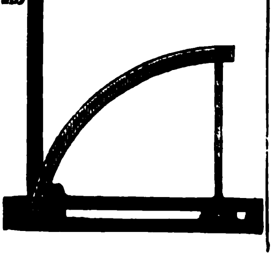

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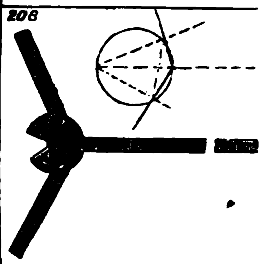


MECHANICAL MOVEMENTS.

ships' batteries, lights, &c., will depend upon the disposition of the chains and ropes which form their moorings. From the parallelopiped can be drawn the changes or additions which the ordinary run of circumstances may require. IV. Suspension bridges.—As these are but little exposed to the action of violent unexpected forces, their equilibrium—conditions of security—as far as their concurrent forces are concerned, can be calculated with great exactitude by the parallelopiped of forces.

SUB-APPENDIX II.

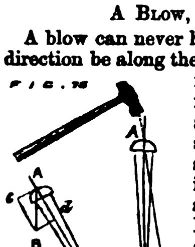
INSECT STRENGTH.

Some time ago (1866) Mr. Felix Plateau published in the *Bulletin de l'Academie Belgique* a most interesting series of papers on the strength of insects compared with that of higher animals.* In this comparison of *weight* to *work*, Mr. Plateau found that while a horse can only do work equal to *two-thirds* of his weight, none of the insects are lower in work than *four times* their weight; some reach to 12, 15, 25, 42 times their weight. Mr. Plateau seems to have arrived at an experimental law, that their power of *traction* or of *pushing* is *inversely* as the weight and size of the insects. Granting the existence of great comparative muscular power, there can be no doubt but that the parallelopiped formed by the multiplication of feet, often armed with claws—curved claws—in many of the insect tribes, enables them to apply their power in a concentrated manner impossible to the horse.

APPENDIX VIII.

A BLOW, FULL FORCE OF.

A blow can never have its full effect unless its direction be along the desired line of effect. Thus, in driving a nail with a hammer, Fig. 75, the force must act along the line A B, the axis of the nail. Should it strike along A C the force is decomposed, part goes along A C, part along A B. Hence the endeavour to drive a crooked nail is a great waste of force, frequently having little more effect than to increase the crookedness. The study of this well-known fact affords an easy exercise in the decomposition of forces. The force of the hammer is shown in direction and intensity by the line A B, Fig. 76. That force may be decomposed into two; say one at right angles to the axis (of the nail) *a b*, and another *along* the axis *a b*. Completing the parallelogram the relative strength of the forces is seen. The effect of *a c* is to bend the nail, *a d* passes on to the point *e*. There *a d*, transferred, decomposes again, say into *e g* and *e h*. If the nail point be not well fixed *e g* takes effect; if the wood can resist, *e h* has some small effect in sinking the point further. Many other possible decompositions of A B would show greater or less force, tending to bend or displace the nail.

FIG. 75
FIG. 76


APPENDIX IX.

ROPES, CHAINS, ETC.

The utility of every sort of cord, rope, wire, chain, &c., from the finest to the most massive, arises from their being able to offer an equal and opposite force to force brought to act upon them. It is "tenacity" which gives them this power up to a certain point.

Thus far the applications of lesser importance. Now are to be seen (studied) some of the so-called "machines," or "mechanical powers." Their most complete explanation depends only on the principles of force applied to a point. As the machines are of great practical utility, they shall be treated in four points. I.—What the machine is. II.—What is the principle of its action. III.—The conditions of equilibrium, established when possible by mathematical reasoning and formulæ. IV.—The development—uses of the machine—and sub-applications. Even *these* have their applications, sometimes very important. They shall be distinguished from the general applications of the laws, by the name of the machine to which they belong.

MECHANICAL MOVEMENTS.*

(Continued from page 344.)

193. Contrivance for polishing lenses and bodies of spherical form. The polishing material is in a cup connected by a ball-and-socket joint and bent piece of metal with a rotating upright shaft set concentric to the body to be polished. The cup is set eccentric, and by that means is caused to have an independent rotary motion about its axis on the universal joint, as well as to revolve about the common axis of the shaft and the body to be polished. This prevents the parts of the surface of the cup from coming repeatedly in contact with the same parts of surface of the lens or other body.

194. C. Parson's patent device for converting reciprocating motion into rotary—an endless rack provided with grooves on its side gearing with a pinion having two concentric flanges of different diameters. A substitute for crank in oscillating cylinder engines.

195. Four-way cock, used many years ago on steam engines to admit and exhaust steam from the cylinder. The two positions represented are produced by a quarter turn of the plug. Supposing the steam to enter at the top, in the upper figure the exhaust is from the right end of the cylinder, and in the lower figure the exhaust is from the left —the steam entering, of course, by the opposite port.

196. G. P. Reed's patent anchor and lever escapement for watches. The lever is so applied in combination with chronometer escapement that the whole impulse given balance in one direction is transmitted through the lever, and whole impulse in opposite direction is transmitted directly to chronometer impulse pallet, locking and unlocking the escape-wheel but once at each impulse given by said wheel.

197. Continuous circular into intermittent rectilinear reciprocating. A motion used on several sewing machines for driving the shuttle. Same motion applied to three-revolution cylinder printing-presses.

198. Continuous circular motion into intermittent circular—the cam, C, being the driver.

199. A method of repairing chains, or tightening chains used used as guys or braces. Link is made in two parts, one end of each is provided with swivel-nut, and other end with screw; the screw of each part fits into nut of other.

200. Four-motion feed (A. B. Wilson's patent), used on Wheeler & Wilson's, Sloat's, and other sewing machines. The bar A is forked, and has a second bar, B (carrying the spur or feeder), pivoted in the said fork. The bar, B, is lifted by a radial projection on the cam, C, at the same time the two bars are carried forward. A spring produces the return stroke, and the bar, B, drops of its own gravity.

201. E. P. Brownell's patent crank-motion to obviate dead centres. The pressure on the treadle causes the slotted slide, A, to move forward with the wrist until the latter has passed the centre, when the spring, B, forces the slide against the stops until it is again required to move forward.

202. G. O. Guernsey's patent escapement for watches. In this escapement two balance-wheels are employed, carried by the same driving-power, but oscillating in opposite directions, for the purpose of counteracting the effect of any sudden jar upon a watch or time-piece. The jar which would accelerate motion of one wheel would retard the motion of other. Anchor, A, is secured to lever, B, having an interior and exterior toothed segment at its end, each one of which gears with the pinion of balance-wheels.

203. Cyclograph for describing circular arcs in drawings where the centre is inaccessible. This is composed of three straight rules. The chord and versed sign being laid down, draw straight sloping lines from ends of former to top of latter, and to these lines lay two of the rules crossing at the apex. Fasten these rules together, and another rule across them to serve as a brace, and insert a pin or point at each end of chord to guide the apparatus, which, on being moved against these points, will describe the arc by means of pencil in the angle of the crossing edges of the sloping rules.

204. Another cyclograph. The elastic arched bar is made half the depth at the ends that it is at the middle, and is formed so that its outer edge coincides with a true circular arc when bent to its greatest extent. Three points in the required arc

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* *Les Mondes*, vol. i. p. 86, and vol. iv. p. 81.

* Extracted from a compilation by Mr. H. T. BROWN, Editor of the "American Artisan.'

being given, the bar is bent to them by means of the screw, each end being confined to the straight bar by means of a small roller.

205. Mechanical means of describing hyperbolas, their foci and vertices being given. Suppose the curves two opposite hyperbolas, the points in vertical dotted centre line their foci. One end of rule turns on one focus as a centre through which one edge ranges. One end of thread being looped on pin inserted at the other focus, and other end held to other end of rule, with just enough slack between to permit height to reach vertex when rule coincides with centre line. A pencil held in bight, and kept close to rule while latter is moved from centre line, describes one-half of parabola; the rule is then reversed for the other half.

206. Mechanical means of describing parabolas, the base, altitude, focus, and directrix being given. Lay straight edge with near side coinciding with directrix, and square with stock against the same, so that the blade is parallel with the axis, and proceed with pencil in bight of thread, as in the preceding.

207. Instruments for describing pointed arches. Horizontal bar is slotted and fitted with a slide having pin for loop of cord. Arch bar of elastic wood is fixed in horizontal at right angles. Horizontal bar is placed with upper edge on springing line, and back of arch bar ranging with jamb of opening, and the latter bar is bent till the upper side meets apex of arch, fulcrum-piece at its base insuring its retaining tangential relation to jamb; the pencil is secured to arched bar at its connection with cord.

208. Centrolinead for drawing lines toward an inaccessible or inconveniently distant point; chiefly used in perspective. Upper or drawing edge of blade and back of moveable legs should intersect centre of joint. Geometrical diagram indicates mode of setting instrument, legs forming it may form unequal angles with blade. At either end of dotted line crossing central, a pin is inserted vertically for instrument to work against. Supposing it to be inconvenient to produce the convergent lines until they intersect, even temporarily, for the purpose of setting the instrument as shown, a corresponding convergence may be found between them by drawing a line parallel to and inward from each.

(*To be continued.*)

WHAT IS ENERGY.[*]

IN TWO PARTS.—PART I.

IT is only of late years that the laws of motion have been fully comprehended. No doubt it has been known since the time of Newton that there can be no action without reaction; or, in other words, if we define momentum to be the product of the mass of a moving body into its velocity of motion, then whenever this is generated in one direction an equal amount is simultaneously generated in the opposite direction, and whenever it is destroyed in one direction an equal amount is simultaneously destroyed in the opposite direction. Thus the recoil of a gun is the appropriate reaction to the forward motion of the bullet, and the ascent of a rocket to the downrush of heated gas from its orifice; and in other cases where the action of the principle is not so apparent, its truth has notwithstanding been universally admitted.

It has, for instance, been perfectly well understood for the last 200 years that if a rock be detached from the top of a precipice 144 ft. high it will reach the earth with the velocity of 96 ft. in a second, while the earth will in return move up to meet it, if not with the same velocity yet with the same momentum. But inasmuch as the mass of the earth is very great compared with that of the rock, so the velocity of the former must be very small compared with that of the latter, in order that the momentum or product of mass into velocity may be the same for both. In fact, in this case, the velocity of the earth is quite insensible and may be disregarded.

The old conception of the laws of motion was thus sufficient to represent what takes place when the rock is in the act of traversing the air to meet the earth; but, on the other hand, the true physical concomitants of the crash which takes place when the two bodies have come together were entirely ignored. They met, their momentum was cancelled—that was enough for the old hypothesis.

So, when a hammer descends upon an anvil, it was considered enough to believe that the blow was stopped by the anvil; or when a break was applied to a carriage wheel it was enough to imagine that the momentum of the carriage was stopped by friction. We shall presently allude to the names of those distinguished men who have come prominently forward as the champions of a juster conception of things; but in the mean time let us consider some of those influences which served to prepare men's minds for the reception of a truer hypothesis.

We live in a world of work, of work from which we cannot possibly escape; and those of us who do not require to work in order to eat, must yet in some sense perform work in order to live. Gradually, and by very slow steps, the true nature of work came to be understood. It was seen, for instance, that it involved a much less expenditure of energy for a man to carry a pound weight along a level road than to carry it an equal distance up to the top of a mountain.

It is not improbable that considerations of this kind may have led the way to a numerical estimate of work.

Thus, if we raise a pound weight one foot high against the force of gravity we may call it one unit of work, in which case two pounds raised one foot high, or one pound raised two feet high, would represent two units, and so on. We have therefore only to multiply the number of pounds by the vertical height in feet to which they are raised, and the product will represent the work done against gravity. The force of gravity being very nearly constant at the earth's surface, and always in action, is a very convenient force for this purpose; but any other force, such as that of a spring, would do equally well to measure work by. Generalizing, we may say, *the space moved over against a force multiplied into the intensity of that force will represent the quantity of work done.* So much for the definition of work, and it is necessary to know what *work* is before proceeding to define *Energy*.

Now what does the word energy mean? In the first place it does not mean force.

Two substances may have an intense mutual attraction, in virtue of which they form a very intimate union with one another; but when once this union has been consummated, although the force still continues to exist, the combination is singularly deficient in energy. Nor does energy mean motion, for although we cannot have motion without energy, yet we may have energy without motion.

By the word energy is meant the power of doing work; and the energy which a labouring man possesses means, in the strictly physical sense, the number of units of work which he is capable of accomplishing.

This is a subject which at this stage we may attempt to illustrate by reference to a very different department of knowledge.[*]

The analogy which we shall venture to institute is between the social and the physical world, in the hope that those who are more familiar with the former than with the latter may be led to perceive clearly what is meant by the word energy in a strictly physical sense. Energy in the social world is well understood. When a man pursues his course, undaunted by opposition and unappalled by obstacles, he is said to be a very energetic man.

By his energy is meant the power which he possesses of overcoming obstacles; and the amount of this energy is measured (in the loose way in which we measure such things) by the amount of obstacles which he can overcome—the amount of work which he can do. Such a man may in truth be regarded as a social cannon ball. By means of his energy of character he will scatter the ranks of his opponents and demolish their ramparts. Nevertheless, a man of this kind will sometimes be defeated by an opponent who does not possess a tithe of his personal energy. Now, why is this? A reply to this question will, if we do not mistake, exhibit in a striking manner the likeness that exists between the social and the physical world. The reason is that, although his opponent may be deficient in personal energy, yet he may possess more than an equivalent in the high position which he occupies, and it is simply this position that enables him to combat successfully with a man of much greater personal energy than himself. If two men throw stones at one another, one of whom stands at the top of a house and the other at the bottom, the man at the top of the house has evidently the advantage.

So, in like manner, if two men of equal personal energy contend together, the one who has the highest social position has the best chance of succeeding. For this high position means energy under another form. It means that at some remote period a vast amount of personal energy was expended in raising the family into this high position. The founder of the family had, doubtless, greater energy than most of his fellows, and spent it in raising himself and his family into a position of advantage. The personal element may have long since disappeared from the family, but not before it had been transmuted into something else, in virtue of which the present representative is able to accomplish a great deal, owing solely to the high position which he has acquired through the efforts of another. We thus see that in the social world we have what may justly be termed two kinds of energy, namely:—

1. Actual or personal energy.
2. Energy derived from position.

Let us now again turn to the physical world. In this, as in the social world, it is difficult to ascend. The force of gravity may be compared to that force which keeps a man down in the world. If a stone be shot upwards with great velocity, it may be said to have in it a great deal of actual energy, because it has the power of doing useful work or of overcoming up to a great height the obstacle interpo by gravity to its ascent, just as a man of gre energy has the power of overcoming obstacles. B this stone as it continues to mount upwards will d so with a gradually decreasing velocity, until at t summit of its flight all the actual energy wi which it started will have been spent in raising against the force of gravity to this elevated positi It is now moving with no velocity—just, in t beginning to turn—and we may suppose it to caught and lodged upon the top of a house. He then, it remains at rest, without the slight tendency to motion of any kind, and we are le ask what has become of the energy with whic began its flight? Has this energy disappeared fr the universe without leaving behind it any equi lent? Is it lost for ever, and utterly wasted? the answer to this question must be reserved another article.

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[*] By BALFOUR STEWART, in *Nature*.

[*] The subject has previously been discussed from this point of view by Messrs. Stewart and Lockyer in an article in *Macmillan's Magazine*, August, 1868.

ON THE RELATIONS BETWEEN BODY A MIND.[*]

(*Concluded from page 342.*)

THE different forms of insanity that occur i young children—as all forms of it excep general paralysis may do—are almost always trac able to nervous disease in the preceding generatio a neuropathic condition being really the essential element in their causation. The cases of acut mania in children of a few weeks or a few years ol which have been described might more properly b classed as examples of idiocy with excitement. There can be no true mania until there is some mind; but we do meet sometimes in older children with a genuine acute mania, occurring usually in connection with chorea or epilepsy, and presenting the symptoms, if I may so express it, of a mental chorea or an epilepsy of the mind, but without the spasmodic and convulsive movements of these diseases. More or less dulness of intelligence and apathy of movement, giving the seeming of a degree of imbecility, is common enough in chorea, and in some cases there is violent delirium; but, besides these cases, there are others in which, without choreic disorder of movements, there is a choreic mania: it is an active delirium of ideas which is the counterpart of the usual delirium of movements, and its automatic character and its marked incoherence are striking enough to an ordinary observer. Hallucinations of the special senses, and loss or perversion of general sensibility, usually accompany the delirium, the disorder affecting the centres of special and general sensation, as well as the mind-centres.

Between this choreic mania and epileptic mania there are intermediate conditions partaking more or less of the character of one or the other—*hybrid* forms of a cataleptic nature. The child will lie for hours or days in a seeming ecstasy or trance, with its limbs rigid or fixed in a strange posture. There may be apparent insensibility to impressions, while at other times vague answers are given, or there is a sudden bursting out into wild shrieks or incoherent raving. If this be of a religious kind, the child is apt to be thought by ignorant persons to be inspired. The attacks are of variable duration, and are repeated at varying intervals. On the one hand, they pass into attacks of chorea; and, on the other hand, into true epileptic seizures, or alternate with them.

In children, as in adults, a brief attack of violent mania, a genuine *mania transitoria*, may precede, or follow, or take the place of an epileptic fit; in the latter case being a masked epilepsy. Children of three or four years of age are sometimes seized wi attacks of violent shrieking, desperate stubborness or furious rage, when they bite, tear, kick, and do all the destruction they can; these seizures, which are a sort of vicarious epilepsy, come on periodically, and may either pass in the course of a fe months into regular epilepsy, or may alternate wi it. Older children have perpetrated crimes of savage and determined nature—incendiarism, an even murder—under the influence of similar attac of transitory fury, followed or not by epileptic co vulsions. It is of the utmost importance to reali the deep effect which the epileptic neuro may have on the moral character, and to keep mind the possibility of its existence when a savag apparently motiveless, and unaccountable crime h been committed. A single epileptic seizure h been known to change entirely the moral charact rendering a child rude, vicious, and perverse, wh was hitherto gentle, amiable, and tractable. one who has seen it can fail to have been stru with the great and abrupt change in moral ch racter which takes place in the asylum epilep immediately before the recurrence of his fits: in t intervals between them he is often an amiab obliging, and industrious being, but when they i pend he becomes, sullen, morose, and most da gerous to meddle with. Not an attendant but c then foretell that he is going to have his fits, nfidently almost as he can foretell that the sun will se next day. Morel has made the interesting obser- ition, which is certainly well founded, that the ileptic neurosis may exist for a considerable period an undeveloped or masked form, showing itself, t by convulsions, but by periodic attacks of mania, by manifestations of extreme moral perversion, hich are apt to be thought wilful viciousness. it they are not—no moral influence will touch them: ey depend upon a morbid physical condition, hich can only have a physical cure; and they get eir explanation, and indeed justification, after- ards, when actual epilepsy occurs.

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[*] Two lectures delivered at the Royal College of Ph sicians in 1870. By HENRY MAUDSLEY, M.D., F.R.C Professor of Medical Jurisprudence in Univer College, London.

The epileptic neurosis is certainly most closely llied to the insane neurosis; and when it exists in ts masked form, affecting the mind for some time efore convulsions occur, it is hardly possible to istinguish it from one form of the insane neurosis. he difficulty of doing so is made greater, inasmuch s epilepsy in the parent may engender the insane eurosis in the child, and insanity in the parent he epileptic neurosis in the child. A character hich the insane neurosis has in common with the pileptic neurosis is that it is apt to burst out in a onvulsive explosion of violence; that when it develops into actual insanity it displays itself in deeds rather than in words—in an insanity of action ather than of thought. It is truly a *neurosis spas- odica*. Take, for example, a case which is one of class—that of the late Alton murderer, who, taking walk one fine afternoon, met some little girls at lay, enticed one of them into a neighbouring hop-garden, there murdered her and cut her body into ragments, which he scattered about—returned uietly home, openly washing his hands in the river n the way—made an entry in his diary, "Killed a ittle girl; it was fine and hot"—and when forthwith taken into custody, confessed what he had done, and could give no reason for doing it. At the trial it was proved that his father had had an attack of acute mania, and that another near relative was in confinement, suffering from homicidal mania. He himself had been noted as peculiar: he had been subject to fits of depression, been prone to weep without apparent reason, and had exhibited singular caprices of conduct; and it had once been necessary to watch him from fear that he might commit suicide. He was not insane in the legal or the ordinary sense of the term, but he certainly had the insane neurosis, and it may be presumed confidently that he would, had he lived, have become insane.

Those who have practical experience of insanity know well that there is a most distressing form of the disease, in which a desperate impulse to commit suicide or homicide overpowers and takes prisoner the reason. The terrible impulse is deplored sometimes by him who suffers from it as deeply as by any one who witnesses it; it causes him unspeakable distress; he is fully conscious of its nature, and struggles in vain against it; his reason is no farther affected than in having lost power to control, or having become the slave of, the morbid and convulsive impulse. It may be that this form of derangement does sometimes occur where there is no hereditary predisposition to insanity, but there can be no doubt that in the great majority of cases of the kind there is such a neuropathic state. The impulse is truly a convulsive idea springing from a morbid condition of nerve element, and it is strictly comparable with an epileptic convulsion. How grossly unjust, then, the judicial criterion of responsibility which dooms an insane person of this class to death if he knew what he was doing when he committed a murder! It were as unreasonable to hang a man for not stopping by an act of will a convulsion of which he was conscious. An interesting circumstance in connection with this morbid impulse is that its convulsive activity is sometimes preceded by a feeling very like the *aura epileptica* —a strange morbid sensation, beginning in some part of the body, and rising gradually to the brain. The patient may accordingly give warning of the impending attack in some instances, and in one case was calmed by having his thumbs loosely tied together with a ribbon when the forewarning occurred. Dr. Skae records an instructive example in one of his annual reports. The feeling began at the toes, rose gradually to the chest, producing a sense of faintness and constriction, and then to the head, producing a momentary loss of consciousness. This aura was accompanied by an involuntary jerking—first of the legs, and then of the arms. It was when these attacks came on that the patient felt impelled to commit some act of violence to others or to himself. On one occasion he attempted to commit suicide by throwing himself into the water: more often the impulse was to attack others. He deplored his condition, of which he spoke with great intelligence, giving all the details of his past history and feelings. In other cases a feeling of vertigo, a trembling, and a vague dread of something fearful being about to happen, resembling the vertigo and momentary vague despair of one variety of the epileptic aura, precede the attack. Indeed, whenever a murder has been committed suddenly, without premeditation, without malice, without motive, openly, and in a way quite different from the way in which murders are commonly done, we ought to look carefully for evidence of previous epilepsy, and, should there have been no epileptic fits, for evidence of an *aura epileptica* and other symptoms allied to epilepsy.

It is worth while observing that in other forms of insanity, when we look closely into the symptoms, there are not unfrequently complaints of strange, painful, and distressing sensations in some part of the body, which appear to have a relation to the mental derangement not unlike that which the epileptic aura has to the epileptic fit. Common enough is a distressing sensation about the epigastrium. It is not a definite pain, is not comparable strictly to a burning, or weight, or to any known sensation, but is an indescribable feeling of distress to which the mental troubles are referred. It sometimes rises to a pitch of anguish, when it abolishes the power to think, destroys the feeling of identity, and causes such unspeakable suffering and despair that suicide is attempted or effected. In other cases the distressing and indescribable sensation is in the crown of the head or down the spine, and sometimes it arises from the pelvic organs. In all cases the patients connect their mental trouble with it, regarding it as the cause of the painful confusion of thought, the utter inability of exertion, the distressing ideas, and the paroxysm of despair. Perhaps they exaggerate its importance; but there can be little doubt that writers on mental disorders, too exclusively occupied with the prominent mental features, have not hitherto given sufficient attention to these anomalous sensations. We have been apt to class them as hypochondriacal, and to pass them over as of no special significance; but I cannot help thinking that, properly studied, they may sometimes teach us more of the real nature of the particular form of insanity—of its probable course, termination, and its most suitable treatment—than many much more obtrusive symptoms.

In bringing this lecture to an end, I may fitly point out how entirely thus far the observation of the phenomena of defective and disordered mind proves their essential dependence on defective and disordered brain, and how closely they are related to some other disordered nervous functions. The insane neurosis which the child inherits in consequence of its parent's insanity is as surely a defect of physical nature as is the epileptic neurosis to which it is so closely allied. It is an indisputable, though extreme fact, that certain human beings are born with such a native deficiency of mind that all the training and education in the world will not raise them to the height of brutes; and I believe it to be not less true that, in consequence of evil ancestral influences, individuals are born with such a flaw or warp of nature that all the care in the world will not prevent them from being vicious or criminal, or becoming insane. Education, it is true, may do much, and the circumstances of life may do much; but we cannot forget that the foundations on which the acquisitions of education must rest are not acquired but inherited. No one can escape the tyranny of his organization No one can elude the destiny that is innate in him, and which unconsciously and irresistibly shapes his ends, even when he believes he is determining them with consummate foresight and skill. A well-grounded and comprehensive theory of mind must recognize and embrace these facts: they meet us every moment of our lives, and cannot be ignored if we are in earnest in our attempts to construct a mental science; and it is because metaphysical mental philosophy has taken no notice whatever of them —because it is bound by the principle of its existence as a philosophy to ignore them—that, notwithstanding the labour bestowed on it, it has borne no fruits —that, as Bacon said of it, "not only what was asserted once is asserted still, but what were questions once are questions still, and, instead of being resolved by discussion, are only fixed and fed."

DIAMOND ROCK-BORING MACHINE AT THE CROESOR SLATE QUARRIES.

(Illustrated at page 378.)

WE recently had an opportunity of visiting the works of the Croesor United Slate Company's Quarries, in Carnarvonshire, and were much interested by the process by which a new and difficult shaft is being driven into the side of the mountain. Hitherto only hand labour has been employed for driving headings in these quarries; but the necessity of pushing on some new work with greater speed than could possibly be got by hand labour, has induced the company to call in the aid of the diamond boring machine, with the proprietors of which, Captain Beaumont, R.E., and Mr. C. Appleby, they have entered into a contract.

Amongst the various propositions which have been brought into notice for machine tunnelling, one of the most courageous and successful is that in which a coarse cheap kind of diamond is used to form the head of the cutting tool. Since the introduction of the system, it has, of course, worked its way through many stages before it arrived at being a practical reality. The work it is getting through at this moment, however, puts its capabilities to a trial which cannot leave a doubt as to its efficiency. The shaft which is being driven commences at an elevation of some hundreds of feet above the foot of the Croesor mountain, and runs downwards at an angle of 40° with the horizon; the purpose of this awkward incline being to get more quickly at that portion of the slate vein into which the company wish to quarry. The shaft is 8ft. high, and 10ft. broad, running through hard bastard slate very full of iron pyrites, and crossed by hard bands of quartz.

The borer is shown in our engraving at work in the inclined shaft. The machine consists of a horizontal base, *a a*, coupled by four links with the motor (B)—an air-engine—behind it. Within the base, *a a*, a horizontal shaft rotates, receiving its motion through a pulley and belt from the fly-wheel of the engine. The vertical columns, c, c^1, have each a shaft revolving in their interior for giving motion to the boring tools, d, d^1. The vertical and horizontal shafts are coupled together by means of bevel gear, the followers being fixed upon the bottom ends of the vertical shafts, and the leaders running in longitudinal grooves cut in the horizontal shaft, and being held in place by suitable bridles.

Each upright shaft has two (sometimes three) similar bevel wheels, each engaging with the corresponding wheel of a boring tool. With this arrangement the vertical shafts can at any moment be shifted horizontally—either brought together or separated—by means of screws, *e, e*, working in suitable nuts fixed to the bases of the columns. The elevation of the boring tools can also be changed at pleasure, and they can be "angled" through any desired range; in one direction by the columns being turned round their vertical axes, in the other direction by the boring tools being turned in a vertical plane.

The boring tool is fixed at the end of a long screw, a nut upon which revolves with it, being connected with the driving gear by a friction clutch. The wheel which imparts direct rotation to the drill has one tooth more than that which presses against the nut. A differential motion is thereby obtained, which causes the boring tool to advance a certain distance with every revolution, unless the resistance which it meets in the rock becomes too great, when the clutch slips and prevents breaking the tool.

To avoid the heating of the drills by friction, and to lubricate them, a constant stream of cold water is kept flowing through them. For this purpose they are made hollow, and the water, entering through the elastic tubes, *g, g*, passes through the drill, during the time it is at work, and flows out of the bore through the space left between the diameter of the hole and that of the drill. The motor, B, attached to the boring machine, consists of an engine worked by compressed air, which is forced down the shaft through a gaspipe, D, D. This machine has to fulfil the double duty of working the drills and of pumping back the water which has passed through them to keep them cool and to lubricate them. The construction of this engine offers no point of novelty beyond the arrangement of the cylinder, which has the slide valve and the exhaust upon opposite sides in order to facilitate the clearing out of the exhausts in the event of their getting choked by ice formed by the refrigeration of water vapour upon the expansion of the air in escaping. The blast of cold air issuing from the exhaust of the motor thoroughly ventilates the shaft and keeps the air in it exceptionally clear and cool. Before the machine is raised or lowered in the shaft the two upper coupling links are drawn back by screws at the sides of the motor carriage upon which their lower ends are held. This causes the vertical columns, c, c^1, to be tilted backwards until the base, *a a*, is brought to rest upon two hind wheels which run upon the metals forming the tramway as shown in the drawing.

The air which works this machine down in the shaft is compressed and supplied by a turbine in the valley below; and this turbine is worked by a head of water conducted to it from a tank on the side of the opposite hill. The tank is fed from a small mountain lake which is perched among the hills high above the sea level, and which has been dammed up and provided with a sluice for the purpose. The tank into which the lake-water flows is 350ft. above the turbine, with which it is connected by a 6in. cast-iron pipe. The turbine works a double action air-pump, and the compressed air is conducted up to the mouth of the shaft through a 4in. cast-iron pipe, and from the mouth down into the shaft to the machine, through a 2in. pipe, till near the machine, where the connection is made with a flexible hose. This compressed air is applied to three purposes: it drives the borer, it pumps water out of the shaft, and it starts the hauling-up drum.

The rope by which the loaded wagons are drawn up out of the shaft is worked on the tail-end system upon an opposite incline outside the shaft. The tail-end of the rope is attached to a wooden tank which runs down upon a tramway. When the wagon is down the shaft, the tank is drawn up under a shoot connected with a mountain stream which fills it. When full, its weight in running down its incline is sufficient to draw up the full wagons out of the pit. When it reaches the bottom of its incline, a valve in the bottom of the travelling tank is opened automatically and the water runs out, leaving it ready to be drawn up again empty by the wagons descending into the shaft. The winding drum over which the rope passes has generally to be started, and this is done by a pair of 8-in. cylinder air-engines supplied from the turbine.

The number of hands employed in working the diamond-boring machine is four men—one to each drill—and a boy to look after the engine.—*Engineering.*

NOTES ON RECENT DISCOVERIES AND THEIR PRACTICAL APPLICATION.*

The Structure of a Gas Flame.—The flame of a batswing or fishtail burner is seen to consist of two distinct parts—one, nearest the nipple, of a light blue colour, sometimes nearly invisible, and a fringe of luminous flame above. The relative proportions of these two parts depend partly on the quality of the gas, but more on the construction of the burner. Small holes or a narrow slit will give more of the blue and less of the luminous part of the flame, all allowance being made for rate of burning and pressure. The constitution of the blue part has been made the subject of study by M. Baudrimont. He finds in effect that it resembles somewhat the flame of a candle. He has not proved it to be hollow, but he shows that the outer part is intensely hot, and the inner part of a very much lower temperature. A small platinum wire carefully brought to the outer part became white hot, and even began to melt. The same wire placed across the blue part of the flame remained dark in the middle, and was only made white hot at the outer margins. M. Baudrimont endeavoured to estimate the exact temperature of this outer margin, but seems to have failed in the attempt.

A New Method of Purifying Water.—Runge has made some observations on the purification of water, which offer some interesting points. Briefly put, his assertion is that metallic iron offers the readiest and simplest means of disinfecting water, and of preserving it fresh. With his explanation we shall not now trouble ourselves, but we may say he accounts for the fact that Thames water taken to sea in iron tanks soon becomes perfectly sweet, and remains so through a long voyage. One observation he has made may be of interest to many readers at this time of the year. It is that a small piece of sheet iron or some nails placed in the water in which cut flowers are put will keep the water sweet, and we may suppose the flowers fresh, for a long time. Runge also put some iron filings in a vessel with a very small quantity of water and placed a leech therein, and found the water quite fresh and the leech healthy after six months had passed. We may return to this subject, which has much interest in a sanitary point of view.

Bleaching Wool.—A French patent, by M. Frègon, describes a novel process for bleaching wool and silk, for which until now we have had only the sulphurous acid method. A bath is made by dissolving 4lb. of oxalic acid and 4lb. of common salt in 200 quarts of water, and the goods to be bleached are left in this bath for an hour, after which they are drained and rinsed in soft water. Oxalic acid we knew to be a good bleaching agent for some animal matters, sponges, for instance, and it may perhaps answer for wool and silk.

To Whiten Yellow Flannel.—Dr. Artus tells us that flannel which has become yellow with use may be whitened by putting it for some time in a solution of hard soap, to which strong ammonia has been added. The proportions he gives are 1¼lb. of hard curd soap, 50lb. of soft water, and two-thirds of a pound of strong ammonia. The same object may be attained in a shorter time by placing the garments for a quarter of an hour in a weak solution of bisulphite of soda to which a little hydrochloric acid has been added. This latter process we dare say will be effectual, and probably the oxalic acid solution mentioned above would answer the purpose as well.

Bleaching Ivory.—We published last year a process for bleaching ivory which had turned yellow. That method did not appear to us very promising any more than the following, which we give for what they are worth. The first directs the article to be placed for an hour in a saturated solution of alum, after which it is to be rubbed first with a woollen and then with a linen cloth until it is perfectly dry. The second process, which the writer we quote from says he prefers, consists simply in digesting the ivory article in thin milk of lime kept hot until such article has assumed the desired whiteness. Then it is to be taken out, dried, and polished. How long it may possibly be necessary to continue the immersion the author does not inform us.

Chinese Gold Lacquer.—The gold-lacquer lining of a Chinese cabinet in the Museum at Cassel pealed off, and thus gave Dr. Wiederhold the opportunity of studying the composition of this substance. On examining it he found particles of tinfoil attached to the lacquer, so he comes to the conclusion that this material formed the ground upon which the lacquer varnish was laid. His attempts to imitate the varnish were perfectly successful, and he gives the following directions for the preparation of a composition which closely resembles the true Chinese article. First of all, two parts of copal and one of shellac are to be melted together to form a perfectly fluid mixture, then two parts of good boiled oil, made hot, are to be added; the vessel is then to be removed from the fire, and ten parts of oil of turpentine are to be gradually added. To give colour, the addition is made of solution in turpentine of gum gutta for yellow, and dragon's blood for red. These are to be mixed in sufficient quantity to give the shades desired.

Dyeing Horn.—According to C. Burnitz, of Stuttgart, horn may be dyed black by a cold process in the following way:—The horn is first to be soaked in a solution of caustic potash or soda, until the surface is a little dissolved, and feels greasy. Then the article is to be washed and treated with Lucas's aniline black, after which it is to be slowly dried and again washed. By exercising a little care, we read that combs with fine teeth may be dyed in this way. The articles look of a dark brown colour by transmitted light, but seen by reflected light they are deep black.

Preserved Bread.—Preserved bread has been suggested by M. Maurice as a substitute for biscuits for the use of sailors, soldiers, and travellers. The bread is made in the ordinary way, and is then thoroughly dried. It is afterwards exposed to high pressure steam for a short time, and is subsequently submitted to hydraulic pressure to reduce the bulk. The cakes so produced will keep, it is said, for years if protected from moisture. They are necessarily hard, but are masticated as easily as biscuits. The process by which these cakes are made is long and troublesome, and the only advantage that they can possess over biscuits consists in the circumstance that they have undergone the primary fermentation which some writers on dietetics allege is absolutely necessary to produce bread of a perfectly wholesome character.

Novel Sea-going Vessel.—The model of a sea-going vessel of very original build is now to be seen in the port of Algiers. A general idea of the construction is obtained if we imagine a steamer cut in two, and the severed parts made the support of a bridge four times the length of the original vessel. This bridge has an air-chamber in its entire length, so that if by accident it should become parted from the supports it cannot be submerged. It is destined for the cargo, but cabins in the form of boats are so arranged along the sides of the bridge that in case of accident to this latter they may be navigated separately. Thus there are three chances of safety if the construction goes to pieces. The supposed advantages are—first, great speed (since the larger part of the vessel not being in contact with the water the resistance is so much diminished), safety, and great space for cargo. Something of this kind has been projected for taking railway trains across the Channel, but we do not remember to have seen it suggested for vessels going a long distance.

Iron and Hydrogen.—A curious observation has been made by M. Caron on an alteration produced in iron when it is kept melted for some time in an atmosphere of hydrogen. The metal, we read, somewhat increases in density and becomes soft and malleable as copper. Re-melted in a crucible it becomes scaly when cold, doubtless in consequence of the evolution of absorbed hydrogen. Are we to regard the softness and malleability as the properties of an alloy of hydrogen and iron?

Wings of Birds.—By means of an ingenious little apparatus M. Marcy has proved that in flight the tip of the wing of a bird describes a simple helix. An instrument placed on the back of a bird follows the figure and registers it on a card. The wings of insects, the same authority shows, have only an up and down movement, the extremity of the wings describing only a wavy line.

Obtaining High Temperatures.—A very useful invention of Mr. Coffey is now to be seen in operation at Messrs. Doulton & Watts's, of Lambeth. It is a new mode of obtaining high temperatures for the evaporation of liquids without the use of high pressure or superheated steam, and is, in fact, a modification of the circulating system, heated water being replaced by heavy paraffin oils. These circulate exactly like water. A close system being made, the oil heated in a coil of pipe placed in a furnace rises first to an air-tight tank, from which it runs through pipes and the jackets of pans, descending as it cools to the coil of pipe in the furnace. With this apparatus a temperature of 600° or 700° Fahr. may be safely maintained without any of the risks arising from the use of steam at high pressures, and, as will be easily seen, with a much less expenditure of fuel. A pyrometer is contrived to show the exact temperature of the oil as it leaves the tank, and means are provided for regulating and keeping the temperature uniform. We look on this invention as destined to achieve great results in many industries.

The fourth consecutive crop of wheat is now growing on sewage-manured land at Barking. The stalks are about 5ft. high, with ears of great length.

SCIENTIFIC SOCIETIES.

BRIGHTON AND SUSSEX NATURAL HISTORY SOCIETY.

A MEETING of the Microscopical Section was held on the 23rd ult., Mr. Glaisyer, Vice-president, in the chair. The subject for the evening was "Infusoria," which Mr. Wonfor introduced by a few remarks. As all were aware, he said, if any vegetable or animal substance was placed in water, in a few days the water would be found full of minute organisms, to which the name "infusoria," or infusion animalcules, had been given. Many forms, though figured and described as distinct species, had since been proved to be only the early stages of other animals, others had been classed among another group of animals, while a very large number were arranged among plants. The class infusoria was much more limited than at one time supposed, and increased knowledge and further research might prove that many more were only the early stages of other and higher types of life. Mr. Wonfor then proceeded to point out the nature of their substance, their mode of development, increase, and propagation. So widely were they distributed that scarcely anywhere could water be found which did not contain some infusoria. Many would live only in fresh water, others in salt or brackish water, while others were to be found only in water containing decomposing vegetable or animal substances. Hence water contaminated by sewage matter always showed certain types, while some occurred only in particular infusions others were common to several. Their appearance under certain conditions had led to theories on spontaneous generation, a much debated and debatable point; but as the atmosphere, according to Tyndall and others, appeared to be full of germs, their sudden appearance under favourable circumstances was not surprising. The water in which cut flowers were kept was sure to yield some sorts; in fact he had obtained an abundant supply of one kind from water in which mignonette had been only three days. Water in bird fountains and water bottles if not looked after and frequently changed, would be sure to contain infusoria.

ETHNOLOGICAL SOCIETY.

A special meeting of this society was held at the Royal United Service Institution on the 21st ult., Professor Huxley, LL.D., F.R.S., President, in the chair. Colonel Lane Fox made some remarks on the Dorchester Dykes and Sinodun Hill, to which attention has recently been directed, and showed that the works are British and not Roman. He stated that the demolition of these works has been arrested for the present. Mr. David Forbes, F.R.S., read a paper "On the Aymara Indians of Bolivia and Peru." He described them as a small, massive, thick-set race, with large heads and short limbs. The trunk is enormously large, and the thorax extremely capacious, being adapted to meet the requirements of respiration in a rarefied atmosphere. as the Aymara lives at an altitude of from 8,000 to 16,000 ft. above the sea-level. The proportions of the lower limbs are curious, the thigh being shorter than the leg: the heel is inconspicuous. In colour the Aymara varies from copper-red to yellowish-brown and blackish-brown, according to the elevation at which he lives. Many of the customs of the Aymaras depend on their conditions of life. In consequence of the low boiling point of water at such great altitudes, beans are rarely used, and the food consists chiefly of potatoes peculiarly prepared. Clay is added to the food, not for any nutritious matter in it, but merely to increase the bulk of the meal. In religion the Aymaras are nominally Christians. They appear to have no system of writing.

The discussion on this communication was supported by the President, Mr. E. G. Squier, Mr. Cull, Mr. Dendy, Mr. Bollaert, Mr. Harrison, and Mr. C. Markham.

At the same meeting Dr. A. Campbell exhibited tracings of certain rock-inscriptions from British Guiana, and the Hon. E. G. Squier displayed a large collection of drawings, photographs, &c., from Peru.

LONDONDERRY NATURAL HISTORY AND PHILOSOPHICAL SOCIETY.

At the concluding meeting for the season of this flourishing society Dr. Cuthbert read a paper on the Abnormal Arrangement of Organs in the Human Subject. A young soldier of the 28th regiment met with a fatal injury in the month of February, 1868, at Knockalla Fort, near Rathmullan. On a post-mortem examination of the body it was found that the liver was ruptured, which was the cause of death; that the liver occupied the left, and the stomach and spleen the right side—the parts being thus transposed, the intestinal canal was also abnormally arranged. In the chest a similar malposition of parts was found—the heart occupying the right side, and the great vessels proceeding from it as usual, but transposed. The man seemed to have been of a delicate constitution, and, as appeared from his history, was unable to bear much fatigue. It does not appear, however, that he suffered from any ailment to which the unusual arrangement of his internal organs in any way contributed. The transposition of the viscera is certainly a sufficiently rare occurrence to warrant a notice of the point. We can only regard such abnormal arrangements as are occasionally met with as strange freaks of nature, with no appreciable influence on the health or habits of their subjects. It seems a strange circumstance that, in no instance that can be discovered, has an abnormal arrangement of the viscera, as the result of natural transposition, been ascertained, or even suspected during life—a fact which would argue one of two conclusions, either the extreme rarity of the cases, or the exceptionally good health of those who are the subjects of such transpositions.

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* From the *Mechanic's Magazine.*

THE ROYAL IRISH ACADEMY.

AT the last meeting of the Royal Irish Academy, June 13, Dr. Sigerson, F.L.S., read a paper entitled "Further Researches on the Atmosphere."

In order to obtain an accurate knowledge of what is usually and what is occasionally present, it appeared requisite to make a careful examination of particular atmospheres as well as of the general air. After detailing his mode of operation, he proceeded to describe the objects found in the sediment from the air taken from ledges above man's height, and observed likewise in the atmosphere.

Iron-factory air, a friable black dust; on examination, this was found to be made up of particles of carbon, of ash, and of iron. The carbon formed the largest masses, the ash-particles were reddish, or white and opaque. Some transparent pieces with a glassy fracture were noticed, and were regarded as glass resulting from the fusion of sand used in the welding process.

The results of the study of the several other atmospheres, and their effects upon the health of those abiding in them, were described at length. A brief summary is all that can be given here. In "shirt-factory air," fine filaments and fragments of cotton and linen were found, with a few minute ova, not generally dispersed. The girls employed in the factory had become snuff-takers. In the atmosphere of "threshing-mills," fibres and fragments of chaff, awns, grain, together with some smut-balls, were found. In that of oat-meal mills, fibres were seen in unexpected number, together with minute fragments of the pericarp of the caryopsis and starch-granules, with a rare spore and an acarus. This air was not so injurious as that of "flour-mills," the dust being less. The atmosphere of mills where flax is "scutched" was found to be so bad, that these mills could only be regarded as human slaughter-houses. In the air of printing-offices, from various symptoms observed, antimony was believed to be present. In consequence, some dust taken from a rafter eleven feet above the floor was submitted to the secretary of the Academy, Professor W. K. Sullivan, whose analysis confirmed the accuracy of the expectation. Antimony was found and no lead. In the "atmosphere of stables" were found moth-scales, some larva, eggs, spores, and a great quantity of cuticle-scales and fragments of fine hairs, with some corpuscles and fragments tinged blood-red. An acarus was present in the dust. Hairdressers had a similar atmosphere, so far as distinctive elements, scales and hairs, were concerned. The "machine-brush" increased their amount.

Tobacco-smoke, with some difficulty, was got under the microscope. It was examined on entering and on leaving the mouth. Little globules of nicotine were discovered twirling and flitting about in it, like monads. Some remained on the walls of the mouth; when the smoke was breathed (by novices), more globules were retained in the lungs, and nausea and illness supervened. These globules, if found in the air, distributed by a cigar-smoker, might be mistaken for germs, as they would resist the iodine-test for amyloids.

In order to arrive at the cause of the ill-health of "tea-tasters," their special atmosphere was examined. In pursuing their avocation (selecting teas), they had to take a sip with quick inhalation, and thus a small shower of fine tea-drops entered their lungs. On examination of such tea-drops, a considerable quantity of fibro-vascular and cellular tissue, from the leaves. was found which might aid to tease the lungs. But the real agents of mischief were numerous droplets of essential oil, very plentiful in Assam tea, which was particularly severe on the tea-tasters. Nausea, disarrangement of the nerves, and sometimes syncope afflicted them.

As a result of numerous observations, some of which are here recorded, Dr. Sigerson considered himself justified in drawing the following conclusions:—

1st. That stomach signs—irritability, nausea, dyspepsia—are frequently symptomatic of interference with the lungs; so that the stomach, in such cases, may obscure the symptoms, but will not cure the disease.

2nd. That the lungs have a power, not hitherto suspected, of absorbing or assimilating even solid matter.

3rd. That the theory of the panspermists seems unfounded on fact—that there are no hosts of germs always floating about in the atmosphere, invisible and maleficent as genii of Eastern stories. Air is not much better, but not generally worse than water.

5th. The "germ theory" asserts "that epidemic diseases are due to germs which float in the atmosphere, enter the body, and produce disturbance by the development within the body of parasitic life." It is opposed to the opinion that epidemic diseases are propagated by a kind of malaria, which consists of organic matter in a state of *motor-decay*. It is supposed to be supported by certain statements about the non-occurrence of putrefactive changes in closed vessels, which have been disputed and by the statement that retten malaria cannot act like leaven, because fermentation is caused by the growth of the yeast-plant. Now, the effect of the growth of parasitic plants in causing skin-diseases is well known; if they caused epidemics likewise, their presence would, in all probability, have been as soon detected.

THE NORTH STAFFORDSHIRE NATURALISTS' FIELD CLUB.

THAT portion of the Valley of the Manyfold which is nearest to the village of Wetton, was chosen for the third meeting for the season.

The party struck the valley, not far from the once celebrated Ecton mine. At a cavernous opening near Wetton Mill, Mr. Carrington, the veteran geologist and barrow-digger, was superintending an excavation in its floor. No proof was obtained in the shape of fragments of charcoal and such objects that the hollow had ever been inhabited by primeval man, but only clay and water-worn boulders of millstone grit, no doubt carried in when the surface of the country was very different, and the rivers larger and at a different level to what they are now. Pebbles from the same formation (the millstone grit) were pointed out by Mr. Carrington adherent to the sides of the limestone cavern. Later in the day bones were dug out of the clay, especially one large vertebra. In the cavern Mr. Carrington read a short paper on the duties of a field naturalist. He ended by exhibiting his original pen-and-ink sketches of the articles exhumed by himself in the floor of Thor's cavern, towards which the party now directed their steps. The instruments discovered were of the Romano-British period, in stone, bone, bronze, and iron. The cave was not a true bone cave, like those of Gibraltar or Kent's Hole for instance, with bones below a layer of stalagmites or imbedded in it, nor did it yield traces of primeval man, such as weapons of flint, but it appears to be a water-worn hollow filled below with clay and stones rounded or smoothed by water-transport or attrition, and more recently the haunt of our British forefathers.

LETTERS TO THE EDITOR.

[We do not hold ourselves responsible for the opinions of our correspondents. The EDITOR respectfully requests that all communications should be drawn up as briefly as possible.]

⁂ All communications should be addressed to the EDITOR of the ENGLISH MECHANIC, 31, Tavistock-street, Covent Garden, W.C.

All Cheques and Post Office Orders to be made payable to J. PASSMORE EDWARDS.

"I would have every one write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks: a vice from whence great inconveniences derive their original."—*Montaigne's Essays.*

ASTRONOMICAL.

SIR,—There is a small comet (D'Arrest's) in Serpens now; but "W. R." (4084) p. 335, will scarcely see it with the naked eye.

The extract given by "Foreigner" (4180), p. 358, from a Brussels paper, is just a little obscure. How in the world a comet "on the *East* of the Sun" can be seen "after midnight" passes my very limited comprehension. I have heard nothing of this comet of Winnecke's, inasmuch as the circulation of an Ephemeris of a newly discovered one among the English observatories, is quite beneath the dignity of the editor of the Royal Astronomical Society's publications. We are only too thankful, as a body, to get our "Monthly Notices" a month after the meeting at which the papers they contain were read. It is only some radical and revolutionary spirits who have dared to hint that we are entitled to early intelligence of recent discoveries in the heavens; but these obtrusive people, however, are crushed out by the sublime indifference of the editor referred to.

"W. H. C." p. 358, puts two questions (4131 and 4133). With regard to the former, I may perhaps be forgiven for saying that, as it stands, it has to me no meaning whatever. With respect to the latter, if your correspondent will turn to p. 649 of Vol. 10, and to pp. 1 and 2 of Vol. 11, he will I hope there find the explanation which he seeks.

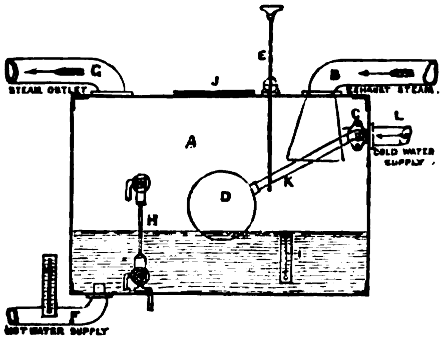
Mr. G. Firth is good enough to criticise my very unpretending "Astronomical Notes" for June. It is quite right as to the pleonasm involved in the employment of the word "a.m. on the next morning," I have no means of knowing whether it was a *lapsis calami* on my part, or a printer's blunder. Certainly I am not responsible for the 7h. 12m. to which your correspondent refers, save to the extent, perhaps, of making my 1's and 7's something alike. The word "afternoon" though, in the context, would suffice to show most people that 7 o'clock could not have been intended, as that is an hour usually and conventionally ascribed to the *evening*. With regard to Mr. Firth's remarkable peroration, it may suffice to say, that as the so-called signs of the zodiac are only twelve divisions of the ecliptic, quite irrespective of any stars whatever, it certainly seems to me—in my weak-minded way—that the position of a planet can be better given by referring it to a known and (practically) unalterable constellation, then to an abstract and impalpable line. Doubtless the precession of the equinoxes is (from the Firth point of view) very annoying; but still, as an obvious result of the law of gravitation, I do not quite see how it is to be got rid of; and as its sole object, *pro hac vice*, is to shift the origin of certain imaginary co-ordinates, I am unable to see what good I, or any other astronomer could do by asserting that a planet was in such and such a "sign," which no one could see, instead of saying that it was in a given *constellation*, known and visible to everybody. Does Mr. Firth imagine that the readers of the ENGLISH MECHANIC would find an object more readily from so eccentric a description?

A FELLOW OF THE ROYAL ASTRONOMICAL SOCIETY.

[1]

"BARTON'S PATENT SELF-ACTING FEED WATER HEATER FOR STEAM BOILERS."

SIR,—On page 302 of the ENGLISH MECHANIC, June 17th, I observe a portion of Mr. Baskerville's letter devoted to criticisms on Llah's or Hall's economiser, implying doubt as to the general efficiency and economical results of feed-water heaters. He says, "The temperature of the waste steam escaping from a non-condensing engine is 212 degrees or so, and that is the maximum of heat it can impart to the feed-water passing through it, but as a matter of fact it never does so by many degrees." So much depends upon surrounding circumstances in connection with this question, it would be premature to fix any given standard of heat to the steam at the outlet of the exhaust. Expansion of steam after cut off, reducing its elasticity, and consequently loss of heat, with distance from cylinder to exhaust outlet, may be said to form primary cause of variation in changing the temperature of exhaust steam imparted to the feed water. Deductions and calculations made by figures, from a scientific point of view, are all very well in theory; unfortunately they do not always harmonise in practice. Again he says, "There is no appendage of the steam engine which is less understood than the feed-water heater." This we quite agree with. If it were better understood, it would be more largely adopted, to the great satisfaction of steam users generally. I can assure Mr. Baskerville (whatever his figures may say to the contrary) that the "inevitable" 25 per cent. saved in fuel is not "a delusion," but a practical fact with feed-water heated to 212 degrees. I have, by careful and trustworthy experiments, proved the truth of those statements, by weighing the coal used week for week, doing the same amount of work with the engines in both experiments; that is to say, one week with cold water, the other week with water heated to 212 degrees by the economiser; in all cases the statements have been fully confirmed. Having had charge of one of these heaters for over twelve months ("Barton's," as represented by the above illustration), I will, Sir, by your permission, endeavour to enlighten your correspondent on what he calls the overrated results of these contrivances. The fallacy of using theoretical argument in opposition to practical results requires no further comment.



The means by which the feed-water is heated by Mr. Barton's plan, is by using the waste or exhaust steam; placing on some portion of the exhaust-pipe a cistern. Into this cistern, the exhaust steam is admitted at the end, and the exit from the other. The admission of cold water into the cistern is regulated by a float placed in the inside, and this float is always being moved by the force of the exhaust steam blowing upon it, thereby securing the constant supply of feed water. The engine blowing the exhaust on the water in the heater under my charge is 14 horse-power nominal, pressure on the boiler 40lbs. to the square inch, making 60 revolutions per minute, length of stroke 2ft. 6in., cutting off at half stroke, passing through the heater about 6,000 gallons of water per day, with a continuous temperature of 212 degrees.

The efficiency, simplicity, and durability of this heater will be best understood by consulting the following description. (See diagram.)

A. Tank for the heated water.
B. Pipe for conveying exhaust steam into the water.
C. Tap for cold water supply.
D. Float.
E. Test-rod.
F. Hot water supply for the feed-pump.
G. Pipe for conveying away the surplus steam.
H. Guage showing the height of water.
I. Thermometer showing the temperature of water.
J. Man-hole.
K. Lever for opening tap C.
L. Cold water supply-pipe.

C. Tap which is coupled to a lever K and float D, where the water in the heater raises the float D, and closes the tap C, and so reduces or shuts off the supply; and when the water-line is lowered by increased withdrawal through F, the float D falling, and opens the tap C, augments the supply of cold water flowing through C. The nozzle of the tap C is arranged to deliver into the bell-mouthed steam-pipe B, directly on the cold water heating to boiling point. E, test rod, whereby it can be ascertained, without removing the man-hole J, whether the tap C is working freely. It is impossible for the tap C to get out of order, for every stroke the engine makes it moves the plug C.

When we consider the extent to which as a nation we are dependent for our commercial prosperity on steam power, and that this power is increasing every day, prejudice, or lack of information ought not to stand in the way of any modern invention, having for its object (as this invention has) the improvement, if not the perfecting of a system the want of which has long been felt. The many existing proofs sent to the patentee, Mr. Barton, in the form of testimonials, as well as verbal declarations personally made of the great utility as an economiser of fuel and water, would in themselves be a sufficient justification for its introduction to the public. There are other results, as follows, though of less importance individually, yet no less momentous as a whole.

1st. Its safety to the boiler, by preventing the sudden and unequal expansion which takes place when cold or partially heated water is introduced.

2nd. By relieving the engine of back pressure produced by heaters of other construction. By purifying the water, and precipitating deposit before it enters the boiler. By using the exhaust steam for heating the feed-water, and giving to the boiler a regular supply at boiling point, thereby saving 25 per cent. in fuel. It supplies a practical safeguard against explosion, by making it impossible while the engine is running to introduce cold water into the heated boiler. It increases the steaming and working capacity of the boiler, the generation of steam with a given amount of fuel being much greater than when the boiler is supplied with water cold or partially heated. It saves water by the condensation of steam, which takes place in the heater, again returning to the boiler. It is perfectly self-acting, thereby doing away with constant personal attention. It frees the boiler of old scale, and other incrustations, and prevents the same from re-forming. It has other advantages, and is easily adapted to engines of any construction. I know that it is becoming extensively patronised by engineers, iron forges, boat-builders, steam sawyers, and steam users generally. I see by a testimonial from Messrs. Laird Brothers, Birkenhead Iron Works, that they adopted one of these heaters some months ago, and found the saving so considerable, and the working so satisfactory, they have now applied it to all the principal engines in the establishment.

Engineers, boiler-makers, and steam users of every class, would do well by making themselves thoroughly acquainted with the many advantages to be derived from the use of this heater.

Though simple in its construction, it accomplishes in the most perfect and satisfactory manner an astonishingly large number of very important results. Space would not be allowed me, or I would have forwarded to you for the information of Mr. James Baskerville and others, a tabulated statement of the saving in coal and water, extending over a period of three months, with three single fire flued Cornish boilers, supplying steam for engines of 50 horse-power with a number of steam hammers. Should Mr. Baskerville or any other of your correspondents require any further information in reference to this heater, I should feel great pleasure in replying to any such request.

S. CROMPTON, Birkenhead.

[2]

THE TELESCOPE, ETC.

SIR,—There is a query, headed "Object Glass" (4088), on p. 335, which at the first blush is unintelligible. On reading it over, however, two or three times, I have a dim notion that it has to do, not with an object glass, but with the terrestrial eyepiece of a telescope, and (assuming that I understand the nature of the question), I may inform "G. B." that his lenses 1 and 2 should be 1¾in. apart. At ¾in. from No. 1 a stop must be placed to define the field of view. His lenses 3 and 4 may be placed 4⅝in. apart. The distance between Nos. 2 and 3 may be varied within considerable limits. The farther they are separated the higher will be the power. 7in. would be a good working distance, with the considerable focal length of the component lenses in your correspondent's possession. I may add that I do not believe that the dimness of which he complains has anything to do with the interval separating the two combinations in his eyepiece, which, as I have said, admits of considerable variation. If his object glass be not faulty, I should unhesitatingly attribute the defect of which he complains to the disarrangement or imperfection of the little stop between his third and fourth lenses. The adjustment of this must be made with scrupulous care, and the opening be of *just* sufficient size to let the crossing rays pass through it. If it be too small it will diminish the effective aperture of the object glass. If it be too large it will let a quantity of false light through, which will fog and obscure the image. I question the ability of any one possessing the somewhat limited knowledge of your querist to make this adjustment for himself, and should advise him, by all means, to send his eyepiece to some *working* optician.

I may answer "Uranus" (4109), same page, by telling him that Chance's price for their warranted optical crown and flint glass of the size that he requires is £7 4s. per disc, so that a pair of 6in. in diameter would cost him £14 8s. His trap tools may be a little larger in diameter than his lens; his polisher should be rather smaller. He may go on grinding his lens with very finely washed emery until the image of a candle can be seen in it. He can then transfer it to the polisher. I have strong reason to believe that alpaca is the best material for that polish. I really cannot tell how many hours a lens occupies in taking a polish, as I have never worked at one except in a desultory way, but I know that polishing is very tedious work. Some of our opticians, who can speak *ex cathedra* on this subject, may probably give "Uranus" the information he requires on this subject.

Regarding the inquiry of "Urban," on p. 331, as a quasi-optical one, I may tell him that my knowledge of bisulphide of carbon prisms is to a great extent theoretical, my practical experience of them having been confined to the employment of two belonging to a friend.

"W. C." (4182), p. 358, has done pretty fairly in seeing Jupiter within 9° of the Sun with his 8¼-inch mirror—albeit, he has not achieved anything very surprising. I have more than once seen Venus with a much smaller instrument, when the glare of direct sunlight was just beginning to be perceptible in the field. I do not think that he would see Mars any nearer to the Sun than he could see Jupiter, but Mercury he certainly ought to be able to follow nearer to the Solar limb. He will find a very constricted field a great help in viewing a planet under such circumstances.

"E. G." (4166), also on p. 358, can do nothing with his object glass. It must be re-ground and polished to get rid of the scratches upon it; and this, if it be of any value, would assuredly ruin its figure. The process of grinding and polishing has been described over and over again in your columns, but is certainly beyond the capability of any one who, like your correspondent, knows nothing at all about it. If he should choose to risk spoiling its figure he had better take his glass to a practical optician, who would, at all events, eliminate the scratches for him.

A FELLOW OF THE ROYAL ASTRONOMICAL SOCIETY.

[3]

GAS.

SIR,—Your readers are too numerous, and like all the public, too little informed upon the subject of the production and consumption of gas, to allow such remarks as those of "C. D. E.," p. 354, to pass unnoticed; and as I happen in the course of my life to have had practical acquaintance with the subject, I take on myself to inform your readers that "C. D. E." evidently knows nothing whatever about the matter. He says, "good coal gas is rich in these vapours as it passes out of the retorts, but the gas companies *find it expedient* to extract a greater part of these condensable vapours and supply their customers with a very low power illuminating gas." A more misleading statement was never uttered, even by the gas quacks, who for years have made it their business to go about making false statements in order to get up squabbles between gas companies and their customers, and particularly with the corporate bodies who can pay "expenses."

The companies are bound to supply a gas of a power which was fixed as being the limit obtainable from Newcastle coals; as a matter of fact they are obliged to use a portion of expensive cannel coal in order to insure the gas being up to that standard. The vapours they remove are those which, being condensable, would otherwise form deposits of napthaline, &c., in the mains and services, and gas manufacturers are doing all they can to secure these vapours being made into condensable gases.

A little anecdote which I can vouch for is a good answer to such a statement. A certain company was summoned for allowing condensed liquids, removed from the mains, to pass into the sewers, and some marvellous statements were made as to the danger of such a course. An eminent witness, who ought to have known better, asserted that the gas companies put naphtha in the mains to raise the illuminating power of the gas close to the services, and that it was naphtha thus inserted which was the source of the danger. "In that case," said the company's engineer, "Why do we pump it out into the sewers?" It is needless to say the witness looked somewhat foolish.

The fact is that almost every complaint made by gas consumers may be traced to their own mismanagement, and the want of care and knowledge by gas-fitters. Bad burners are used, and small pipes expected to supply endless lights, while half the lights are allowed to burn with ragged flames and the gas hissing away, giving nothing like its proper light, and the fault is of course laid upon the gas company. As to price, I can tell Londoners as a fact, that they now pay 6d. and perhaps 9d. a thousand more for their gas than would be the case but for their so-called friends, who, saddling the companies every year with the law expenses of a parliamentary fight, put that cost on the gas, for every effort is made to reduce cost and price, in order to increase consumption. As to carburetting gas, the best evidence that it is not a practical process at present, is that numerous as are the patents and processes, none have established themselves in use.

SIGMA.

[4]

THE CLAVICHORD, ITS CONSTRUCTION, ETC.

SIR,—The loudness of the sounds of this, and, indeed, all other stringed musical instruments, must, *cæteris paribus*, be in proportion to the force with which its strings are struck; and as this will be, *cæteris paribus*, in accordance with the velocity communicated to the tangent or string-striker, it would appear that the direction of improvement—so far as the action is concerned—will be to insert the tangent in the key as far from what is termed the key balance (*i.e.*, the surface on which the key rotates), as is consistent with a reasonable width of case. For carrying out this it is preferable to make the key balance as near as can conveniently be done to the ivory, say within ½in.; and if the strings of the instrument be disposed like those of a horizontal grand piano (which is far preferable to arranging them like those of a square piano) the tangent may be as much as three or four times as far behind the key balance as the finger acts on the key in front of it.

With an instrument which has but little width from back to front, whose strings are disposed obliquely like those of an old clavichord, virginal, spinet, or the square piano, it is impossible to insert the tangent far behind the key balance in the bass. This, besides much weakening the force of the blow, has the disadvantage of enabling the player to press the tangent against its string with far more force than is required to enable it to act efficiently as a bridge. This evil might be cured by inserting the tangent into a lever situated *between* the key and the string. By this arrangement any required velocity might be communicated to the tangent, and the force of the blow might be further augmented by loading the intermediate lever, just as the keys of a clavichord with its strings arranged like those of a harpsichord or horizontal grand piano might be loaded to any extent which did not make the touch too heavy. It is obvious that the greater momentum of the loaded key or lever *must* cause the tangent to strike the strings with more force than the smaller momentum of a key only loaded sufficiently to cause it to rise can do. The ancient clavichord was capable of executing very rapid music, as is obvious from its construction; in this respect it surpasses either the harpsichord, on which it is possible to play a melody in pretty close repetition, or even the pianoforte. In both these instruments the striker is not rigidly connected with the key, and even in horizontal pianos the hammers do not always fall as quickly as the key rises in front. Their hoppers descend faster than the hammers can follow them, especially if the hammers be supported on checks; but nothing of this kind can occur in the clavichord: its hammers (tangents) are fixed in the keys, and *must* descend with them, so that no keyed instrument can be made to repeat more rapidly than a clavichord, whose keys are pretty heavily weighted; but it has the defect that its sounds cease the instant the key begins to rise, for then the tangent leaves the string and it is effectually damped by its cloth. This, which is a defect when performing melodies in repeat, becomes an excellence for ordinary playing, for the sounds do not run into each other like those of bells, harmonicas, dulcimers, and other instruments which have no dampers—not to mention pianos with more or less efficient dampers, which, by the way, seldom act so perfectly as I could wish. Even when they can act, their proper action is too often prevented by that class of performers who, so long as they can make a great noise, are not at all particular about discord, and treat their suffering hearers to the chromatic scale with the damper pedal held down throughout their abominable performance.

As formerly constructed, the clavichordist had but little power to *strike*, but he had great power to *press* the strings of his instrument; consequently the tone must have been feeble and its pitch uncertain, for any increase of the pressure of the finger must have increased the tension of the string and caused its pitch to rise. By loading the key and placing the tangent far behind the key balance, we should not only greatly diminish the performer's power to produce these disagreeable results, but if the weight of touch was increased to about three ounces—which is not heavier than many modern pianos—the blow would become sufficiently powerful to put a pair of No. 22 or 24 steel wires, 27 inches long, into strong vibrations. Perhaps for the easy performance of very rapid music, it might be well to keep the weight of touch within 2¼oz., which modern pianists would term a light touch. I have known 3½oz. used, but it is unpleasantly heavy until, like the skinned eels, you get accustomed to it. It is obvious that in clavichords of the ordinary construction one-half the force of the blow is entirely wasted, so far as the production of musical sound is concerned, for that part of the string which is damped (although it receives a blow of equal force with that which strikes the vibrating part) is prevented from sounding; hence it is not surprising that the astute German intellect soon devised a method of utilizing this hitherto wasted force by employing it *for* the production of sound. This is the principle of Silberman's Double Clavichord, in which the tangents are made to strike its strings exactly at their centres, *i.e.* between its two bridges on its one or two soundboards. If four strings can be put into vibration without abstracting anything from the force of the blow, it follows that, *cæteris paribus*, the loudness of the sound will be doubled; and in a clavichord with such long, thick, and, consequently, very tight strings, as I have suggested to be made, the chief objection to Silberman's plan could hardly obtain, for, with its tangents four or five times as far from the key balance as the finger acts in front of it, the player will have but little power to *press* the strings sufficiently to raise their pitch to any objectionable extent. A very slight rise of the pitch, only just sufficient to give prominence to the melody, the ear can endure: it is not only *bearable* but even desirable as one means for expression, which is the soul of music, and chiefly distinguishes the performance of beings possessing minds from that of the barrel, whose brass fingers not only exceed ours in number but, being actuated by a force purely mechanical and always in their *right places*, don't ever make mistakes during performance—a thing some of us *intellectual* beings have been more than suspected of doing.

It is obvious that a double clavichord, à la Silberman, must be provided with dampers which can be removed from its strings. The single clavichord is most effectually damped by interweaving a strip of list with its strings between one of their resting places and the place at which the tangent strikes them; but as this would permanently damp one-half of the strings of a double clavichord, a removable damper becomes a necessity. The very best damper for horizontal strings that I know of is the one formerly used in old square pianos, which is so attached to the key that the preponderance of the keys is utilized to press the dampers to the strings. To carry out this principle it is quite unnecessary that the connection between the key and the damper be permanent, any simple contrivance which connects them when in use will serve; but it is very desirable that the parts may be easily disconnected when needful, so that any one individual key may be taken out with great facility. There are several ways of doing this, probably the simplest is to guide the damper wire sticker by an upper and lower socket, and to have two screw buttons on it, one above and the other below a fork made in the further end of the key itself, which should be reduced about ¼in. thick at its further end, by rebating its under side for about 1in. of its length. This fork should be wide at its extremity, and its prongs tapered for the first ⅜in. of its length, so that when putting in a key it may allow the damper wire to enter easily. The damper is regulated by turning up the lower nut or screw button until the key is supported at the proper height in front by the damper resting on the string. Should the clothing of the dampers become unequally compressed, some of the keys will be lower than others, and must be raised by turning up the lower screw buttons on the damper wires. The upper buttons may be adjusted to a position sufficiently above the upper surface of the keys to allow them to rise some distance before they commence to lift the dampers. The amount of this so-called "waste touch" is not important so long as the damper be lifted sufficiently to prevent any part of its surface from touching the strings when at its widest vibrations. In practice it is best to allow the key to descend from one to two-thirds its total path, so that the key's momentum may prevent the additional weight of the damper being felt by the finger as an increased resistance. Of course these observations apply rather to pianofortes, in which the finger has to raise a hammer *detached from* the key, than to the clavichord, in which the hammer is *attached to* the key; but, even in the latter instrument—the weight of whose damper head and its wire sticker is much less than the loaded damper of a pianoforte—I think it would be desirable to allow some waste touch between the key and the damper. The design of J. Jenkinson for a double treble piano is at first sight something like a Silberman Double Clavichord: both have the great advantage of enabling us to duplicate the unisons without any increase of tensile force; for it is obvious that a string stopped or touched at its centre, and speaking the octave above the sound due to its whole length, is rendered no tighter than when uttering its fundamental sound. I don't know if Silberman carried out this principle throughout the entire compass; but, if he did, his double clavichords must have been as long or longer than a modern concert grand piano. Probably the additional power of sound obtained by this system was not required in the bass, and, as in Mr. Jenkinson's piano, it was only carried out in the two or three upper octaves. Silberman's plan had one great advantage over Jenkinson's, not from any fault which can be eliminated from the design of the latter, but which is inherent in the clavichord over the piano. In the latter the hammer does not also serve for a bridge; so, to carry out Mr. Jenkinson's idea, I had to provide two very firm bridges and a bicephalus, or rather two hammers. In the clavichord these metal bridges and one of the hammers are not required, simply because the one metal hammer (*i.e.* the tangent) serves at once to strike both that part of the long string which is to the right of it (or above it in an upright clavichord), and the other portion of the string which is to the left or below it. This, besides its far greater simplicity, entails the avoidance of one of the greatest defects in Mr. Jenkinson's plan, viz., the necessity of tuning each portion of the long string separately. In the clavichord this is not required, because it can be tuned by applying the straining force at one end only; for it is obvious that, when its vibrations are accelerated by increasing its tension, so that its pitch is raised (say from B to middle C when vibrating as a whole) the pitch must be raised from B to pitch C also when struck and stopped at its middle and compelled to vibrate in two unisonous parts, situated one beyond the other instead of alongside as usual. The one thing needful for correct intonation is to adjust the tangent so that it shall strike the long string exactly at its centre between the two bridges on which the string rests, which are attached to the one soundboard or two soundboards. It will be seen that in the clavichord there is not, as there is in Mr. Jenkinson's plan, any risk of altering the tension of one portion of the long string which has already been correctly tuned, by increasing or diminishing the tension of the other portion of the same string for the purpose of raising or lowering its pitch to bring it into unison with the portion previously tuned.

Nearly a year ago, when requested to advise "Ye Workynge Man"—then very hot, indeed, on building himself either an organ or a piano—how to construct the latter, I was tempted to repeat Punch's advice to persons about to marry, "Don't." I recommended that most important member of "ye bodie politique" to make himself old Bach's favourite instrument (the clavichord) instead. I doubt not some of my *practical* friends, "W. T." especially, smiled at my ignorance; but so complicated an instrument as a piano, requiring great a variety of special tools used by different workmen (for in pianoforte making labour is greatly divided) for its production, did not then seem to me a very promising subject for amateur art. It appeared even yet more hopeless than the then popular working man's organ—I mean musical organ. N.B. The E.M. is not only *his* but *our* organ also in another sense, and a very good and improving organ it is. It "goes ahead" as if it knew no *stops* whatever, except those it puts on the progress of its rivals by buying them up, a process which must in time make it a very "full" organ indeed, and I hope will cause its contributors to express their "scientific opinions" and to "pipe" harmoniously. To return from this rather long bat, I trust, not altogether unwelcome digression—since I advised my fellow *workses* (as the author of Saturday night and Saint Monday terms his class) to make themselves clavichords, and was requested by one of them to furnish instructions for carrying out my recommendations, the subject has been brooding in my mind, and that being but a shallow vessel, you see, Mr. Editor, that its thoughts have run over on to this paper, which contains, at least, some suggestions how to do it. I fear my old fault of not seeing how to do a great deal for a very little money yet clings to me; and although a modern edition of a Silberman Double Clavichord would not cost quite so much to make as one of Broadwood's Iron Concert Grands, nor anything like the sum I have spent on my own experimental grand piano (which amount—being heartily ashamed of my great extravagance—I don't intend even my wife to know, lest it should become a standing reproach to me for the probably small remainder of my days) I do fear such a clavichord would cost a considerable sum to construct, for it would require to be braced considerably stronger than any ordinary grand piano. Certainly the action, excepting its keys, would cost but little, and its case need not be ornamental; but then the latter may be the case with the case of a piano, some of which are not only plain, like the cooks, but downright ugly. It would also occupy considerable space, perhaps as much as a large grand square piano; so all things considered, I must not boast of its cheapness in the sense of costing very little money. But, then, I utterly deny that this is the only condition of true cheapness; to me naught is really cheap which is not excellent: cheap and nasty seems to me simply a contradiction in terms, for the nasty in music is worse than worthless.

I am sorry I cannot yet furnish complete designs for the construction of a clavichord. I have seen but one since I saw the two in 1832 at Messrs. Kirkman's. I am sorry to add both these are burnt. I need hardly add I have not yet attempted to make one. Were I to do so I should certainly carry out Silberman's plan, at least for two octaves in the treble. Under these circumstances it will be seen that for me to fulfil the request of your correspondent to furnish him detailed designs would be rather a hard task. Perhaps if I cannot persuade your *very practical* correspondent "W. T."—who is, probably, far more able than I am to contribute a good design for a clavichord, which would have the further advantage over any design of mine of his special or professional knowledge—I may be tempted to help my fellow readers to construct old Bach's favourite keyed instrument with expression *à la main*. And if I do so I will embody in my design every probable improvement that my very partial and imperfect acquaintance with more than a century's experience in the construction of stringed instruments of the clavier class may suggest to me. Should a few of my supposed improvements make their appearance on the stage of public judgment in the guise of what my friend "W. T." satirically terms my crotchets, perhaps and other of my fellow-readers will bear with them as patiently as they may, in consideration that much music is largely composed of "crotchets" more harmonious than those of

THE HARMONIOUS BLACKSMITH.

[5]

BRAZILIAN RAILWAYS.

SIR,—With your permission, and in compliance with your correspondent Bernardin's request, as contained in your journal for the 24th ult., requiring more light upon what may appear confused remarks of mine as given in reply to your previous correspondent (No. 8977), I do not wish it to be understood that the length I gave as 69 miles is the actual length of the Bahia and San Francisco Railway. Although your correspondent quotes an authority, yet I do not intend to accept such before my own. I make a kilometre to be ·62,125 of a mile, but cannot allow that the above railway is near such as quoted—viz., 183·5 kilometres. Not having ever measured the distance of this line, nor having asked Mr. Thompson, the superintendent at Bahia, also not considering it worth while to go to the office in New Broad-street to ask Mr. W. Clay, the secretary, I am unable to state actually the distance. The term, as given in my previous answer, about it, "beginning at a pillar and ending at a post" is one I heard applied to it there by one of its own officials.

Bahia is a city, not a town. The company is English principally. I could easily state much more than your correspondent can learn from any work that has been made up to order, and not upon the writer's experience.

Having passed some five years in the province of Bahia (principally travelling), I have stated what I know, my authority being my own senses. Trusting that these few remarks will satisfy Bernardin and yourself.

J. G.

[6]

LUNAR ACTIVITY.

SIR,—I have the pleasure to inclose a summary of observations of the lunar crater Plato during April, May, and June, 1870, in which opposite effects upon certain spots are pointed out, more particularly on spots Nos. 18 and 19, not observed in April (ENGLISH MECHANIC, May 27, p. 263) and only once in May. At present the degree of visibility of these spots is very low—only ·024. On the contrary, the higher visibilities of Nos. 16 and 25—·357 and ·262 respectively,—strongly indicate the existence of local action of some kind in these spots.

W. R. BIRT, Cynthia Villa, Walthamstow.

SUMMARY OF OBSERVATIONS OF SPOTS ON PLATO—APRIL, MAY, AND JUNE, 1870.—BY W. R. BIRT, F.R.A.S.

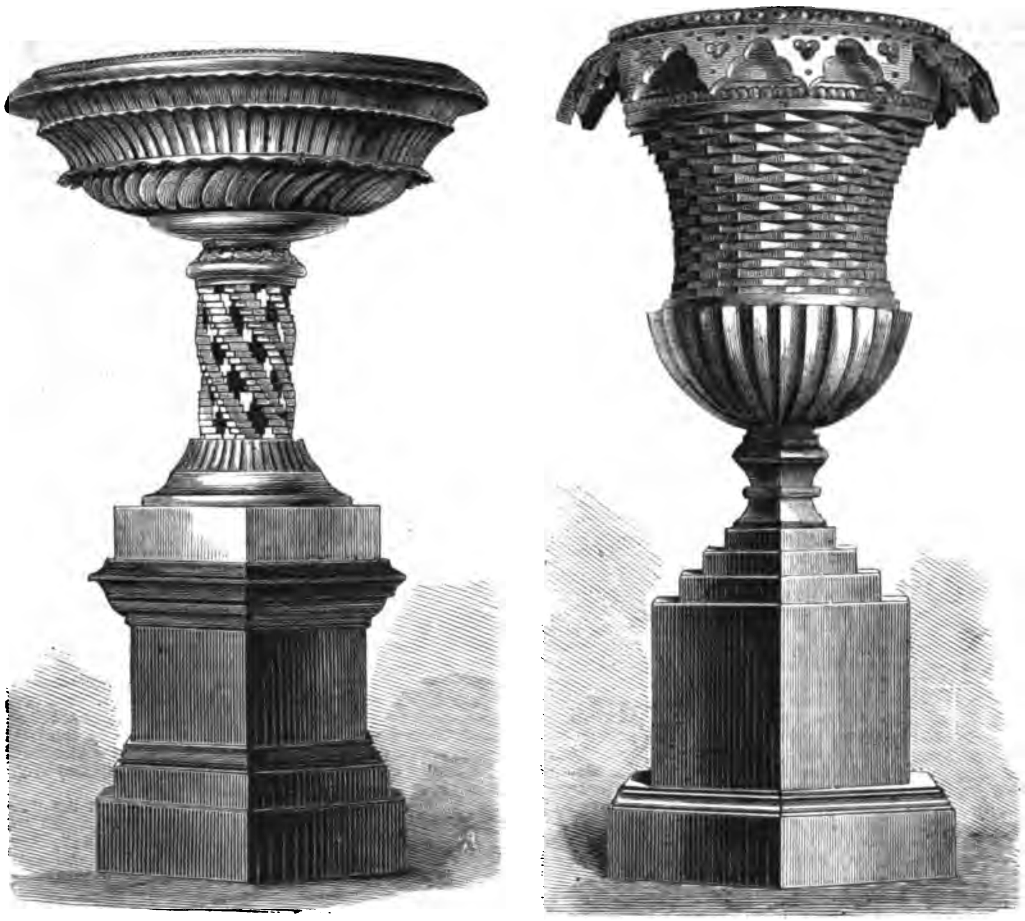
The June lunation having been very unfavourable for observations on the physical aspect of the moon's surface, the returns are inadequate to determine with the necessary degree of accuracy the gradations of visibility of the spots on the floor of Plato. The number of observations amount to 35 of nine spots out of the 36 now known; nevertheless, they may be combined with the observations of April and May; the number in April amounting to 118 of 17 spots, and in May to 111 of 28 spots.

The entire number of spots observed in the three lunations is 30, of which four only—Nos. 1, 3, 4, and 17—were recorded by four observers, Messrs. Gledhill, Elger, Pratt, and Whitley. No. 5 was seen by the three gentlemen whose names stand first. Eight spots were noticed by two observers—not in all instances by the same two—and no less than 17 were seen by one observer only—the observer, as in the case just mentioned, not being the same in every instance.

As may be expected from the unpropitious state of our own atmosphere during June, the average number of spots seen on any one occasion in that month was as low as 5, and not more than 6·29 for the three months. Excluding spot No. 1 (the standard) and No. 35 (the spot discovered by Mr. Gledhill in April last) we have 28 exhibiting variations from the annual visibility given in the Monthly Notices of the Royal Astronomical Society, Vol. XXX., p. 161. The greatest number (18) have manifested a decrease not by any means of a regular character, or of nearly similar degrees, which, if the decrease of visibility had depended solely upon a deteriorated state of our own atmosphere, ought to have obtained. The small variation of many of the 18 spots may fairly be attributed to this cause; there are, however, six instances in which the decrease is greater than ·100, spots Nos. 18 and 19 having varied as much as ·245 and ·236 respectively.

It was noticed in the paper communicated to the Royal Astronomical Society, and to which reference has already been made as above, that spot No. 19 exhibited the largest decrease of visibility in the six lunations, Oct., 1869 to March, 1870. This decrease was as much as ·374 below the degree determined between April and Sept. 1869. It is now ·236 lower than the annual degree of visibility determined in March, 1870. No. 13, a neighbouring spot, has participated in this decrease next to No. 19: its variation from the degree of visibility for the first six months was ·316: it is now lower than No. 19—viz., ·245. It is noteworthy that these spots are situated upon a light band or streak in the N.W. part of Plato [see diagram in the *Student*, April, 1870, p. 161]. The neighbouring spot, No. 16, on the same streak, has not continued to participate in this decrease: although at first it declined in visibility as well as Nos. 13 and 19, it has during the last three lunations increased, and was observed during the unfavourable month of June. These facts appear to be incompatible with the supposition that apparent changes on the moon's surface depend upon changes in the direction of the sun's light upon objects, or on alterations of the angles in which the sun's rays from them meet the eyes of observers.

Ten spots have exhibited during the three lunations an *increase* of visibility which is irreconcilable with the idea that the larger decrease during the same period is entirely due to a deteriorated terrestrial atmosphere. The greatest increase, ·177, occurs in the spot No. 25, discovered by Mr. Elger, on October 18th, 1869, and subsequently observed by Messrs. Gledhill and Pratt. The increase or decrease of visibility of a spot does not necessarily indicate, after a certain epoch, either a present or continued change in the spot itself; for as the determinations are comparative, an *actual* change in the spot rendering it, for example, "brighter," and consequently more readily seen, its visibility during the time its brightness continues would *rise*, and its higher degree of visibility, so long as it was maintained, would, to a certain extent, measure the duration of its *maximum*, to borrow an illustration from the phenomena of variable stars; but when this brightness subsided, and during the time the spot remained at its



SPECIMENS OF TURNED WORK.

minimum, it would be seen only on very favourable occasions, and its degree of visibility would fall and oscillate within certain limits, dependent in such a case on the state of the earth's atmosphere.

[7]

SPECIMENS OF TURNED WORK.

SIR,—I beg to send you photographs of some of my "turned work," which I hope will reach you safely. I much regret you have not received them long ere this, but I have been prevented doing any photographic work until last week.

J. H. MORGAN.

Parklands, Clifton, June 28.

[8]

READINGS FROM THE GLOBES.—VI.

SIR,—As our object is to illustrate, and these readings are intended not for the mathematician, but chiefly for those whose pursuits prevent them from studying spherical trigonometry from the works of Vince, Hymer, Todhunter, and others, it may be as well for us, before proceeding farther, to see if we have clear notions of what a spherical triangle is; as without them we are liable to get into confusion on such subjects. We have not the intention (and if we had our Editor would object) to introduce long demonstrations by lines, tangents, and cosines, but to show how even anyone who attends can obtain some ideas of spherical trigonometry, even by studying a globe only; and in fact if we have not access to a celestial globe, everyone knows what a cricket ball is, and he may even by making marks upon that understand something about it. Of course we know that accuracy is the order of the day, and we cannot be thoroughly accurate without formulæ, but these remarks may possibly serve as an introduction to some who may hereafter become eminent in this branch of study.

First we shall inquire what a spherical triangle is, [2] state what is meant by the pole of a circle, [3] show how a spherical triangle may be measured when it is made on a globe. A spherical triangle is made by great circles on the surface of a sphere, and not by small circles. Thus, referring to a globe or even a map of the world, we shall see that all the parallels of latitude are small circles, because, if the globe were cut through on these marks it would not be divided into two equal parts, but if cut throgh where a great circle is, at the equator, ecliptic, or the meridians which pass through the poles, it would then be divided into two equal parts. Where then three great circles cut one another they will form a spherical triangle. Thus, on the globe the ecliptic cuts the equator and forms an angle, the meridians cut the equator and ecliptic and form angles and sides; and this is where the distinction lies, in the sides not being straight lines but arcs of circles, of greater or less measure, as it may happen. Then again, when we turn a globe it spins on its axis, and the extremities of the axis are called poles, from a Greek word signifying to turn. Now these poles—namely, the north and south poles on a terrestrial globe, are the poles of the equator, and every great circle on a sphere has a pole round which it would spin. Thus the pole of the ecliptic has a different pole from the pole of the equator, and if we wished to find the pole of a meridian line, we must measure 90° distance from that circle in order to find it, and we must thoroughly understand this before we venture far upon the wide ocean, whether of investigation or commerce, and in fact it is most necessary for a nautical man to be acquainted with this subject, as upon his knowledge the lives of his fellow passengers may depend. Thus, in Fig. 1, let A B C be a right-

FIG. 1

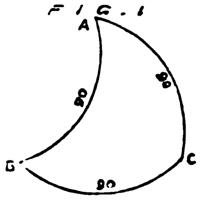
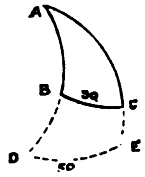


FIG. 2



angled spherical triangle, then the point A, being 90° from the arc B C, is the pole of the circle of which A C is an arc, and in like manner C is the pole of the circle of which A B is an arc, and we must always go to the poles of the arcs to measure spherical angles. It will be clear by inspecting the figure, that a spherical triangle may have more than two right angles. Euclid tells us that the three angles of every triangle are equal to two right angles, but this applies to plain triangles only, and not to spherical triangles, for by a globe it is easy to see that there may be three right angles in a spherical triangle, for if the angle A be situated at the pole in a parallel sphere, it will be measured by the wooden horizon and will be found to be 90°, the angle C would be at the east point of the horizon, and would be measured by the brazen meridian, and the angle B could be measured by the quadrant of altitude. If again we have an oblique angled spherical triangle how must we measure the angle B A C; we must not measure it by the arc B C, which is 80°, but we must measure it by the arc D E. The arc B C is one of the sides, but not the measure of the angle at A. We must go to the point D, just 90° distant from the point A, or we must find the arc of which A is the pole, and the width of this arc will be the measure of the angle A; and we must proceed in the same way with regard to the angles B and C, then we shall be able to tell whether they are oblibue or right angled. In fact all the cases of spherical triangles may be solved by means of the globe, and if when working by the formulæ we are in doubt as to the result, we may obtain an answer approximately by forming the triangle with prepared chalk, so as not to injure the globe, on its surface. This method will not by any means supersede the use of mathematics, but by using both methods together we may generally obtain accurate answers.

T. S. H.

P.S.—Upon further trial, I make the distance from Cape Horn to Good Hope [illegible] miles. from Good Hope to Port Jackson 5,815 miles, and from Port Jackson to Cape Horn 5,827 miles, which very [illegible] correspond with "M. L.'s" results.

[9]

SHORTHAND.

SIR,—I feel it my duty to remark upon the description of Pitman's shorthand given by Mr. F. W. Grierson, on page 328. I am a writer of that system, and by several remarks made by the above named gentleman, I can only conclude that he, when learning Pitman's Phonography, must have gone contrary to the directions given by the inventor. Mr. Grierson has learned three systems, at times sufficiently far apart as not to mix one system with another. I can speak from experience on Pitman's alone, as I never saw the other two.

Mr. Pitman advises no one to write quickly until he is able to write well. Speed will be attained by practice. Mr. Grierson says the great fault in Pitman's consists in using the same characters when made thick and thin to represent different letters. Here he is in error. If one is made thick and the other thin, they cannot be the same character. For instance, the letter "p" is written in the slanting position from left to right, thin, the thick form in the same direction being the representative of "b." It will be perceived that there is as much similarity in the pronounciation of the two letters as there is in the appearance of their respective phonograms.

Mr. Grierson proceeds to say that "the consequence of this similarity is, that unless the subject is transcribed while it is fresh on the memory it is practically illegible." Here he is again labouring under a delusion. I have transcribed reports of speeches, &c., both of my own and others' reporting, several months after being written, with the most perfect ease, and some of the subjects I had not previously seen; and it is a rare occurrence indeed that a letter is written thick instead of thin, and even in a solitary case of this kind the difficulty is soon solved, for if a letter should, by accident, be written thus, it merely alters the sound from "p" to "b"—the word "paper" would read "baper," "perfect" "berfect," &c., and the error is at once detected. Mr. Grierson's remarks upon the vowels and diphthongs, as being the most ridiculous feature of Pitman's shorthand, is in my opinion about the most ridiculous idea he has favoured us with. (See lines 38 to 25 from bottom, page 328.) There are, as he says, no less than six different positions for the vowels, but each vowel is always in the same position; and in the case of a foreign word, requiring insertion of vowels, it requires no more time for the "considerations" he speaks of (in the lines just referred to) than it takes an ordinary longhand writer, when about to write the word "Grierson," to think how to make the capital G, where to commence making it, and, after having written it, to turn back (and take his pen with him) for the purpose of dotting the "i." If he had to make out a table, in order to remember the positions of the vowels, &c., it is evident that he had not learnt them properly, and Pitman's explicit directions are not to leave one page until you thoroughly understand it.

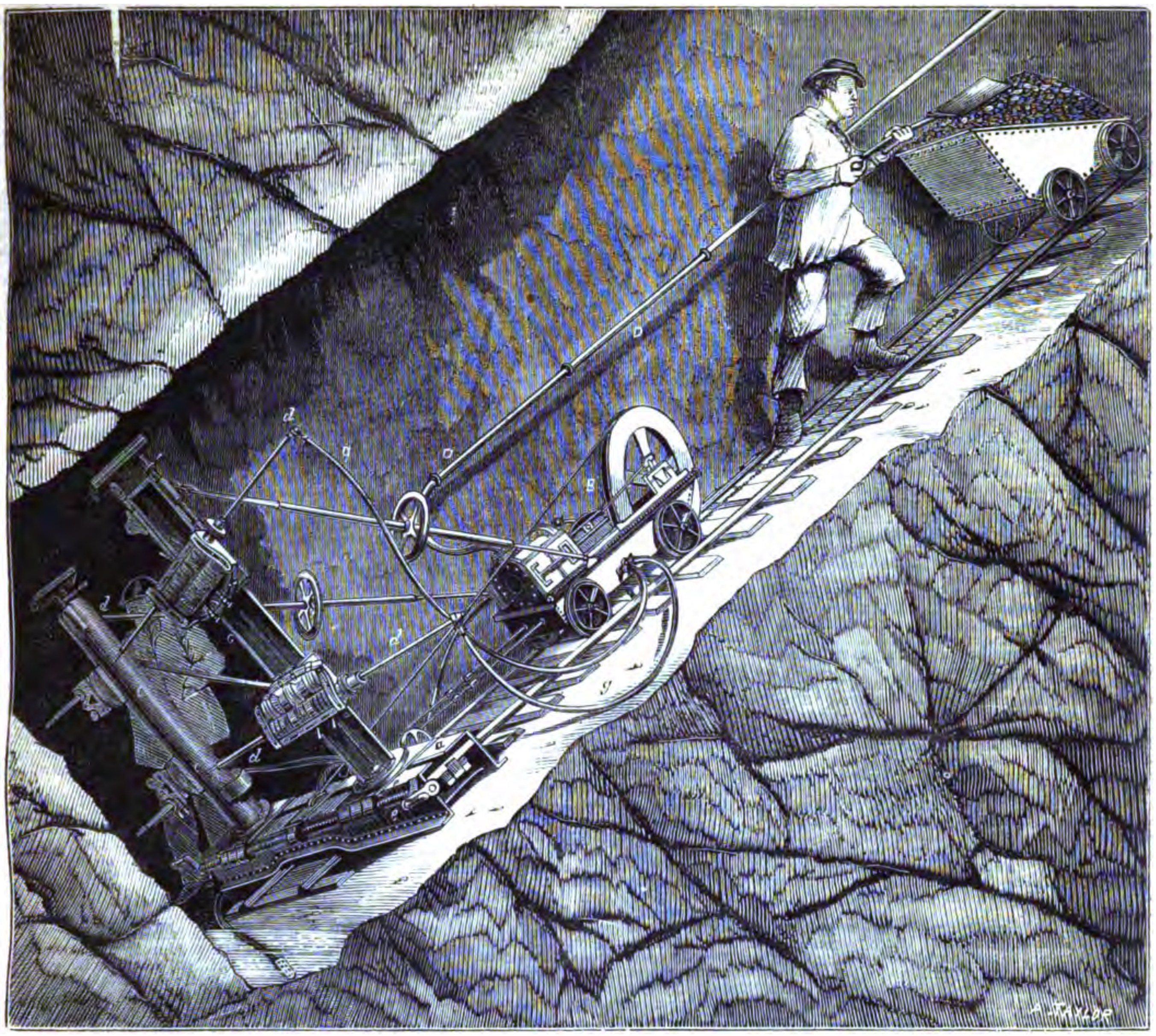
Anything can be read in twenty or thirty years hence without difficulty in Pitman's system, unless there are improvements added. Additional improvements are quite possible, as I have no doubt is the case with Lewis's, although it has undergone improvements for the last forty years. The art of joining several words together is an advantage of Pitman's over most others. In some cases nearly a dozen words may be written without lifting the pen, although only three or four are generally used. I think there is no advantage in having short hand for figures, as the present system of numeration is calculated to be quite equal to our utterance, especially when there are more than six figures.

Mr. Pitman publishes his teacher at sixpence, while Mr. Lewis's is ten and sixpence. Does Mr. Grierson supply this information for the choice of his readers, or does he think that the systems are to be compared to each other in value, in accordance with the price? He has one advantage over me. He says "only those who speak from experience ought to express an opinion on the relative values of various systems." I may say, however, as one having considerable experience in Pitman's system, if his experience in Lewis's is not better grounded than it was in Pitman's, I am afraid he won't make much at it. If his "advantages" of Lewis's system are as much exaggerated as the "disadvantages" of Pitman's are in his description (without wishing in the least to hurt his feelings), I would not give half a guinea for all the shorthand books Mr. Lewis has in his possession.

WM. F. MOSLEY.

[We have received several other letters in answer to Mr. Grierson, and written pretty much in the same strain as the above. We should like to have inserted those sent by "W.," "J. R.," and "An Experienced Hand," but space forbids.—ED. E. M.]

[10].

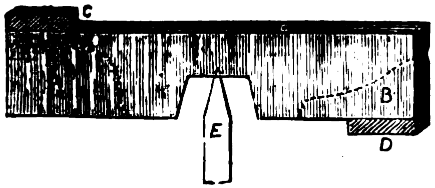


DIAMOND ROCK-BORING MACHINE AT THE CROESOR SLÂTE QUARRIES (described on page 367).

TO MILLERS.

Sir,—In common with others of my profession, I have watched the discussion in your columns on the subject of mill-stone balancing with much interest; nevertheless, it is by no means clear to me that the subject has been satisfactorily disposed of, either in favour of the supposed perfect unity at all times of the standing and running balance, or in favour of the other position—namely, that the standing and running balance are not necessarily identical, but may vary under certain circumstances.

It has always appeared clear to me that, with the present construction of mill-stones, it is theoretically impossible to secure perfect unity of both standing and running balance—that they should exactly coincide—because the size of the "burrs" is never the same precisely; and, to satisfy myself more thoroughly, I resorted to the following simple experiment, which occupied only a few minutes, and if repeated by my brother millers, I feel convinced they will find in it an explanation of the difficulty:—Procure a rectangular piece of wood, of a shape similar to that indicated in the annexed sketch (say 5in. long by 1in. square) A B.



This is hollowed in the middle to receive an upright support—say the top of a pencil—E, slightly impressed into the timber to make balancing the easier. On either end, one above and one below, as in the drawing, is fixed a piece of lead or other heavy substance (a quarter-ounce weight will do if well tied on), of equal weight, C D. When the whole is balanced nicely as in the illustration, the timber is supposed to be perfectly horizontal. Now begin gently to blow with the breath at one end, so as to cause the timber to revolve, when the end A will be depressed and the end B elevated to a considerable distance from the original horizontal position, in obedience to the law of centrifugal force, by which, of necessity, the heaviest portions of the outside extremes of a revolving object tend to the furthest point from the centre of rotation.

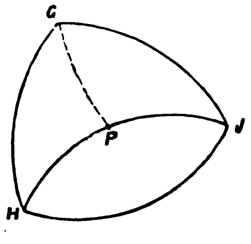
The application will be obvious. Suppose the timber to represent a section of a millstone, and the dotted lines surrounding A and B the burrs; now these are of much greater specific gravity than the plaster which covers them. The one (A) is much deeper than the other (B), and therefore nearer the top—the one B, is thinner, and nearer the bottom; therefore the centre of gravity of A is at a little distance above that of B, considered in relation to the horizontal. Burr A is, therefore, represented by the weight C, and burr B by the weight D in the experiment, the timber representing the plaster of the stone; the difference being that I have purposely exaggerated the proportional distance between the relative positions of the centres of gravitation of the heavy part of periphery, in order to make the principle clear; which principle is in no way affected by being presented in an exaggerated form, because, whether the vertical distance between the centres of gravity of the burrs at opposite sides (considered relatively to the horizontal) be 2in. or 2ft., the disturbing cause is the same *per se* namely, the influence of centrifugal force, as before mentioned.

If I have made myself understood, I think it will be apparent that a standing and running balance may not be identical under all circumstances.

[11] F. Davis.

CAPE HORN, GOOD HOPE, AND PORT JACKSON.

Sir,—One of your correspondents, "M. L.," has computed by spherical trigonometry the distances between these three places, and is desirous of having his results verified. He makes H G = 4,135 miles, G J = 6,824 miles, H J = 5,831 miles [see page 332]. I was induced to try them at his request, and I make the results somewhat near, but not exactly. This may possibly arise from not taking the same latitudes and longitudes. The way I proceeded was this: I made the triangle with prepared chalk on the globe, and found that the complements of the latitudes, and the differences of longitude were as follows: P H = 84° 1′, P G = 55° 36′, P J = 56° 8′, these form the sides of the three triangles; then the angle H P G = 85° 49′, G P J = 132° 45′, and H P J = 141° 27′. Thus we have two sides and the included angle, and the question is to find the third side. Perhaps some other of your correspondents might bring the figures nearer to "M. L's." results. I am not mariner, nor have I, at least for some time, had an opportunity of meeting with any one who has computed the distance by sea, but I should imagine the course H J could not be accomplished, the route being too near to the south pole.



By the bye, sir, as you have invited letters on summer pastimes, would not one of your correspondents give us a few remarks on the art of swimming, so useful both to mariners and every one.

T. S. H.

P.S.—I make H G = 4,032 miles, G J = 6,794 miles, and H J = 5,828 miles.

[12]

FLUTE FINGERING.

Sir,—A correspondent complains of the bother of flute fingering in extreme keys, by which I suppose him to mean the flat keys. But is it possible, in these days of sliding heads, that anybody submits to the bother of making the flat notes independently as they come? Supposing your correspondent has to accompany a piano, the music being in D flat, he should, by means of the slide, tune his D to the D flat of the piano, and then play the notes as though they were written in the key of D, with two sharps, which is the natural scale of the flute, and causes no extra fingering whatever. Exactly the same sounds will be emitted as if he had elaborately flattened each note as it occurred. The reason is evident—by drawing out the slide he flattened all seven notes. But the staff directed him only to flatten five, B, E, A, D, and G; therefore he has to sharpen the other two, F and C. For the same cause, with the flute so adjusted, six flats is to be played in one sharp, four flats in three sharps, three flats in four sharps. It may appear to the uninitiated as if it would be easier to play in three flats than in four sharps, but it is not so, for in the first case C and F have to be made natural, making, with the signature in the staff, five notes to alter; in the latter case there are only two to alter, the other two being in the scale; only in using this mode an accidental flat must be played as a natural, and an accidental natural as a sharp, because the natural note is flat to the sharp, and sharp to the flat. With a sliding head a flute requires but four keys, the D sharp, E sharp to make F natural, the G sharp, and the A sharp. All others are mere surplusage. If the music leave the flat key for a natural without there being an opportunity for fresh tuning, make before starting a nail mark on the tube at the length for the natural note: the composition with which it is made to go smoothly will take it. I hope these directions may bring some relief to perplexed fingers. T. S. G.

[13]

THE LUNAR CRATER—"ALPETRAGIUS D."

SIR,—Mr. Michell Whitley, of Penarth, Truro, a very careful observer of lunar objects, has addressed a letter to the editor of *Scientific Opinion* (see No. 85, June 15, 1870, p. 258), containing his observations on June 8, 1870, of the spot "Alpetragius d," (not the Greek Delta as printed, but the Roman d), in which he speaks of a minute blow hole in the centre of the white spot now occupying the place of Beer and Madler's crater. I am not aware of anything having been published on this spot since my article in the *Student*, referred to by Mr. Whitley; but at the close of 1868, and in the spring of 1869, I received communications on it from the well-known observer Mr. Knott, of Cuckfield, and shall feel obliged if you will kindly give publicity to the following extract from his letters:—

"December 24th, 1868," Mr. Knott says, "I hasten to report to you the result of an examination of 'Alpetragius d' last evening, which adds one more to the points of resemblance between it and our old friend Linné. Observing with my 7¼ in. Alvan Clark refractor and a negative eyepiece magnifying 424 times, I detected on d (which appeared as a bright soft edged spot) a minute craterlet, with a diameter barely one-half that of B and M's little craterlet on the south. This is evidently the same object as is figured by Lohrmann on his unpublished plate (see *Student*, vol. ii., p. 48, plate) referred to by Schmidt." On February, 20, 1869, Mr. Knott again examined this region, when he distinctly saw the craterlet as a crater, and estimated its diameter as equal to half that of B and his little craterlet on the south.

It is exceedingly gratifying to find three such observers as Schmidt, Knott, and Whitley agreeing so closely with regard to this spot, all three placing B and M's little craterlet on the south edge of the white spot, and the last two finding an exact resemblance to Linné in its three main characteristics, as observed since October, 1866. I hope many of your correspondents will often turn their telescopes upon it, that these features may be closely watched. It is situated to the east of the two undesignated craters eastward of No. 205, on Webb's map; the largest is Alpetragius d of B and M, the smallest B. The colour of the interior of B is darker than given by either Lohrmann, Beer and Mädler, or Schmidt.

Your correspondent Albert P. Holden will find recent estimations of the distance of Xi Ursæ Majoris by Messrs. Whitley and Ingall, in the above quoted number of *Scientific Opinion*.

W. R. BIRT.

Cynthia Villa Observatory, Walthamstow.

[14]

BICYCLE RIDING. MEDICAL OPINION WANTED.

SIR,—I wish to ask a favour of some of your medical readers, and though it is like a sort of consultation gratis, yet, as it is a question of universal interest at the present time, it may not be considered asking too much.

Several individuals who have never "risked their necks" on bicycles have occasionally grumbled at the many letters respecting such machines; but I am sure not one of them would object to space being given to determine whether their use is, or is not, injurious to their numerous riders, and whether the strain on the abdominal rings is or is not so great as to cause ruptures, &c.

I am aware that a letter appeared about this some six months ago, in your columns; but there was only one reply, and surely on such an important question as this we ought to have a more general opinion. I have heard that in five years it is considered that a bicycle rider would be completely ruptured with daily practice. I of course cannot vouch for the truth of this myself; but I had it from medical quarters. What a calamity it would be if, in about that time from the commencement of bicycle riding, all those who frequently used the machines were served in this way. I therefore request opinions on this important point, with the editor's permission, and also, whether the use of a broad band round the abdomen would be sufficient to prevent such consequences. Perhaps, also, velocipedes which drive by levers with a horizontal motion may be free from this objection. It would be well to know this, and if they are not, the only safe velocipede would be one propelled by the hands.

[15] S. JAMES.

SEWING MACHINES—REPLY TO "GROCER."

SIR,—That a Thomas's shuttle will work best with the thread unwinding from the under side of reel is well known. The instruction books teach it. I have not recommended the reverse, and although the drawing shows it reversed, it was done intentionally, believing it would be easier to comprehend so illustrated. Thus far I beg to thank "Grocer" for pointing out the error, but entirely disagree with him as to making the "spring long enough to catch the brass end of shuttle reel." Firstly, in practice the brass end of a shuttle reel is usually far from being a true circle. Secondly, the spring pressing upon an irregular form must give an irregular tension. Thirdly, if the brass end of a shuttle reel had a true circular form it would be inferior to the short spring to give a regular tension. Fourthly, because when the reel is full of cotton it pulls off easier than when it is nearly empty, owing to the difference between the diameters. When full, the diameter being largest, affords a greater leverage to turn the reel when the cotton is pulled off. A full reel of cotton or thread presses strongly against the spring, and resists strongly the pulling off, but *as the diameter of the thread diminishes, so the resistance of the spring diminishes, and thus compensates for the irregular action caused by the using, and diminishing the diameter of the reel of thread.* It is, therefore, far superior to a constant uniform pressure of the spring on the brass end of shuttle reel, *which cannot compensate for the varying strain on the shuttle reel when nearly full or empty.* "Practical Man" recommends a short spring, as represented, to any one who would make a shuttle for himself (but it is far more economical to buy one), and further recommends the kind of reels to their respective shuttles, as illustrated at page 157. "Grocer" is in favour of a Singer reel, "because *if* the reel is not pressed firmly down (in the Thomas's shuttle) the hinge goes behind the end of the shuttle reel and shuts it out, instead of in." If "Grocer" found this to be the case *two or three times* with persons he sold machines to, what would he expect to find if he applied the Singer reel to a long shuttle, or a No. 1 Thomas for shirt collar work, where the best stitch is required at the highest speed? The latter part of "Grocer's" remarks will be best replied to by the description and illustration of machines about to appear in a systematic manner; and nothing could be more unfortunate to those who seek a thorough knowledge of the subject, than to introduce haphazard the whole or part of certain sewing machines of doubtful merit, or to use valuable space merely for advertising purposes without payment. A PRACTICAL MAN.

[16]

VELOCIPEDE CONSTRUCTION.

SIR,—Each maker—amateur or otherwise—seems to me to judge of his and other machines by the rate he can go on it. Now I think that is an erroneous test, for I saw a machine, horrible in appearance, construction, and principle, propelled at as great a rate as thirteen miles an hour (which for tricycles I believe to be the maximum rate), only the driver was a strong swarthy fellow, and exerted his utmost. It is therefore not to be wondered at that "A Pattern Maker" should think "the whole stock of velocipedes up to nothing when put really to practical work, and particularly in a hilly district." After describing a veloce the usual finis is "that it can be made to go fifteen miles an hour with ease," which, by my criterion, is folly. I grant that these machines can be made to go at that rate, and uphill, but it is practically "no go." I have practised the bicycle for a year in a hilly district (compared with many in England a very hilly one), and can keep my saddle over most of the hills without difficulty, but the labour is excessive. I would judge of a good machine by the "ease" required to propel it eight or at most ten miles an hour, to gain which lightness, combined with simplicity of construction, height of wheel, india-rubber tires, and yielding springs are the necessary things. Loose and light clothing is also very desirable for summer riding. But in my opinion, to rattle over the ground at the rate of one mile in four minutes on any but a first-class machine with even roads is sheer folly, and undoubtedly more so with a tricycle than a bicycle. One of the chief ingredients of pleasure is ease, I take it; and as veloces are at present used chiefly for pleasure, the further we exceed ten miles an hour so much do we lessen our pleasure.

Another thing that I am sceptical about is the common dogma that the driving-wheel ought not to be more than 36in. or 38in. It is being continually brought forward in the MECHANIC, yet to my knowledge has never been discussed, but seems to be quietly swallowed by brother readers. The little S. James (page 309) says on the two and three wheeler is very correct; but I don't see why the driving wheel should not be as large as the leg will admit of. If, however, any one will be kind enough to "show cause why" I should believe the common dogma he will very much oblige. HUSBAND.

[17]

UNFAIR CRITICISM.

SIR,—It may seem unwise to refer in the pages of the most widely circulating scientific journal in England, to adverse criticisms in a contemporary of minute circulation. But I look at the matter in this light. Professor Pritchard has chosen, in reviewing my "Other Worlds," to make certain charges against me in *Nature*. If these charges are true they ought to be more widely known than they can possibly be while confined to the columns of *Nature*; if they are not true my countercharges ought to be more widely circulated.

I deliberately assert that Professor Pritchard has written a more discreditable review than any which the veriest hack-critic would have penned. I have no doubt, as I have written to him, that he is "by this time heartily ashamed of the paper;" but unfortunately justice requires that I should take further notice of his indiscretion.

I pass over his remark that he cannot follow my reasoning in a certain chapter, with the simple comment that from Sir J. Herschel (who has done me the honour of indicating special approval of this very chapter) down to the least instructed reader, not one I venture to assert has found any difficulty in mastering the reasoning, save only the Savilian Professor of Astronomy.

The *gravamen* of my charge rests, however, on his assertion that "Laplace, the elder and the younger Herschel, Humboldt, Admiral Smyth, Sir William Thomson, Mr. Tait, Dr. Balfour Stewart, Professor Tyndall, and other honoured names, all in their turn come under Mr. Proctor's adverse criticism, with greater or less severity." This assertion is inexact. If the remark that one does not agree with this or that opinion of such and such a person, be rightly described as "criticising that person with severity" then I am open to Professor Pritchard's charge; if not, then there is no truth in it.

But a type of my severity was wanted, and Professor Pritchard, with as much dexterity as though his trade were hack-reviewing, conveniently *makes one*. There is *one* sentence, which, taken apart from the context, sounds severe. Whewell had spoken of Jupiter as a watery globe with a few cinders perhaps at its centre. I remark in "Other Worlds," that surely "no astronomer worthy the name" can regard Jupiter as it was thus regarded "by one who, be it thankfully remembered, was not an astronomer." But then I go on to indicate in what sense I use the word astronomer. "He," I say, "who has not gazed hour after hour on the glories of the giant planet," &c. Every one knows that Whewell was not an astronomer in the sense in which I wrote. For the larger portion of his attention was directed to quite other matters than astronomy, and it is simply true, as he himself admits in his "Plurality of Worlds" that he was not, properly speaking, an astronomer. Fortunately I have spoken with far too obvious appreciation of Whewell's wonderful abilities for my meaning in this passage to admit of being misinterpreted by others than Professor Pritchard.

Professor Pritchard then goes on to say that I attack Mr. Lockyer's views about the corona "simply because they do not square with mine." He knows perfectly well why I attack them; for I assign very definite reasons. He would not venture to assert that these reasons are insufficient, because, if he did, he would lose all title to be regarded as a mathematician.

Equally clever is his quotation of a passage having reference to the theory of the meteoric origin of solar heat. I write "I am quite certain that there is no flaw in the evidence I have adduced from the laws of probability; and that," &c. But it suits Professor Pritchard's purpose to make it appear that I am only expressing over confidently a mere opinion—so he quietly drops all reference to the evidence, and makes me say, "I am quite certain that at least an important part of the sun's heat, &c." He immediately adds, "we may fairly ask whence has Mr. Proctor this certain knowledge," &c. Yes; but if he had quoted the sentence in full, it would have become unpleasantly obvious that one had only to turn to "Other Worlds" *to find out* whence Mr. Proctor derived his conviction.

It is well known that Mr. Lassell, the eminent and skilful astronomer who is the present President of the Royal Astronomical Society, considers that Uranus has only four satellites; for he can see but four with his splendid reflector at Malta. "How then can Mr. Proctor," asks Prof. Pritchard, "venture to set his *opinion*" (that there are eight at least) "in antagonism," &c, &c. How indeed? But suppose Mr. Proctor wrote thus—"Four of the satellites discovered by Sir Wm. Herschel have not indeed been yet identified; but one cannot read the account of his method of procedure without feeling that no amount of mere negative evidence can be opposed effectively to the positive information he has left us respecting these four orbs." Does not this somewhat alter the aspect of matters?

Then what am I to think of his quoting a printer's blunder (obviously so from the context) as only *probably* an inadvertency? On page 41 of my book are these words—"a glowing vapour gives a spectrum of *white* lines," where it should be "bright lines"; but within a few inches, on the same open paging, are these words—"They tried the spectra of glowing vapours. and .... they found bright lines of various colour." He then goes on to speak of "*an alleged breaking of a dark glass*" where I have spoken of no such event as having actually happened; and somewhat spitefully adds—"these (two) misstatements are easily corrigible in a second edition, presuming that they are not typical of much else in the volume itself," from which we may fairly conclude that Prof. Pritchard had not read the volume, and was therefore hardly in a position to criticise it.

I am sorry to have to comment severely on Prof. Pritchard's conduct in this matter. I cannot at all understand why he should be irritated against me; but it is clear to me that nothing but *some* irritation could have made him so forget himself. If I had attended the meetings of the Astronomical Society when he was president, I should imagine he gave me credit for some of the anonymous attacks which were so freely made on his school-masterly reading of the part of President. But I was not. A year ago I had occasion to remark at one of the meetings of the Royal Astronomical Society, that in commenting on a paper of mine, he had "begged the whole question" at issue; but surely so small a matter as that cannot have angered him for a whole year. *Tant ne, &c.?*

[18] RICHARD A. PROCTOR.

INDIGO.

Sir,—The samples of indigo which I have had the pleasure of sending you were extracted at Accra, on the west coast of Africa, from a species of plant known as Indigofera. Tthis plant grows in great abundance on the west coast, more particularly on the Liberian or grain coast, where there is great quantities. Merchants who trade to the coast seem to have entirely overlooked the benefit to be derived by the cultivation of this valuable dye. Several important things have to be observed in collecting the plant fit for fermentation. The *modus operandi* is similar to that which I have carried out in the East Indies, excepting that the maceration is useless in this case, and that the fermentation takes about 26 hours. The indigo when precipitated has a greenish tint, which may be destroyed by being boiled with one part SO_3 to 30 parts of water, which entirely destroys the chlorophylle (which gives it that tint), and renders it similar to that which I have sent you. Market value of the dye at the present moment is quoted to me by one of the first firms in the trade at 7s. 6d. per lb.

I hope to have the pleasure of submitting to you samples of cloth manufactured by the natives of Benin, and dyed with the indigo.

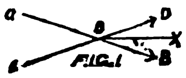
R. F. Garth.

[19]

ELECTRICITY.—PARALLELOGRAM OF CURRENTS.

Sir,—I am anxious to obtain information on some matters connected with electricity; and I write to you in hope that "Sigma," or some other of your correspondents, may afford me the information I desire.

It is well known that magnetic currents in the same direction attract one another, while those in opposite directions repel one another; and also, that currents converging to or diverging from the same point attract one another, so that if A B, C D, Fig. 1, be two similar wires, along which currents of equal quantity are passing, and which can move freely about their middle point O, they will swing round into the position O X, where O X bisects the ∠ Bo D.



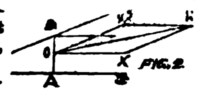
Now I wish to know if these facts have suggested to any experimentalist the idea of a parallelogram of currents, analogous to the parallelogram of forces or of velocities.

I have neither the time nor the skill to make such delicate experiments as would be required, myself; but I will state what I conceive would be the enunciation of such a theorem, and I should like to hear whether my statement represents an established fact.

This then is my ideal statement.

If two rectilinear currents cross one another, and a magnet or solenoid be placed so as to bisect the shortest distance between the two, it will take up a position as though it were acted upon by a *resultant* current, whose quantity and direction may be estimated as follows:—

Let Ax, By, represent the directions of the currents, and let AB be the shortest distance between them. Bisect A B in O, and draw O X, O Y, parallel to Ax, By, making, O X : OY :: quantity of electricity passing along Ax : quantity along By.



Complete the parallelogram X Y; then O R will represent the resultant current in direction, and its *quantity* will be represented by $\frac{2\,OR}{AB}$

In the figure the magnet is supposed to be placed at O, and if the theorem be stated correctly the magnet would take up a position at right angles to O R. If this were found to be correct by experiment, the theorem would be proved as regards the *direction* of the resultant: to prove it as regards the *quantity* of the resultant would require a delicate galvanometer.

[20] R. P. S.

AIR PUMP.—INDUCTION COIL.

Sir,—I beg to thank the two correspondents who have answered my inquiries about the Air Pump; though, as I feared, they have not given me any information beyond what I already knew. The first one has simply given a description of Tate's pump, a form well known; the other describes nothing more than an ordinary exhausting syringe, which, I have ascertained, is sufficient for the vacua required for the experiments mentioned by me in my letter, but utterly useless for higher vacua. I thought, among your numerous correspondents, there might be some who have gone in for the subject in its higher branches, and who could and would give me the result of their experience.

What I want is a pump that will produce a vacuum equal to about one-twentieth of an inch of mercury, and I know that the expensive class of pumps sold for this purpose—and they are indeed expensive—are made with a single barrel. It was the construction of one of these that I wanted to elicit from some of our scientific friends. There is a plan of Grove's called a repulsion pump, that I have read about, which I believe is very good, but I do not know the particulars sufficient to work by. I am now constructing one on my own plan, about which I am rather sanguine; still I shall be very thankful for any useful information on the subject. With regard to the induction coil mentioned by me, I shall be very glad to give a full description of its construction if you, sir, think it of sufficient interest; or I will give it personally to any inquirer if they write to you for my address. I have had the opinion of a celebrated electrician on it, and he tells me it is a marvellous success. It is constructed on the vertical plan—so far there is nothing original about it; it only remains for me to describe the *method* of its construction, which is peculiarly simple. I have about the same *weight* of secondary wire as that mentioned by A. Farquhar; but as my wire is No. 36, I have a much greater length. No. 28 is too large to produce length of spark, though, with proper insulation, it ought to give great density; but, in my opinion, it is much too thick. Mr. Farquhar may find his coil, with its imperfect insulation, answer with *small battery power*; but I caution him not to try four or five cells, or else he will find it come to grief; for cotton covering and shellac varnish is quite insufficient, even when constructed, as I presume his is (for his description is not at all clear) on the vertical method. My coil, with one cell, the platina about 2in. by 4in., gives a good dense spark at 1¼in. surrounded by a thick aureole; and the spark I get at from 3in. to 4in., is *sharp, bright, and zig-zag, not straight and thready*. I have tried it with a mercurial break, but I cannot get nearly the same length of spark as I can with the vibrating spring; the cause of this I am unable to comprehend, not having had any experience with this form of break.

In conclusion let me advise those who are thinking of constructing a large coil, not to think of the old horizontal methods with gutta percha insulation: they are a delusion. I do not say they cannot be made, because they have been and are; but they are *always likely to break down*, and *then they are done for*. While on my plan they cannot break down, and much greater results can be obtained with small battery power, which I consider to be one of the great desiderata.

Inductorium.

[21]

TRADE AND COMMERCE.

Sir,—As "Herbert" has written you a third letter before my answer to his second one appeared, I must again trouble you with a few lines in self defence. I have got "Herbert" into a little corner; and although he fights fairly and manfully, I cannot make up my mind to let him out until he proves his case, or acknowledges his error. He assumes that trade is barter, with the corollary that the balance of imports over exports is profit. Upon this point he must stand or fall. I have endeavoured to prove the contrary, and cannot consent to accept as an axiom that which is really the point in dispute. It is in vain that he builds elaborate edifices upon this basis, until he prove that it is a sound foundation.

At page 306 "Herbert" says that even I (F. W. M.) can see that when a foreign-made article is purchased, part of the money goes to the foreign workman, but that I cannot see that some foreign gentleman pays an equivalent sum, which comes into the pocket of an English workman. My inability to see this does not arise from shortsightedness. In the well-known play of *The Critic* Tilburina was not to blame because she could not see the Spanish Fleet—her failing, which called forth the rebuke, was that she professed to see it when it was "not yet in sight." The case would be exactly as "Herbert" states, if trade were barter, and trade were free, but the first condition is disputed—the second unfortunately does not exist. The real state of affairs is just this:—The foreigner, having received £29 for his goods, is willing to spend that amount upon English manufactures, but his government has laid a restrictive duty upon these; and if he buys them in spite of the duty, his £29 goes somewhat after this fashion, £18 for English goods, and £11 to the State for duty; so that the Englishman gets but £18 back against his £29 expended and sells but £18 worth of goods against the £29 worth that he buys; or, to extend the example so as to embrace the whole of the foreign trade of the country, England buys from the foreigner £294,693,608 worth of goods yearly, whilst he is unable to buy from her more than £179,677,812 worth in return. "Saul Rymea" may well ask "What sort of prosperity does this indicate?" "Herbert" is fond of similes. I will give him one as a counterblast against his "cargo." Suppose the nation to be a business firm which buys and consumes every year £29,000 of goods and manufactures, and sells but £18,000 worth. Is this firm doing a profitable business?

Last week there was a discussion in the House of Commons on the subject of "Unemployed Labour," which was very interesting, although unsatisfactory in its result. We may, according to our several prejudices, believe, with Mr. Torrens, that the country is in a state of destitution and misery, or with Mr. Goschen, that it is prosperous and happy; but above all differences of opinion, beyond all contradiction, looms out the damning fact that the nation is unable to support its people.

There was a time when increase of population brought with it a corresponding increase of work, and the nation was stronger and more prosperous in proportion to the increase. All this is changed now, and it is a suspicious circumstance that the change should date from the period when, through the influence of Free Trade, our imports have commenced to be much in excess of our exports. Some of your correspondents regard the necessity for emigration as a proof of our prosperity. It is an unfortunate time for a nation when the symptoms of weakness and disease are looked upon as proofs of healthiness and strength—when the hectic flush of consumption is mistaken for the rosiness of health, and the nation disports itself in a fool's paradise, unconscious of the disease which is destroying its constitution.

We have had five-and-twenty years' experience of the working of Free Trade, and ought now to be in a position to judge of its effects. A Government Commission, appointed to investigate the subject, could not fail to bring to light many interesting and instructive facts, but there is little chance of such an appointment. The great apostles of Free Trade—those who persuaded us to shut our eyes, throw open our ports, and see what fate would send us, have made an enormous reputation thereby. By the majority of people they are worshipped with a devotion which does not fall short of bigotry. Any attempt to question the infallibility of their wisdom is at once drowned with cries of derision. Their followers are as certain of their case, and as intolerant of opposition, as were the opponents of Galileo in their belief that the sun revolved round the earth.

Were it once proved that their commercial policy was wrong, these great men would be in danger of losing the vast reputation they have acquired; and although we must credit them with every possible honesty of intention, yet as every one sees things through spectacles more or less coloured, it is possible that such a consideration as this might deepen the *couleur de rose* of their spectacles sufficiently to conceal from their vision the blackness of tint which is slowly but surely overspreading the aspect of affairs.

[22] F. W. M.

SEWING MACHINES.

(Continued from page 261.)

Sir,—In a shuttle lock-stitch machine there are four primary, continuous, and essential motions for making the stitch, and three adjustable or moving parts to regulate the stitch. These may be classified as follows:

1. The Needle Motion.
2. The Shuttle Motion.
3. The Feed Motion.
4. The Main Shaft and Driving Wheel.

The first three motions are not *uniform*, either separately or combined. Attempts have been made to obtain uniform motion to prevent noise, or for some supposed advantage, but such changes from the correct motions entail certain disadvantages.

The machine must be fitted with

5. The Tension.
6. The Thread Take-up.
7. The Stitch-screw or Regulator.

Some machines require, in addition, other parts, as a Presser and a Lifter, when the under-feed is used.

The usual terms will be used in the description of sewing machines, so far as practicable; but to prevent confusion when comparing them, certain changes are necessary. For example, it is usual to speak of the frame or bed on which the shuttle slides, as the *shuttle race*; this bed being immovable it is not appropriate to apply the term *race* to it. By using the term *shuttle path*, it will apply without confusion to a straight, curved, or oscillating shuttle movement, either sliding or carried.

To the courtesy of the Howe Machine Company, of 64, Regent Street, London, we are indebted for the following illustration of the first machine invented by Elias Howe, jun., the late president, who made many kinds of clothing on it at the rate of 300 stitches a minute. The idea of this invention was worked out in a rough model of wood and wire, in October, 1844. In July, 1845, he sewed by his first machine the seams of two suits of woollen clothes. In 1867 the same machine was displayed at the Paris Exhibition. A model of it may be now seen at the Museum of Patents, South Kensington.

It is not a little perplexing to find the invention of the sewing machine claimed for France, and a tailor the inventor, who had many of his machines, in 1841, making army clothing.

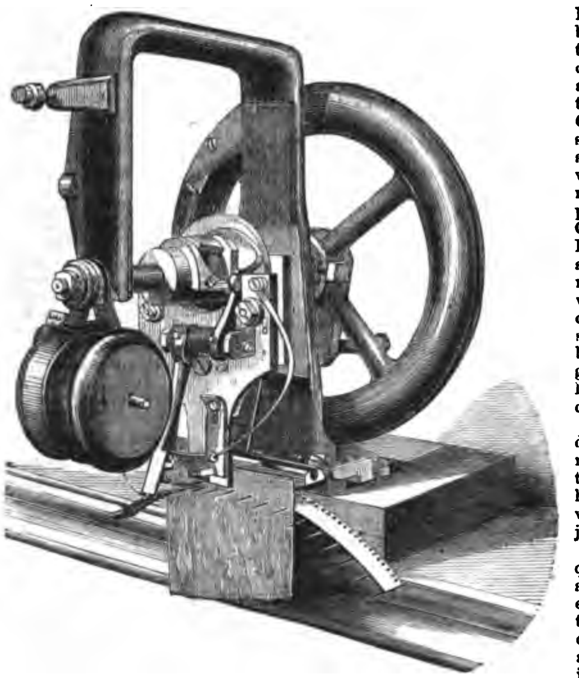
The mob, it is stated, in the Revolution, ruined the establishment in which the inventive tailor had a share, and sent him to die at Amplepius in great poverty.

If there be a shadow of truth in this statement that army clothing was made by a French sewing machine four years earlier than Elias Howe's successful working of his machine, surely we ought to have sufficient evidence of so important a fact. Are our neighbours in France so careless of the reputation of their countrymen when most deserving? Is it wise to bestow so much glory on war, and leave the hero who conquers in the arts of peace to die in poverty, unrecognized?

If the story of the inventive tailor will bear investigation, we appeal, as "English Mechanics," to "French Mechanics," to perform their duty, and let us have the particulars of the machine, that it may be illustrated in our "English Mechanic," and duly honoured. If the story be a myth, let it be dealt with so that it may not be further circulated by being copied in the public press as an established fact.

A close inspection of Elias Howe's first machine will show that he embodied all the essential movements. An eye-pointed needle passed the thread from a reel through the fabric, then the needle loop was formed, and the shuttle passed through it, the needle being pulled out of the fabric and the stitch tightened, when both needle and shuttle came to the end of stroke; the feed then advanced the fabric the length of stitch, the shuttle travelled back, and the needle again penetrated the fabric to make another stitch. In the illustration it will be seen the fabric is placed vertically on pins, the pins being connected to a rack plate which moved a given distance, stitch by stitch. When the rack had travelled its full stroke it had to be placed back to commence afresh, the fabric being at the same time readjusted on the pins. This feed motion appears now very awkward. It was used in other machines in the early attempts; and I have seen a rack, and the bed of the machine, a yard long, so that one yard could be stitched without stopping to readjust the feed.

All the essential motions were transmitted from the main shaft, on the end of which may be seen the driving wheel, behind the fabric and above the machine. On the main shaft may also be observed the cam, having the same kind of action as that attached to the



SEWING MACHINE.

modern Howe machine, an illustration of which will follow, and prove to satisfaction that Elias Howe deserved all he received of wealth and honours.

ERRORS IN ILLUSTRATIONS.—At page 281, Fig. 4, the spool case is represented resting on the end of the upright shaft *g*. In such a form the needle thread would not pass between the spool case and its bed. The surface of the spool case and its bed should be as smooth as possible to allow the thread to pass in the manner described. At page 157, Fig. 9, the thread is represented passing over, instead of under the reel. It works much better under the reel, but may not be so clearly understood by the thread being hid below the reel. The shuttle should be made in all respects as represented in the illustration, Figs. 9 and 10.

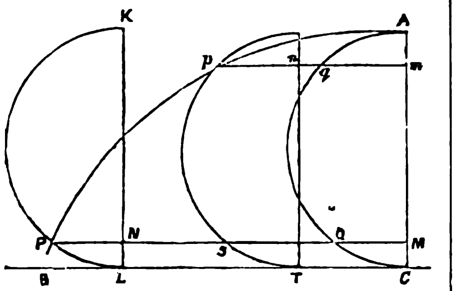
A PRACTICAL MAN.

[23]

HOW TO TRISECT AN ANGLE.

SIR,—I have read with interest the letters of your correspondents, F. C. Penrose, June 24th, and "O. H. S.," June 3rd, on the subject, "How to trisect an angle."

May I suggest to them the following, which appears to me a solution of the problem? If I am wrong perhaps they will kindly set me right.



Let A P B be a cycloid. L P K any position of the generating circle. Draw P Q M parallel to the base B C. Then A Q is any arc.

It is required to trisect it.

Take T C, one third of L C, and draw the generating circle in the position T S P, and draw *p n q m* parallel to base.

$$\text{Now } PN = QM \;\therefore\; PQ = NM = LC$$

$$\text{And } LC = BC - BL = \pi - \text{arc } PL = \text{arc } PK = \text{arc } AQ$$

$$\therefore \text{arc } AQ = LC = 3\,TC = 3\,nm = 3\,pq = 3 \text{ arc } Aq$$

By which means any arc of a circle may be divided into any number of parts.

R. T. B. R.

24]

TOURISTS' TRIPS.—NORTH WALES.

SIR,—I have read with great pleasure several letters in the ENGLISH MECHANIC on the subject of "Tourists' Trips," and I am very glad to see that there is evidently a growing taste in several, for thoroughly seeing the beautiful scenery which abounds in our own country, in preference to taking continental trips. It has occurred to me that an outline of a walking tour undertaken by me, through a part of North Wales, might be acceptable to the readers of the ENGLISH MECHANIC. From Llandudno to Conway, four miles, thence to Bangor, fifteen miles. From Bangor proceed to Beaumaris (only a short distance) by way of the ferry, and then on to Carnarvon (*vid* the Menai Suspension Bridge), passing on the way the Menai tubular railway-bridge. While at Bangor, the tourist should not fail to visit the Penrhyn slate-quarries, distant six miles. From Carnarvon a walk of ten miles brings the tourist to Llanberis, and he then has an opportunity to ascend Snowdon. A capital way of doing this is to ascend the Pass of Llanberis, and climb the mountain by what is called the Capel Curig Path, descending on the opposite side to Beddgelert. Here the tourist has a choice of roads, and the way I chose was on to Capel Curig, a distance of nine miles. While at Beddgelert, visit the pass and bridge of Aberglaslyn, and at Capel Curig the falls of the Ogwen. From Capel Curig to Bettws-y-coed, and thence to Llanrwst. Here the tourist may complete his tour by walking to Conway and Llandudno, thus completing the circle, or he can extend his tour in the same manner I did, by going on to Denbigh, St. Asaphs, Rhuddlan and Abergele, calling, on the way between the two latter towns, to inspect the beautiful church at Bodellwydan.

This tour occupied me about nine days. It would be impossible to enumerate all the objects of interest along the route, but the tourist should provide himself with a guide book, in which he will find interesting notices of every object worth mention.

Several of your correspondents enquire the most economical way of doing a trip; I should suggest to them to stay each night at a good hotel, breakfast there, and then, during the rest of the day, eat and drink when they require it, and where they can get it. Another plan is to take cheap private lodgings at some central town, and from thence make day excursions through the surrounding district. If they wish to do it very cheaply, they must cater for their own eatables, &c., &c., and take a good supply out on each excursion. In the course of a month, I intend taking a walking tour in the lake district of Cumberland and Westmoreland, when I expect I shall adopt the former of the two methods I recommend, with the addition of a good dinner at an hotel each day. Should any reader of the ENGLISH MECHANIC be disposed for such a tour I shall be glad to hear from him, with a view of going together. I have not yet met with a companion, and I think it decidedly pleasanter as well as more economical for two to travel together. My object is merely to enjoy the scenery, &c. I am no artist, botanist or geologist, but an ardent admirer of the works of nature. Should any one similarly disposed address me as below, I shall be glad to give further particulars.

Donington, Spalding, Lincolnshire. B.

[25]

TOURISTS IN SCOTLAND.

SIR,—The many readers of your scientific columns seem to be panting for a little recreation to their *minds*; and no doubt not a few of them meditating a tour, are desirous of knowing where to go. It is a well-known fact that Englishmen are more given to admire the beauties of other countries than their own, or rather, neglect these to attend to others. I have met with men who have been round the world who have never seen the famed Scottish lake-scenery, though born within thirty miles of it. In Scotland our scenery is in many parts very fine, and those of your subscribers who have travelled in many lands without visiting it, will, I am certain, find it compare favourably with other countries in this respect. The Highlands of Perthshire, are, I can conscientiously say, a very charming retreat for the summer months, and to those who are from month to month shut up in smoky cities, will be found to be all that I have stated. I may mention a few towns where capital and suitable accommodation can be had either in hotels or lodgings—viz., Crieff, Dunblane, Blairgowrie, Pitlochrie, and Dunkeld. The drives around Crieff are very lovely; and those who are advocates or lovers of the water-cure, will find a fine hydropathic establishment convenient and healthy. At Dunkeld, the wooded scenery is said to be the finest in Scotland; and the tourist in the summer months can get a four-horse coach running thence to Braemar, *vid* Blairgowrie and Spittal of Glenshee, passing through the beautiful scenery of Craighall, a few miles above Blairgowrie; but I would recommend those who wish to see Craighall in all its grandeur to put up in Blairgowrie for a few days and go through the walks, which is kindly permitted by the proprietor on certain days of the week. I have seen Airlie Castle (the "bonnie house o' Airlie" famed in song), and Hawthornden, near Roslin, but Craighall is decidedly finer than either. At Braemar, the tourist will be within easy reach of the home of our beloved Queen, and can find her sitting in the parish church of Crathie, amongst the humblest of her subjects. I would also mention Drummond Castle, near Crieff, the property of Lord Willoughby D'Eresby, with its magnificent gardens and noble trees. This is the finest place in the county of Perth, and the estate extends to between 30,000 and 40,000 acres. There are also many other places in Perthshire where the tourist can spend an agreeable day; but I will not further intrude upon your space, but conclude by recommending to your readers the Highlands of Perthshire as an elysium for those desiring change of air and a "glorious quiet."

EPSILON.

[26]

THE BOEHM FLUTE.

SIR,—Will you permit me to correct an error which appears to have been made in the ENGLISH MECHANIC of June 10th, wherein you gave a sketch of the "Boehm" Flute. The flute represented is the "Equisonant," which your correspondent "Sable" describes in his letter.

I should like at the same time to remove the impression which, it occurs to me, "Orion" intends to convey by his letter in the ENGLISH MECHANIC of June 17—*i.e.*, that the Clinton flute is being abandoned in consequence of its inferiority to the other instruments he specifies.

In his attempt to do this he makes an unfortunate admission, as two extracts from his letter will show. He says, "I was induced to read Clinton's essay on his flute . . . . . personally I know nothing of it." I fear his reading benefits him little. As to his other assertion, I think he would have some difficulty in producing one instance of the Clinton flute having been "abandoned" after it was once fairly adopted.

That within the last four or five years, the "Equisonant" has to some extent lost ground, I am not altogether prepared to deny; but this is mainly attributable to the death of its talented inventor, who died just as he had perfected his instrument, and might fairly have expected to reap the benefit of the years of study, labour, and expense he had bestowed upon it.

Circumstances have since deprived the flute of that publicity, which in these times is so essential to success, and have given its opponents ample opportunity to depreciate its merits, which, nevertheless, are acknowledged by all who have given it an impartial trial, and which have alone enabled it to maintain its ground as well as it has up to the present time.

JUSTITIA.

[27]

SQUARING THE CIRCLE.

SIR,—I quite agree with the remarks of Mr. H. W. Reveley, respecting the approximatively correct solution of the squaring the circle by mechanical means; but it is open to him to supply a superior method of his own, on the principle of ocular demonstration, as he has thrown no new light upon the subject.

We live in a practical age and we are not up to *ad infinitum*.

ARTHUR GEARING.

[28]

THE BICYCLE.

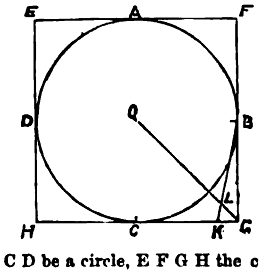
SIR,—J. Hare (p. 309) thinks I was rather hard on the bicycle by calling it dangerous, and informs me that he has performed journeys without a scratch. It was well for him that he had been so fortunate up till that time. That the bicycle with a few minor improvements will be the velocipede of the future, I by no means believe, but that it will have its day like long-sleeved hats and chignons, and then become the bicycle of the past. If J. Hare, or some other practical bicycle rider, will give me information by answering a few questions, I in turn will give an account of experimental advantages and disadvantages of the three and four wheelers (the latter I believe to be the velocipede of the future). The questions are:—Does it require much practice and care to ride without falling on a smooth road? On a bad road I have seen them twist about right and left like a stream of water running down a crooked brook; is that turning about to keep them from falling? If so, and you are in a narrow road, meeting a carriage or wagon, is there a danger of running into the carriage? or falling when turning a sharp corner (perhaps uphill)? is not power over the machine lost, by the crank's being thrown out of proper position? and does the wheel rub the thigh? Is there a danger of thrusting the foot against or through the spokes? In treading the front wheel, sitting so far behind it, is it not like, and to be compared to, sitting in a low chair, placing the feet 18in. forward from the seat, then trying to rise up? Is there a danger, in jumping up when started, of pitching too far back on the saddle and doing yourself a personal injury? Are the accounts to be relied on that we so often see in the papers, of ruptures, &c., caused by riding the bicycle? How do you get it up a steep hill? would it make you dirty to lug it up if it was dirty weather? I took some luggage (10 years ago) on a four-wheeler 52 miles in 8 hours, I should like to know whether any one has done better with the bicycle.

N. G. LAMBORNE.

[29]

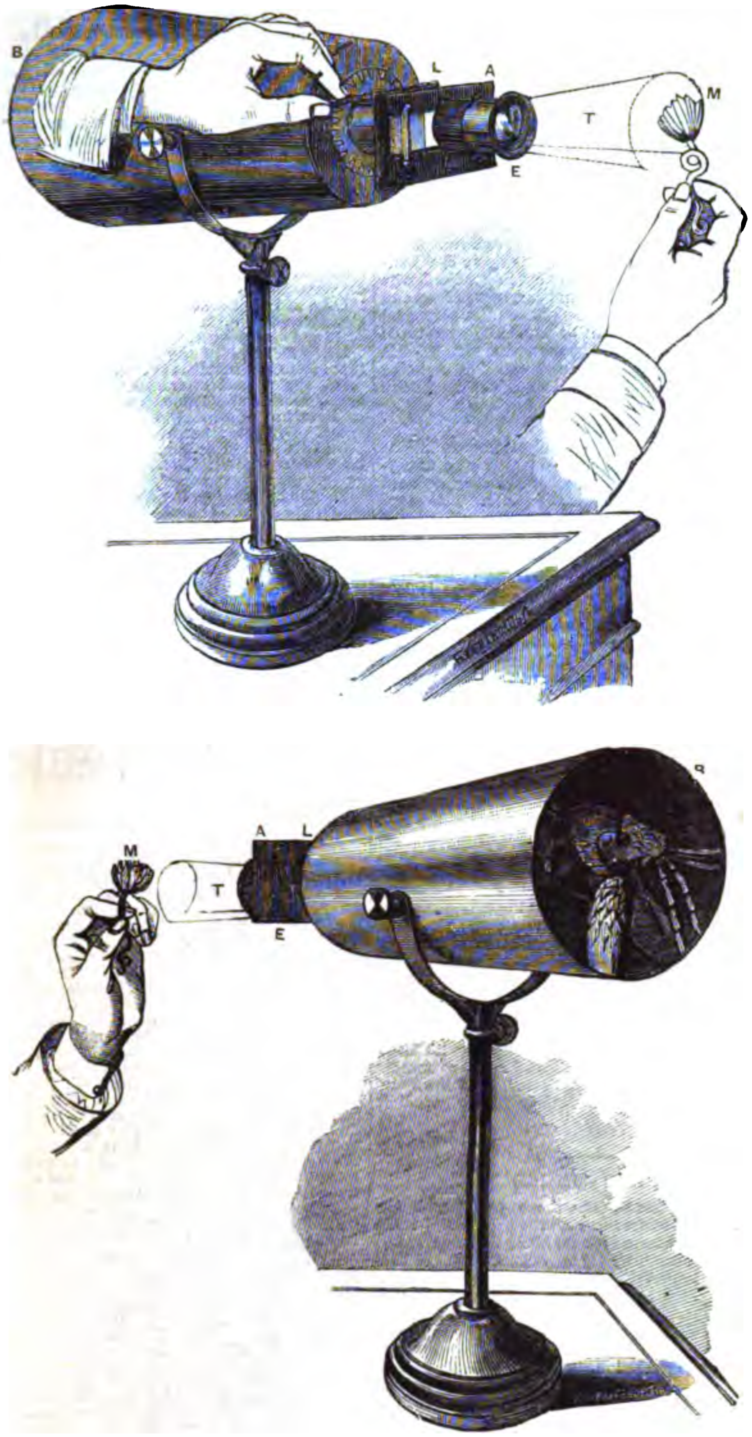
AN APPROXIMATE MODE OF RECTIFYING THE CIRCLE.

SIR,—The following mode of approximately rectifying the circle may interest your subscribers.



Let A B C D be a circle, E F G H the circumscribed square touching the circle in A, B, C, and D. Let K G be one-fourth of C G; and let O G and B K intersect in L. Then, L G H E F is *very* nearly equal to the circumference A B C D.

If the diameter of A B C D be 1ft., L G H E F falls short of the circumference by *about the five hundredth part of an inch.*



THE PHOTOSCOPE.

A correspondingly near approach to the quadrature of the circle follows at once from this.

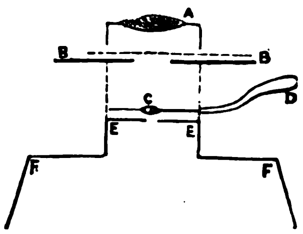
RICHARD A. PROCTOR.

[30]

THE PHOTOSCOPE.

SIR,—I send you an illustration of the pretty optical recreative toy known as "The Photoscope," made in Paris, but which may be procured of Messrs. Cassell, the publishers of the "Popular Educator." It consists of a conical tube, of which the base corresponds with a screen or disc, and is represented by ground glass, and the truncated apex of the cone is formed by the microscopical lenses and focussing arrangement. Fig. 1 shows the whole apparatus in elevation. A B is the conical tube, having the ground glass at the letter B, and the microscope slide-stage at A. In order to illuminate the object, the end of the instrument may be furnished with a reflecting mirror like the Hollander's apparatus. A light tin conical tube, T, open at the bottom, is fitted over the eye-glass at E, when it is desired to project an image of the object in the slide on the ground glass at B. The instrument is either held in the sun's rays so that they impinge upon the attached mirror, or, if the photoscope is shown at night, a piece of magnesium band is ignited at M; and whilst this brilliant light is obtained at M, the figure becomes visible at B if the lenses are carefully brought to focus by the lever at L.

In Fig. 2 the instrument is turned round so as to show the figure (not a *rara avis*) on the ground-glass screen at B. Of course some practice is required in using the magnesium band, and in placing it in the right position. It would be better to use a fixed magnesium lamp, which would prevent the unsteadiness arising from the movement of the hand.



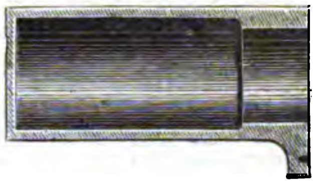
The lenses used in this contrivance are shown in Fig. 3. The lens nearest the eye, or that to which the burning magnesium band is held, is a double convex, and is shown at A. The next is BB, the stage to carry the object, shown by the dotted line. C is a very small double-convex lens, of a short focus, which is moved towards A, or away from it, by the lever D. The diaphragm to reduce aberration is shown at E E, and being a very small aperture, it shows what great care must be taken to get the light exactly in the centre of the first lens, or condenser, at A. This optical arrangement is screwed on to the conical body, F F, which, as already stated, has a circular piece of ground glass fitted into the end B (Fig. 1.)—R. T. K.

[31]

CALLAN'S BATTERY.

SIR,—I should have written on the above subject last week, but I considered the query a personal one, and knowing "Sigma" to be able to answer most of the questions addressed to him, did not wish to trouble you with two replies when one would be sufficient. Finding that he has not heard of Callan's battery under that name, I trust you will find space in your next publication for the annexed description of one which I possess.

Some five years ago I had occasion to vapourize thick metal wires for some experiments I then had in hand, and finding that I should require enormous power, I naturally looked about for the cheapest mode of producing it. Platinum I found out of the question, and I therefore tried the system of Dr. Callan, and had forty round cells made in cast iron, according to the sketch I send herewith, their dimensions being 7in. high and 4in. diameter. Inside this cell I placed an ordinary porous one of large diameter with a rod of thoroughly amalgamated zinc in the centre. The outer cell was then filled with a mixture of equal parts strongest nitric and sulphuric acid, and the inner one with sulphuric acid and water in the proportion of one of the former to seven of the latter.



In order to ensure perfect metallic contact throughout, there were no binding screws throughout, but the wires were amalgated at either end, one being cast into the zinc rod, and the other dipping into a hole filled with mercury, which had been previously drilled in the projecting "lug" shown in the sketch of iron cell.

The reason of my making the upper part of greater thickness than the lower, is this: I found in practice that a great amount of wear took place at the surface of the liquid, and therefore by thickening that part the cell lasted much longer.

Now for the results—the battery being arranged for intensity, I used a copper wire ⅛in. diameter, which was melted *instantly* with the production of a green cloud of smoke or vapour. Platinum wire of nearly 1-16th in. diameter ran into drops, but was not vaporized, mercury gave off a perfect shower of sparks with a slight report, and also such a quantity of vapour that it partially salivated a friend.

In the end I think I may say that it is nearly as powerful as Grove's; but it has the following great defects. While the acid in the outer cell retains its full power all goes well; but as soon as it becomes weakened, the action on the iron is so enormous that owing the ebullition the cell is in a few minutes almost emptied, while the fumes given off are something to be seen and felt before they can be appreciated. I would therefore not advise your correspondent to use it unless he make the cells double the height he requires, and then only half fill the outer one. Even then he will not have half the convenience of either Grove's or Bunsen's.

T. S. CONISBEE.

[32]

MANGANIC SESQUI-HYDRATE.—WATER ANALYSIS.

SIR,—"Manganic Oxide's" query in your issue for the 1st inst. is not very definite, as the principal fact is omitted. On what quantities does he wish to act? A method that will suit perfectly for obtaining a couple of ounces, may be absurdly unsuitable for manufacturing a couple of tons, and *vice versa*.

Therefore I forward him four methods, each of which is meant for operating on a different amount, and to yield a resulting oxide of various purities.

The first is only suitable for quantities not under 16 pounds, and would succeed best with half a hundredweight. In an open, or a reverberatory furnace, the oxide is to be roasted at a bright red heat, with small coal and coke, or charcoal and water, in the proportion of for every 100 pounds of oxide, 8 of small coal, and 5 of coke, or else 10 to 12 of charcoal, and 25 of water. After the oxide is well reduced, a current of steam is to be driven over or through the mass until it is nearly cold, and the whole exposed to the air and kept well wet for some days. Treated in this way, the red manganic oxide yields about 70 per cent. of the manganic sesqui-hydrate.

The next two plans are only suitable for obtaining rough sesqui-hydrate, for laboratory use, and are not suitable for large quantities. The method is as follows:—

Place a mixture of 10 parts of manganic oxide, 2 of small coal, ½ of nitrate of soda, and 5 of water, in a crucible, and raise to a red heat as long as carbonic oxide is disengage. Let it cool, lixiviate with water, wash well, and boil with twice its weight of water, next add five times its weight of sulphuric acid of about specific gravity 1·5, and boil until nearly the whole is dissolved, let it cool, and precipitate with ammonia, wash well, and let it dry slowly. When only a couple or so of pounds is required, this is a very good method.

The next mode is only fit for obtaining a few ounces at a time, and is the following:—A mixture of 10 parts of red oxide, 8 parts of peroxide of manganese, 6 parts of charcoal, and 1 of sodic carbonate, is to be raised to too high, and consequently dangerous, and this high pressure may vary from 1oz. to 600lb on the square inch.—J. H.

[4030.]—HEAD INSCRIPTIONS ON STONE.—The letters are cut deeply, and with the sides as square as possible (the plainer the letters the better) then a strip of cold lead, a little larger than the size required, is laid in, and hammered with a wooden mallet till the incised space is perfectly filled (the hammering requires much care). The surplus lead is then scraped away, leaving the surface quite smooth.—W. H. A.

[4033.]—SLIDE REST.—I called "J. D. L.'s" attention to my letter of October 15, last year, correcting the description given by "Levers or no Levers," of the way of making a worm-wheel; and since that "W. H. N." has given a method in answer to the same correspondent, which is more faulty still than the first. I can say "proved" t• my directions, as I have made many for single threads, and one for double, and one for triple thread, and I know, from having failed without in my first trial, that the notches must be first cut in with a circular cutter in the dividing machine, in order to ensure having the desired number, before they can be finished with the hob or tap, and I am perfectly sure that any one who has tried to do without will say the same. The reason is this:—Say you want a wheel of 120 teeth to work with a screw of ·15in. pitch or 6⅔ threads to an inch, as is the case in my dividing apparatus. This will require the circumference of the wheel to be 18in. at half the depth of the teeth, at which point the diameter will be rather less than 5⅞in. Now for the total diameter of wheel, we must add the depth of tooth —viz., half on each side, which in this case is (say) ⅛in. full, making the total diameter (say) 5⅞in. exactly, and the circumference over all will be 18·457in., giving room for rather over 123 spaces of ·15in. each; so that if we started cutting as "W. H. N." proposes, we should get 123 teeth instead of the 120 that we required—to say nothing of the fact that the teeth would be out of all shape, from the job being commenced with a tap suitable enough for 123 teeth, but not coarse enough by 1-40th of its own pitch for making 120 teeth on that particular diameter. Proved.—J. K. P.

[4034.]—BOAT STEERING.—The power will be increased exactly in proportion to the extra length given to the arms of the yoke.—J. B.

[4040].—WHEEL GEARING.—Bevelled wheels to run well must be cross sections of two cones, whose axes are the axes of their respective shafts, and the apices of the cones therefore at the point where these axes cut each other. One of these cones being given there can be but one of which the side under these conditions will exactly touch through its whole length the side of the given cone. And therefore there can be only one bevelled wheel which will gear properly with a given wheel on the same shafts. Both wheels must be therefore changed to give altered speed.—J. B.

[4054.]—MICROSCOPIC INVESTIGATION WITH POLARIZED LIGHT.—If "H. P." will, with your permission, kindly give his promised hints, I am sure they will be highly acceptable to many of your readers, as well as to myself. Muspratt calls acetic acid "the bane of the brewery;" and a ready method of watching this intruder and instantly detecting his presence would be valuable to me and many of my "great posterity." Acetic acid is specially mentioned (*Circle of the Sciences*, p. 85) as a polarising substance. Perhaps "H. P." would kindly give a handy chemical test for its presence and strength. I find the microscope very valuable, and have ordered a polariscope.—JOHN BARLEYCORN.

[4071.]—DRAUGHT IN BOILER.—Open up the flue running into the chimney and clean all out thoroughly—the larger these flues are the better—and govern the draught by the damper. Will find there is nothing the matter with the boiler in making bad draughts.—J.H.

[4075.]—SOLDERING SOFT METAL.—For soldering soft metal use bismuth, 8 parts; tin, 8 parts; lead, 5 parts. A little mercury will make this more fusible, addition of tin less so.—J. B.

[4077.]—WATER ANALYSIS.—"Aqua" I think expects too much of the volumetric system of analysis. If he will give the names of the solutions obtained from Messrs. Griffin & Sons, I may perhaps be able to answer this first part of his query. He must not expect to be able to estimate the organic nitrogen, carbon, the nitrates, nitrites, ammonia, and albuminoid constituents by using litrated solutions; the nearest approach to what he requires is Wanklyn's process, which is scarcely more than a series of ammonia determinations. For full details of this I refer "Aqua" to "Water Analysis," by E. T. Chapman, 5s. (Trübner), or if he particularly wishes it, I will give an outline of the process.—GEORGE E. DAVIS.

[4063].—CLEANING WHITE CORAL.—Muriatic acid diluted with four times its weight of water will answer the purpose. He must let the coral remain in the solution and watch the effect till satisfactory, then wash well in clean water.—AN OLD READER OF THE MECHANIC.

[4063.]—CLEANING WHITE CORAL.—Place the coral in a running stream for a week or ten days, turning it once or twice to let the stream impinge on the different sides.—J. B.

[4084.]—COMETS.—In reply to the query of "W. R." the following may be interesting:—The comet expected by astronomers is known as D'Arrest's; it has not, I believe, been detected yet. Mr. John Birmingham, of Tuam, and Mr. George J. Walker, of Teignmouth, have both made repeated observations for the re-discovery of the comet, but they have not been successful in their efforts. The position of the comet on the 29th inst. is predicted to be RA, 15h. 27m. 52s. and NPD 77° 59'. On this date it should therefore be situated a little to the north-east of the star Delta in Serpens. The comet, if visible, certainly cannot be seen with the naked eye but only with the assistance of the most powerful telescopes. The comet recently discovered by Dr. Winnecke, is unfavourably situated for observation.—WILLIAM F. DENNING, Hon. Sec. O.A.S.

[4085.]—PERRY'S MICROSCOPE.—"Salopian" is informed that the distance between the lens and object glass is ¼in. The microscope can be had for 30 stamps from the maker, E. Perry, Sherbourne-road, Birmingham. (See advt.)

[4067.]—GLASS PAINTING.—I herewith furnish "Sable" with browns and blue. For brown use flux, which is formed thus: glass of lead, 1lb.; pearl ashes, 6oz.; borax, 4oz.; arsenic, 1oz. This mixture, treated like the one given in No. 12, p. 286, produces a very soft flux, with a strong vitrifying power. Glass of antimony (black). By the mixture of the red and yellow as given (p. 286), a great many browns may be produced. Blue: to the above flux add a sixth or an eighth part of ultramarine, and keep it in fusion till the ultramarine vitrifies. To darken the colour without increasing the quantity of ultramarine, zaffre fluxed with borax may be employed. A deep and very good blue may be prepared by zaffre, 1 part to 4 parts of either flux with a little borax. Vitrify the mixture in a strong fire, and prepare it for use by levigation. A strong body of this colour will give the effect of blackness. For a weaker blue, the quantity of zaffre must be diminished. As I do not know where "Sable" resides, I cannot say where he can get them, only at any respectable chemist's.—D. F. ASHTON.

[4087.]—RAILWAY GUARD'S WATCH.—A good English "frame" lever is the best watch anyone can have for keeping time; the "three-quarter plate," though more expensive, does not go better, and anything worth having will cost £5 and £6. Persons who do not mind going to a little more expense to be sure of a good watch, and always perfect time, can get one with a compensation balance, rated, for £8 to £12. These are all in silver cases; they can be had in gold for about £6 more. I do not enclose a diagram, as it would be impossible for any one not acquainted with watches to tell a good from a bad one. The holes absolutely necessary to be jewelled are five in number—both the balance holes, always jewelled in every watch, both the 'scape wheel holes, and one fourth wheel, or seconds hole. It is a mistake to go to a jeweller's or silversmith's either to buy or to have a watch repaired, especially a person to whom money is an object. I speak to those who wish to possess, and to those who value, a good watch, and with no intention to injure anyone. The reason is obvious, it takes at least ten years at the bench to become a good workman, not a thorough one. The less jewellery in a watchmaker's "show" the better the workman, and I may as well include Dutch and American clocks, and cheap watches in the same category. Not that good watch-makers do not keep such things, but because they will rather be found inside the shop, or perhaps hidden quite out of sight. They are acknowledged only to prevent the loss of a sale or a possible customer. It is needless to say these remarks apply only to London and the larger towns. In the country watchmakers are everything,—"umbrellas to mend," teapots, and even opticians.—NOBODY.

[4095.—SILVER COIN.—I made a mistake in reading on the sketch KAROLUS REX. FR., Mr. H. W. Henfrey is quite right reading RICARDUS REX.—BERNARDIN.

[4113.]—PHOSPHATE OF LIME.—This valuable substance is used to a large extent as a manure; is known also as "coprolites," and is found in the tertiary beds of mountainous districts, such as Norfolk "Crag;" but before using, it is usual to purify it by the addition of sulphuric acid, which liberates a portion of the phosphoric acid—under the influence of which part of the bone-earth is rendered in the form of tolerably pure superphosphate of lime. The use of this as a manure is to keep up the supply of mineral matter in the plants. If these mineral bodies be present in the ground in small quantities, and if fresh crops be continually carried off without provision for the return of matter so removed, the land will, in process of time, become exhausted, and sterility will be the inevitable result. It is now well known to the practical farmer that the superphosphate, when drilled in judiciously with the turnip seed, stimulates the growth of the plant in the earliest and most critical stage of its existence, and in this manner secures a far more abundant return than when the supply is omitted. Phosphate of lime is used also in medicine, and is obtained chemically pure by the following process:—burnt bone or animal charcoal is put into large pans, and hydrochloric acid is added in the proportion of about 15 gallons for every cwt. of charcoal employed, then the pans are filled up with water and stirred daily for about a week; the charcoal is then allowed to settle and the liquid drawn off into a suitable vessel, and common soda is added, until it no longer occasions a precipitate; this is allowed to settle. The liquid, which is a solution of chloride of soda or common salt, is drawn off and the precipitate repeatedly washed with water, until the presence of hydrochloric acid cannot be detected by nitrate of silver; it is then strained to free it from the water as much as possible, pressed and dried, and is then ready for the market. The charcoal which is left in the pans furnishes (after washing) animal charcoal—pure for organic analysis. Phosphate of lime is taken as a medicine principally in the form of "syrup of the hypophosphites," and is used where disintegration of the human frame exists.—A. E. TUCKER.

[4114.]—METRICAL ACT.—Not having the statutes at hand I cannot speak with certainty, but I think that the Metrical Act passed in 1864 or 1865. In reply however to "Inquirer" and to "Blacksmith" (page 331), I give the subjoined tables of equivalents between French and English weights and measures from the "Engineer's Pocket Book":—

Measures of Length.

Millimetre = 0·03937 in.
Centimetre = 0·393708 in.
Decimetre = 3·937079 in.
Metre = 39·37079 in.
= 3·2808992 ft.
= 1·093633 yds.
Kilometre = 1093·633 yds.
Myriametre = 6·2138 miles

Superficial Measure.

Square metre = 1·196033 square yards.
Are = 0·098845 rood.
Hectare = 2·471143 acres.

Measures of Capacity.

Litre = 1·760773 pint.
= 0·2200967 gallon.
Decalitre = 2·2009668 gal.
Hectolitre = 22·009668 gal.

Weights.

Gramme = 15·433 grains [Troy.
Do. = 0·643 dwt.
Kilogramme = 2·679 lb. [Troy.
Do. = 2·205 lb. [Avoirdupois.

Any bookseller will procure from the Queen's printers a copy of the Metrical Act, with table of statutory equivalents, for a shilling or less.—J. B.

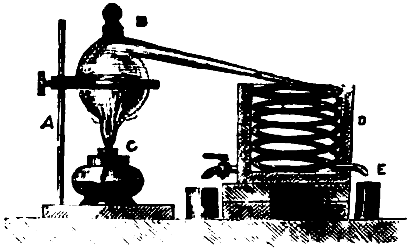
[4115.]—TROPICAL FIBRES.—The book in question has for title "Tropical Fibres: their Production and Economic Extraction, by E. G. Squier, formerly Minister of the United States in Central America. London: Sam. Madden & Son, price 6s. I wrote to the firm, Sam. Madden & Son; but my letter returned with the words "unknown." If I can get the book I will give, in another number, some more particulars about it.—BERNARDIN.

[4116.]—AIR-STRUNG PUMP.—If "Coal Miner" will take his pump out, or rather the pipes that are in the water, he will find that the short pipe, which is called the blast hole piece, is what is called blast hole tight: that is, all the holes, or nearly so, are more or less choked up with dirt, so that the water will not enter fast enough to follow the bucket in its upward stroke. Perhaps "Coal Miner" is not aware that when the bucket decends in the pump barrel, the greater part of the air which lies between the bucket and clack is forced through the bucket valve, provided the clack is air-tight, and consequently there is a partial vacuum or empty space, the atmospheric pressure pressing upon the top side of the bucket, so that if it is only a 3in. pump there is 136lb. nearly, additional weight to be lifted at each upward stroke of the bucket. The blast hole piece is usually a short pipe, perforated with a number of holes at the sides, with a wood plug driven into the bottom end. Sometimes they are put in without a blast hole piece, with only a plain pipe open at the end instead. If the blast holes are air-tight, the water will not ascend through the clack sufficiently to counterbalance the atmospheric pressure.—BELL VALVE.

[4117.]—BULLION IRON CEMENT.—William Hall, of Bourne Brook, near Birmingham, can supply "R. G. B." with the above.—LLAH.

[4120.]—FLY PAPERS.—Sugar and water, in which, bits of quassia bark are soaked is the best thing to destroy house flies, as the bark is poison to them.—J. B.

[4122.]—DISTILLED WATER.—"Moses" should use an apparatus for distilling water similar to the engraving,



and of which the following is a description. A is a retort-stand, B a retort, an d C is a spirit lamp or any other convenient heating apparatus, D is a vessel containg a small spiral tube ending in E. When in use, the beak of the retort B should be luted in the end of the spiral, and the tube D filled up with water, which should be frequently changed. The distilled water is discharged at E.—WALTER J. NICHOLLS.

[4122.]—DISTILLED WATER.—If "Moses" wants any quantity of distilled water, he will find the old saucepan of no use. The best plan is to drill a hole in the top of the kitchen boiler and fix in it a gas pipe, carry it through a cold water tank, if one is near, or a bucket, which he must keep filled, and he will find his wants supplied without further trouble. He must arrange his pipe so that he has no lodgment of water in it, and the highest point must be above the tank.—M. W. G.

[4123.]—SOLDERING BRASS.—Nothing better than Dr. Burnett's disinfecting fluid—*i.e.*, chloride of zinc. —J. B.

[4123.]—SOLDERING.—I always solder brass with the ordinary flux (hydrochloric acid killed with zinc); can give others if required.—CURRENT.

[4126.]—DAMP WALL.—If the wall will not hold pasted damp-proof paper, tack it to the plaster and paste the ordinary paper upon it. The damp-proof paper can be bought at the paper-hanger's.—LLAH.

[4126.]—WALL PAPER.—Wash the wall before papering with two or three coats of shell or seed lac dissolved in naphtha or methylated spirit, till a slight glaze appears on the face of the plaster showing that it will not absorb more.—J. B.

[4128.]—WATCH-MAKING.— beg to inform "Compensating Balance" that the jewels are fixed into watch plates by being fitted into brass settings of their own, and *they* are fitted into the plate, and kept in their place by two or sometimes three small screws. I think that it would be a difficult thing for any one to do, without the apparatus and the practice of a watch jeweller. With regard to the magnetic balance, I am sorry to say that there is no cure but to put a new one, and also a new pendulum spring. I am not aware of any means of destroying the magnetism of a piece of steel except by making it red-hot, which of course would spoil a watch balance.—HENRY CHAPMAN.

[4129.]—FISHERMAN'S NETS.—For garden, take a hank of sailmaker's twine, rub about half an ounce of common fat on it, then dip it in Stockholm tar, put one end over a pin or nail, and put a stick through the other part, and twist it until all the tar is squeezed out of it, but see that every part is coloured; then ball it off same as worsted, and fill your netting needle (this you can make). Now stretch a piece of stout whipcord along for headline, same length as net required, and begin at the right hand, and work towards the left, forming a clove-hitch with the twine round the cord, every inch for size of mesh (Fig. 1), then form a second tier of mesh by passing the needle up through the last mesh, now toward the right hand, underneath, over, and under its own part (see Fig. 2). Draw it tight and regulate the size of the mesh by the fingers of the left hand. But a better net for a garden would be what is called a diamond

FIG. 1.

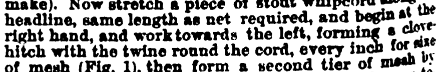
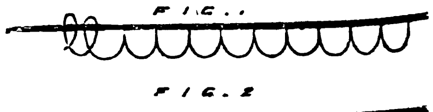


FIG. 2



net, the same as ships have worked round their "poop," made from stout whip-cord or ratlin line. Put two iron bolts horizontal, as far apart as length of net required, bearing in mind that when finished and seized into its proper place, it works up one foot in every ten, make one end of the line fast to one of the bolts, and pass it over the other bolt, until you have got as many parts as width of net required—all this to be stretched perfectly tight, and all the parts close together. Take a rule and chalk, and mark the place for the seizings, or tyings, tying every alternate two with twine. Suppose you wanted a net which when done, was to fill up a space 30ft. long, by 24in. wide, and the size of the diamonds to be 6in. by 3in., then the length between the bolts should be 33ft. and the number of parts of line on stretch nine, and the distance between chalk marks for seizings 3in.—W. W. **Larkin**, Scarborough.

[4130.]—FERN CASE.—If the design is too heavy, cut the legs off level with the top of the box and screw into each a length of ⅜ iron gas pipe, and get a light metal rib made to go round the top, which can be screwed to the top ends of the tubing. The clumsiness depends on the style of work; mine is as light and elegant as a case needs to be.—T. **Fletcher.**

[4133.]—SIDEREAL TIME.—If "W. H. C." is in possession of a transit instrument he will find little difficulty in setting his clock to exact sidereal time, and ascertaining its performance. What he will have to do is to make it work 0h. 0m. 0s. at the instant of the passage of the first point of Aries, or the intersection of the ecliptic and equator, over his meridian, and to ascertain whether it continues to do so or not day by day, and if not what is the variation. The passage of the commencement of Aries itself does not admit of observation, as there is nothing to mark its position in the heavens; but "W. H. C." will find in the "Nautical Almanac," or in "Dietrichsen and Hannay's Almanac," a list of stars whose right ascensions have by continual observation been very accurately determined, and as right ascension is nothing more than the distance in time from Aries, he may observe one or other of these stars instead of that point. At the instant of the passage of the star chosen for observation over the middle wire of his transit, the time by the clock supposed to be going should show the right ascension of the star. If it does not, the clock must be altered by the difference. He will no doubt have been able to set his clock so that this difference shall not be very large. After he has in this manner brought his clock into some accordance with the heavens, he may, by comparing the time which it gives with the right ascensions of several stars taken from the almanac, obtain a difference for each object, and the mean of those will give the difference on sidereal time for any instant, called the "clock error." The daily sidereal loss or gain, *i.e.* the "rate," may be ascertained by a comparison of the errors for different days. Having found the "clock error" and "rate," he may if he pleases correct his clock for both—for the first by moving the hands, and for the latter by the means provided for regulating it, but if they are small he will perhaps find it better not to alter the clock, but to allow for them as a correction. If "W. H. C." is not furnished with a transit instrument, he may perhaps contrive some substitute for it, such as the smooth edge of a board placed accurately perpendicular and at some distance due south of a small hole in a metal plate. With his eye at the hole he may observe the stars as they disappear behind the board, or, if he likes to arrange it so, as they pass from behind it.—**Henry T. Vivian.**

[4134.].—STAINS IN CLOTH.—"H. A." can take the stains out of his cloth with liquid ammonia, by applying it to the red spot. A small quantity is sufficient.—J. M.

[4134.]—STAINS IN CLOTH.—"H. A." can remove the red stains that he speaks of by ammonia or any other strong alkali, the object being to decompose the organic salt (sulphate of picrine, I believe) which is formed by the sulphuric acid combining with the materials of the cloth.—A. E. **Tucker.**

[4137.]—BRAZING BAND SAWS.—"Subscriber" must bring the two ends of the saw close together and fasten them, then take a small pan of charcoal and place it under the ends, and then direct the flame of a blowpipe upon them. The ends will soon become red hot, when sprinkle some borax (powdered) upon them, and then add your solder with a piece of iron. The way to make the solder is to melt 8 parts of brass filings and 1 part of silver in a crucible, and this when poured out must be filed away and the filings put into a solution of sal ammoniac in water. When wanted for use this must be taken out with a piece of iron rod and laid on the ends of the saw until melted. When the ends are firmly united and quite cool you may file off the superfluous solder. I do not know that this is the best way, but it is the way I have always seen it done.—F. W.

[4141.]—ELLIPSOGRAPH.—I have an instrument such as Thomas Smith wants, which I made in 1857, and sent a sketch of to the *Engineer*, on November 7th that year, and it appeared about a fortnight after in that paper. It is exactly suited to isometrical drawing, as there is only one adjustment—viz., an expanding crank for any sized ellipse up to 8 inches, so long as you do not require to alter the proportion between the axes, and you can strike the complete oval without moving the instrument. I have not time to make a drawing of it just now; it is rather troublesome and expensive to make.—J. K. P.

[4145.]—OIL VARNISH.—The best varnish for oil paintings is made of mastic and turpentine. Copal varnish is more durable, but the mastic varnish is more commonly used, as it can be removed and renewed with less risk to the picture. A warm dry atmosphere is absolutely necessary for the successful varnishing of a painting, which should be thoroughly dry to prevent any subsequent cracking.—**Digamma.**

[4146.]—BOOKS ON PRINTING.—A "Young Printer" will find Houghton's "Printer's Practical Everyday Book" to answer his purpose best. It is a foolscap 8vo., of 150 pages, which makes it very convenient for the pocket; and considering the amount of really *practical* information contained in it, 3s. 6d. is not too much for it. It may be had of the author, Lily Bank, Tulketh-street, Southport. There is another, published by Mr. Crisp, of the *Independent*, Yarmouth, about the same price. If not already a subscriber, I would strongly advise him to send at once three stamps to 3, Bouverie-street, London, E.C., for a specimen of the "Typographical Dictionary," at present issuing with the "Printer's Register." It and the "Register" are only 2d. monthly; and the "Dictionary," when complete, cannot fail to be of the utmost service to all "Young Printers."—T. **Johnson.**

[4147.]—COIN OR MEDAL.—"Exergue's" coin is one-third of a farthing, coined for Malta in 1827.—**Henry W. Henfrey**, M.N.S., &c.,

[4149.]—ELECTRICITY AND EPILEPSY.—It is exceedingly unlikely that electricity can do any good in this disease, nor can medicine do more except by attending to the general health. Epilepsy is either due to an organic defect in the brain, derived from ancestry, or in some cases to the formation of a "cyst" or parasitic inmate within the head; and in neither case can any direct influence be exerted: good food, proper air and exercise, and cleanliness, are the only agents.—**Sigma.**

[4150.]—BOILER FEEDING.—"The Giffard Injector" is considered the best substitute for the force pump; detailed in our **Mechanic**, Vol. X., No. 240, Oct. 29, 1869.—J. H.

[4151.]—ORCHIS.—The orchis described is most likely "Orchis Fusca," which is larger than "Orchis Ustulata," but sometimes hardly distinguishable from it. —**Tressilian.**

[4153.]—COLOURING IRON WIRE.—"A. E. O" can colour his iron wire, which must be bright and clean, with green lacquer, by heating the wire on a stove and dipping it in, if it is in the bundle; if not, he could use a brush; he will find this give it the required brass colour. Pins are coloured by boiling them in tin shavings and cream of tartar in water, which gives them the white colour.—J. M.

[4154.]—STEEL PLATE.—"H. W. H." must put his steel plate in quick lime, pounded very fine. This will keep it for many years if it is put in a dry place.—J. M.

[4154.]—ENGRAVED STEEL PLATE.—The best plan for "H. W. H." to preserve his plate is to let the wax stop on it, and keep it in a dry place.—**Peter Pindar.**

[4155.]—LANTERN LENS FOR PHOTOGRAPHY. —It is not only possible to use the same lens for portraiture and magic lantern, but easy to accomplish. I am doing the same thing he wishes to do. First obtain the focal length of the lens, then place a picture in the lantern; with the rack-work move the inner fittings containing the lenses to the centre of the outer fitting, measure from the picture to the centre between the two lenses, the same distance as the focal length, make the nozzle of the lantern the length to receive the lense at the distance just obtained. For price of lens see the sixpenny sale column.—W. H.

[4158.]—WATER PUMPS.—Rule to find the number of gallons a pump will lift per minute. Square the diameter in inches, and multiply by length of stroke in inches, and by ·002833, and by the number of strokes per minute. 8 × 8 = 64 × 10 = 640 × ·002833 = 1·813120 gallons in each stroke, × 20 = 36·262400 gallons per minute.—J. H.

[4159.]—VINEGAR.—"E. H." may prepare a very good vinegar for domestic purposes by adding to each gallon of syrup composed of 1½lb. sugar, and 1 gallon of water, a quarter of a pint of yeast. If kept for three days at a temperature between 77° and 86° (25° and 30° Cent.), it will be sufficiently acetified to allow of being drawn off into the ripening cask, where 1oz. of bruised raisins and 1oz. of crude tartar are to be added to each gallon of liquor. When the sweet taste has entirely disappeared, it should be drawn off into bottles and corked down tightly. It is stated that such vinegar will contain as much as 5 per cent. of pure acetic acid. From 2 to 3 per cent. is the average strength.—A. E. **Tucker.**

[4160.]—KILLING MOTHS.—"J. C. S." will find "Benzine Collas" answer his purpose. The insect to be killed should have some poured on it, when death is almost instantaneous. The benzine seems at first to destroy the colour; but on evaporating, which it does in a minute or two, it reappears. I have collected for five years, and never use any other poison. N.B.—The benzine sold for burning will not do.—A. S. C.

[4160.]—KILLING MOTHS, &c.—If your correspondent, "J. C. S.," will drop his moths and other small insects, which he intends to preserve, into a jar of carbonic acid gas, he will have a most certain plan of keeping them entire and perfect; besides that, the insects are not tortured, as they are killed instantly. By keeping the carbonic acid gas in a stoppered bottle it will last him some time, so that he will not require to make fresh every time. Any respectable chemist will supply a jar of gas or the material for making it for a trifle.—**Dragon Fly.**

[4160.]—KILLING MOTHS, &c.—The quickest and best method of taking the life of an insect intended for preservation is as follows:—Frame a tin or metal box air-tight and water-tight suited to the size of the insect, having carefully placed the insect inside, float the box on the surface of boiling water, the heat generated inside will suffice to speedily and mercifully kill the insect. After the lapse of a few seconds the struggles of the insect will cease, take the box off the surface of the water, dry the outside of the box and proceed to set the insect in the usual way. After the insect has remained for a few days undisturbed, remove the braces and pins, and I defy any one to preserve insects better than by this mode. To re-set insects badly preserved, obtain a fish globe, place some silver sand at the bottom, damp it, pour off superfluous water, take some blotting paper, press it on the damp surface of the sand until it likewise becomes damp, place the insect to be re-set on the surface of the damp blotting paper, then get a cloth, thoroughly wet it, squeeze all the water you can out of the cloth, fold it into several thicknesses, cover the mouth of the fish globe, and having tied it round, place a plate on the top of the globe to prevent evaporation, after the lapse of 24 or 48 hours the insects will have become relaxed and can be set afresh; but they must be set directly they are removed from the globe as they dry very rapidly. The latter part of these instructions do not strictly relate to the question asked, but I have added them, thinking that to the uninformed they would prove useful.—G. F. **Smith.**

[4160.]—TO KILL MOTHS.—Drop a little chloroform on blotting paper and place it in the box where the moth is; this prevents pain (if insects have feeling), afterwards stab, with a bone blade dipped in prussic acid, the thorax. This will entirely destroy life at once.—T. J. C. C.

[4163.]—LEAD STICKING TO STEEL.—"Anon" will find that if he blackleads his steel before hardening it, the lead in which he hardens will not adhere to it, as actual contact will be prevented between the lead and the steel.—**Henry Chapman.**

[4165.]—ASTRONOMICAL.—T. Round, Handsworth, may convert heliocentric latitude and longitude (L and l) into geocentric (L′ and l') by means of the following equations:—

$$c = S + 180^\circ - l$$

$$\text{tang}\ \theta = \frac{R \cos L}{r}$$

$$\text{tang}\ \phi = \text{tang}\ (\theta - 45^\circ) \cot \tfrac{1}{2} c$$

$$e = 90^\circ + \phi - \tfrac{1}{2} c$$

$$\text{tang}\ L' = \frac{\sin e\ \text{tang}\ L}{\sin c}$$

$$l' = e + \epsilon.$$

L, l, and R, the distance of the planet from the sun, and S and r, the sun's longitude and the radius vector of the earth, are supposed to be known quantities. L, l, and the log. of R may be found from the planetary tables for any given time, and S and the log. of r are given in the "Nautical Almanack" for every day in the year.—**Henry T. Vivian.**

[4168.]—THE VALUE OF A TESTRIL.—In answer to "B.," I think that the word Testril in the passage of Shakespeare referred to is only another version of "Tester," viz., a sixpence. Further, sixpences are mentioned in the preceding lines, and this line says "a Testril *also*."—**Henry W. Henfrey**, M.N.S. &c.

[4169.]—RUST JOINTS.—Take one of sal ammoniac in powder (by weight) two flowers of sulphur, eighty iron borings, made to a paste with water, to set quickly.—J. H.

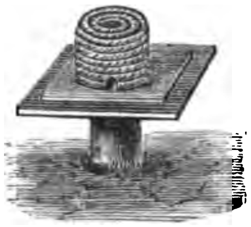
[4173.]—CLEANING GALVANIZED VESSELS.—The simplest plan is to scour them with a strong solution of hot water and common washing soda; but I should recommend your correspondent to have the vessels painted, or if used for hot water and soap, to use best tinned vessels, as galvanized iron attracts soap in such a manner as to cause this deposit, which is disagreeable and unsightly. —**Peter Pindar.**

[4175.]—OLIVER CROMWELL'S SHILLING.—The ordinary shilling of Oliver, dated 1658, with the obverse inscription "OLIVAR. D.G. R.P. ANG. SCO. HIB., &c. PRO.," is worth from one guinea to two guineas. At the sale of Mr. Duncombe's cabinet, June, 1869, one in splendid condition sold for £2.—**Henry W. Henfrey**, M.N.S., &c.

[Mr. Batty values it at from 12s. to 30s.]

[4176.]—CALLAND'S BATTERY, Etc.—The first part of this question I have already dealt with. The other I cannot reply to.—**Sigma.**

[4177.]—BEES AND BEE KEEPING.—"Anon" is sorry that he cannot give a more precise address of the publisher of Payne's Bee Book than Paternoster-row, the price he thinks was one shilling. Probably Mr. Neighbour of Regent would be able to give more precise information, as "Anon" well remembers Mr. Payne speaking of that house. The additional box, or glass, or straw hive, called by whatever name it may, should have no entrance hole in it. Any old cigar box, or American cheese case, or butter keg, capable of holding from 5lb to 20lb may be used. If "Anon" had not mislaid Payne's book he would willingly have given it to "Apiator"—there is nothing like it for simplicity. Mr. Payne conceived it better that the hive should have a board under it distinct from, and not fastened to, the board which is nailed on any old stump, as by this means the hive could with ease be bodily moved from one place to another. The hive must be quite flat at the top, and not fastened down with mortar: the bees do that part of the business themselves.



[4182.]—GALVANOMETER.—If "T. B." will refer to Vol. IV., p. 149, and Vol. VI., p. 494, he will find a mode of making a galvanometer. If these do not suit him, I will give him full details for making a galvanometer, needle instruments, &c., through the columns of the **English Mechanic.** The following references relate to galvanometers:—Vol. IV., p. 6; Vol. IV., p. 199; Vol. VI., p. 155, 177, 494, 495; Vol. VIII., p. 59; Vol. IX., p. 179.—**Current.**

[If all readers were like "Current" we should not be so often required to repeat information previously given.—Ed. E. M.]

[4185.]—SILVER COIN.—In reply to "H. R. G.," his coin is a silver consular denarius of the Roman family of Lucretia. *Obverse*, helmeted head of Pallas; X. (for the value) in front, and TRIO. *Reverse*, Castor and Pollux on horseback with lances in rest. Underneath, CN (*eius*) LVCR (*etius*), and in the exergue ROMA. This coin was probably struck by Cneius Lucretius Trio, moneyer to the Republic in B.C. 219. Common: value 2s.—**Henry W. Henfrey**, M.N.S., &c.

[Mr. Batty has also kindly answered this.]

[4188.]—SOFTENING ASH TIMBER.—Steam is the usual agent, but where practicable boiling in water is the very best means. The great thing is to have the right quality of ash: some kinds will bend, some won't. One locality will yield prime ash, another close by, with equally good soil, will yield inferior. The timber should be heavy, tough, and cut from a good butt; no matter if three years cut and seasoned. A splinter from this quality of ash will peel or pull off toughly, and run a long way down the plank before it gives way. Half-an-hour's boiling will soften 2in. square. Then have everything ready, for sharp is the word. Out with your stuff, from the boiler to the mould, and screw or wedge it up without "stop stay, or hesitation," and leave it to cool for a few hours. If "J. L. B." fails again he may blame his timber.—**Paddy.**

[4189.]—CONDENSER.—About fifty sheets of tin foil, of the suitable size to the stand, would probably answer. The quantity varies according to the battery power used, and this with the quality of the insulation. "Electron" had best try by commencing his condenser and watching the action as he adds sheet after sheet. The size of the Bunsen cell used is of little consequence so it is sufficiently large for his wire; it is the number in series that is of importance, as this supplies the force for raising the tension, and this must depend entirely on his insulation, and may be from two to six cells.—SIGMA.

[4192.]—CUTTING GRANITE.—I had a piece of granite to cut and polish, very little larger than the piece he wants, and I got a piece of sheet iron, and with the aid of sand and water cut five sides while it was on the block as true as I could to the size I wanted. I then sawed it from the larger piece, and let it into a piece of soft stone. Then I got a small slab of Robin Hood or Hare Hill York, and rubbed until it was quite smooth, and then got a piece of snake stone and a little putty powder, and rubbed until it was quite hot, and gradually a fine polish came on it, though it took a great deal of time and patience. Perhaps "Chemicus" may live nearer a place where they polish granite by steam power—if so, he can no doubt get it done cheaper and better that way.—J. W. G. S.

[4195.]—SENSITIVE FLAMES.—I fear that a satisfactory answer to "F. W.'s" query would occupy more space than should be allotted to one reply. The only apparatus "F. W." will require consists of—1st, small glass tubes (open at each end,) ranging in length from 10in. to 40in., and in diameter from 5-10ths in. to 1¼in.; and, 2nd, a series of small jets (differently sized orifices in a metal pipe will serve the purpose) capable of giving a small flame of adjustable height. "F. W." has simply to place the tube over the flame and proceed to experiment. He has to bear in mind that the size of the flame, and length and diameter of tube, have their influence over the result, and that he cannot expect to succeed in obtaining "grand" results at the onset. Further information can be obtained from Dr. Tyndall's lectures on "Heat—a Mode of Motion," p. 254 (last edition.)—H. P.

[4198.]—GAS COOKING.—We often bake bread with the oven as sketched, but it hardly pays, as will be seen from the following comparative consumption of gas for different purposes. Bread, 8ft. of gas per lb. weight; meat, 1ft. to 1¼ft. of gas per lb. weight; small fruit pie, 2ft. to 2½ft. of gas per lb. weight; large pan of potatoes, 2ft. of gas per lb. weight; to boil water, 1ft. to 1½ft of gas per gallon. To keep 1 or 2 gallons of soup or stew boiling steadily, 1ft. of gas per hour; toasting bread, about 2ft. of gas for 8 large rounds; boiling eggs, ½ft. of gas The above are from careful experiments with a meter registering small quantities of gas, for the purpose of testing the comparative cost with coal, and the result has been that the fire has been entirely discarded for several years. In fact, we have been in two houses and have never used the oven once. All our cooking is done on the kitchen dresser under the window, without any trouble or dirt.—T. FLETCHER.

[4201.]—RED LEAD.—The dry red lead draws in the oil if made up quickly, and seems to dry. Oil must be added till this tendency is overcome.—J. H.

[4201.]—RED LEAD.—"Staem" could keep his red lead soft by putting it in a jar that has got an air-tight stopper, same as colour tubes.—J. M.

NOTES AND QUERIES.

[4203.]—PARIS.—I wish to go to Paris for a fortnight. Can any one who has been inform me as to the best way of proceeding so as to see the place in as complete a way as possible, and not be too expensive? I should start from London with one or two companions.——PEREGRINE.

[4204.]—DRAWING-PEN.—I am aspiring to become a draughtsman, but find great difficulty in using the drawing-pen. After making perhaps half a dozen strokes the ink collects above the pen points, and I cannot produce a stroke. I have Indian ink at 8s. the ounce, and a good pen. Will any of your numerous readers give me a few hints as to the management of the drawing-pen, and kindly inform me whether there is any medium that could be mixed with the ink to cause it to flow freely, though not so as to blot the paper?—T. M.

[4205.] — NAVAL ARCHITECTURE. — Thanks for information obtained respecting my query, but I think there has been a slight misunderstanding. I applied at South Kensington previously to my writing to you, and was informed that it was no use my attending only in the evening, and my business does not permit me to go at any other time. The fee also being £30 for a course of four years, no artisan has a chance of going there. Could any reader tell me of any other class that meets in the evening only, or where I could gain any information respecting any?—G. E. J.

[4206.] — CHROMATIC FAIRY FOUNTAIN.—Could you or any of your numerous correspondents give me the details of the illuminating portion of the Illuminated Chromatic Fairy Fountain, with the mode of producing various colours?—JET.

[4207.] — BLACK DIAMONDS FOR DRILLING. — Will any brother reader inform me where I can procure black diamonds for drilling?—W. MORTON.

[4208.]—ADULTERATION.—Knowing the interest you take in the purity of articles of food, perhaps you or some of the contributors to "ours," could inform me how I might get examined a sample of tea (so called), just purchased in this neighbourhood. It contains a large quantity of positive dirt and dry twigs—very few grains of tea to be seen. Could I acquaint the authorities with the subject in any way?—J. MOODY.

[4209.]—WATER-WHEEL.—Will any of your readers inform me what description of water-wheel I could have erected, and what power could be obtained from a 8in. supply pipe (without pressure), and only 5ft. fall from pipe to drain below. Also what size wheel and diameter of pipe would be required for 10-horse power. Is the turbine better than the ordinary water-wheel?—J. BOYD.

[4210.]—SIGN WRITING.—Would any of our correspondents give me information upon sign writing?—BRUSH HAND.

[4211.]—SILICA, OR WHITE FLINT.—Can any of my brother subscribers inform me where I can obtain the above?—W. W.

[4212.]—VERNIER.—What is the simplest and most useful kind of vernier for dividing the 5′ spaces in an hour circle of an 8½in. equatorial? How can such a vernier be made, and how ought it to be fixed? Also one for the declination circle of 16½in. span. If some kind friend would give a short paper with instructions how to set an equatorial with regard to N. and S. management of the verniers—levelling with respect to E. and W.—how to regulate and manage a sidereal clock, &c., he would, I am sure, bestow a great favour on ignorant "beginners" like myself.—H. A. C.

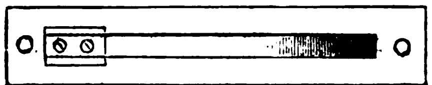
[4213.]—WITH'S REFLECTOR.—At what distance from the sun ought an 8½in. "With" reflector to pick up Jupiter, Mars, Mercury, and Saturn?—H. A. C.

[4214.]—TACKLE FOR SALMON.—As I think of taking a holiday in the highlands this autumn, I should like to have some advice as to the kind of tackle to take for salmon-fishing. I should like to set about making a rod, if anyone would give me a few ideas as to the matter. Will any of your readers oblige me so far?—DONCASTRIAN.

[4215.]—COLOURING TILES.—I should feel much obliged if any of your correspondents can tell me how I can colour red roofing tiles (after they have been burnt) so as to give them a dark brown or blue colour, and to so fix in the colour permanently by acids, or otherwise, that it will not wash off with the rain. The process should not be difficult or costly.—A SUBSCRIBER.

[4216.]—THE STAR ζ.—Is the star ζ (Sigma 2084) Hercules divisible with an 8½in. "With" reflector at the present time?—H. A. C.

[4217.]—HARMONIUM REEDS.—I am building a small harmonium on the vertical principle, for my own use, with two rows of vibrators. My wind chest is divided into four compartments, to represent four different instruments. I have one row fixed which represents bassoon and hautboy. These reeds are made by Esteve, Paris, and speak well. This is the size of lowest note, CC—8 feet value. Now I shall esteem it a great favour if our good friend "Elève," or the Doctor, will advise me what reeds I should use for the other row that will harmonize with those I have fixed, and that will be very soft and not take up any more room. I should like to use the reeds that represent flute and cor-anglais, but the reeds generally used are too large for my instrument.—W. D.



[4218.]—LEVEL.—Will any reader of our valuable paper be kind enough to inform me how to fix the tube in a wood-frame pocket level?—APPRENTICE.

[4219.]—TIGHTENING PIANO PINS.—Will the "Harmonious Blacksmith," or any other practical contributor, kindly instruct me how to tighten the pins of an old piano (grand, by Stodart, 1783), because it will not keep in tune, and I really cannot afford to buy another. Will "Harmonious Blacksmith" or others give opinions as to my suggestion to drive a small hardwood wedge in the front of each pin, and so tighten the pins, or else give me other and better instructions? I would like to do it without removing strings if possible.—MAN OF NECESSITY.

[4220.]—HUYGHENIAN EYEPIECE.—Will one of our kind readers give me a description of the above, and tell me the kind of lenses to get to obtain powers of 50, 100, and 150 on a 40in. focus; also a good simple way of mounting, centreing, and glazing the same? A small sketch will greatly oblige.—A SUBSCRIBER.

[4221.]—RE-TINNING CAST-IRON HOLLOW WARE.—Will any brother reader be good enough to inform me how to re-tin cast-iron hollow ware (saucepans, &c.), and say what chemicals are used?—ONE IN A FIX.

[4222.]—PHOTOGRAPHY.—Can any photographer or painter inform me how to paint a photographic background on canvas so as not to crack?—OLD TOM.

[4223.]—DEFECTIVE BATTERY.—Will you allow me to thank you most heartily for inserting, and "Sigma" and "Ap-Rhys" for their kind and prompt reply to my query (No. 2598, April 29) respecting a defective battery? Living in the country many miles from a large town, repeated efforts had to be made, to obtain zinc plates, &c. The silver plate, being nearly as thin as writing paper, got rent from the copper. I suppose it is fixed in the frame, and came off in removing the oxidation, &c., which had largely collected from using running water, but when the battery stopped there was about an inch entire. Will use soft water in future, as advised by "Sigma." Not having suitable articles for replatinising, and afraid of not being able to do it properly, I got a new silver plate, and would feel most thankful if anyone would kindly inform me as to the material and process of soldering. Is the ordinary solder used? In replatinising the silver plate it is heated over a lamp or iron to drive off the mercury? I may add that the battery is one of Smee's, with six glass cells, six silver and twelve zinc plates with coil. Any information which may enable me to get it to act properly will be most thankfully received.—G. F. L.

[4224.]—TREATMENT OF A CHRYSALIS.—Will any brother reader kindly instruct me how to procure the perfect insect from the chrysalis, in fact how to treat these that require to be kept damp, such as the chrysalis of a death's-head moth, and those that are kept drier, such as the chrysalis of a butterfly?—G. F. SMITH.

[4225.]—ICE.—Will any reader oblige by telling me how to make ice quickly and cheaply, and also how to keep it when made?—A WARM COUNTRYMAN.

[4226.]—FERTILIZATION OF STOCK SEED.—Can "Bernardin," or any of your numerous readers versed in floriculture, tell me the reason why double stocks never produce seed? Information as to the method of impregnating the single stocks, so as to secure 75 per cent. of double flowers will doubtless be interesting and valuable to many of your readers.—SAUL RYMEA.

[4227.]—PIKE-FISHING.—As the season for pike has now arrived, might I ask for a few hints from any of your contributors who are fishermen, as to the kind of tackle, method of using it, likely haunts to find Mr. Jack, best baits, and, indeed, any information that will be useful to an amateur angler out for a day's fishing?—CITIZEN.

[4228.]—RE-PLATING.—Would some kind br[illegible] reader of our MECHANIC inform me how to [illegible] articles with gold and silver.—M. SCHNEIDER.

[4229.]—UNNOTICED QUERY.—WASHING MACHINE—No one has yet answered the query asking for plan of an easily-made washing machine. Will some reader do so?—J. W.

[4230.]—A GENERAL FISHING ROD.—I should feel obliged if any of your piscatorial readers would give me some little information as to the making of a fishing rod for general purposes. I should like to have the dimensions of the joints, with the different kinds of wood of which they should be made.—PEDESTRIAN.

[4231.]—SMALL PLANING MACHINE.—Would any correspondent give me a full description of a small planing machine to fit in the vice for planing up chucks, small slides, &c., say 12in. by 9in. by 6in. high? If not asking too much, please let me have drawing, and a full description, as it will most assuredly be read by a great number of your correspondents, besides—TOMETER.

[4232.]—UNNOTICED QUERIES IN MAGNETISM.—What is meant by horizontal and vertical intensity? Secular variation? How do you figure mentally the magnetic curves of the earth, and show their relation to the line of dip? Should be glad if "Sigma" would enlighten me on these points.—F. PEEL.

[4233.]—BICYCLE BRAKE.—Will some kind reader inform me how the brake of a bicycle is constructed where the wheels are covered with india-rubber? Is the facing of it iron or india-rubber, and will it wear out the india-rubber very much?—F. G. C.

[4234.]—SEWING MACHINE IRONWORK.—Can any reader tell me how to give the ironwork of a sewing machine that smooth jet-black surface seen on those turned out by manufacturers?—J. W.

[4235.]—UNANSWERED QUERY.—I am sorry that no notice has been taken of my query (4010, melting and casting metal), page 287, for which I have been most anxiously waiting a reply. I should be greatly obliged if any reader would assist me, believing that many are able to give the information, and that it would be useful to many readers besides myself, for which I would willingly repay, through our MECHANIC, in any way in my power.—A BRISTOL AMATEUR.

[4236.]—BAR MICROMETER, &c.—I beg to thank "F.R.A.S." for his kind reply to my query respecting Xi Ursæ Majoris. In reference to the "bar micrometer," the only place in which I have seen it mentioned is the present list of Messrs. Cook & Son, where it is priced at 50s., the other forms of this instrument ranging in price from seven to twenty guineas. As your respected correspondent has not met with any micrometers in this form, possibly it may be either some recent invention, or else not efficient enough to bring it into general use. While thanking "F.R.A.S." for his generous offer to measure Xi Ursæ, for me, I beg to express the hope that he will, at his convenience (and when circumstances—instrumentally—are more favourable), fulfil his kind intention at some future time.—ALBERT P. HOLDEN.

[4237.]—VINEGAR.—I have 25 hogsheads of white wine which has turned so completely acid that it can only be considered as wine vinegar. Although it is pure and far superior to the vinegar made from malt, none of my customers will buy it, so great is the prejudice in favour of the odour and taste of malt. Could some chemical reader recommend how to prepare an aroma entirely free from injurious effects on the human constitution, which would give my sour wine the odour and taste of malt vinegar?—GROCER.

[4238.]—KANSAS.—In No. 273, page 302, J. D. Rogers gives a glowing account of Kansas, which he thinks is the best place to emigrate to. Will *J. D. Rogers inform* me how much money it would require to reach Kansas—the fare, including all? I may state that I am a bricklayer—a trade I do not altogether give my mind to—in fact I do not like it; yet I could work at it till I got something else. Any other particulars would be thankfully received through the Mechanic.—ISAAC R. F.

[4239.]—MEDICAL COIL.—I have a home-made galvanic coil, 5 in. long, case 7 in. diameter; the primary wire consists of 1½lb. No. 16; secondary about 2½lb. No. 26, worked by a single-cell zinc and carbon, with bichromate solution. I think it is a very powerful coil. When the whole of the bundle is in, it is as much as six persons can stand. I wish to make it useful. Lately I have been troubled with pains in the back and chest. I think it is lumbago. Would "H. P.," who kindly wrote to our Mechanic (page 326), give me a little information on the above subject. Should he do so, I will make known the result in our pages.—A LEARNER.

[4240.]—WATCH-MAKING.—Will some of our readers oblige a country watchmaker's apprentice with the best method to properly compensate or rate an expansion balance, so as to keep proper time in various climates; also the best way to cut and poise them, and what machine is generally used.—CHADWICK WEAVER.

[4241.] — BRICK OIL (huile de brique, oleum de lateribus).—What may be this oil. and for what is it employed? It costs 10s. a pound.—CURIOSUS.

[4242.]—INCRUSTATION IN BOILERS.—I shall feel obliged if any of the numerous correspondents of the ENGLISH MECHANIC will give me a cheap, *tried* method for preventing this.—A NEW SUBSCRIBER, Brussels.

[4243.]—WIRE NETTING MACHINE.—I should feel obliged if any of your correspondents could give me instructions how to make the above, or the name of a firm who make them.—PETER PINDAR.

[4244.]—EQUISONANT FLUTE.—On p. 280 of your journal appeared a communication from "Sable" respecting the Equisonant Flute, which interested me very much—the more so, perhaps, as I had just met with a treatise by the late Mr. Clinton in which this instrument is alluded to. Having made many inquiries, without success, I am induced to ask if your correspondent will be kind enough to inform me *where* I can see or purchase such an instrument.—S.

[4248.]—SPARK FROM INDUCTION COIL.—Would any kind reader tell me the way to find the length of spark that can be got from an induction coil.—H. A. R. D.

[4249.]—COINS.—Obv. two laureated heads, on the one is Otho, and on the other Hamerani: legend Franc. Romr. Imp. A. M. Ther. Avg. Hvn. Bo. R. On the reverse, two smaller heads; legend Æternitas Imperii.—F. W. C.

[4250]—ALGEBRA.—Will "C. H. W. B.," "Bernardin," or some other mathematical reader kindly inform me what parts of algebra, plane trigonometry, and conic sections it is absolutely necessary to read in order to learn the elements of the differential and integral calculus. References to be made to Mr. Todhunter's books on the above subjects.—A. Davies.

[4245.]—ELECTRICITY AS A REMEDY FOR EPILEPSY.—I would recommend "T. M." by all means to try electricity. Properly applied from a proper machine it cannot fail to have a good effect. I am neither a galvanist nor a doctor, and cannot therefore recommend the most desirable points of application of the poles, as found by experience, in cases like "T. M.'s." But this I know, that epilepsy may be the direct or indirect result of too much electricity in the nervous centres, and therefore requires decreasing. To bring about this, place the positive pole on the back of the neck, and the negative pole on the lower extremities of the body, as the feet, hands, &c. Let a good quantitative current of feeble intensity pass through the body. In this way increase the application a minute each day, up to ten or fifteen, beginning low. Then decrease in same way. "T. M.'s" case is just such a one as my letter was intended to reach, and I sincerely hope that the pages of the Mirror of Science may become the means of expounding the practical way of constructing and applying apparatus suitable for self management.—W. A.

[4246.]—GLYCERINE AS A SUBSTITUTE FOR COD LIVER OIL.—Some time since I heard that glycerine was being successfully administered as a substitute for cod liver oil, and have inquired at several druggists without obtaining a satisfactory reply as to the quantity that should be taken as a dose. I shall take it as a favour if you, or some of your correspondents, will kindly furnish me with the information required.—H. Jevons.

[4247.]—CHEAP GAS.—I write to thank "L. M.," and specially "C. D. C.," for answering my last query respecting cheap gas. I purpose to adapt both the plan given by "L. M." of regulating the supply of gas to the burners, and also the plan of carburetting the gas on its way from the meter, as practised and found good by the latter gentleman, but before I do so he will greatly oblige by answering the two following questions:—1st. Must I, in order to get any increase of light and corresponding decrease in my gas bill, use a smaller burner than the ordinary No. 3, which I have all along been using? And, 2nd, where can I obtain the benzole he speaks of at 4s. 6d. per gallon, as I have been to at least a dozen chemists, druggists, and oilmen, but cannot get it, some affirming that they know nothing about it, others stating that I have made a great mistake as to price, and offering me what they state to be chemically pure benzole at 1s. 6d. a pint (which is a vast difference to "C. D. C.'s" estimate), and others again offering me *benzoline*, used in the common sponge lamps. An answer from the gentleman named would greatly oblige.—Cheap Gas.

[4248.]—SILKWORMS.—I shall be glad if some brother reader will be kind enough to answer the following questions respecting silkworms. What is the average number of cocoons to make an ounce of silk? What is the price given for raw silk per ounce? Where can it be sold?—Ver a Soie.

[4249.]—ANATOMICAL MODELS.—In reading your widely circulated paper, I have often wondered at not seeing any articles on the construction of anatomical models in it. Could any of your readers or correspondents give me any information as to the mode in which they are constructed, or as to the materials that are used in their manipulation? I should like to glean some information on the subject, as I have been often told that it is both a scientific and profitable occupation, and from the figures I see quoted in price lists the profit must be very large indeed, some very accurately constructed models bringing in price as much as from £40 to £150 each. I would also like to know if there are any works printed on the subject.—W. L. P.

[4250.]—MUSHROOM CULTURE.—Will any one give some instructions on the cultivation of mushrooms, as I understand this is a good time to start the beds?—J. T. P.

[4251.]—PAINT FOR AQUARIUM.—What is the best paint for the inside of an aquarium, only one side of which is glass? It should render the aquarium watertight, and at the same time should not injure the fish. If possible, I should prefer a green paint.—Dixi.

[4252.]—ISOMETRICAL DRAWING.—I would be obliged to anyone describing the method of drawing the ellipses that represent circles in isometrical drawing. I have tried to do so by Mr. Thos. Sopwith's scales, but they do not appear to be correct.—Isometros.

[4253.]—TODHUNTER.—Will one of your high mathematical friends kindly and indulgently give me his opinion on the following:—Todhunter (Trig. p. 11), states "the circular measure of two right angles is π." Yet at p. 8, he asserts, "the symbol π is *invariably* used to denote the ratio of the circumference of a circle to its diameter." I cannot comprehend this use of the word "invariably," and should be glad to have it explained.—Gimel.

[4254.]—SEA ROUTE.—Can I go by sea from Liverpool, or Isle of Man, to London, and what will it cost?—W. J. Eggleston.

[4255.]—GOLD LACQUER.—I should feel grateful if any of your readers could give me a receipt for making French gold lacquer for brass work? Also a receipt for making steel bronze as used by Birmingham gas lamp makers.—Brassfounder.

[4256.]—NEW VELOCIPEDE SADDLE SPRING.—I have recently seen a bicycle with the saddle spring carried beyond the guide socket, about 6in. over the front of the driving wheel. Can any of your obliging correspondents inform me if it is patented, and by whom? The hinder wheel was very small. Is there any advantage in this, if so, what is it?—T. L.

[4257.]—BOOKBINDING.—I think I have read somewhere that bookbinders use something with their glaire so that it does not matter whether the book is finished at once, or in a day or two's time. Can "Ab Initio" or any other reader tell me what it is? A few hints on finishing will no doubt interest many readers.—G. P. T.

[4258.]—STEAM CARRIAGE.—Will your correspondent, signing himself "G. Prew," kindly state where the steam carriage described in No. 273, may be seen, and what is the probable cost?—M. A.

UNNOTICED QUERIES.

◆

In future, if any query remains unanswered for four weeks, we shall insert the number and subject of the query in this list, where it will remain for two weeks, if not previously replied to. We trust our readers will look over the list, and send what information they can for the benefit of their fellow-contributors.

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USEFUL AND SCIENTIFIC NOTES.

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HYDROSTATIC WEIGHING MACHINE.—The *Shipping and Mercantile Gazette* says,—"Mr. F. E. Duckham, of the Millwall Docks, has invented a most useful hydrostatic weighing machine, which may be seen in use at the docks in question. The principle of the apparatus consists in filling an open top cylinder with water and suspending the same from a crane. A piston is fitted with its rod passing downwards through the cylinder, and terminating in an eye for the attachment of the goods to be weighed. The dial gauge on the exterior shows the pressure, and consequently the weight sustained. The patentee very justly claims as a merit of his invention, extreme simplicity and portability. A machine to weigh 10 tons weighs in itself only 84 lb. Machines to go in the pocket may be manufactured which will prove weights up to one ton; and the apparatus is applicable to denote strains up to 100 tons, or more. A visit to the Millwall Docks enables us to speak of the use of this machine as there applied. The ironclad turret-ship *Abyssinia*, built by Messrs. Dudgeon for the defence of Bombay harbour, is in process of fitment in the basin. Her plates are weighed on delivery, and, as they are from 8 to 10 inches in thickness, they weigh 7 to 10 tons each. At the place of manufacture these enormous slabs are tested and marked, and, on re-weighing, have been found very correct. The Duckham machine used to weigh these iron plates is capable of testing up to 25 tons, and, after two months' work, shows no sign of leakage or inaccuracy."

THE AMATEUR MECHANICAL SOCIETY.—A meeting of this Society took place on Wednesday, the 22nd ult., to view the Royal Arsenal at Woolwich, special permission having been obtained for that purpose from the War Office. The members assembled at the Arsenal at 2 o'clock, when they were conducted through the various departments by Capt. Stoney, R.A., and his assistants. The Gun Factory was first visited, where the method of preparing and welding the large coils of metal for heavy guns was exhibited, and the guns, in various stages of completeness, were shown. After a short examination of the Pattern Room, they were shown the process of casting, finishing and testing the heavy shot and shell for these guns, and then passed on to the rocket manufactory and machinery for producing bullets of compressed lead and other parts of the central-fire cartridges for breech-loaders. After witnessing the manufacture and filling of the percussion caps used in these cartridges, they proceeded to inspect the wood-shaping machinery in the gun-carriage department, where is to be found one of the new Moncrieff gun-carriages. Leaving the Arsenal a little before six, they started by steamboat for Greenwich, where they sat down to an excellent dinner at the Ship Tavern, at 7 o'clock.

THE NOMENCLATURE OF STARS.—Up to the time of Bayer (1603), it is reported that the stars were never otherwise distinguished in Europe than either by their Arabic names, such as Aldebaran, Rigel, &c., or by their position with respect to the constellation, such as "in the head of Andromeda," "the first in the belt of Orion," &c. The maps of Bayer gained him immortality at no great price, simply from his employing the letters of the Greek and Roman alphabets to distinguish the stars. The idea, if original, was improved by himself before the end of his life, as appears from the joint edition by himself and Julius Schiller, in which numbers are substituted. But in our time, Bayer is only known by his letters, and the numbers employed are those given by Flamsteed, Piazzi, &c. It has escaped the notice of all the historians of astronomy that letters had been used to distinguish one star from another before the time of Bayer, by Alexander Piccolomini, of Siena, who was successively Bishop of Patras and Archbishop of his native place. The third edition of his treatise "Della Sfera del Mondo," accompanied by his work "Delle Stelle Fisse," was published at Venice in 1553; and throughout the whole of the latter he employes italic letters to distinguish the principal stars of each constellation from one another, and gives some rude maps in which they are employed. Neither Bayer nor Piccolomini at all insists upon the use of letters as an improvement, or even make any prominent allusion to it in their introductions; although, as it happens, the name of either would hardly have been mentioned in our day on account of anything else in their writings. The work of Piccolomini was sufficiently well known to be translated into Latin and published at Basle in 1568 or 1588, so that Bayer may very possibly have seen it and adopted or adapted the method from it.

MADNESS IN ANIMALS.—The statistics given in M. Bouley's course of lectures on "Madness in Man and Animals" confirm the statement that hot weather is not a cause of *rabies*. Out of 302 cases recorded in six years, eighty-nine occurred in the spring from March to May, seventy-four in the summer from June to August, sixty-four in the autumn from September to November, and seventy-five in the winter from December to February. Male animals appear far more subject to the attacks of the disease than female animals. Out of 320 cases of bites from rabid animals, 284 occurred with dogs (male), twenty-six with bitches, five with cats (male and female) and five with wolves (male and female). No instance is recorded of any attack on man by a rabid herbivorous animal. Now that we are approaching the dog-days, we commend these facts to the notice of the chief commissioner of police, and trust we shall have no repetition of the cruel and senseless police regulations as to the muzzling of dogs: to be consistent they should be in force all the year round.

THE MEDULLA OBLONGATA.—This important portion of the brain is placed between the tuber annulare and the foramen magnum, through which it passes into the vertebral canal, and is then called the spinal cord. If the membranes which invest the medulla oblongata are removed and its middle groove drawn asunder, there will be seen four or five bands of white substance ascending obliquely from one side of the medulla to the other. These bands decussate, some passing above, others below those of the other side, so that they are interwoven like plaited straw. This decussation is considered to explain the phenomenon, that when injury is done to one side of the brain, the disturbance of function is manifested on the opposite side of the brain. Thus, paralysis of the *left* side would be caused by some injury to the *right* lobe of the brain. Pressure on the medulla oblongata induces heavy sleep or stupor; while its laceration, even with the point of a needle, instantaneously extinguishes life; it is, however, placed in such a secure position as scarcely to be liable to injury.

THE *ENGLISH MECHANIC* LIFEBOAT FUND.

Subscriptions to be forwarded to the Editor, at the Office, 31, Tavistock-street, Covent-garden, W.C.

Amount previously acknowledged	£189	19	7
Weegee	0	1	0
Overlooker	0	1	6
Inventor and self-taught Mechanic..	0	2	6
Dixi	0	1	0
Paddy	0	2	6
	£190	9	1

ANSWERS TO CORRESPONDENTS.

*** All communications should be addressed to the Editor of the English Mechanic, 81, Tavistock-street, Covent Garden, W.C.

ANOTHER ADVERTISER'S OPINION.

The English Mechanic is one of the wonders of the world. I have paid 10s. and 15s. for advertisements in other journals that have not done me so much good as a sixpenny one in the English Mechanic.

W. J. Eggleston, Dewsbury.

The following are the initials, &c., of letters to hand up to Tuesday morning, July 5, and unacknowledged elsewhere:—

J. Waghorn, W. Compton, Veritas, P. Brown, J. Millington, T. M. G., S. C., David Fisher, D. H. and Co., A. Varley, T. Taylor, Ashworth Bros, A. Ledward and Co., J. Hinks and Co., Webb and Co., A. F. P., H. E. H., F. P., H. Taylor, Rev. T. F., W. Hewlett, J. Frances, W. H. Hunt, Overlooker, Robert Still, J. Gillingham, Wilson, Deeley, and Co., J. T. S., Payne and Sons, W. Whiteman, S. Compton, Thos. Over, S. Rogers, E. J. L., J. Willis, Ladybird, James Steen, W. B., J. P. E., P. F. McD., Amy Jordan, D. F. Batty, R. Gay and Co., J. G., J. B., B. P., White and Co., H. Childs, W. Hewlett, E. H. T., P. and W., A. and L., E. Ledger, W. Southwood, G. P., A. O. S., S. M., John Jeffrey, Rev. E. Kernan, E. S. K., W. Barker, R. M. and Co., B. and W., Jas. Lusty, Jas. Peters, M. A. Ennis, T. M., C. N. and Co., J. P., B. P., A. Millidge, R. A. Proctor, John Hudson, M. Barker, Mem., A Stoneman, Tautau, W. R. S., Beriro, R. E. W., J. E. Mollon, Electron, Ignoramus, Joe, Giles, W. B., Anxiety, H. G. T., Wm. Thomas, J. P., W. Gyngell, A. E. Tucker, Saddler, West Coaster, E. V. D. S., E. S. Woollett, Prof. M., N. T. M., B. M.

Erratum.—"Falcon" writes to correct an error in his description of Templeton's Method of Calculating Pressure of Steam on a Boiler by a Safety Valve. Instead of "the lever being weighted with a weight of 15lb." read "105lb."

J. H. (Velocipedes for Sportsmen.)—A small amount of banter may be right enough, but we cannot find room for a long answer, which consists of nothing but banter.

H. Jeffrey.—The first part of your letter has been amply discussed before. Your suggestion may be seen amongst "Extracts from Correspondence."

Wm. Johnson.—Your suggestion for improved candlesticks is not new, and therefore not worth patenting.

An Ambitious One.—Write to the Secretary of the Society of Arts.

Nathan.—Any respectable optician will give you the required information much better than any one else.

Yorkshire Amateur.—Get the number, we cannot repeat.

J. Dawson.—You might have saved yourself the trouble of writing, if you had consulted our advertisement pages. The address is Clarke and Dunham, 48, Mark-lane, E.C.

Boiler Jack.—Exchanges must be paid for before insertion. The scale of charges appears at the head of the column.

Cambridgeshire.—For hints on preserving flowers, see Reply 4068, last week.

W. L. G. Wright.—Your best plan is to advertise your invention.

Painter.—Brodie & Middleton, Long Acre, W.C.

Harry Walker.—See latter part of description of the Phantom Bicycle, on page 276.

"English Mechanic" Mutual Improvement Societies.—"Bell Valve" writes, hoping that the "Black Country" subscribers to the English Mechanic will shortly form several of these societies. He suggests that one should be formed in Wolverhampton, one in Wednesbury, and another in West Bromwich, and that members of either should be admitted to the meetings of all.

Albert Priest.—The dry earth system has been described in a former volume.

J. H. S.—Your views on the Patent Laws are in the main correct, and have always been upheld by us. The course you suggest of bringing pressure to bear on individual Members of Parliament is the best way by which a revision of the present law could be effected.

David Fisher (New Zealand). The subscription paid by you to the former proprietor entitles you to receive the numbers from him till the date mentioned. *We* have sent you the numbers you require. Please include the cost when you next remit a subscription.

Mus's congratulation will appear with others.

Edward Steane.—We cannot recommend your Household Fire Escape.

The Cause of Storms.—Mr. E. Jones, of 115, Royal Road, says; "I hope our good friend Mr. Proctor, or some one else, will give us a paper on the Cause of Storms. Every one thinks he knows what a thunderstorm is. I do not, neither do I think that one in fifty does know."

J. Sargent, jun. (Finchley).—"I do not remember seeing the subject of pre-adamite man discussed in your columns. I think it is one that would interest many readers."

V. Shepherd.—You are wrong. Mr. Perry's address has been given in advertisements and elsewhere several times. Correspondents at least should search before they complain.

"Cotton Clerk" and "Railway Clerk."—See announcement in this week's Sixpenny Sale Column.

Aster.—Your symptoms can only be rightly understood by an oculist.

J. P. P.—See our imprint at bottom of last page of advertisements. Second query can only appear in Sixpenny Sale Column.

A Constant Subscriber (Derby).—Write to the District Highway Board.

Mr. Proctor says:—"Sir,—I cannot wholly agree with you as to the 'Astronomical Register.' I have always thought it very plucky and praiseworthy on Mr. Gorton's part to publish a magazine devoted wholly to astronomy; and if there were nothing else to give the Register a good standing, the excellent reports of the Astronomical Society's meetings would suffice for the purpose. But I *did* think the attack on the English Mechanic uncalled for and ill-considered (I withdraw the word 'ill-natured,'—writing in extreme haste, and not meaning my words to be published, I used an ill-chosen expression). I am quite certain that if you were to adopt rigid rules for the exclusion of all subjects except exact science from your correspondence columns, you would soon lose many thousands of your supporters." We do not withdraw a single word we considered it our duty to write last week, as the small attack on us by the publication alluded to was as unprovoked as it was senseless. Of the hundreds of letters which "F.R.A.S." has been kind enough to send us, the only one we thought it advisable not to insert was one written some months since, which indicated in a few sentences the poorness and dearness of the said publication.

Arthur Green (Bermuda.)—Your former letter was received and has been attended to. The vehicle is a French invention, and we do not know the inventor's address. Its merits are, to say the least, doubtful.

R. Hovenden.—Your suggestions for bringing rain from the clouds by chemistry, electricity, and pneumatics, are far too vague.

Colonisation and Emigration.—Letters on this subject have been received from F.R.G.S., Maskelongue, Alexandra, the correspondent who suggested an English Mechanic colony, and "M. D." who offers favourable comments on the suggestion. All are pressed out this week by other matter.

"A Reporter," who defends, in a rather weak way, "Lewis's System of Shorthand," should have sent his address. The same observation applies to Amy Jordan.

J. R. D. (Coventry).—The subjects treated in the English Mechanic are too numerous to admit of the order and classification you suggest. You complain of "wanted" advertisements appearing in our columns, when skilled mechanics are offered, say, 22s. weekly. If you advertised for a violin for instance, and said you would give 5s. for it, could you expect a good one for the money? It is the same with advertisers who offer ridiculously low prices for skilled labour.

J. R. T.—Simply a notion, and a poor one to boot, or about as good as that sent us for a Bicycle by W. J. Pigott (p. 352) last week, and which by mistake crept into our columns.

Natural Science and Military Education next week.

Manns and Son.—No stamps enclosed.

F. R. G. S. tenders his thanks to the Rev. W. F. Mc Donald and G. Bennett, Esq., for so quickly and courteously responding to his appeal for Australian papers.

Hy. Chapman on the Flute, next week.

W. E. Maggs.—You are right. The notion is simply absurd, and W. J. P. will not catch us napping again in a hurry.

Hints to Astronomical Students by Rev. T. W. Webb, next week.

Pitman's Shorthand.—Besides the correspondence alluded to elsewhere we have received letters from Rosebud, J. F. Ballard, J. Bredall, and J. T., all in defence of Pitman's system. Mr. Pitman has certainly a cloud of witnesses in his favour. One correspondent, however, complains of the frequent improvements which he introduces. F. W. Grierson, in no way discouraged, promises a further vindication of Lewis's system next week.

THE INVENTOR.

In obedience to the suggestions of a number of readers, we have decided on appropriating a portion of our space to a condensed list of Patents as nearly as possible up to the date of our issue.

APPLICATIONS FOR LETTERS PATENT DURING THE WEEK ENDING JUNE 28, 1870.

1759 W. Rainford, Oxford-street, improvements in wardrobes

1760 C. J. Fox, R. Larchin, and J. Dodd, Saint Pancras, improvements applicable to reaping and mowing machines.

1761 J. Outram, Sevenoaks, improvements in rotary engines.

1762 G. Atterbury, West Bromwich, and G. Whitehouse, improvements in apparatus for communicating on railway trains.

1763 H. T. Davey, Chilton-road, Sudbury, improvements in apparatus for washing and boiling linen and other fabrics.

1764 W. R. Lake, Southampton-buildings, improvements in fastenings or connections for securing the cables and standing rigging of ships. A communication.

1765 A. C. Bamlett, Thirsk, improvements in reaping and mowing machines.

1766 B. J. B. Mills, 85, Southampton-buildings, improvements in the process and apparatus for making soap. A communication.

1767 J. Bullough, Accrington, improvements in slasher sizing machines. A communication.

1768 T. C. Brown, Ipswich, improvements in valves applicable to steam or water pressure.

1769 C. L. Franke, 18, Wilson-street, Finsbury, improvements in the manufacture of steel.

1770 D. Collet, 18, Boulevart St. Martin, Paris, a new or improved bleaching agent.

1771 J. H. Johnson, 47, Lincoln's Inn-fields, improvements in railways and engines. A communication.

1772 I. Bates, Dukinfeld, and J. Taylor, improvements in the bridges of the furnaces of steam boilers.

1773 S. Neville, Ellison Glass Works, Gateshead, a new or improved manufacture of plates of glass.

1774 P. Boland, Dublin, an improved bakers' barm or yeast.

1775 L. Hamel, improvements in the mode or method of producing certain colours to be used for calico-printing purposes.

1776 W. J. Cunningham, 480, New Oxford street, and A. Dabb, improvements in means and apparatus for cutting type, and carving, moulding, and ornamenting wood, metal, stone, and other materials.

1777 L. Mégy, J. de Echeverria, and F. Bazan, 60, Bouvelard de Strasbourg, Paris, an internal spring coupling and brake for transmitting, stopping, or regulating motion.

1778 J. Reid, Glasgow, improvements in locomotive steam engines.

1779 T. Graham, Green Mount-street, Beeston Hill, Leeds, and T. Dixon, of Leek-terrace, Hunslet, improvements in rotary engines.

1780 E. Morewood, Britton Ferry, Glamorgan, improvements in the manufacture of tin and terne plates.

1781 J. J. Mendez, Buenos Ayres, improvements in ships and vessels.

1782 G. Speight, Spencer-street, Goswell-road, an improved glue pot.

1783 W. E. Newton, 66, Chancery-lane, an improved mode or process for obtaining glycerine from soap-makers' spent lyes. A communication.

1784 A. L. Holley, Brooklyn, U.S.A., improvements in apparatus for making Bessemer steel.

1785 T. Rishmond, Burnley, and G. Catlow, certain improvements in the preparation of "cops" and "healds" employed in the manufacture of woven fabrics.

1786 W. Spence, 8, Quality-court, Chancery-lane, improvements in the construction of boxes or cases for containing eggs, glass, crockery. A communication.

1787 H. Pooley, Liverpool, and T. Roberts, an improved automatic machine for weighing and registering grain.

1788 A. Walker, Edinburgh, improvements in window sashes.

1789 D. Forbes, York-place, Portman-square, and A. Prior, 6, Lincoln's Inn-fields, improvements in the production of compounds capable of being employed as manures.

1790 A. Barclay, Kilmarnock, improvements in smelting iron and other ores.

1791 R. Hudson, Graystone House, Adwalton, near Leeds, improvements in the manufacture of cloth.

1792 E. Finch, Beaufort-square, Chepstow, improvements in machinery for forcing or exhausting air or aeriform fluids.

1793 W. R. Lake, Southampton-buildings, an improved faucet. A communication.

1794 A. Ruiz and Le Pelletier, 62, Rue de Provence, Paris, improvements in the construction of revolving collars, applicable to looms for spinning hemp and flax.

1795 C. Stephens, Admiral's Hard, Stonehouse, improvements in boot trees.

1796 W. Brown, Portsmouth, improvements in the construction of steam and hydraulic rams used in naval warfare.

1797 P. Jensen, 89, Chancery-lane, improvements in apparatus for indicating the speed of vessels and the velocity of running water. A communication.

1798 J. Smith, Keighley, improvements in machinery or apparatus for spinning.

1799 A. Stewart and J. Stewart, Glasgow and Coatbridge, improvements in the manufacture of welded iron and steel tubes.

1800 J. Sinclair, Manchester, improvements in respiratory apparatus.

1801. S. F. Van Choate, of Boston, U.S.A., improvements in distilling alcoholic liquors.

1802. G. Ritchie, Belmont Villa, Tyrwhitt-road, Upper Lewisham road, improvements in sunshades, tents, tent-pegs, and weather protectors.

1803 T. Wrighton, Stockton-on-Tees, improvement in apparatus for lowering weights.

1804. R. Saunders, Croydon, improvements in breakwaters and structures for coast protection.

1805 J. Shackleton and B. Shackleton, Silsden, improvements in machinery or apparatus for manufacturing "spool" or paper tubes for use in spinning machinery. A communication.

1806 G. Thomson, Glasgow, improvements in treating manganese ores, oxides, or salts, and in making ferro-manganese.

1807 S. J. Fellows and E. Fellows, Wolverhampton, improvements in planishing, levelling, and creasing frying-pans and other metallic articles.

1808 J. Sax, 108, Great Russell-street, Bloomsbury, an improved mechanical recorder.

1809 S. Norris, 15, Gough-street, London, W.C., and T. Griffiths, Lombard Exchange, London, a machine or apparatus for mixing and kneading dough and other ingredients.

1810 J. Napier and W. Cruickshank, Edinburgh, an improved arrangement and construction of portable bath.

1811 W. Martin, Nottingham, improvements in the *manufacture* of woven gauze fabrics made on bobbin net or *twist lace* machines.

1812 E. Lambert, Eagle, Lincoln, improvements in the construction and arrangement of stages made *of iron or other similar* material, applicable to windmills or other buildings.

1813 E. V. de Forville, Nantes, France, *improvements in velocipedes.*

1814 R. Morton, Stockton-on-Tees, *improvements in apparatus* for cooling liquids.

1815 D. Rowan, Glasgow, new or improved constructions and arrangements of valves and their actuating parts.

1816 H. A. Bonneville, 18, Chaussee d'Antin, Paris, a new and improved apparatus for warming and ventilating carriages and boats. A communication.

1817 J. Clark, Belmont-terrace, Notting-hill, radiating the axles of locomotive engines.

1818 V. Rastouin, 87, Boulevard Bonne-Nouvelle, Paris, improvements in steam engines.

1819 W. E. Gedge, 11, Wellington-street, Strand, an improved process of drilling and cutting plane surfaces in the manufacture of crystal glass or metal ware, and an improved lathe for this purpose. A communication.

1820 J. G. H. Hill, Rouen, improvements in fastenings for elastic stockings, stays, corsets, bandages.

1821 W. E. Newton, improvements in the production of glucose, syrup, and sugar. A communication.

1822 W. B. Adamson, Glasgow, improvements in the manufacture of artificial stone.

1823 R. Kell, Bradford, improvements in treating and distilling petroleum. A communication.

1824 J. Butterworth and J. B. Hutchinson, Leeds, improvements in the making of carriage, cart, and other wheels.

1825 J. Butterworth and J. B. Hutchinson, improvements in making wooden skewers.

1826 E. W. Sandford, New York, U.S.A., improved friction brake for cars and other purposes.

1827 W. R. Lake, improvements in rails for railways. A communication.

1828 W. Riddell, Crosby Hall Chambers, improved apparatus for cutting wood into small strips, filaments, or shavings.

1829 W. R. Lake, improvements in breech-loading fire-arms, and in cartridges for the same. A communication.

1830 W. Bull, F.L.S., F.R.H.S., King's-road, Chelsea, an improved case for the conveyance of plants.

1831 W. R. Lake, improvements in candles. A communication.

1832 C. McDermott, Brixton, improvements in pencils for marking on linen and other materials.

PATENTS SEALED.

3745 E. P. H. Vaughan, improvements in the manufacture of fluoride of potassium and sodium, and of hydrate and carbonate of potash and soda. A communication.

3748 C. A. Marriott and E. Holt, improvements in steam engines.

3749 P. Pierce, improvements in horse or other gearing.

3767 C. W. Petersen, improvements in steam and other life boats and vessels.

3778 A. Matthiessen, a new or improved insulating subtance for the covering of electric telegraph conducting wires.

12 H. H. Cochrane, improvements in machinery or apparatus for working signals and switches on railways.

52 P. Jensen, improvements in means for closing or fastening neckties, stocks, cuffs, and other objects. A communication.

74 W. W. Hughes, improvements in furnaces.

118 G. Thorneloe, a new flexible valve for regulating the flow of fluids in pipes.

242 S. Lewin, improvements in elevators for raising and stacking straw.

320 W. R. Lake, improvements in spring bed bottoms. A communication.

356 B. Walker and J. F. A. Pflaum, improvements in clutches for engaging and disengaging parts of machinery.

725 H. A. Bonneville, certain new and useful improvements in machines for setting types. A communication.

833 S. Brooke, improvements in the doffers of condensing carding engines.

969 T. L. Livsey, improvements in machinery for "filling" or starching woven fabrics.

1093 W. R. Lake, improvements in looms for weaving. A communication.

1120 J. L. Norton, improvements in apparatus for dressing and furrowing mill stones.

1175 H. Shaw, improvements in machinery for hulling cotton seeds.

1186 L. C. Schermerhorn and C. Schermerhorn, improvements in manufacturing cheese.

1229 T. Thorpe, improvements in the manufacture of piled fabrics.

1365 J. Ormerod, improvements in looms for weaving.

3757 R. H. Kay and A. T. Richardson, improvements in the manufacture of crape.

3769 W. R. Lake, an improved apparatus for roasting iron pyrites. A communication.

3774 J. Stanton, an improved rebounding safety gun-lock.

3777 W. H. Richardson, a new method of indicating or stamping crystal or glass measures.

3781 A. Bradshaw, improvements in printing machines.

3784 A. Chaplin, improvements in steam boilers.

1 C. Hodgson, improvements in the manufacture of compound rivetted bands of iron, steel, or other metal to be used as a substitute for wire ropes.

8 S. Holman, improvements in apparatus for hinging, adjusting, and fastening gas-retort lids, covers, or doors.

he English Mechanic

AND

RROR OF SCIENCE AND ART.

FRIDAY, JULY 15, 1870.

VALEDICTORY.

HE following is the farewell address of Dr. Lawson, late Editor of *Scientific Opinion* : Various correspondents have kindly expressed regret that the present Editor should cease old the reins of *Scientific Opinion*. We k them for their good feeling. Much of the ess which has attended our labours has been to the generous help and friendly advice, gestion, and encouragement held out by our espondents, and especially by one who, we not hesitate to say, is the first man of Science the age. But, in retiring from the Editorial ir, we do so not without a feeling of relief, n if tinged with regret at losing pleasant intercourse with many respected colleagues. The sk of conducting a weekly journal, which shall ot, as certain journals are, be as it were, pitchrked together, and of so considering the curent of politico-scientific questions as to be nabled to help public opinion on its way to eform, is so arduous, so unceasing, attended ith so much anxiety, and such intense [illegible], at after nearly two years of editorial toil, we y down our burden and are glad to be able to t in practice the old aphorism, 'Rest and be ankful.' We believe that our successor will ot lose sight of the interests of those who have o long and so favourably supported *Scientific Opinion*, and in resigning to him the Editorial hair, we bid a kind adieu to our old friends, and ish our future representative God-speed in all artiness and goodwill."

WORKING MEN'S EXHIBITIONS.

AFTER nearly twenty years of experience it has been discovered that in order practally to interest working men in artistic and lustrial exhibitions, they must be partakers their management, and share the rewards of ccess. At the Agricultural Hall, Islington, ere is to be a display, commenced during the esent month, in which this principle will be, for e first time, amply recognised. [illegible] ms and large employers of labour will [illegible] t to every specimen of [illegible] will affixed the name of the artisan who wrought so that, by obtaining a prize, he will [illegible] erpetual certificate of skill, which [illegible] l him, even in the worst of times. [illegible] empts of a similar kind have been made in gland, but upon a limited scale, and [illegible] staken arrangements. At the [illegible] Hall, [illegible] tance, and at the Mechanics' Institute [illegible] eds, working-class emulations have been [illegible] t they bore an amateur and immature [illegible] nce. We regretted to find so much [illegible] nd patience wasted upon elaborate patchwork uilts representing every colour in the uniforms the British army, tables and tea-caddies mbining a thousand pieces of wood; [illegible] imes, and other monuments of devotion [illegible] ating a Chinese dexterity and perseverance, t not improving either the position or the pacity of the worker. At present we have no eans of judging how far this or a different stem has prevailed at the Agricultural Hall, t there is reason to believe that the emulation ll be seriously and strictly industrial. It is to international, as we have said. Now a great ficulty has always stood in the way of commucation between the artisans of one country d those of another. The cost of travel is one stacle. The want of a common language is anher. The value of time, to people who, by daily fort, earn their daily bread, is a third. Still, as r superior working-classes will find, in course of time, when more habituated to these rivalries, they are of immense, and even immediate use. We are kept out of many fields by that rarest of all sentiments—a national modesty. This point requires explanation, which we hasten to give. It is a popular idea among us, that we can never hope to vie with the weaver of Lyons in the production of silk tissue. Why not? Lyons borrowed her cunning from Venice, buys a principal part of her machinery in Great Britain, and imports her raw material, as we do, from China, Persia, and Italy. At Paris, at Amsterdam, at Munich, at Wittenberg, at Leipsic, at Mayence, last year, specimens from the English loom were shown which by no eye could have been distinguished from the finest of French manufacture. So, too, with porcelain, with bronze, with all the fine arts. We have been deafened out of self-respect by foreign praises of foreign wares, and have been in danger of forgetting that which in reality we ourselves have taught to half the world. Not, by any means, that we would counsel [illegible] on the part of our workmen [illegible]; but a due consciousness of merit is a species of [illegible] same pride. Next week, no doubt, when the French and Italian artisans are among us, we shall recognise, [illegible] the [illegible] of a peculiar genius, [illegible] and deserving to be applauded. But to get a true [illegible] a movement which, [illegible], will grow into a European custom, we must trace [illegible] and [illegible] a practical end. In [illegible] of this view we would [illegible] some [illegible] of International Exhibitions in the past. [illegible] they have not generally [illegible] artisans; they have been [illegible] [illegible] all her flowers." [illegible] invention, and [illegible] patent, and while the [illegible] credit of knowing a good workman, the workman can claim the credit of his own [illegible]ance. This is as it should be. [illegible] greater results from a series of [illegible] Exhibitions than ever [illegible] are prepared for—all [illegible] their elevation in the [illegible] to one episode. In [illegible] Belgian frontier—an [illegible] and the skilled mechanics of the [illegible] building-yards—men [illegible] culture, and modes of [illegible] the idea of an International [illegible] banks of the Amstel. They [illegible] the other to learn new [illegible] and life: and, while [illegible] resolved that the [illegible] capital should [illegible] Their attention was [illegible] materials, plans of [illegible] kitchens, and yards, [illegible] cement, concrete, [illegible] damp, and foundations. They [illegible] mixed cheap and useful [illegible] the world had a [illegible] than they had [illegible] They [illegible] working men [illegible] [illegible] respects to the French [illegible] German; the Russian, Spanish and Italian being *hors de concours*. Now there was a good deal of plausibility in all this. Workmen's mechanical schools, no doubt, abound more on the mainland of Europe than in these islands; but we are not aware of any failure which has been humiliating to the working class genius of England in the international competitions which have taken place. Indeed, it strikes us that this is not the real question involved. It is not whether we are outdone by rivals; but whether we might not outdo ourselves as we are, by what we are capable of being. To that result do these workmen's exhibitions tend, and in that prospect we must welcome them. The choral workman's song, sung in Dutch at Amsterdam, sets forth the idea, and, if a free translation may be pardoned, we quote from it one stanza :—

> No [illegible] of iron, or gunpowder-fed,
> No [illegible] of steel, no whizzing of lead,
> Makes the blood in our arteries tingle;
> But the whirl of the wheel, and the whistle of steam,
> And the [illegible] of the seething stream,
> Is the sound where our sympathies mingle.

Of course a Workmen's Exhibition may be intended to serve one of two purposes, or the two together. It may be designed to meet the many wants of his class which have hitherto been unprovided, or it may aim at extending his power over the materials which he has to manipulate, so that his ability shall exceed that of his rivals belonging to other nations. Or, we repeat, it may attempt both purposes. We are inclined to think that the former scheme is the more important. Taking the two, however, together we may assign them to seven descriptions. The first is that of habitations. When the poor, herded in crowds, occupy common lodgings, [illegible] their wants and [illegible], losing all sense of [illegible] and home, they become inevitably demoralised, and no work so good has been done on the Continent as that which has been done in connection with exhibitions by teaching [illegible] may be [illegible] and yet very com[illegible]. The [illegible] and the Prussians are far in advance of [illegible] nations in this respect, [illegible] may claim a high pre[illegible] on account of their model workmen. As [illegible] it may confidently be said that our working classes do not understand it at all. A [illegible] or a German [illegible] by a family, the [illegible] of which do not average [illegible] a week, will [illegible] a [illegible], a [illegible], and a [illegible] we [illegible] look for in vain. [illegible] in the homes of our artisans. We [illegible] find some of our working class [illegible] their [illegible] to the means of [illegible] and [illegible] in [illegible] Europe in Sweden and [illegible] [illegible]

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one of these industries exists which has not been promoted by the emulous spirit of international exhibitions. We would therefore counsel our mechanics to take these opportunities in good earnest, and to appreciate the chances they offer of general and personal advantage. The world knows too little of its workmen. Thousands of tasks finished by apt and patient hands, tender suggestions of form and colour, marks of thoughtful capacity and memorials of loving care, like that bestowed by Ascanio on his lily, abound in the workshops whence, hitherto, no name has ever issued forth to fame. It is with pleasure then, we notice that in the forthcoming exhibition which Her Majesty has privately visited, and the Prince of Wales will open, the personal merits of the workman will be recognized. Indubitably while he demonstrates his own high quality he will perceive that he has much to learn from his fellows, and we trust, notwithstanding our denial of the idea that foreign workmen are, upon the whole, inferior to ours, he may yet be so unprejudiced as to acknowledge that something may be taught to him by the Frenchman, the Dutchman, or the German. How is it that we cannot make *articles de Paris?* How is it that we are utterly beaten in toy-making by the manufactories of Nuremburg? This localization of peculiar industries is among the most unintelligible of phenomena. A workmen's exhibition brings it however before the workman's eye, and sets him reflecting upon his position in the great race of industrial nations. At an exhibition he can see clearly on what courses, and for what prizes, he is first, second, or third, or not placed at all. We have every confidence in the prowess of our exhibitors at the Agricultural Hall, but would prefer that our mechanic should look to the exhibition less for triumph than for teaching.

HINTS TO ASTRONOMICAL STUDENTS.

(Concluded from page 265.)

OUR enquiries into the nature of telescopic definition have been restricted to the case of an uninterrupted pencil of incident rays, when no other interference takes place excepting that which invariably arises from its external boundary at the edge of the cell in which the object-glass or speculum is placed, or, if the aperture is contracted, at the edge of the interposed diaphragm; but another case requires to be understood, as it enters materially into the difference of performance between achromatics and reflectors. The case of an interrupted beam of light, which must always occur in reflecting instruments, unless we adopt the arrangement commonly known as the "front view," or, from its inventor, the Lemairean form of telescope. In this the disc and rings should be theoretically the same with those of the refracted image, were it possible to avoid the distortion necessarily introduced by the employment of oblique reflection; but on account of this serious objection, as well as from the irregular refraction through the heated air, proceeding from the observer's head, this mode of mounting is not likely to meet with much favour, except for the discovery of feeble nebulæ or comets, or very minute stars. The success which attended its use in the hands of the two Herschels, at Slough and the Cape of Good Hope, is a striking instance of the way in which instrumental defects may be counterbalanced by experience and skill. But no sooner do we escape the annoyance of a distorted image and a disturbed medium, by the employment of either Gregory's, Cassegrain's, or Newton's construction, than we are confronted by an additional source of interference all round the edge of the small speculum, as well as at each side of the arm which carries it. The latter makes itself sensible in feeble rays, proceeding from the focal image, if of sufficient brilliancy; the former acts in a direction concentric with the interposed body, and of course with the external boundary of the incident light. The effect of this, though more conspicuous than that of the interference of the support of the mirrors, its less injurious than might have been supposed, and in some cases positively advantageous. It is stated by Airy to consist theoretically in a diminution of the spurious disc, with an increase in the number and brightness of the rings, while their diameter is somewhat diminished. Dawes, on the other hand, found practically that the distance of the rings from the disc was increased. I do not know that this discrepancy has been noticed, nor am I able to conjecture its cause; nor do I know what may be the discordant conclusions arrived at by Frauenhofer and Sir J. Herschel, for which Airy refers to the article on "light" in the "Encyclopædia Metropolitana." Perhaps some of the readers of the English Mechanic who have access to that publication will favour us with some information as to this point, which is of considerable interest.

But at any rate the general result is, that the performance of a reflector must be similar to that of an achromatic in which the centre of the object-glass is stopped out by a patch of a size proportioned to that of the small speculum. Sir J. Herschel says in his book on "The Telescope," that the performance of an achromatic object-glass is often very materially improved by a central patch of from 1-12th to 1-10th of its diameter, the increased distinctness much more than compensating for the loss of light. As quoted by Dawes, however, he recommends a patch of 1-6th to 1-5th of the aperture. Dawes himself found the minute companions of large stars sometimes hidden, and the discs of nearly equal stars apparently distorted, when the brighter rings passed through them; and therefore he seldom used the expedient, though admitting that "in some instances it is undoubtedly advantageous." It was also occasionally employed by Admiral Smyth, to increase separating power in the examination of very close pairs. According to the Rev. H. C. Key, one of our highest authorities, the proportional apertures of reflectors to refractors of equal dividing power are as 26 to 31, and this advantage arises of course from the smaller disc given by the former construction.

This then is one great difference between the definition of equally perfect reflectors and achromatics (supposing, in the case of the latter, that the disc and rings have the same magnitude and proportion that they would have had if formed by a single lens—a point which, as far as I know, has not been submitted to theoretical investigation). The spurious discs in the reflector being smaller, but the rings more intense, the definition is less pleasant where the rings are conspicuous, as around the larger stars, but sharper where these appendages are too faint to interfere with the effect, as in viewing the moon, planets, and crowded globular clusters (or "resolvable nebulæ," as they were formerly called). To this we may add, on the score of defect, the feeble interference-rays proceeding from the arm of the small mirror, which disturb a little the blackness and neatness of the background of a brilliant star; the irregularly refracting currents of air which sometimes circulate in the open tube; the increased amount of atmospheric imperfection or perturbation included by the larger aperture; and the necessity of occasionally renewing the silver film, and we shall have stated the case fully and fairly against the reflector. On the other hand the achromatic has its own special disadvantages—the fringe of outstanding colour, or "secondary spectrum," around the focal image under high powers, which is very unpleasant to an eye accustomed to the picture in the reflector—the unpleasant position of the head at any considerable altitude, unless a diagonal eye-piece is used—and the much greater expenditure necessary to secure an equal amount of efficiency.

The secondary spectrum, just referred to as the peculiar drawback of the ordinary achromatic, may claim a share of our attention. It is the necessary result of what is called the "irrationality," that is, dissimilar ratio or proportion, of the coloured spaces in the spectra of the two kinds of glass of which the object glass is composed. Every lens acting as a kind of curved prism, the image produced by the old refractor, with a single convex lens as an object-glass, was full of colour and consequent indistinctness, unless the defect were palliated by a most exaggerated and inconvenient focal length. In the achromatic object-glass (as now made) we have a convex and concave lens of two kinds of glass, differing in their power of dispersing white light and colour, and so adjusted that the colour produced by the concave corrects or neutralizes that produced by the convex, while the greater refractive power given to the convex makes the corrected rays converge to form a colourless image. If practice here corresponded with theory, the result would be, in this respect, perfection. But it so happens that different kinds of glass not only differ in their total power of dispersing white into coloured light, but also in their separate action on different colours; so that taking the case of plate and flint glass (which are used for telescopic work), though we could easily assign such angles to a prism of each that their spectra would be of equal length, red ranging alongside of red when violet matched violet, we should find still that green in the one would not correspond with green in the other, or if we made the greens continuous, the reds and violets would no longer match each other. The result of this "irrationality" is that two lenses formed of these materials cannot possibly produce a colourless image. Their contrary dispersion may be varied in many ways, so as to bring different colours to match, but it will be found impossible, in the use of these media alone, to include them all in one focal image: one or more will always be left out, and appear as a surrounding fringe to any white or luminous object, which is known as the "outstanding colour," or "secondary spectrum." The great art of the optician is of course so to arrange the balance of correction that the brightest colours shall be combined into approximate whiteness; and the best effect is considered to be produced when a blue fringe is left outstanding in focus. When this is the case, an object-glass is said to be "over-corrected for colour," the meaning of which I believe to be that the correction has been pushed beyond the point in which simply the extremes of the spectrum would be combined. This blue tint may, however, be thrown out to an unpleasant degree, and is said to be usually so in the Munich glasses. The result of course is that the whiteness of the focal image, being impaired by the absence of the blue, exhibits the complementary tinge of a faint orange, which becomes visible more especially in the use of high magnifiers. When the correction of the brightest colours is as complete as can be effected, Sir John Herschel says that the image of a white object will show a purple or lilac fringe (which has sometimes been compared to the hue of claret) on one side of the focus, and a green fringe on the other. Attempts have been made, with more or less success, to get rid of this nuisance, which involves not merely an unpleasant effect to the eye under high powers, but a loss of valuable light. Dr. Blair succeeded admirably by means of fluid media, but the idea has dropped into what seems undeserved oblivion. Wray has attained the same end, in what may be a more permanent mode, by the interposition of a transparent current between the lenses; but his instruments are as yet not generally known. It is more to our present purpose to remark that in a perfect object-glass another defect requires compensation, as well as that of colour, the spherical form in which alone lenses can be well worked producing, alike in theory and practice, a shorter focus for the rays near the edges than for those in the centre. This defect, which is called spherical aberration, or spherical error, or sometimes aberration only, admits fortunately of being neutralized, at the same time that this dispersion is corrected, by the combination of two lenses—a happy circumstance, which makes the achromatic object-glass a truly wonderful work of art; the compensation is, however, frequently imperfect in practice.

In reflectors there is of course no colour to be corrected; and any defect in this respect must be imputed to the eyepiece alone; there is a corresponding spherical error to be removed, but this is done by the workman in "figuring," as he is able to communicate to the surface that parabolic curve which enables it to reflect the central and marginal rays to the same focus; and but for this controlling power over the figure, the reflector could never compete, as it may now fairly do, with the achromatic. The series of papers now drawing to a close has been extended to a very considerable, and some may perhaps think to an undue length. But the subject grew under the hand, outlying materials were gradually absorbed into the stream, and points were touched upon as to which some readers might be fairly supposed to need no information. Still, the writer hopes his remarks may have been of use to others, for whose sake the better instructed will bear with his prolixity. It now remains only to say what has not been fully said, as to the trial of a telescope. Much that appertains to this point has already come incidentally before us; and we shall scarcely require to be informed that in the use of the highest power, the focal image of a bright star by night, or a thermometer bulb by day, ought to be a sharp circular disc surrounded by a few bright rings, and, as a test of the accurate concentration of the rays, it should be "quick in and out of focus," that is, distinct vision should be confined to one position of the eyepiece, and be very rapidly obliterated by motion either way. There should be no tendency to a double image, or radiating flames, or "wings," or unsymmetrical distortion of any kind: but patience will often be called into exercise to discriminate between actual defects in the instrument, and disturbance in the atmosphere or tube, which may produce a marvellously misshapen image, and turn a star into a ball of tangled wool, or, as has been aptly said, "a full blown rose, revolving upon its axis"! And we must recollect that the moments of best vision are the true measure of the capability of the instrument. What it has once done, it can always do again. In addition to this focal testing, which we may render still more severe by unscrewing and laying aside the field-lens of the strongest eyepiece (thus materially raising the power, though at the expense of all but central distinctness), we should move the eyepiece through a considerable range on either side of the focus, in order to ascertain the regularity of the convergence and divergence of the rays. The expanded discs thus viewed should be uniformly luminous (excepting where the "flat" in the reflector occasions a central darkness) and accurately circular, bearing in mind, however, that unequally heated currents will sometimes give them an elliptical appearance in opposite directions on either side of the focus. They ought not in any position to show a much brighter centre, or a ragged outline, and the margin should be as similar as may be on either side of the focus. In a perfect telescope, either achromatic or reflecting, the out-of-focus disc will be bordered by a narrow bright rim within which will be a minute black circular line, and within this again a number of other black hair-lines may be traceable; and if this appearance should be the same on either side of the focus, little more can be done for the instrument by the skill of man. The test is however a needlessly rigorous one. Great excellence is compatible with a slight dissimilarity in the interior and exterior discs, arising from a trifling under or over correction of the spherical error, the former condition being indicated if the border of the disc is sharper within than without the focus, the latter, if the reverse. "If," says Dawes, "the rings in these out-of-focus images are similarly disposed in both cases, the figure is perfect; but a moderate deviation from this perfect equality does not stamp a telescope as bad, or even unfit for delicate work. And it is a fact, which I have proved by experiment, the difference between an object-glass which bore this most severe test perfectly well, and one which fell obviously short of it, was not to be dis-discovered by any decided superiority of the one over the other, either in separating power upon close double stars, or even in the perception of faint objects close to bright ones; though this latter is more likely than the former." The same great observer was also of opinion that telescopes under-corrected for spherical aberration usually performed better than those with the opposite, which is also the less common defect. In the same manner we may investigate the true parabolic figure of a speculum.

Each eye-piece ought also to be examined. With the achromatic they will probably be of the Huygenian form, which is excellent, if well constructed, but is too often very carelessly made by rule of thumb." This kind of eye-piece, which is also called "negative," consists of two plano-convex lenses with their convexity towards the object; and if applied simply to the eye as microscopes, they give no image, the focal picture in the telescope falling between the lenses. The eye-pieces of silvered reflectors are either of this form, or more usually Browning's achromatic construction, especially adapted to the instrument. But occasionally we meet with Ramsden or "positive" eye-pieces, in which the two lenses have each their plane sides outwards, and which act separately as microscopes, the telescopic image falling in the place of an external object. These always show colour towards the margin, an imperfection which the observer must tolerate in consideration of the beauty and flatness of the field, rendering it peculiarly suitable for micrometrical purposes. If of any other construction, an "ocular" should have a field free from colour to the edge, as well as equally distinct in every part, without readjusting the focal distance. The Kellner eye-piece, less frequently met with, has a large and beautiful field, it is subject to annoyance from the visibility of magnified dust on the inner surface of the field lens, which is nearly in the focus of the other, and in the process of frequent cleaning it is liable to be scratched. Single lenses, either plano or double convex (Sir W. Herschel, I believe, employed the latter), may be very serviceable in experienced hands, giving a central sharpness not surpassed by any combination; but as the edges the field are in every respect intolerable, a fine and steady motion is required to keep the object in position. In testing an object-glass or speculum, such a lens is preferable to a combination, which may introduce errors of its own; and should there appear any defect in the image shown in a compound ocular, the removal of the field lens answers the same purpose as a change of eye-piece, to show where the fault may lie. A terrestrial eye-piece of four lenses will of course not be employed, where it can be avoided, for astronomical purposes, not only from the loss of sight, but from the desirableness of accustoming the eye, as much as possible, to the inverted image, and reversal of motion through the field, which characterize the astronomical ocular.

And now we shall leave the student with his instrument, wishing him many a pleasant hour in the diligent use of it, and above all, that it may be the means of aiding him to a more intelligent and impressive view of the heavens in their highest and noblest aspect, as showing the handywork of their All-great, All-wise, All-good Creator.

T. W. WEBB.

Hardwick Vicarage, June 29, 1870.

ELECTRICITY, ITS THEORY, SOURCE, AND APPLICATION.

By J. T. SPRAGUE.

(*Continued from page* 341.)

143. DELAURIER'S CELL. This is a modification of the bichromate cell lately introduced with a considerable amount of laudation; its real purpose is simply to obtain a somewhat stronger solution for the porous cell; because the larger cell itself, and plates, with other details of construction, are mere matters of arrangement of no novelty, and equally applicable to other solutions. All the remarks made as to the bichromate cell apply equally to this: its force is the same as nearly as possible, so also is its rapidly failing current. The added salts add nothing to the work, they only take oxygen from the bichromate and reserve it in a more soluble form. I will therefore only show its cost of working by taking in grains the quantity given by its introducer and calulating the cost for pounds as before. The solution is made in the order given, a precipitate being at first produced which the acid redissolves.

300	Water, fluid measure		
54	Bichromate of potash	at 8d.	432
45	Sulphate of iron	,, 3d.	135
50	Sulphate of soda	,, 2d.	100
			667
	Divided by 7,000 gives		·0953
94	Measure sulphuric acid being 3½ units, at ·0089		·0311
			·1264

The bichromate here is equal to 1·4 units; but by the time the current had fallen to the same point as with the bichromate cell, page 341, ·820 only of useful work was done which brings the cost per unit to ·1541 to which adding the zinc as with the other ·0293, the total cost is ·1834 as against ·1406, so that the small advantage gained of the solution lasting a little longer is obtained by increasing the cost nearly one-third.

For use in the single cell the proportions vary somewhat from the above, but the result is the same.

144. BICHROMATE SINGLE CELL.—Though out of the order of classification, it is convenient to deal with this much used cell while on the subject. It consists of two plates of carbon, with one of zinc between them, fitted so that it can be raised out of the liquid. Of late I have noticed in many of the shops small bichromate cells without this fitting, the intention being to let the cells go on working to exhaustion; it is therefore desirable to warn readers against using such cells, which are most extravagant and unsatisfactory. Used for the purposes to which it is suited, the bichromate cell is one of the most useful; it furnishes a most powerful current for a very short time, it is therefore admirably adapted for short experiments with induction coils, as it gives a greater force than the nitric acid batteries, and has no unpleasant fumes, while it can be set aside for weeks and be ready for action at any instant. But for long-sustained action it is utterly useless, as its force fails very fast. The simple action of raising and lowering the zinc, however, instantly restores it. The reason of this is that there is no circulation in the liquid owing to no gas coming off, and the motion of the zinc stirs the liquid up. Thus by setting up the battery in a thin glass vessel to which heat can be applied by a gas burner, I have maintained the current in full even flow until the whole liquid was exhausted.

The containing vessel is usually a glass bottle, the lower part of which is enlarged with a globe, but this is merely for the convenience of holding a large quantity of solution: any kind or shape df vessel will equally serve. The essential part is the top, to which the plates are secured. This is best made of ebonite, but hard baked wood well soaked with paraffin will answer. In the centre is secured a brass tube, split at the upper part, which projects in order to grip firmly the brass rod which slides in it, and supports the zinc; a plate or wire of metal passes from this tube to the binding screw, which is fixed with the cover for the zinc or connection. This part is often troublesome, as the zinc tarnishes, and imperfect connection follows. The best remedy for this is to thoroughly gild the interior of the tube, and that part of the supporting rod which is in contact with it while the zinc is immersed. It is a great improvement also to form a screw thread on the top of the tube, and fit to it a nut, by tightening which contact is improved, and the zinc firmly held up when not in action; also a square tube and rod are better than round ones, as they keep the zinc always parallel with the carbons. The zinc is commonly fixed to the rod by means of a screw on the end, but it is far better to solder them together. I was once greatly troubled with an irregular battery, which I could not keep to its work, though I pulled it to pieces and set everything right, and after great trouble traced the whole fault to this point—acid had found its way into the thread of the screw and entirely destroyed the connection. The carbons are secured to the cover by means of two angle pieces or brackets of brass or iron, as shown (*a* fig. 42), and these brackets are connected to the cross binding screw. The connection is thus one of simple contact, and with a porous carbon it is common for acid to find its way up between the surfaces and destroy the contact. This may be entirely remedied by the plan described in sec. 133, and the upper part of the carbon being coppered the bracket may be soldered to it, and perfect connection ensured, and protected by a covering of paraffin.

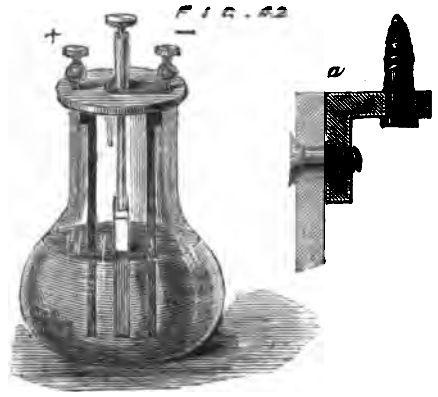
As the conditions of working of this cell are so variable, it is nearly impossible to make any estimate of its cost. For experiment I fitted up a small cell which, connected with the same coppering arrangement as in other cases, showed at first 65°, falling at five minute intervals to 61°, 53°, 35°. On raising and replacing the plates it rose to 64°, and fell as before; as I did this several times the result would approach to those of ordinary working, and the solution used being equal to 3·54 units, 3·22 of zinc were dissolved, and 1·72 copper deposited. This gives an actual loss by local action of about 87 per cent., and of 100, including the solution left unacted on. The cost per unit being—

32·6 zinc, at 7d.	228
50 bichromate, at 8d.	400
50 × 2⅓ acid = 117, at 1¼d...	146
	774
This divided by 7,000, gives per unit	1106

which doubled brings the actual cost to 2212, or between a fourth and a fifth of a penny per unit. In order to obtain the greatest economy in working this battery, care should be taken that no larger surface of zinc is immersed than is necessary to do the work. It is the large surface of carbon which most conduces to the effect of the zinc. Only enough is needed to effect the chemical action as fast as it is required; as soon as this is exceeded the local action is favoured, and no advantage gained.

145.—BICHROMATE SOLUTION.—I must here correct an error made (p. 341) as to the solution for use with this battery. Describing this in two forms (sect. 142), I said the *last* was similar to that usually recommended. The first is really the most like the proportion of, acid as 1 to 12, being 87 to 1000; the second, 115 to 1000, is of course considerably in excess; observing this I wished to examine the calculations afresh and to test results. The conclusion I have come to is that the authors who recommend this proportion have considered only the acid required by the salt itself and overlooked that needed for the zinc, and that consequently nearly every one using the bichromate cell wastes unnecessarily one third of the

FIG. 62



salt, the most expensive part of the working ingredients. This is evident from the following experiment:—I took 200 grains of solution and added one twelfth or 17 grains of sulphuric acid and left a piece of zinc in it for 24 hours. The solution is equivalent to 15·39 grains of zinc, but only 11·61 were dissolved. In a similar quantity with 30 grains of acid, the ratio given in the table, 24·82 grains were dissolved. This last is considerably over the equivalent, but the reason is to be found in an action subsequent to the real process—viz., a reduction of the chrome alum by the excess of zinc and the formation of an insoluble deposit; a similar action had occurred in the first solution also, making the apparent action higher than the true one. I may add that the action in the battery of the solution as given by me is much more constant than usual, but the local action somewhat greater—both due to increased activity, which produces heat at the surfaces of the plates and a consequent circulation of the fluid, aided by a tendency to giving off a little gas.

It is unnecessary to say anything further of the solution given by Delaurier for the simple cell, as exactly the same remarks apply to it as to that given for use in the porous cell.

146. Perchloride of Iron.—This has been recommended for use both in porous cells and in simple cells. I have experimented with it at different times, but with little satisfaction. It has the same disadvantage as the Bichromate—rapid failure of current owing to the want of circulation; and therefore I will not occupy space with any particulars, but pass on to those forms of cell in which solid oxidizing agents are employed.

Errata.—Page 340, column 3, line 22 from bottom, a full stop instead of comma after "oxygen" breaks the sentence and destroys its meaning; in second line, paragraph 142, "nitrous power" should be "nitrous fumes."

ECONOMISING HEAT.

MOST persons who have any practical acquaintance with the production and utilization of steam are aware of the loss of heat, and consequent waste of fuel and power, caused by the radiation from the unprotected surfaces of boilers and pipes. As the baker wraps his rolls in a blanket, in order to keep them hot for breakfast, so we should cover up our boilers and pipes in some way to prevent the loss of that heat which is in reality the "prime" mover. For this reason we wish to call attention to the non-conducting composition of Messrs. Leroy, a circular from whom, with testimonials, is now before us. The advantages claimed for this substance are lightness, cheapness, adhesiveness, durability, and non-conductivity. It adheres to iron and other metals without "lagging" or binding, and while preventing radiation, effectively preserves the iron from rust. It cannot catch fire; and it is not necessary to remove it to examine the boiler, as it shows the smallest leakage immediately. For boilers exposed to the atmosphere, and which are consequently peculiarly liable to injury from unequal expansion and contraction caused by extremes of temperature, it is invaluable, effectually preventing those evils, as well as securing the material from the effects of rust. By applying this composition to the steam pipes and cylinders, the engine may be removed some distance from the boilers without the power of the steam being materially deteriorated.

Applied to the boilers of steam boats it not only economises the fuel, but, by preventing radiation, reduces the temperature of the engine-room (which has hitherto been unbearable for any length of time), and as a natural sequence, of the other parts of the vessel. One advantage of this particular composition is that any person can apply it; and it lasts a much longer time than the ordinary felt. A saving of at least 15 per cent. of fuel is claimed for this composition.

FRICTION IN STEAM CYLINDERS.

By Mr. P. Jensen.

(Concluded from page 345.)

STORER'S lubricator, patented in 1866, deserves some notice, because it has been brought prominently before the public. The lid of the lubricator is fixed by means of a bayonet-joint. A screw passes through the lid, and its end is tightened down on a soft metal seat: this is for shutting off the lubricator. A strainer or cage fits over the bottom outlet, which has a cock below for regulating the quantity of steam coming in and grease passing out. Supposing this grease cup be filled with suet, which is the material it is worked with, the suet will first melt, and the light oil which is present in it will be brought forward and in a profuse quantity enter the cylinder. This is an operation requiring but very little time; but the suet will remain in the grease cup for many hours after that, but only the gelatinous part of it, which partakes of the nature of glue, and is gradually being distilled off, and is of no use to the cylinder, but rather does it harm. We then see that the action of this lubricator is very imperfect, very irregular, and, in point of fact, nearly as barbarous as the old grease cup; nevertheless, it has been brought widely into use, and maintains its position on account of its cheapness and simplicity.

Attwood's tallow-pump, patented in 1864, was a step in the right direction. Though it has since been superseded by better means it well deserves a notice. The body of the pump is provided with a steam jacket, to keep the tallow hot, otherwise it is fitted like an ordinary pump, with valves and piston, which latter is worked up and down by being connected to some reciprocating part of the engine. The point of attachment is made variable to regulate the quantity of tallow injected. This apparatus ranks intermediately between the old fashioned way of injecting the whole contents of the grease cup every two hours or so, and the modern way of continuously greasing the steam. It would even now be useful, were it not for the often troublesome matter of keeping the valves in proper order, and of arranging its connection to the engine, and for the circumstance that the engineer in charge is too apt to forget all about the tallow pump. Finding that it gives too much tallow if always at work, he throws it out of gear, and often forgets to throw it into gear till too late. Engineers in charge of flour-mills, and other works where the power is variable, sometimes say that a tallow pump is the right thing, or else the old grease cup, because the engine often labours hard when the stones are pressed together a little too much, and a sudden injection of tallow is apparently beneficial, the engine at all events recovering its speed. A little consideration has, however, persuaded many of them that this view of the case is quite wrong; if such a quantity of tallow is required all at once, and does produce such a marked effect, what must be the state of the piston and other internal parts? The answer is—very much too dry. But this would never happen were the steam properly lubricated. There is no surer way of clogging the piston-rings, &c., nor a more likely way of starting red-lead joints, than by injecting a quantity of tallow at once. If a mill engine labours occasionally, the power is not large enough to overcome the resistance; and it is the wiser plan to improve the condition of the engine, and thus increase its actual power, than by dosing it with what might be likened to a strong dram of neat spirits, all very well in extreme cases, but very bad taken habitually.

It will have been observed, that all the lubricators hitherto described are regulated more or less by throttling the steam admission to them, a consequence of which is that the least dirt is apt, as experience has shown, to stop their action altogether. Within the last two years another lubricator, acting on the displacement principle, but yet working in a different way to the others, has been introduced. It is the invention of Mr. Gamble. The principle of this lubricator is this. The steam comes in from the steam-pipe, passes over the surface of the tallow, which it absorbs and retains in the shape of vapour charged with tallow. This is true as regards part of the steam, but the other part condenses and falls to the bottom. There is, consequently, a continuous charging of the entering steam with tallow, a continuous condensation of entering steam, and a consequent tendency to rise in the level of the tallow floating on the water. To restore the equilibrium, one of three things may take place. There may be a continuous return flow of vaporized tallow from or near the surface back into the steam-pipe, and thence into the cylinder, or a continual flow of condensed water, if it could be siphoned out from the bottom, or a continual flow of a mixture of both. In his latest modification, Mr. Gamble has contrived a simple means of accomplishing the object, and at the same time making it a perfect means of regulation. The steam enters from one side, through a pipe, and rises into the steam space, part of it falls to the bottom, as water, while part of it may flow back as greased steam or vaporized tallow. The steam-pipe, at its termination at the centre of the apparatus, has a small hole at the tallow level for the entering of the steam, and the egress of the greased steam. The steam-pipe has a siphon-pipe screwed into its bottom, reaching nearly down to the bottom of the lubricator. Into the inside top of this siphon-pipe a small pipe—the regulating-pipe—is screwed, which has a small hole in its side, and has plenty of play round it when it passes through the steam-pipe. If this pipe is screwed down, so as to have the hole in its side at the same height as the steam or tallow-hole, then, singularly enough, no doubt owing to the capillary attraction, the water will take the preference, and will continue to be siphoned out from the bottom as fast as it comes in and condenses, so that little or no lubrication takes place. On the other hand, if the regulating pipe is screwed up so that its hole comes somewhat over the steam or tallow-hole, then no water will be siphoned out from the bottom, and a very plentiful lubrication with tallow takes place. In any intermediate position, partly tallow and partly water will overflow into the steam-pipe. This can be regulated to the greatest nicety. In one case, for instance, the engineer in charge said that if the lubricator emptied itself in ten hours it would do. It was set to do it, and did it. He found that he had more tallow on his rods than he wanted. It was regulated accordingly, and then used its tallow in fifteen hours. He found that he had got more than enough lubrication even then, and it was accordingly set so as to empty itself in twenty-two hours. As the mill works twenty-two out of the twenty-four hours, that just suited him. He fills the lubricator once a day, while oiling round, and does not trouble himself further about it, for it will just use its tallow by the time he has done. These lubricators will work in very hot engine-rooms, without special means for condensing the steam. The means of regulation are such as not to offer temptation for meddling, for the jam screw must be taken out of the top after the steam has been shut off. A little crutch key is fitted into the top of the regulating pipe, and by turning it a trifle up or down more or less tallow is fed into the steam. But there is no regulation by throttling the entering steam by means of the steam-cock, and neither is there any regulation by contracting the opening for the overflow of the tallow. These lubricators are simple in construction, and they have no working or wearing parts that require looking after or setting or renewing, and when once regulated they are always set, no further trouble being incurred than to draw the condensed water off, and fill afresh with tallow. As soon as the engine has started its action begins at once. They are now working successfully on marine engines, locomotives, stationary and portable engines, and are made in suitable sizes for all purposes.

The same principle is carried out in a different way by another arrangement. As steam users sometimes ask for a lubricator with which they can at any time vary the supply of tallow, the inventor contrived this arrangement. The author contends, however, that this is quite unnecessary, except in very few cases. As before explained, if an engine is constantly and properly lubricated, there is practically no need for constant regulation of the tallow supply. It is made in the shape of a hollow plug-cock passing vertically through the lubricator. The plug has several small ports with corresponding holes in the plug shell, which is fitted with a siphon-pipe, leading to the bottom of the lubricator, the same as the others. To vary the respective vertical height of the tallow overflow and water overflow, the plug has a slanting slot corresponding with a horizontal slot in the shell; and by turning the cock to any of the pointer divisions on the outside of the lubricator neck, these levels can be varied to such an extent as to cause the same action as above explained with reference to the former class of Gamble's lubricators. The same objection may, however, with justice be urged against this last arrangement as against some of the lubricators by other inventors, which have been previously described—namely, that any cock arrangement in course of time gets out of order by constant wear.

The author has now, it is hoped, shown that steam lubrication is a subject well worth taking into account in steam-engine economy; also, that the continuous system is the only correct one, and ought to be more generally introduced, wherever the old-fashioned and wasteful intermittent system has been found better than no lubrication at all. It is therefore important that engineers should more generally take notice of these facts, which form a small link in the large chain of steam economy.

REVIEWS.

Water Analysis: a Practical Treatise on the Examination of Potable Water. By J. Alfred Wanklyn, M.R.C.S., late Professor of Chemistry in the London Institution, and Ernest Theophron Chapman. Second Edition, edited by Ernest Theophron Chapman, Member of the Council of the Chemical Society. London: Trübner & Co.

THIS work, the second edition of which is now before us, although doubtless invaluable to analytical chemists, contains but little to interest the general public. The science of water analysis is as yet in its infancy, and while "doctors differ" as to even the method to be pursued in determining the purity of samples of water, it cannot be matter of surprise that we should decline to pin our faith too strictly to one side or the other. This *brochure* contains elaborate expositions of the experiments of Messrs. Wanklyn and Chapman to arrive at the relative salubrity of the waters supplied to some of our most important towns; and while agreeing in the main with the conclusions of these gentlemen, we cannot but acknowledge that there is room for some more definite settlement of the vexed question of the impurity of water and the method of its analysis. The new matter in this edition consists of a chapter on the Tetration of Waters, a Modification of the Process for the Estimation of Nitrates, and a Method of Estimating Minute Traces of Lead; chapters on the Volatile Organic Matter present in Water, and on the Purification of Water. But there is no information which will serve to guide the public in the choice of a filter, though a few remarks of interest to our readers are contained in the following paragraph.

"Slow filtration through a layer 4in. thick of animal charcoal in coarse powder removes all organic matter from water, or almost all; but the charcoal fouls to some extent, and after it has been in use with a bad water for some length of time it lets much of the organic matter pass. If we take some of this charcoal out, and treat it with permanganate of potash and potash, we shall get off ammonia from it in large quantities, proving the presence of organic matter; but if we let it stand for some hours in the air, nearly all the organic matter will be oxidized and disappear."

After all that has been said as to the impurity of the water supplied to the metropolis, it is some consolation to be told that average London water from the Thames contains only 0·03 per cent. of impurity. We are at present very much in the dark with regard to the sanitary aspect of the amount of solids existing in water. Whether a water having an exceptionally small amount of solid contents is specially salubrious remains to be ascertained. A very large quantity of fixed matter is certainly unwholesome; for instance, sea-water is absolutely non-potable. But whether the twenty-one grains per gallon present in London water, or even double that amount, would do the smallest damage to the health of any one who should drink it, is an open question.

Undoubtedly sewage-contaminated water is and must be unwholesome, and it is matter for regret that nearly all the water supplied to London has been tainted at one time or another; but whether it is completely purified by contact with the oxygen of the air or is delivered in its impurity, is still a question for the *savants*, and the sooner it is settled the better for the credit of our scientific men, if not for the health of the people.

Transactions of the Woolhope Naturalist's Field Club, 1869. Hereford.

Natural history societies and naturalists' field clubs are doing good work through the length and breadth of the United Kingdom. There is scarcely a county which does not possess its coterie of "lovers of nature" and amateur philosophers, and by their untiring efforts (though here and there strongly tinged with egotism) we are rapidly acquiring a complete knowledge of the flora and fauna, the bryology and fungology of the whole country. The club whose transactions are now before us most certainly ranks as one of the best, as this volume of its proceedings amply testifies. In the record of what was done in 1869 by the members of the Woolhope Naturalists' Field Club we find papers on a variety of interesting subjects, some of course more particularly concerning the county of Hereford, others of interest to the whole kingdom. Thus, for instance, a paper on Spheroidal Structure in Silurian Rocks; Meteorology, by Balfour Stewart; Richardson's Forces of Electrical Discharge; some excellent illustrations, with descriptions, of the edible fungi of Herefordshire; and last, but certainly not least, a *Clavis Agaricinorum*, by Mr. Worthington G. Smith, now first published, together with a complete list of the British Agarics. The president, in the address with which he closed his year of office, speaking on the subject of mushrooms, said:—"Edible funguses, by their chemical constituents, are known to be highly nutritious, and in a great degree supply the elements of animal food; but hitherto the ignorance of those forms which were wholesome has deterred most people from making any use of them beyond the common mushroom. Without this practical knowledge it is undeniable that serious mistakes may be made, and therefore, the great aim of our fungologists should be to lay down some easily comprehended rules for the diagnosis of wholesome species." This the Woolhope Club are doing admirably, by giving coloured illustrations and minute descriptions of every variety found in the county of Hereford. Those illustrated in the present volume bear the inviting names of "Vegetable beefsteak," "Vegetable sweetbread," and "Plum mushroom." There is also a drawing of the "Hedgehog mushroom," which the Rev. W. Houghton describes as "one of the most excellent fungi that grows: its flavour very strongly resembles oysters." Besides the lithographs of the fungi there are photographs of two celebrated oak-trees in the county of Hereford, and to Mr. Worthington Smith's valuable "Key of the British Agarics," there are some plates of typical forms of fungi coloured to match the natural tints of their species; indeed, in the matter of illustration no expense seems to have been spared to render the "Transactions of the Woolhope Naturalists' Field Club" what it really is, a valuable book.

EMIGRATION.

A Few Remarks on Victoria.—(*Concluded.*)

By "F.R.G.S."

Manufactures.

IT is with mingled feelings of regret and pleasure that I pen these last remarks upon this flourishing colony. In the attempt to convey information—whether that attempt be good or bad—I always derive pleasure, but I sincerely regret the circumstances which call for any such information as that contained in my humble efforts. It is a momentous question to be decided, which places home, friends, and fatherland, combined with want of work, on the one hand, and a new country, new associations, with plenty of work on the other. I feel there rests a great responsibility upon every writer on this subject. Many people are tempted to make a decision to emigrate here or there, as the case may be, by the advocacy of popular writers or demagogues paid by interested persons to whitewash every drawback—nay, more, to paint everything in the most gorgeous colours that can be imagined. How careful then should every conscientious person be who dabbles with this question. How deliberately should his statements be chosen, his extracts weighed; for if one person is influenced by one sentence, and upon experience finds the fact stated therein fallacious, ruin is the result, but the responsibility rests upon the writer's shoulders. Could I, by high flights of oratory and rhetoric, pour forth the despairing accents of hundreds of the surrounding population—were I, perhaps, the heir or the head of an aristocratic name, and influenced by the feelings I now possess—then some good might arise from the advocacy of the claims of such as would work if work there were to do. It cannot be denied but that in this enlightened country the vast majority of questions are settled by influence, and not from the innate goodness or badness of the questions themselves.

Millions are spent annually upon a vast army and navy, upon material for destroying our fellow men; but where do we find brotherly love, the hand of fellowship, or the suffering of an imaginary (or real) wrong, without persistent efforts at retaliation. But what has this to do with emigration? I say, much. Look at New Zealand. Ten centuries hence the acts of Englishmen will be read with abhorrence. Go to Australia. Have the Aborigines suffered nothing at our hands? Do not we perforce appropriate their property, and laugh at their futile efforts to recover it, paying the price of our inheritance by extermination?

If the thousands who now annually leave our shores were to go with a Christian determination to do what is right, we should soon hear no more of these terribly merciless massacres which every now and then flash meteor-like from America, Australia, or New Zealand.

Having given vent to various pent-up feelings, and mentioned subjects requiring long and calm meditation, I return to my subject. The manufactures of Victoria were for many years scarcely worth mentioning, and even now it is difficult to say what is the staple manufacture of the colony. Perhaps that which has latterly drawn most attention is the preservation, &c., of meat. Owing to the scarcity of animal food in England, ingenious minds turned their attention to the importation of "meat" from the countries where superabundant "animals" existed. South America and Australia were looked upon as the great "flesh-forming emporiums." Companies were floated for the purpose of preparing the "meat," and the most successful of these is the "Melbourne Meat Preserving Company." At a recent meeting a dividend of 10 per cent. was declared, and a balance of more than £9,000 was carried over to the reserve fund. Far more important to my readers than the percentage gained is the statement of payments for labour. I find that for a longer period than the past eight months the company has paid away *weekly* a sum of not less than £1,000 for labour and materials. In six months 160,752 sheep and 590 oxen had been disposed of, and there was every prospect of more extended and more successful operations. Better than dwelling upon the various manufactures, I will give a list of the *raw materials* of the colony, taken from an elaborate prize essay by C. Mayes, C.E., entitled "Essay on the Manufactures more immediately required for the Economical Development of the Resources of the Colony":—

Mineral Substances.

Basalt, clay (pottery and fire), cement, stones, coal, feldspar, gems (diamonds, topaz, beryl, &c., &c.), gold, iron (hæmatite, &c.), limestone, manganese (oxide), quartz, salt, tin, &c.

Vegetable Substances.

Arrowroot, almonds, bark, barley, beet-root, beans, carraway, cucumber, castor-oil plant, colza-oil plant, cabbage, fruits (mostly similar to English), gum (various), grapes, grape seed, hemp, hop, lavender, maize, mulberry, narcissus, olive, oat, orange, poppy, potato, rose, sassafras, tobacco, wheat, walnut, &c., &c.

Animal Products.

Offal (all kinds—*e.g.*, bones, furs, horns, hoofs, &c., &c.), hides, &c., tallow, and wool.

Most of these products are utilized to a greater or less extent, and therefore readers will be able to form an opinion regarding the manufactures:—

Addenda II. (From the *Times*, June 28.)

The annual general meeting of the Chamber of Commerce was held in Melbourne on the 20th April. The retiring president, Mr. Lorimer, read his annual address, and in reviewing our recent commercial history he touched on many topics interesting to commercial men in all parts of the world. After remarking on the depressed state of trade during the past year, which he attributes to excessive importations, he proceeds as follows:—

"A reference to the statistics of our import trade, as furnished by the Customs' returns, does not exhibit any great increase in the importations of last year, when considered in connection with the increase of population. The total value of imports in 1869 was £13,908,990, including £1,415,473 for gold, the produce of New Zealand. It was pointed out last year that this gold was included in the returns of imports for the first time in 1868, and it is therefore necessary to deduct the item from the returns of both years in order to institute a fair comparison with previous ones. We then get a value of £12,498,517 for all other imports in 1869, as against £12,014,836 in 1868. The population during the year increased from 683,977 to 710,284, so that the value per head of the population rose from £17 11s. 4d. in 1868 to £17 11s. 9d. in 1869. This increase may to some appear unimportant, but it must be borne in mind that for years our importations have been in excess of our actual wants, and that the changes in the circumstances of the people have considerably diminished their consumption of imported commodities. The increase of £478,681, as shown above, has, therefore, overstocked our markets. The articles which chiefly make up this increase are all subject to the new duties imposed by the present tariff, and the increase of £447,109 which the figures exhibit must be very bewildering and disappointing to those politicians who imposed the duties for the purpose of restricting importations and encouraging local industries. With reference to our export trade, it appears that contemporaneously with the increase in imports there was a considerable diminution in the value of exports. The decline of wool last year was somewhat compensated for by a material increase in other products of our pastoral industry—viz., tallow, skins, leather, bone-dust, and preserved meats, the last-named article contributing £80,885 to the value of exports, as compared with £28,565 the previous year."

Addenda III. (From the *Times*.)

The following extract, relating to the state of the labour-market, is from the *Argus* of April 23rd. It disposes of the foolish and selfish "mechanic cry" raised from time to time here against the continuance of assisted immigration:—

The Labour Market.

"The long-continued drought having now fairly broken up, farming operations have been resumed with great activity throughout the country, and there has been a corresponding demand created for farm labourers. All descriptions of tradesmen are able to obtain full work at the current rate of wages. In many parts of the country the rates rule higher than those quoted. On one Government contract the bricklayers employed were receiving 12s. per day, and an attempt was made to extort 14s. per day by means of a strike. For domestic servants the demand is as great and as badly supplied as ever. Since last mail, the immigrant ship *Percy* has arrived with 366 passengers; but, owing to sickness on board, the vessel has been detained at the quarantine ground. As most of these passengers will go to their friends, the market will be but slightly relieved."

Addenda IV.

The reform agitation is still fresh in our memories, and agitations are still in progress relating to education and other matters. Would it not be advisable to "agitate" that the Government supply information, more especially adapted to the wants of immigrants, relating to every "colony" under British rule. This information could be supplied in pamphlet form at a remunerative price of (say) 6d.

MEDICAL EXPERIMENT.

On Monday, July 4th, a large gathering of the medical profession, numbering very nearly 2,000, and embracing the *élite* of the metropolitan and surburban practitioners and some distinguished foreign visitors, assembled at the invitation of one of their fraternity, at the Royal Polytechnic Institution, to witness the trial of a new mode of conveying practical instruction in a department of surgery which has long been considered as one of the *opprobria medicinæ*. For some time past efforts have been made to improve in various ways the means of imparting clinical information, as distinguished from mere book-knowledge, to the students of medicine in this country. The University of London has of late taken the lead amongst examining bodies, by requiring of its graduates in medicine that they should pass a *practical* examination, in addition to the previous theoretical examination, in order to obtain its much-coveted degrees; and the late Sir James Clark was a steadfast advocate of the necessity of improvement in this most important branch of medical education. The large theatre and effective optical apparatus of the Institution having been placed for this purpose by the directors at the disposal of the profession, Dr. Balmanno Squire proceeded to demonstrate to his audience some of the more important cases of cutaneous disease that had lately occurred in the practice of the British Hospital for Diseases of the Skin in Great Marlborough-street, and also in Finsbury-square, of which institution Dr. Squire is one of the honorary surgeons. The room having been darkened, magnified images of the patients themselves were thrown, considerably larger than life-size, on the spacious screen of the theatre, by means of the dissolving-view apparatus, so that all the details of the various eruptions were plainly visible even from the most distant parts of the theatre. Dr. Balmanno Squire, after given a *résumé* of the acknowledged difficulties of imparting a practical knowledge of the medical art to students, proceeded to show how the method he submitted would dispose at least of the more serious of these difficulties, and explained that it was not only applicable to the department of practice that he himself followed, but was capable of wide extension to the subject of medical education generally. Students of medicine at every hospital persisted in flocking round the most popular teacher; consequently, but a few could get anything like a satisfactory view of the patient concerning whose case instruction was being given. Again, it was by no means an easy thing, even at our largest hospitals, to find within a limited space of time a sufficient variety of illustrative cases to enable the members of any given class to go forth from the hospital with a comprehensive practical knowledge of the subject treated. The plan he proposed would, by magnifying the object to be demonstrated, enable every detail to be seen by every member of a large class, and to be pointed out to all of them by the lecturer at the time he was describing it. By the method proposed, the patient might be instantaneously photographed before either the natural progress of his disease or its amelioration under the resources of art had impaired its utility as a means of conveying instruction; and at the same time in cases where colour formed an important feature of it, this could be added to the photograph itself by an expert artist, working under the eye of the teacher himself. In the case of cutaneous disease—the most difficult of all subjects to illustrate by these means—colour was certainly a most important feature. But he appealed to those he saw around him, many of whom he knew to be well versed in this special subject, whether the illustrations he had brought before them were not in colour as well as in form and shadow sufficiently life-like to afford a lecturer ample opportunity for pointing out to a class of students all the essential peculiarities of each disease, and to enable those students when they entered upon private practice to recognize at once the nature of similar cases whenever they might meet with them. He trusted to see at the next medical session this important aid to tuition, as he would take leave to call it, utilized at all of our great medical schools, not only in the matter of cutaneous diseases, which might be taken as a crowning test of its efficacy, but also in the matter of tumours, dislocations, deformities, fractures, characteristic alterations of the countenance, and in short, all occasions to which this process is applicable.

WHAT IS ENERGY?[*]

In Two Parts.—Part II.

In our first article it was shown that energy, or the power of doing work, is of two kinds—namely, energy due to actual motion, and that due to position. We ended by supposing that a stone shot vertically upwards had been caught at the summit of its flight and lodged on the top of a house; and this gave rise to the question, What has become of the energy of the stone? To answer this we must learn to regard energy, not as a *quality*, but rather as a *thing*.

The chemist has always taught us to regard quantity or mass of matter as unchangeable, so that amid the many bewildering transformations of form and quality which take place in the chemical world, we can always consult our balance with a certainty that *it* will not play us false. But now the physical philosopher steps in and tells us that energy is quite as unchangeable as mass, and that the conservation of both is equally complete. There is, however, this difference between the two things—the same particle of matter will always retains the same mass, but it will not always retain the same energy. As a whole, energy is invariable, but it is always shifting about from particle to particle, and it is hence more difficult to grasp the conception of an invariability of energy than of an invariability of mass. For instance, the mass of our luminary always remains the same, but its energy is always getting less.

And now to return to our question,—What has become of the energy of the stone? Has this disappeared? Far from it; the energy with which the stone began its flight has no more disappeared from the universe of energy, than the coal, when we have burned it in our fire, disappears from the universe of matter. But this has taken place:—the energy has changed its form and become spent, or has disappeared as energy of actual motion, in gaining for the stone a position of advantage with regard to the force of gravity.

If we study this particular instance more minutely, we shall see that during the upward flight of the stone its energy of actual motion becomes gradually changed into energy of position, while the reverse will take place during its downward flight if we now suppose it dislodged from the top of the house. In this latter case the energy of position with which it begins its downward flight is gradually reconverted into energy of actual motion, until at last, when the stone reaches the ground, it has the same amount of velocity, and therefore of actual energy, which it had at first.

Let us now revert for a moment to the definition of energy, which means the power of doing work, and we shall see at once how we may gauge numerically the quantity of energy which the stone possesses; and in order to simplify matters, let us suppose that this stone weighs exactly one pound. If therefore, it has velocity enough to carry it up one foot, it may be said to have energy enough to do one unit of work, inasmuch as we have defined one pound raised one foot high to be one unit of work; and in like manner if it has velocity sufficient to carry it 16ft. high, it may be said to have an energy equivalent to 16 units of work or foot-pounds, as those units are sometimes called. Now, if the stone be discharged upwards with an initial velocity of 32ft. per second, it will rise to 16ft. high, and it has therefore an energy represented by 16. But if its initial velocity be 64ft. per second it will rise 64ft. high before it turns, and will therefore have energy represented by 64. Hence we see that by doubling the velocity the energy is quadrupled, and we might show that by tripling the velocity the energy is increased nine times. This is expressed in general terms by saying that the energy or quantity of work which a moving body can accomplish varies as the square of its velocity. This fact is well known to artillerymen, for a ball with a double velocity will penetrate much more than twice as far into an obstacle opposing its progress.

Let us now take the stone or pound weight, having an initial velocity of 64ft. per second, and consider the state of things at the precise moment when it is 48ft. high. It will at that moment have an actual velocity of 32ft. per second, which, as we have seen, will represent 16 units of work. But it started from the ground with 64 units of work in it. What, therefore, has become of the difference—or 48 units? Evidently it has disappeared as actual energy; but the stone, being 48ft. high, has an energy of position represented by 48 units; so that at this precise moment of its flight its actual energy (16) *plus* its energy of position (48), are together equal to the whole energy with which it started (64).

Here, then, we have no annihilation of energy, but merely the transformation of it from actual energy into that implied by position; nor have we any creation of energy when the stone is on its downward flight, but merely the re-transformation of the energy of position into the original form of actual energy.

We shall presently discuss what becomes of this actual energy after the stone has struck the ground; but in the meantime we would repeat our remark how intimate is the analogy between the physical and the social world. In both cases we have actual energy and energy of position, the only difference being that in the social world it is impossible to measure energy with exactness, while in the mechanical world we can gauge it with the utmost precision.

Proteus-like, this element energy is always changing its form; and hence arises the extreme difficulty of the subject; for we cannot easily retain a sufficient grasp of the ever-changing element to argue experimentally regarding it. All the varieties of physical energy may, however, be embraced under the two heads already mentioned, namely, energy of actual motion and of position. We have chosen the force of gravity, acting upon a stone shot up into the air, as our example; but there are other forces besides gravity. Thus, a watch newly wound up is in a condition of visible advantage with respect to the force of the main-spring; and as it continues to go it gradually loses this energy of position, converting it into energy of motion. A cross-bow bent is likewise in a position of advantage with respect to the spring of the bow; and when its bolt is discharged, this energy of position is converted into that of motion. Thus again, a meteor, a railway train, a mountain torrent, the wind, all represent energy of actual visible motion; while a head of water may be classed along with a stone at the top of a house as representing energy of position. The list which represents visible energy of motion and of position might be extended indefinitely; but we must remember that there are also invisible molecular motions, which do not the less exist because they are invisible.

One of the best known of these molecular energies is *radiant light and heat*—a species which can traverse space with the enormous velocity of 186,000 miles a second.

Although itself eminently silent and gentle in its action, it is nevertheless the parent of most of the work which is done in the world, as we shall presently see when we proceed to another division of our subject. In the mean time we may state that radiant light and heat are supposed to consist of a certain undulatory motion traversing an ethereal medium which pervades all space.

Now, when this radiant energy falls upon a substance, part of it is absorbed, and in the process of absorption is converted into *ordinary heat*. The undulatory motion which had previously traversed the thin ether of space has now become linked with gross palpable matter, and manifests itself in a motion which it produces in the particles of this matter. The violence of this rotatory or vortex-like motion will thus form a measure of the heat which the matter contains.

Another species of molecular energy consists of *electricity in motion*. When an electric current is moving along a wire, we have therein the progress of a power moving like light with enormous velocity, and, like light, silent in its operation. Silent, we say, if it meets with no resistance, but exceedingly formidable if it be opposed; for the awe-inspiring flash is not so much the electricity itself as the visible punishment which it has inflicted on the air for daring to impede its progress. Had there been a set of stout wires between the thunder-cloud and the earth, the fluid would have passed into the ground without disturbance.

The molecular energies which we have now described may be imagined to represent motion of some sort not perceived by the outward eye, but present nevertheless to the eye of the understanding; they may therefore be compared to the energy of a body in visible motion, or actual energy, as we have termed it.

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[*] By Balfour Stewart, in *Nature*.

But we have also molecular energies which are more analogous to the energy of position of a stone at the top of a cliff.

For instance, two bodies near one another may be endowed with a species of energy of position due to *opposite electrical states*, in which case they have a tendency to rush together, just as a stone at the top of a cliff has a tendency to rush to the earth. If the two bodies be allowed to rush together, this energy of position will be converted into that of visible motion, just as when the stone is allowed to drop from the cliff, its energy of position is converted into that of visible motion.

There is finally a species of molecular energy caused by *chemical separation*. When we carry a stone to the top of a cliff, we violently separate two bodies that attract one another, and these two bodies are the earth and the stone. In like manner when we decompose carbonic acid gas into its constituents we violently separate two bodies that attract one another, and these are carbon and oxygen. When, therefore, we have obtained in a separate state two bodies, the atoms of which are prepared to rush together and combine with one another, we have at the same time obtained a kind of energy of molecular position analogous on the small scale to the energy of a stone resting upon the top of a house, or on the edge of a cliff on the large or cosmical scale.

MOTIVE POWER FROM DEEP WELLS.

THE value of the hydraulic ram for raising water to the top of country mansions, by utilizing the power of a neighbouring stream, has already been proved by experience; but to raise water from wells, the pump has hitherto been considered the most convenient apparatus. But if the invention of Mr. Hanreau, of Meaux, France, succeed according to his anticipations, pumps will no longer be necessary. Take a case in which it is proposed to raise a certain height the water of a spring or stream rising in an ordinary well. This well is extended to the necessary depth for affording a fall below the level of the spring or stream sufficient for actuating a hydraulic ram placed a short distance from the bottom of the well. At the bottom of the well a boring is effected until the absorbent bed is reached. The characteristic feature of this arrangement consists in intercepting the water of the spring or stream by means of an annular trough communicating with a reservoir, from which the water descends into the hydraulic ram through a conduit. One portion of the water escapes through the valve of the ram and flows away through the tubing into the bed which absorbs it. The other portion is raised by the action of the ram through the pipe into a reservoir, where it is employed for any desired purpose. The opening of the tubing is covered by a grating for preventing the entrance of foreign matter, which might eventually choke the tubing, and also destroy the absorbent properties of the bed. If the yield of water in the well is too small, a second reservoir may be connected to the first by means of a siphon with intermittent action.

THE LEAF AS A WORKER.

DR. J. S. SEWALL, in the *American Entomologist and Botanist*, says, Let us consider the leaf as a *worker*. Let us learn *what* it does, and *how* it does it. In the first place, let us fully understand what we mean by *worker*—or let us agree as to the definition of the term. To illustrate, we say of the locomotive, that it performs a certain amount of labour, it turns so many wheels, drives so many looms, draws so many cars so many miles an hour—we speak of it as a worker. So, too, of man—we speak of him as a worker. He performs so much labour, physical or mental. Yet the locomotive, with all its ponderous bars, its mysterious valves, its great levers, its hidden springs, can do nothing. It is dead, inert metal. True, too, of man—that wonderful combination of bones and muscles and nerves and tissues can do nothing, but decay, and be resolved to dust again. The brain cannot think, the eye cannot see, the ear cannot hear, the nerves cannot thrill, the muscle cannot contract.

In the *same sense* the leaf can do nothing. Yet in the *same* sense that a locomotive can draw a train, or that man can think and labour, is the *leaf* a labourer that outworks them all. The locomotive is a combination of material things so arranged that through or by them we discover the operations of force. Man himself is nothing more. The leaf is the same. Better, perhaps, that we say that these are the *workshop* wherein force exhibits itself, and produces results. When did the leaf begin its work? It was the *first* to rise on creation's morn and go forth to labour. Ere the almost shoreless ocean dashed upon the low Silurian plain, the leaf was at its work. And through all the long ages it has worked—worked to develop better and higher forms of life. And the earth's broad face is written all over with the evidences of its faithfulness.

Now what does it do? It pumps water from the ground, through the thousands of tubes in the stem of the tree (the tubes which itself has made), and sends it into the atmosphere in the form of unseen mist, to be condensed and fall in showers—the very water that, were it not for the leaf, would sink in the earth, and find its way perchance through subterranean channels to the sea. And thus it is that we see it *works* to give us the "early and the latter rain." It works to send the rills and streams, like lines of silver, adown the mountain and across the plain. It works to pour down the larger brooks which turn the wheel that energizes machinery, which gives employment to millions. And thus a thousand wants are supplied—commerce stimulated—wealth accumulated—and intelligence disseminated through the agency of this wealth. The leaf does it all.

It has been demonstrated that every square inch of leaf lifts three five-hundredths of an ounce every twenty-four hours. Now, a large forest tree has about five acres of foliage, or six million two hundred and seventy-two thousand six hundred and forty square inches. This being multiplied by three five-hundredths (the amount pumped by every inch) gives us the result—two thousand three hundred and fifty-two ounces, or one thousand one hundred and seventy-six quarts, or two hundred and ninety-four gallons, or eight barrels. A medium sized forest tree, about five barrels. The trees on an acre give eight hundred barrels in twenty-four hours. An acre of grass, or clover, or grain, would yield about the same result.

The leaf is a worker, too, in another field of labour, where we seldom look—where it exhibits its unselfishness—where it works for the good of man in a most wonderful manner. It carries immense quantities of electricity from the earth to the clouds, and from the clouds to the earth. Rather dangerous business transporting *lightning*. I think it would be considered contraband by the "U.S," or "Merchant's Union,' or any common carriers; but it is particularly fitted for this work. Did you ever see a leaf entire as to its edges? It is always pointed, and these *points*, whether they be large or small, are just fitted to handle this dangerous agent. These tiny fingers seize upon and carry it away with ease and wonderful despatch. There must be no delay; it is "time freight." True, sometimes it gathers up more than the *trunk* can carry, and in the attempt to crowd and pack the baggage the trunk gets terribly shattered, and we say that lightning struck the tree. But it had been struck a thousand times before. This time it was overworked.

As we rub a stick of sealing-wax or a glass tube with a warm silk handkerchief, so the air is always rubbing over the face of the earth with greater or less rapidity. And what a huge electrical machine! But be not afraid, the leaf will see that it is taken care of. As we guard our roofs from the destructive action of lightning—dashing to the earth—crashing, rending, burning on its way—by erecting the lightning rod, whose bristling points quietly drain the clouds, or failing to do this, receive the charge and bear it harmless to the earth—so God has made a living conductor in every pointed leaf, in every blade of grass. It is said that a common blade of grass, pointed by nature's exquisite workmanship, is *three times* as effectual as the finest cambric needle; and a single *twig* of leaves is far more efficient than the metallic point of the best constructed rod. What, then, must be the agency of a single forest in disarming the forces of the storm of their terror. Nature furnishes the lightning, and it furnishes the lightning rods. Take a hint, then, and plant trees.

THE HALFPENNY POSTAGE.

THE bill for further regulation of duties of postage, and for other purposes relating to the Post-office, has just been published. For the purposes of the Act, the Channel Islands and the Isle of Man are to be deemed parts of the United Kingdom. The Act will come in force on Oct. 1st. Allowance will be made for stamps to those who at that time may be in possession of them. Any publication coming within the following description shall, for the purposes of the Act, be deemed a newspaper—that is to say, any publication consisting wholly or in great part of political or other news, or of articles relating thereto, or to other current topics, with or without advertisements, subject to these conditions:—That it shall be published in the United Kingdom; that it shall be published in numbers at intervals of not more than seven days; that it be printed on a sheet or sheets unstitched; that it have the title and date of publication printed at the top of every page. The proprietor or printer of any newspaper may register it at the General Post-office in London, at such time in each year, and in such form, and with such particulars as the Postmaster-General from time to time directs, paying on each registration such fee, not exceeding five shillings, as the Postmaster-General, with the approval of the Treasury, from time to time directs. On and after the 1st of October, 1870, registered newspapers, book packets, pattern or sample packets, and post cards, may be sent by post in the United Kingdom at the following rates of postage:—On a registered newspaper, not exceeding, with any supplement, and with any cover, six ounces in weight, one halfpenny. On a book packet, or pattern or sample packet, if not exceeding two ounces in weight, one halfpenny; if exceeding two ounces in weight, for every additional two ounces, or fractional part of two ounces, one halfpenny. On a post card, one halfpenny. The Treasury may, from time to time, by Treasury warrant, allow any newspapers and periodical publications, British, Colonial, and foreign, to be sent between the United Kingdom and places out of the United Kingdom, whether through the United Kingdom or not, at such rates of postage not exceeding twopence for each newspaper or publication, irrespectively of any colonial or foreign postage, and on such conditions as they think fit, and according to Post-office regulations to be from time to time made in that behalf.

CARMINE.

THIS beautiful red pigment is obtained from the cochineal insects, which were natives of Mexico originally, but are now raised with success in many other countries, and particularly in India, Spain, and Algeria. They feed upon the Nopal cactus or prickly pear, on which the females fix themselves, being wingless, and from which they never move. At a certain time in the year they are gathered from the pear by means of a brush, and they are then plunged in hot water and exposed in the sun to dry. When dried they have the appearance of small berries or seeds, being of a grayish purple colour, and in this state they form the cochineal of commerce, and are exported to this and other countries for making carmine. It takes 70,000 of the dried cochineals to weigh a pound.

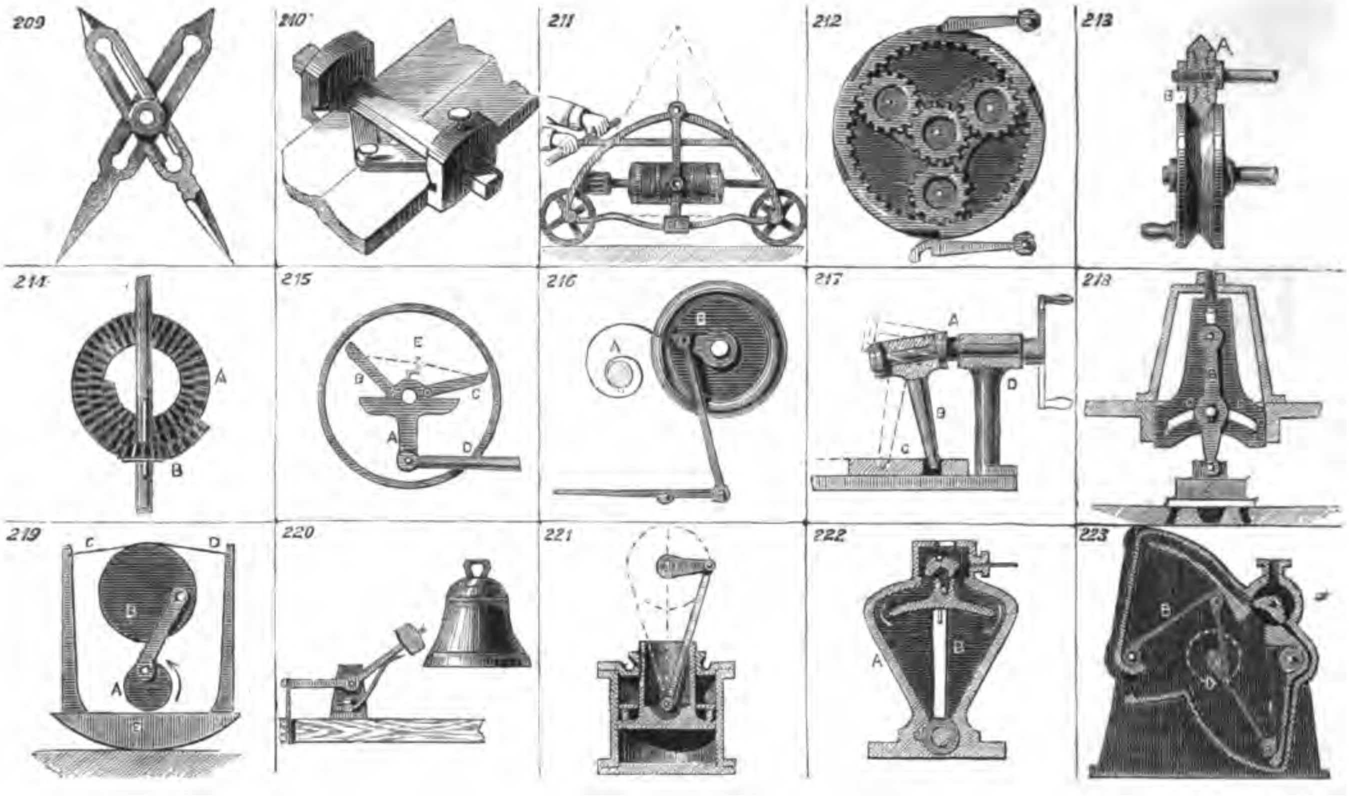
Carmine is the most brilliant of all red colours, but its beauty depends materially upon the method of manufacturing. It was first prepared by a Franciscan monk at Pisa, who discovered it accidentally while compounding medicines containing cochineal, and in 1656 it began to be manufactured. A great many experiments have been made to extract it in a state of absolute purity, but repeated trials have proved this to be a most delicate operation, and one requiring great skill, as well as very careful attention.

There are several modes of manufacturing it. One process is to digest 1lb. of cochineal in 3 gallons of water for fifteen minutes; then add 1 ounce of cream of tartar; heat gently for ten minutes; add half an ounce of alum; boil for two or three minutes; and, after allowing the impurities to settle, the clear liquid is placed in clean glass pans, when the carmine is slowly deposited. After a time the liquid is drained off, and the carmine dried in the shade. Roret, in his well-known encyclopædia of colours, gives the following as an old method:—20 grammes (310 grains) of cochineal, 2 grammes of the seed of chouan, an Oriental tree, 10 grammes of the bark of the autour, another Oriental tree, and 1 gramme of alum are pulverized, each in a separate mortar. 2 litres (2⅛ quarts) of very clear river or rain water is made boiling in a clean vessel. When it boils, the chouan is thrown into the vessel, and after boiling very fast the liquid is poured cautiously through fine white linen into another well cleansed vessel. This liquid is again made to boil, and when it commences boiling the cochineal is added; next autour, and at last the alum, at which moment the vessel is taken away from the fire. The liquid is poured into a porcelain plate, and left there for seven or eight hours in order to subside. Then the clear liquid which flows uppermost is cautiously discharged, and the sediment is exposed to the sun to dry. When dried it is gathered from the plate with a fine brush or a feather, and this very fine and very beautifully coloured powder is the carmine of cochineal.

In the preparation of carmine, much depends on a clear atmosphere and bright, sunny day, during the process, as the beautiful colour is in no case nearly so good when it is prepared in dull weather. This accounts in a great part for the superiority of French carmine over that made in England. Moreover, carmine cannot be made during cold weather, because in such case it will not precipitate to the bottom of the liquid, but will form into a sort of jelly, and in this condition will soon spoil.

Pure carmine is very expensive, and this has led to the manufacture and sale of many substitutes. All of them are inferior, however, and for finest work only the pure article should be employed.

THE SCHOOL OF MINES' SCHOLARSHIPS.—At a meeting of the Council of the Royal School of Mines held on Saturday, July 2nd, the following awards were made:—Two Royal Scholarships of £15 each for first year's students, to W. H. Greenwood and F. C. Mifoord; H.R.H. the Duke of Cornwall's Scholarship to P. C. Gillchrist; the Royal Scholarship of £25 to R. R. Atkinson; the De la Beche Medal and prize of books to W. Gowland; and the Director's Medal and prize of books to P. C. Gillchrist. The Edward Forbes Medal and prize of books were not competed for this year.



MECHANICAL MOVEMENTS.

MECHANICAL MOVEMENTS.*

(*Continued from page* 366.)

209. Proportional compasses used in copying drawings on a given larger or smaller scale. The pivot of compasses is secured in a slide which is adjustable in the longitudinal slots of legs, and capable of being secured by a set screw. The dimensions are taken between one pair of points and transferred with the other pair, and thus enlarged or diminished in proportion to the relative distances of the points from the pivot. A scale is provided on one or both legs to indicate the proportion.

210. Bisecting gauge. Of two parallel cheeks on the cross-bar one is fixed and the other adjustable and held by thumb screw. In either cheek is centred one of two short bars of equal length, united by a pivot, having a sharp point for marking. This point is always in a central position between the cheeks, whatever their distance apart, so that any parallel sided solid to which the cheeks are adjusted may be bisected from end to end by drawing the gauge along it. Solids not parallel sided may be bisected in like manner, by leaving one cheek loose, but keeping it in contact with solid.

211. Self-recording level for surveyors. Consists of a carriage, the shape of which is governed by an isosceles triangle having horizontal base. The circumference of each wheel equals the base of the triangle. A pendulum, when the instrument is on level ground, bisects the base, and when on an inclination gravitates to right or left from centre accordingly. A drum, rotated by gearing from one of the carriage wheels, carries sectionally ruled paper, upon which pencil on pendulum traces profile corresponding with that of ground travelled over. The drum can be shifted vertically to accord with any given scale, and horizontally, to avoid removal of filled paper.

212. Wheel-work in the base of capstan. Thus provided, the capstan can be used as a simple or compound machine, single or triple purchase. The drumhead and barrel rotate independently; the former, being fixed on spindle, turns it round, and when locked to barrel turns it also, forming single purchase; but when unlocked, wheel-work acts, and drumhead and barrel rotate in opposite directions, and velocities as three to one.

213. J. W. Howlett's patent adjustable frictional gearing. The upper wheel, A, shown in section, is composed of a rubber disk with V-edge, clamped between two metal plates. By screwing up the nut, B, which holds the parts together, the rubber disc is made to expand radially, and greater tractive power may be produced between the two wheels.

214. Scroll gear and sliding pinion, to produce an increasing velocity of scroll-plate, A, in one direction, and a decreasing velocity when the motion is reversed. Pinion B, moves on a feather on the shaft.

215. P. Dickson's patent device for converting an oscillating motion into intermittent circular, in either direction. Oscillating motion communicated to lever, A, which is provided with two pawls, B and C, hinged to its upper side, near shaft of wheel, D. Small crank, E, on upper side of lever, A, is attached by cord to each of pawls, so that when pawl C is let into contact with interior of rim of wheel D it moves in one direction, and pawl B is out of gear. Motion of wheel D may be reversed by lifting pawl C which was in gear, and letting opposite one into gear by crank E.

216. A device for assisting the crank of a treadle motion over the dead-centres. The helical spring, A, has a tendency to move the crank, B, in direction at right-angles to dead-centres.

217. Continuous circular motion into a rectilinear reciprocating. The shaft, A, working in a fixed bearing, D, is bent on one end, and fitted to turn in a socket at the upper end of a rod, B, the lower end of which works in a socket in the slide, C. Dotted lines show the position of the rod, B, and slide, when the shaft has made half a revolution from the position shown in bold lines.

218. Buchanan and Righter's patent slide-valve motion. Valve A is attached to lower end of rod B, and free to slide horizontally on valve-seat. Upper end of rod B, is attached to a pin which slides in vertical slots; and a roller, C, attached to the said rod, slides in two suspended and vertically adjustable arcs, D. This arrangement is intended to prevent the valve from being pressed with too great force against its seat by the pressure of steam, and to relieve it of friction.

219. Continuous circular motion converted into a rocking motion. Used in self-rocking cradles. Wheel, A, revolves, and is connected to a wheel, B, of greater radius, which receives an oscillating motion; and wheel B is provided with two flexible bands, C, D, which connect each to a standard or post attached to the rocker, E, of the cradle.

220. Arrangement of hammer for striking bells. Spring below the hammer raises it out of contact with the bell after striking, and so prevents it from interfering with the vibration of the metal in the bell.

221. Trunk engine used for marine purposes. The piston has attached to it a trunk at the lower end of which the pitman is connected directly with the piston. The trunk works through a stuffing-box in cylinder-head. The effective area of the upper side of the piston is greatly reduced by the trunk. To equalise the power on both sides of piston, high-pressure steam has been first used on the upper side and afterwards exhausted into and used expansively in the part of cylinder below.

222. Oscillating piston engine. The profile of the cylinder A, is of the form of a sector. The piston, B, is attached to a rock-shaft, C, and steam is admitted to the cylinder to operate on one and the other side of piston alternately, by means of a slide-valve, D, substantially like that of an ordinary reciprocating engine. The rock-shaft is connected with a crank to produce rotary motion.

223. Root's patent double-quadrant engine. This is on the same principle as 222; but two single-acting pistons, B, B, are used, and both connected with one crank, D. The steam is admitted to act on the outer sides of the two pistons alternately by means of one induction valve, *a*; and is exhausted through the space between the pistons. The piston and crank connections are such that the steam acts on each piston during about two-thirds of the revolution of the crank, and hence there are no dead points.

(*To be continued.*)

THE MANUFACTURE OF SUGAR FROM BEETS.*

WITHIN the last fifty years the manufacture of sugar from beet-roots has made rapid strides, not only in France and Germany, but also in Russia, Belgium, Austria, and some other European countries. The harvest of 1865-6 in France yielded no fewer than 275,000 tons of raw sugar, in addition to which there were about 10,000,000 gallons of strong spirits, extracted partly from roots and partly from molasses. The value of this sugar and spirit amounted in round numbers to £7,500,000; but besides this there were the by-products of 20,000 tons of potash, value £500,000, and 1,600,000 tons of pulp, after extraction of the juice, which was valued at £1,000,000, and was eagerly bought by farmers for fattening cattle; so that the produce of that year's harvest was represented in round numbers by £9,000,000. The process of manufacture usually adopted in France was complete to the minutest particular, and so advantageously is each product turned to account that there is literally nothing wasted. As the waggons conveying the roots arrive at the manufactory they are carefully weighed, and an account kept of the quantity of the raw material received. From the waggons the roots pass to the washer, which consists of a long, cylindrical drum, constructed of parallel rods of iron, and slightly inclined as it revolves in a tank of water. At its lower end is an inclined plane, on which the beets fall, and are passed to the first pulper, where they are cut into small pieces by revolving knife-blades. These fragments are then passed into the second pulper, where, by means of saws, the pulp is finely comminuted and put into bags made of sheep's wool, a small quantity only being placed in each bag. These sacks are piled one over another, separated by trays made of sheet-iron, and submitted to the action of a press, which extracts a great portion of the juice; after which they are taken to the hydraulic press, where the remainder is squeezed out. The juice is then run through pipes into an iron reservoir, connected by means of a valve with the *monte-jus*, a cylindrical vessel made

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* We are indebted for the facts of this article to Mr. Crookes's recent work "On the Manufacture of Beet-root Sugar in England and Ireland." Longmans & Co.

FIG. 2

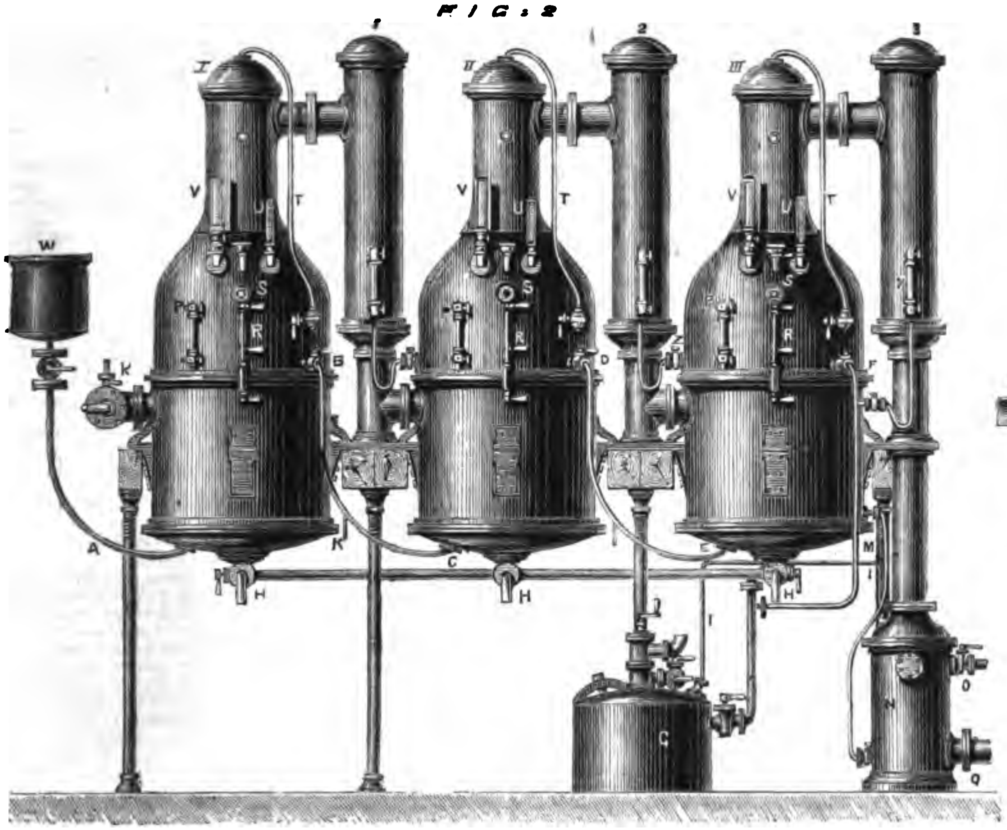
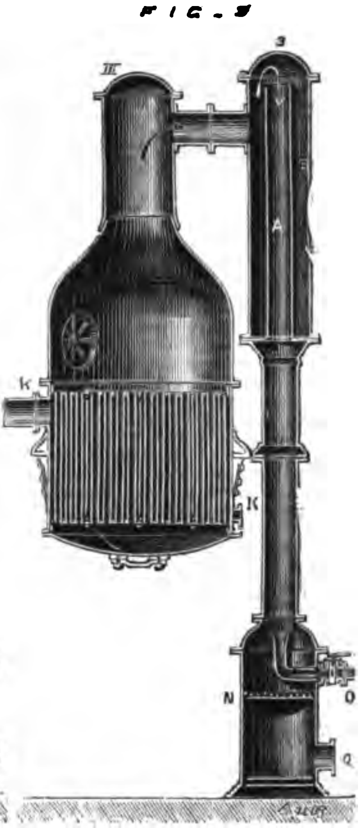


FIG. 3



ROBERTS'S TRIPLE VACUUM PAN.

of strong boiler plate. By the pressure of steam, admitted at the top of this *monte-jus*, the juice is forced through a pipe into the defecating pans, where it is rapidly raised to about 180° Fahr., and "dosed" with milk of lime. It is then brought to the boiling point, when the scum is removed, and submitted to the action of powerful presses, for the purpose of obtaining what juice may be still contained in it. The whole of the juice is then transferred to the carbonatation pan, and carbonic acid gas forced through it. After undergoing this process it is conveyed to the filters, upright cylindrical vessels, filled with granulated bone-black, a section of one of which is seen at Fig. 1. M is a cover, fitting tightly on the top, for the purpose of introducing the bone-black. N is a man-hole for drawing out the spent bone black, and also for admitting a sieve, covered by a cloth, which is introduced into the bottom of the filter before the bone-black is admitted. S is a pipe for the introduction of steam, pure water, beet-root juice, and syrups into the filter, by means of the pipes F, E, D, C, which are in connection with S, through which the passage of either of these fluids is regulated at will, by means of special taps. The pipe S is also fitted with a small connecting pipe, L, through which the air escapes from the filter, as it gradually fills with liquid. The juice, after having traversed the whole body of bone-black in the filter from top to bottom, is not allowed to run out at the bottom through the pipes W and Y, the cock, V, being kept close, so as to force it to ascend through the upright pipe, U, whence it is allowed to flow out through the open cock, H. The juice is received in a movable funnel, T, which fits on the upright pipes, R and A. If juice is being run through the filter, the funnel is placed on R, and the liquid is thus conveyed either directly to a tank or to the evaporating pans. If syrup is being passed through the filters the funnel is placed on Q, and run to the concentrating pans. V is used for running water into the pipe, Y, which carries it off as waste. After leaving the filters, the clear juice is conveyed to the evaporating pans, where it is reduced to a certain degree of consistency, "syrup," after which it has to be filtered a second time. The old-fashioned evaporating pans have given place to the "triple effect" vacuum pans, a side view of which is given at Fig. 2. The three pans, or bodies, are marked I., II., III., the three intermediate vapour columns are numbered 1, 2, 3. A is the pipe which carries the juice into the first body; B C, is a pipe which carries the juice from the first body to the second, and G F another which conveys it from the second to the third body, from whence the pipe F takes it to the *monte-jus*; K is a pipe and valve for introducing the steam for heating into the first body; K^1 is a pipe for running off condensed water; L M is a pipe for conveying spent steam and condensed water to the condenser; Q is the outlet for the hot water of condensation; P is a glass indicator for the height of the juice in the pan; R is the apparatus for sampling, in order to learn the density of the juice; S represents the glass bull's eye for observing the progress of ebullition; T is a small funnel for the introduction of melted fat to arrest too violent ebullition; T^1 is the small cock for admission of air; U is a thermometer indicating the temperature of the boiling juice; V is a special barometer for low pressures for determining the degree of vacuum; X is an indicator of the water accidentally collected in the columns; and Z the pipe for running it out.

FIG. 1

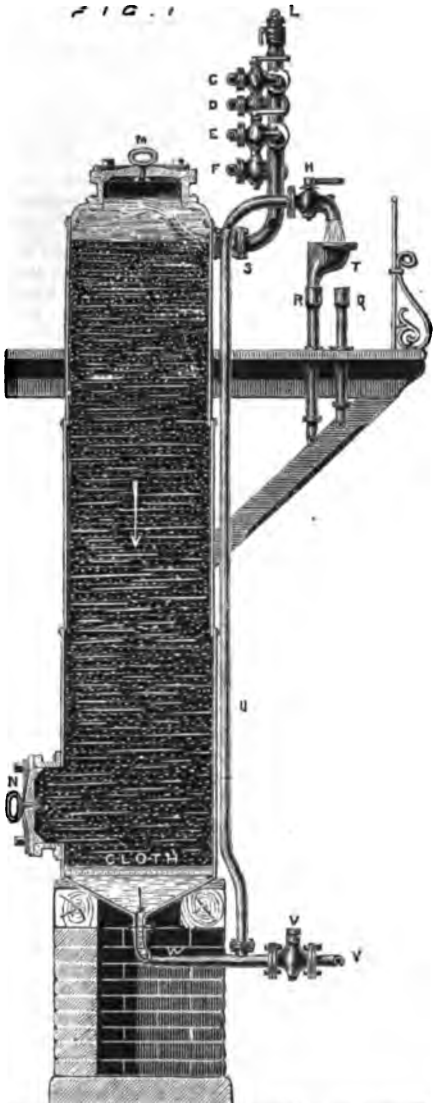


Fig. 3 shows a section through the last body of the apparatus represented in Fig. 2, and gives a view of the internal arrangement of a vacuum pan. The lower portion of the body, III., shows the disposition of the tubes, around which the steam for heating the juice circulates. These tubes are inserted at both extremities into the perforated end-plates. The space above the top plate is the steam or vapour chest, where the vacuum is formed, and the steam of the boiling juice collects before being carried off. N is the condenser, O its injection pipe; M the exit pipe for heated condensation water, which is drawn off by an air-pump; A is an upright pipe surrounded by an empty space, B, in which accidental water and liquid collects. The theory of the vacuum pan is very simple, being based on the fact that the juice boils, under the ordinary pressure of the atmosphere, at 212° Fahr., and as this pressure is reduced so the boiling point is proportionately lowered. Now, waste steam, with a temperature of 212° Fahr. will boil the sugar in the first pan without any vacuum, and passing to the next, in which is a partial vacuum, will boil that at a temperature say, of 190°; and finally going to the third will cause the sugar to boil at 150°, under the influence of a more perfect vacuum. Thus the concentration of the juice costs nothing for fuel, being all accomplished by the exhaust steam.

The syrup, after being boiled and filtered till it reaches the proper consistency, is distributed into a number of crystallizers, and left quiet in a room the temperature of which is kept at 95° Fahr. When crystallization has taken place the contents of the crystallizers are emptied into centrifugal turbines, the outer surface of which is covered with metallic tissue, through the meshes of which the syrups flow, by the action of the centrifugal force, while the crystals of sugar are retained within. In a very short time the sugar may be scooped out of from the inside of the centrifugal, and after being broken up in a "lump-breaking" machine and passed through a screen it is ready for market.

THE MANUFACTURE OF CHLOROFORM.—According to the late Jas. Y. Simpson, there is a single manufactory of chloroform, located in Edinburgh, which makes as many as eight thousand doses a day, or between two millions and three millions of doses every year—evidence to what an extent the practice is now carried of wrapping men, women, and children in a painless sleep during some of the most trying moments and hours of human existence.

ON ZYMOTICS.*

ON referring to the Registrar-General's reports for the last ten years, we find that in England and Wales about 500,000 people die every year; of which 500,000, 100,000 die of zymotic diseases; that is, 20 out of every 100 people who die, die, usually at an early age, of disease which can and ought to be prevented. These so-called zymotic diseases have been chosen for the subject of this article, because, they best illustrate what has been said about the prevention and the cure of disease. No approach to any means of curing them has been discovered; but of all the complaints known, they are the most easily preventable; in no other group of diseases is there a something which can almost be handled—which is the essence of the complaint, without which the complaint would not exist. It is to the destruction of this substance that our efforts in the suppression of these diseases are directed; for could all the contagious material in the universe be destroyed, these diseases would cease to have a place in the nosology. A knowledge of their natural history is necessary to a comprehension of the means to be employed in preventing their occurrence, and a slight sketch will therefore be given of their course when attacking the individual, and of the circumstances under which they spread.

The diseases called zymotic—a name which is bad, because based upon a false theory, but which has become sanctioned from long use—are, in systematic medicine, known as the acute specific diseases; acute, because always of short duration, tending spontaneously to cease at a fixed date from the attack, and never extending over months and years like chronic diseases; specific, because they are accompanied by a process peculiar to each one of the group, a process quite *sui generis*, and unknown in the course of other acute complaints. Amongst them stand measles, scarlet fever, hooping cough, diphtheria, mumps, typhoid fever, typhus fever, and small pox. Measles may be regarded as a type of this class of complaints. It has a greater tendency to spare the life of the individual than most of the others; it is very widely distributed, and few people reach adult age without having suffered from an attack. The history of the complaint, and of those associated to it, is therefore personally interesting to almost every one.

The acute specific diseases are distinguished by five peculiarities. 1. They occur but once in the life of an individual, who thenceforth is secured from a second attack. 2. They always result from contagion or infection, never arising *de novo* from exposure to cold, or other causes of disease, as bronchitis or rheumatism does. 3. There is always an interval, longer or shorter, between the date when the individual receives the contagion into his system, and the date when he first begins to feel ill. 4. There is an interval between the first feelings of illness and the first appearance of the specific process, the rash on the skin, or the sore throat. 5. The specific disease always runs a sharp well-defined course lasting a certain number of days, and tending to end in the recovery of the patient, at the termination of the specific process. These five characters will now be considered more in detail.

Each disease, as a general rule—and only as a general rule—occurs but once during life. Every mother, for example, knows that when her child has had the measles, or the hooping cough, it will be secure against a second attack. It not unfrequently happens, however, that a second attack of measles or small-pox occurs; in these cases, especially the latter, the complaint runs a much less severe course than in the first. In the great majority of individuals, the protection afforded by one of this group of diseases against its recurrence is complete. This immunity from a second attack is one of the most curious problems in medicine. Everyone knows how a part, once affected with a complaint, is liable to a return on the slightest causes, *e. g.* a common cold, or a sore throat. With the acute specific, or zymotic diseases, the case is exactly the reverse; and at the present moment there is of this no satisfactory explanation whatever.

* * * * *

Another striking feature in the natural history of these disorders is that they are never known to arise spontaneously, as other complaints do; but their origin is always due to a certain *contagious matter.* There is no properly authenticated case on record of a person having suffered from an acute specific disease without having been in some way infected from another person suffering from the same complaint. Recent discoveries seem to suggest that this contagious matter is a vegetable growth—a fungus. Some observers, especially in Germany, aver that they have been enabled to detect under the microscope the little plant which is the cause of cholera; others assert, that certain fungi found in mouldy straw will produce measles in less than forty-eight hours after inoculation. Sir Henry Holland has thrown out the idea that these diseases are produced by clouds of animalcules passing over a country; and he considers that the way in which an epidemic or contagious fever advances, supports this view. The zymotic theory has just been stated These opinions are introduced only to show how little is really known about the nature or composition of the contagious material. Of its existence, there can be no doubt, but of its form, whether animal or vegetable, whether a ferment, or simply some organic chemical combination, nothing is known. With regard to the mode in which this contagious material is conveyed to individuals, it is a common idea that it is carried through the air, or even that it is produced *de novo* where there are bad smells, defective drainage, and in low, damp situations. The notion that the air carries the contagious matter is singularly devoid of any support from the manner in which these complaints usually spread. When, for example, an infectious disease passes from one place to another, it moves along the line of traffic, not in the direction of the wind, but along the course taken by travellers. When a contagious disease leaves a continent for an island, it always makes its first appearance in a sea-port. In fact, the contagious material seems capable of being carried but a very short distance, probably only a few feet, by the movement of the air; one of the best means of disinfection is to send a free current of air through the room or space, fresh air seeming to have the power of destroying or weakening, perhaps by dilution, the contagious material. Nor is there any evidence to prove that bad smells, &c., produce these specific diseases anew. There is no doubt that defective drainage, and crowding of people together, predispose to the reception of these specific complaints, and are themselves the direct causes of many and serious illnesses; but bad sanitary arrangements in a house or a town never generate these epidemic disorders—they must be brought from without, and then, under these bad sanitary conditions, they spread with frightful rapidity, and cause immense mortality. An instance in proof of this may be found in the hygienic condition of England before the time when the cholera first visited us. Then the sanitary condition was probably as bad as could be, yet the cholera did not exist until it was brought over from the continent of Europe, when it spread rapidly and decimated the country.

(To be continued.)

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* Written by J. Wickham Legg, M.D., and extracted from *The Student.*

THE ECONOMICAL PURIFICATION OF COAL GAS.

MR. F. C. HILLS, of Deptford, makes the ammoniacal liquor of the gasworks of sufficient purity to become a cheap and effective purifying agent for depriving gas of its sulphuretted hydrogen and carbonic acid. The gas liquor, when purified, is run through the common scrubber, and the gas allowed to pass up through the scrubber. It then comes into contact with purified ammoniacal liquor, which deprives it of its impurities, and thus the desired result is obtained and all the expense of excessive labour is avoided. The mode of purifying the gas liquor is as follows:—A series of stills or vessels are placed one above another, partly filled with gas liquor to be purified, which runs through these vessels by means of connecting pipes from the top to the bottom, where it is made to boil. By this boiling the carbonic acid and sulphuretted hydrogen and also a little ammonia are driven off, and pass into the liquor in the next vessel above, by which the ammonia vapour is mostly absorbed, but not the carbonic acid or sulphuretted hydrogen. By passing these products in like manner through the whole series of vessels, the ammoniacal vapour driven off from the boiling gas liquor is absorbed by the gas liquor in the higher vessels, and the carbonic acid and sulphuretted hydrogen are left free to pass away whenever desired. If wished, the whole of the gas may be purified entirely by this gas liquor; but as the quantity required would be considerable, it is perhaps best to purify the gas about two-thirds by this process, and then to finish the purification with oxide of iron.

SCIENTIFIC SOCIETIES.

GEOLOGISTS' ASSOCIATION.

AT the meeting of this association, held at University College on Friday the 1st July, Professor Tennant, F.G.S. (in the absence of the President, Professor Morris), in the chair, the following papers were read by Mr. J. Logan Lobley, F.G.S.:—

"Two Days in a Mining District," "On the Distribution of the British Fossil Brachiopoda."

Adam Murray, Esq., F.G.S., exhibited a collection of specimens of ores and other minerals from East Cornwall, as well as a plan and section of a copper-mine.

The first paper contained an account of a brief visit paid to the mining district of east Cornwall, in which both copper and tin mines are very numerous. The author dwelt with evident pleasure on the beautiful scenery of the river Tamar, which meanders through the richly wooded valleys on the eastern side of this district, to which the river is of very great service, as it facilitates the conveyance of the ores to the localities where they are smelted.

From the little town of Calstock a very large quantity of "dressed" copper and tin ore is annually shipped.

The first mine visited was a copper-mine at a little distance from the town just mentioned, and here the process of dressing the ore was going on briskly. The dressing is effected by means of washing, crushing, and "jigging," which operations were fully described. A large tin-mine was then visited. The oxide of tin being usually associated with quartz, tungstate of iron, or wolfram, and other minerals harder and of greater specific gravity than those with which copper ore is generally found, a more elaborate process for dressing the ore of tin is requisite than is necessary for that of copper. It is especially worthy of remark that the copper lodes are met with in the "killas" or Lower Devonian rock, while tin ore is found only when granite is reached. This is strikingly exemplified at Kit's Hill, a bold elevation forming the highest land in east Cornwall. The upper part only of this hill is granite, the flanks and base being lower Devonian. Accordingly we find copper-mines around the lower portion of the hill, while the engine-house of a tin-mine crowns the summit.

In this district mines are descended by means of vertical ladders placed in short shafts or "winzes" connecting the "levels" which are worked at regular distances below each other.

One of these mines, worked to a depth of upwards of 400ft. below the Tamar, was explored by the author, and the description of the mine and mode of working out the lode concluded the paper.

In the second paper Mr. Lobley gave the results of an investigation into the range and distribution of the genera and families of Fossil Brachiopoda in British strata, and exhibited a series of diagrammatic tables embodying the results arrived at, and intended to show by a peculiar arrangement the increment, decrement, and maximum development of each genus and family. The genera and families were arranged in the order of their incoming or earliest appearance in British strata, and every species occurring in each geological formation was separately and distinctly indicated. The number of species indicated in the tables and catalogued in the lists accompanying the paper was upwards of eight hundred. A great number of these are, however, recurrent species.

On the conclusion of the paper, which was of too detailed and technical a character to be condensed with success, Mr. Henry Woodward, F.Z.S., pointed out the difficulty that exists in assigning to the genus Calceola its true zoological place. The presence of a so-called *operculum* seems to be an insuperable objection to this remarkable genus being included in the Cœlenterata. Mr. Woodward expressed his opinion that it was probable further research will lead to the conclusion that Calceola is allied to the Hippuritidæ.

Professor J. Rupert Jones said the tables would have been more complete had they embraced the results of foreign as well as British research, the area of these islands being too small for satisfactory conclusions respecting the life of any one geological epoch to be drawn from a study of British fossils merely.

Mr. Bath, F.G.S., thought the indication in the tables of the continuance of certain genera to the present time from evidence obtained from the existence of living species in any of the seas of the globe, while the fossil species indicated were from the British Islands only, was, unless fully explained on the tables, calculated to confuse the student. The tables and paper were, however, of such value that he moved that they should be printed by the association. This was seconded by Mr. J. Hopkinson, F.G.S., and carried unanimously.

Mr. Lobley replied to the objections that had been made, and the chairman, after paying a well merited tribute of praise to the great work on the Brachiopoda by Mr. Davidson, concluded the proceedings by urging the members of the association to take advantage of the facilities afforded by the railways for visiting interesting geological localities, and to record their observations in such papers as the former of the two that had been read that evening. He called for a vote of thanks to the author of the two papers, and the meeting separated.

This was the concluding meeting of the session 1869—70.

TRACTION.—Mr. A. Thomas says:—"It is stated that the resistance to draught on a well macadamised road is about 66lb. to the ton, on a good granite pavement 33lb. to the ton and on a rail about 8lb. to the ton. Now, of course, these figures are calculated for a dead level, a very small gradient altering the proportion which they bear to each other altogether, and this leads me to ask some of your correspondents to inform me whether where the roads are hilly any advantage results from the use of tramways. Does not this want of bite make it harder work for horses to draw a load up hill on a tramway than on a macadamised road?"

FOWLS v. WORMS.—M. Giot, a French Entomologist, has lately found new employment for fowls. He says that French farmers have, during the past year, complained bitterly of the prevalence of worms, which infest corn and other crops, the highest cultivated fields being the most infested. Fowls are known to be the most indefatigable worm destroyers, pursuing their prey with extraordinary instinct and tenacity. But fowls cannot conveniently be kept upon every field, nor are they wanted there at all seasons. Therefore M. Giot has invented a perambulating fowl-house, which is described as follows: "He has large omnibuses, fitted up with perches above, the nest beneath. The fowls are shut in at night, and the vehicle is drawn to the required spot, and, the doors being opened every morning, the fowls are let out to feed during the day in the fields. Knowing their habitation, they enter it at nightfall without hesitation, roost and lay their eggs there.

LETTERS TO THE EDITOR.

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[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]

*** All communications should be addressed to the Editor of the English Mechanic, 31, Tavistock-street, Covent Garden, W.C.

All Cheques and Post Office Orders to be made payable to J. Passmore Edwards.

◆

"I would have every one write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks: a vice from whence great inconveniences derive their original."—*Montaigne's Essays.*

◆

DE OMNIBUS.

[47] Sir,—I may perhaps be permitted, under the above heading, to notice a few queries of a somewhat heterogeneous character, which would otherwise involve two or three separate short letters.

Imprimis: If Mr. Gould's "Ingenious Friend," to whom he refers on p. 378, were to take his gun down to the equator he would find that he might fire it either due east or due west without making any difference whatever, either in the range or flight of the ball, the earth and gun, *pro illâ vice*, forming one system. On the other hand were he to fire it either north or south a *theoretical* deflection would undoubtedly take place.

I much fear that it is the telescope of the "Optical Bricklayer" (same page) which is in fault; albeit, according to his showing it is by no means placed in a good situation for observing with. Still, imperfect discs to stars seem to indicate a defective figure to some extent in the speculum. With regard to Saturn he is of course very near the horizon, and unfavourably situated for observation; but your correspondent ought to see very considerably more detail than he appears to do with 7 and 5-16th inches of aperture. With your permission, sir, an engraving showing the precise aspect of the planet at present, in a *perfect* 4½in. achromatic, will appear in these columns in the course of a week or two. This will enable the "Optical Bricklayer" to see how far his mirror fails in definition of this particular object. I am, of course, assuming that the eyepiece my querist employs has no defect in it; but at the same time 120 is far too low a power to use upon Saturn, and, for the matter of that, upon a star either, with such an aperture as he has.

Your "Subscriber" (4220), p. 382, will require the following lenses for the construction of the eyepieces he proposes to make:—1st for his 50-power, eye-lens, ·58in; field-lens, 1·6in. Secondly, for the power of 100, eye-lens, 27in; field lens, ·8in; and, thirdly, for that of 150, eye-lens ·18in; and field-lens ·53in. The practical detail asked for will all be found on p. 270 of the 5th vol. of the English Mechanic.

It might probably tend to obviate the difficulty under which "Gimel" (4253), p. 383, labours, were the sentence which he quotes from Todhunter, transposed thus:—"The ratio of the circumference of a circle to its diameter is invariably denoted by the symbol π." If he will read the words in this order, and then reflect that as the circumference of a circle contains the the diameter π (3·1415926) times, it must contain the *radius* 2π times—and, quite obviously, that the semicircumference (180° or two right angles) must contain the radius half this number (or π) times—he will, I think, see that the two statements to which he refers are perfectly in accordance with each other.

Since I wrote the letter which you honoured me by printing on p. 369, I have received my copy of the current number of the Royal Astronomical Society's "Monthly Notices." I find that it contains an imperfect ephemeris of Winnecke's comet down to the 5th of this month, on which day its right ascension is given as 2h. 15m. 42s., and its north declination 1° 59, Berlin mean midnight. It would thus be to the north of *o* (Mira) Ceti. It is travelling rapidly in a S.E. direction. But for the morning twilight it might be visible to the naked eye.

A propos of the reference you make to me (in your "Answers to Correspondents") in connection with the *Astronomical Register* I may say that I quite endorse what Mr. Proctor says, with regard to the value of its reports of the meetings of the Royal Astronomical Society, which are certainly unparalleled in any other serial; but that my chief complaint against it is the abominable dilatoriness with which it is published. Of all things on the face of the earth, it is essential that an Ephemeris should appear in advance of the time to which it refers; but my "Register" never reaches me until the 3rd of the month, and has been much later. Considering the nature of its contents, this is quite indefensible, and naturally damages its already limited circulation.

A Fellow of the Royal Astronomical Society.

Errata.—On p. 369, col. 2, line 3 from the bottom, dele "but." In the next column on line 8, "It is" is printed for "He is;" and on the 11th line, "lapsis" for "lapsus." Again on line 30, I find "*object*" put where I wrote "effect." Turning to col. 2 of p. 370, the word "brass," on line 25, is converted into "*trap*," and on line 31, "polish" appears for "polisher."

STARCH.

[48] Sir,—In the article on starch (page 162, No. 267, Vol. XI.) there are two little mistakes, "Inulien" should be Inulin; eleven lines from the end a full stop is inserted, where a comma only ought to have been placed—after "fennel;" this said, I proceed with the article from where I left off. 1st. The office performed by starch in nature.—Starch is the usual form in which nutriment is stored up for the future wants of plants or their offspring; the reservoirs in which this nutriment is stored are generally either the root, the seed, or, if perennial, frequently the stem. In the seed, and in such productions as the potato, the store is laid up for the use of new individuals, in other cases for the future growth of the same individual. The starch grain appears to be attached to the side of the cell in which it is contained, and probably at the point or by the points called the hilum. It is difficult to distinguish the exact point of attachment, on account of the intervention of the cell wall; but by the difference of focus required to distinguish the two surfaces of the cell, it is easy to see whether a grain is contiguous to the floor or roof of the cell; if the attachment is by the hilum that point ought to be turned away from you when it is fixed to the floor, and towards you if fixed to the roof; as far as my observation goes this is always the case. If the grains were not attached, frequent movements might be expected to take place amongst them in the uninjured cells; but movement of the grains in these cells is the exception. The hilum of starch, like that of the seed, varies in appearance in the different kinds of starch; in the potato it appears as a point, generally more or less elevated above the surrounding surface. I have sometimes thought I could detect an appearance like a very small circle, the central portion, when viewed by transmitted light, not brighter than the surrounding. The hilum in wheat starch assumes various forms, such as a point, curved line, &c., and is at least generally even with the surrounding surface; in arrowroot it assumes frequently a fissured appearance, more or less depressed, the light being reflected from the sides. These instances may serve the present purpose. For the purpose of illustrating the formation and use of the starch grain, we cannot do better than follow the growth of the potato. The cells of the potato germ contain starch grains from their first development; during the early growth of the germ these are carried outwards in their containing cells, and may be seen in a thin section of the sprout. They are the first of the store consumed, and the difference in size between them and the grains in the body of the potato soon becomes evident. The vessels of the germ are distributed in the substance of the potato, similarly to the fibres of roots. The starch is contained in cells, the walls of which admit only of the passage of liquids; therefore, before it can serve as nutriment to the plant, it must be brought into a liquid state. With the growth of the plant, the size and number of the grains contained in the *set* diminishes until there are scarcely any left. The absorbable state is probably produced in a similar way to that in a germinating barley grain; that is, by the action of a special substance. But while starch is being assimilated, the production of starch is still going on. On making a section of the year's shoot of many plants, a number of minute particles are observed in the cells, and floating in the liquid on the slide, some of which turn blue under the action of iodine; in some, larger bodies are observed, which appear to the eye in all respects like starch grains, giving also the characteristic colour with iodine. This is the case with the potato-plant. A number of grains, generally more or less oval in form, are found, chiefly in cells surrounding the central portion of the shoot. As starch must become liquid before it can be absorbed by the vessels of the plant, these grains must have been formed in the cells in which they are found. The potato has not grown long before it begins to provide for future wants. It sends out side shoots underground called *pendulums*, the ends of which become enlarged, forming the potato. The sole function of the potato is to serve as a storehouse of nutrition for the buds developed on its surface, from the size of a pea to its full size; it consists of a number of cells containing starch grains, which appear to increase by successive deposits of the substance which composes them. The second special store is laid up in the seed, to supply nourishment for the development of the embryo. The starch grains serving this purpose are, at least generally, smaller than those stored up in the root or stem. In many seeds a mass of cells exists surrounding the young plant analogous to the substance of the potato; in others the nutriment is only stored up in the seed leaves, which become detached when the plant is in a condition to procure sustenance from the earth, after which the history of its internal economy is similar to that of its parent. Light seems to be necessary for the production of starch; potato-plants deprived of their proper supply of light produce tubers which are deficient in starch, or are what are called watery—this is the result of reading, not my own observation. The green colouring-matter of leaves, called chlorophyll—for production of which light is indispensable—is sometimes produced in the same cells with starch, and it has struck me that the form of the two kinds of grain seem to bear some relation to each other. The grains of chlorophyll seem to be attached to the walls of their containing cells, and frequently to have a point on their surface. Their chemical properties are of course very different. In blanched leaves I have noticed the cells are not empty, though deficient in chlorophyll, the little grains, showing the blue colour with iodine, occupy the cells, and appeared to me just as numerous.

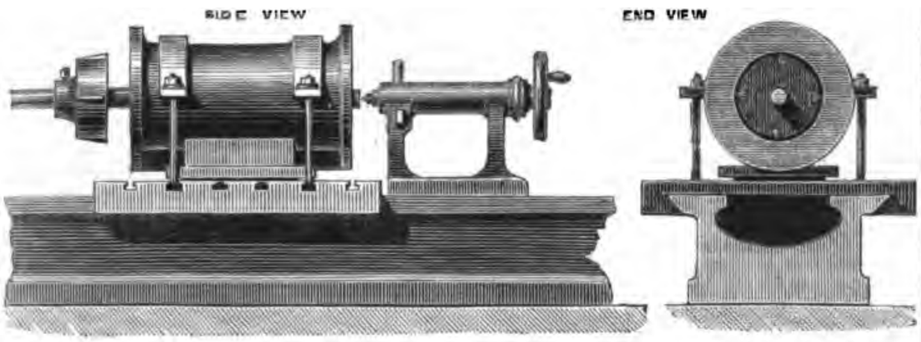
But, as this subject has only just come under my notice, I must defer further expression of opinion on it until more observations and experiments have been carried out. Of course, as the grains are frequently too small to observe the shape, with a magnifying power of between 400 and 500 diameters, particulars above alluded to refer to the larger grains. The mode in which starch appears to be formed seems to bear some analogy to crystallization—the definite point of aggregation—the increase by deposition of material on the outside—the cross shown under the action of polarized light, all seem to bear this out. The last point I will refer to is prevalence of starchy matter in the air. On examining water under the microscope that has been exposed to the air for a short time, you rarely fail to find bodies, appearing to the eye like starch grains, and, on adding iodine solution, these grains give the characteristic starch blue. These grains are so prevalent, that it is difficult to obtain water without them, at least I have found it so. In the *World of Science* for July 27, 1867, there is an article headed "Experiments with the Microscope on the Effects of Prussic Acid on the Animal Economy," being a paper by T. Shearman Ralph, read before the Medical Society of Victoria, from which I will make a few quotations, leaving the readers to judge its bearing upon the subject in hand, not presuming to express any opinion myself. He says, "If the ordinary prussic acid of Scheele be examined under the microscope, under a power of 200 diameters, the acid, if pure, will present nothing worthy of remark; but occasionally specimens will be met with, which contain . . . . . . Prussian blue, and also a number of starchy-looking bodies, which actually turn purple with iodine . . . . . . these changes will be found to take place in it, if the bottle is repeatedly opened and portions taken out ever so carefully." He goes on to say, "These remarkable changes appear to me to be due *to the renewed access of air, and minute particles of dust getting in*, and to the possible electric state of the glass rod." He says if after "a period of many days the bottle be shaken, and a drop placed on a slide, and examined with a microscope, bright blue particles will be seen . . . . . . with a number of starchy-looking bodies, which polarize feebly and turn purple with iodine, like vegetable starch." "On taking a drop of prussic acid free from such contamination . . . . . . and some organic matter be added . . . . . these starchy bodies will make their appearance. First of all a minute dot, resembling an oil globule, will be seen, which . . . . . will be observed to increase in size, sometimes attaining to that of an ordinary starch grain . . . . . . and then it will assume a thicker consistence, and solidify into a starch grain," &c. The prevalence of starch in the air would account for its presence in the liquid. The last part of the quotation I *must* leave. Lastly, is it safe to rely solely upon the property of turning violet under the action of iodine, as a test for the presence of starch?

Starch grains are considered frequently to form part of the contents of pollen grains; and certainly many of the particles forming the contents show the supposed characteristic colour with iodine. The pollen of the Ealla turns a deep purple—almost black—when touched with the iodine solution; the transparency and thinness of the skin allow the contents to be seen through; and yet I have never been able to detect starch in water in which pollen grains have been heated, whatever quantity I used of the pollen.

J. C.

PURIFICATION OF FEATHERS, HAIR, Etc.

[49] Sir,—The aphorism of the discovery of the circulation of the blood—"omne animal ex ovo"—is specially applicable to all the cognate facts (practically educed) from our present knowledge of the impurities of bedding and the mode of remedying its pernicious and wasteful effects,—pernicious because the conditions of health depend upon the adoption of that remedy, and wasteful, inasmuch as all materials, even though "doctors disagree," are alike subject to the devourer moth, and the parasite. That their causes have their spring in the nature of the material we cannot deny; but nevertheless, the neglect of certain rules—viz., the submission of all material to the process under consideration—must inevitably eliminate and develop the ova in question. Horse-hair, so called, cannot where the markets are competitive be produced pure and simple—in other words, that of the buffalo, ox, bison, and pig, is proportionately intermixed. At the extremity the epidermis, and occasionally minute portions of cuticle, adhere. The curling does not destroy the tendency to generate ova. Wool and other material, from its naturally oily nature, is also subject to the ravages of neglected attention, *alias* moth, &c. Feathers occasionally are subject to their attack, but in a much less degree, inasmuch as these must be prepared by some process before it is possible to use them. All the inferior materials used by the moderns cannot but be the hot bed, so to say, of these destroyers, inasmuch as old carpets in which they have long made their home, old clothing—in a word, the mixed refuse—&c., contribute their quota to multiply them. And now to speak of the more mystic causes—these will be manifest upon unfolding facts. "If from the body's purity the mind derives a secret and sympathetic aid," the homes of the wealthier portion of the community should be subject to special vigilance in ascertaining the condition of all bedding, and cause them to be subject to a process capable of fulfilling all its intentions, and must be appreciable in an economical as well as sanitary aspect. It will, of course, be readily conceded the necessity of preserving the greatest immunity from all cutaneous and febrile maladies, but others of a more subtle nature demand equal attention. The process employed in manipulating is one simple and effective. 1st. Thoroughly saturating with alkalies of a certain



BORING CYLINDERS.

strength. 2nd. Submitting the materials to sulphur dioxide in combination with water of a certain specific gravity, so as not to destroy the material. 3rd. Well steaming at a pressure of two atmospheres. 4th. Removing to rotatory drying chambers, and finally to the dusting machine. By this process, feathers, hair, wool, &c., acquire a freedom from impurities, also elastic properties, and an intrinsic value not to be obtained by other means. R. F. G.

BORING CYLINDERS.

[50] Sir,—I send a rough sketch of the method for boring cylinders, which I think will serve to give "Amateur Turner" a slight idea of how they are fixed to the saddle of lathe, and likewise the sort of tool generally used to effect a true and smooth cut. The first thing to do is to plane off the valve facing on cylinder — that is in case the steam chest is not cast on. After planing the face, fix the cylinder on the saddle of lathe, as shown in the sketch, then firmly bolt the cylinder to the saddle, so as to keep it from moving in any direction during the process of boring; this being done, fix the boring bar between the centres of lathe, taking care to have the boring bar sufficiently long enough to allow the cylinder to pass over the tool, or else the cylinder would come in contact with the back head. The saddle of lathe would be self-acting, so that when the saddle moved, the cylinder would move with it. The cutter would be firmly fixed on cutter bar, so that the cylinder would form the feed to the cutter. This is only one of the many ways used in boring cylinders. Turners have various ways for boring cylinders, but in the case described, the bore of cylinder would be true to a nicety with the valve facing. But where the cylinder will not allow of being bolted to the saddle, pieces of planed iron are put under the valve facing to keep it up to the required height. The tool shown is one that will effect a regular and true cut, owing to the number of cutters fixed on the edge of cutter boss. Some turners use more cutters than others for boring; in some cases there is only the bar, and one cutter fixed in a slot on the bar; but a true cut cannot be effected with this, for if the hole in cylinder should be cast a little out, there would be more metal to cut one side than the other; the consequence would be that when the cutter came around to take a deep cut one side and a light one the other, it would spring the bar, or press the cylinder over; whereas, in the other case, all the cutters would be cutting at one time, so that one or other of the cutters would always be in the deep cut, and keep the cutter bar, likewise the cylinder, from moving. In the course of a few publications, I will send a sketch showing how cylinder covers are turned on both sides, without any holes through them.

J. C. Mollony, Exeter.

HOW TO MAKE A CAMERA.

[51] Sir,—With your kind permission, by request of one of our readers, I will try to describe the method of making a camera. I should advise any one who intends making one, to choose a good dry piece of mahogany light Spanish is the best), or he may have it in more than one piece.

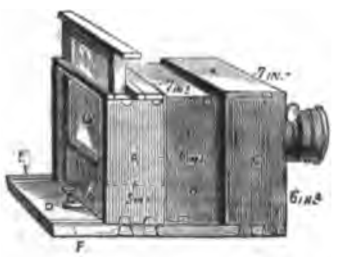


FIG. 1

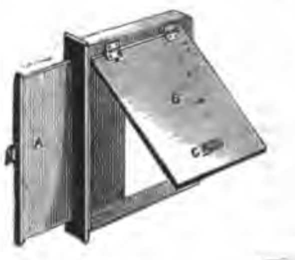


FIG. 2

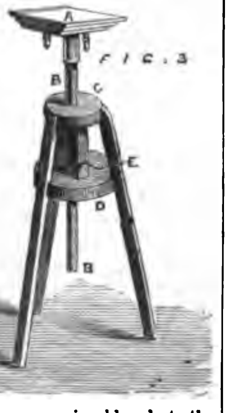


FIG. 3

For ½ plate camera:—Dovetail four pieces together, as A. Fig. 1, of ¼in. thick, 7in. by 6in. × 3in. Next dovetail a similar square, only smaller, so that it may fit into A and project beyond, as B. Fit about 2in. of it into A, so that, the dimensions of the square being 5¾in. × 6¾in. × 5in., there will be just 3in. projection of B outside of A (all the measurements are outside). C is of exactly the same construction as A, and has in addition a front with a hole for the lens. With the above you obtain from 6in. to 9in. focus. C is fixed to the bottom board D. D has a groove or rather slit through the centre for the screw and nut E to work in, in order that the back A may slide in and out of C as far as you like, the screw and nut E tightening it when required. A works in a kind of shute formed by the pieces F F. Now in the sides of A and in the bottom there must be grooves for the focussing screen G of Fig. 1 and Fig. 2 to work in. At the bottom is a hole on one side of the slit (that E works in), for the triangle to be fixed to, if one is used. If a table tripod is used, no hole is required.

Fig. 2 is the dark slide or back. A is a shutter that runs in a light-tight groove. B is a hinged door, also light-tight. It is almost impossible to describe the making of Fig. 2. "Snatch Block" would do better to ask some photographer to let him see one. It is the most difficult thing in the whole apparatus to make. The cost of them is from 15s. upwards, from a manufacturer. C in Fig. 2 is a loop of leather to open B with. G of Fig. 1 is only some finely ground French glass fixed in a frame. I must impress upon the mind of the maker the absolute necessity of having the ground glass exactly the distance from the lens that the prepared plate will be when in the back. Without that the whole is useless.

Fig. 3 is a table stand. A is a flat piece of wood attached to B, which is a rod that runs in a hole in the blocks C and D. The handle E keeps it from slipping, so that it can be placed at any required height.

I fear that my description is not very clear, but as clear as I can make it, it being a very difficult thing, unless the maker is used a little to joining.

Let us hope that any one trying it may succeed; and that the tools may be in good order, and the wood not warp, is the sincere wish of Mrs.

ELECTRICITY.—REACTION OF CURRENTS.—AIR-PUMP.

[52] Sir,—Without going particularly into the subject mooted by "R. P. S.," p. 375, for which I have not time at present, I may say that he is correct in his supposition, because it is well known that if several currents are acting on a magnet, it will take the direction which is the resultant of the several actions. Of course not only the direction but the force of the current also must be considered, the position taken being due to the combined actions and calculable from that which each of the currents acting singly would produce, hence it is not possible to draw such a figure as he does without taking the relative forces of the currents into account and also the resistance offered by the magnet itself.

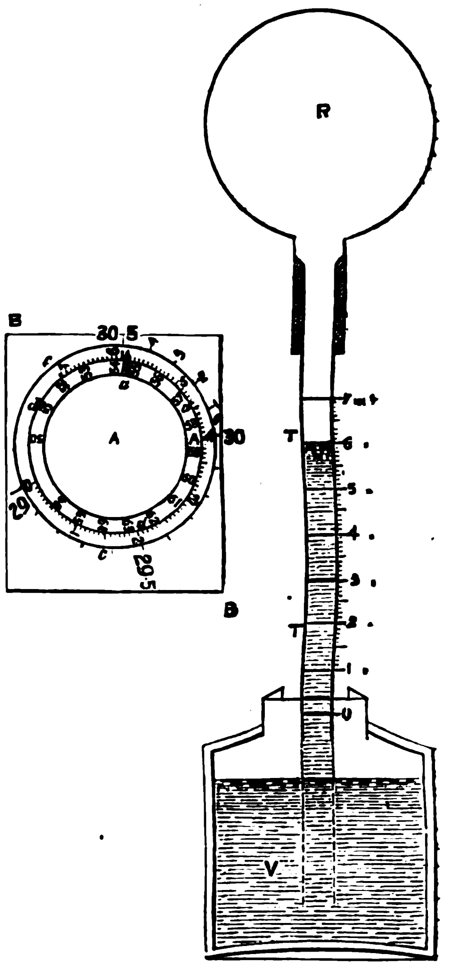
I did not reply to "Inductorium's" earlier questions on the air-pump because he expressly limited the replies to the result of actual experiment on the same subject, but as he now takes a different position I may be able to help him. If I am not mistaken he will find the Sprengel's mercury pump serviceable, but the Groves's, as to which he enquires is very simple and efficient, but requires first class work; its principle lies in making the end of the barrel conical, and the piston also conical and fitting close to the barrel-end; there is thus no space left in the barrel to hold air; when the piston is drawn back the barrel and receiver are in connection and come to equal pressure. The piston, as soon as it passes, closes the connection and compresses the air in the barrel, but does not depend for its expulsion on this compression rising beyond that of the outer air and lifting the valve; but even thus it seems to me that no possible exactness can prevent a little air following the piston on its return. For my own part I like the Tate's pump best of any I have tried, as I find that it exhausts very closely and with much less labour than any of the ordinary pumps.

The battery described by Mr. Conisbee is the Callan or Maynooth Battery which I have referred to, and quite agree with Mr. Conisbee as to its demerits, for which its cheapness at first is a very poor compensation indeed; but the cell enquired for was the Calland, a French device, and from the description evidently one of the numerous modifications of the Daniel.

Sigma.

A CHEAP WATER BAROMETER.

[53] Sir,—Enclosed is drawing of cheap water barometer, which I have had at work for some months, and it has not differed more than ·05in. from a good mercurial barometer during that time.



R is a small glass retort.

T T, a glass tube, graduated into inches and tenths.

V, a vessel containing mixture of alcohol and water coloured with aniline.

B B, a stout piece of card, 8in. × 10in., fastened to wall.

A A A, a circular card, revolving on an axis, and carrying with it the pointer, *a*.

d d d, a circle inscribed on B B, and graduated into inches and tenths.

c c c, a larger circle, graduated (after trial) into barometric inches, &c.

Now fill V with mixture as above.

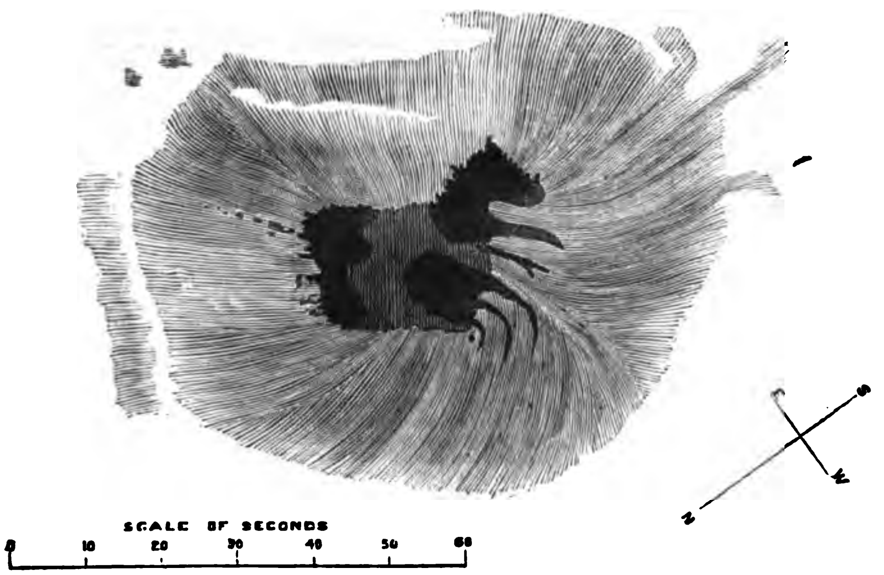
T T (which must be at least 20in. long) is now fitted air-tight with wax, into the neck of R. When hard heat R gently over lamp to expand the air therein, and immediately plunge bottom of tube T T into liquid in V. The air cooling and contracting will draw up liquid to (say) 6in., when it ceases rising; observe thermometer (say) 54° Fahr. Now by turning A A A around till pointer *a* coincides with 6 on *d d d*, the barometer is indicated, and supposing it to stand at 30·5, set the same down on the outer circle, *c c c*.

The liquid may rise only to 1in. Then temp. 54° brought round shows 29·2. Again, temp. 58°, glass 2in. = 30 barometer.

Cornubia.

SUN SPOTS.

[54] Sir,—I beg to forward a sketch of a remarkable sun-spot observed here on the 21st ult., with an equatorial, by Cooke, of 4in. aperture, power 200. When first seen, on June 19th, it was nearly central,



SUN SPOTS.

and formed the *preceding* spot of a large scattered group, which measured about 2′ 52″ in length. At 10 a.m. on the last mentioned date, an isolated mass of light, intensely bright and of a crescent shape, was remarked on a nucleus. This was carefully watched at intervals during the day; at noon it was no longer isolated, but formed a "bridge" connecting adjacent sides of the umbra. At 5 p.m. there were no traces of it, the penumbra having encroached upon the place which it occupied during the early part of the day.

On June 21st the spot appeared as represented in the accompanying drawing. The cyclonic type of the penumbra is here evident.

After the 21st ult., the group showed unmistakable signs of closing up; on the 24th it disappeared at the limb.

An unusual feature in the spot, and indeed in most of the large spots observed during the present year, was the uneven colour of the nucleus, which was very far from being uniform, patches of every shade, from a comparatively light brown to an intense black, were remarked. On the 21st ult., less than half the area of the nucleus was black; the remainder was of various shades of brown interspersed with small black patches. It is noteworthy that on the 19th ult. the *central* portion of the nucleus was brown and the *edges* black, and there was no gradual shading off between the brown and the black, but a sudden transition from one tint to the other.

As the sun is just now an object of great interest to astronomical students, perhaps some of your numerous readers have noticed similar phenomena.

I have observed and drawn most of the large sunspots which have appeared during the past five or six years; but, until the present epoch of maximum solar activity, have generally found the umbræ of large spots much more uniformly black than they now are.

Is this peculiarity connected in any way with the present comparative shallowness of the penumbræ as remarked by Mr. Lockyer?

Bedford, July 6. **Thos. G. Elger.**

PERSPECTIVE DRAWING.

[55] Sir,—Perspective is often divided in two parts—viz., parallel and angular—the former when a side is towards the spectator, the latter when an angle is seen.

Parallel perspective is generally given first in lectures on the subject, so we will follow the rule and treat it first.

In a cube, or any other right-angled object, having one of its faces parallel to the P P, the sides will vanish to the C of V, as stated in the last, and by rule.

As things in perspective do not appear less till they are beyond the picture plane, all measurements taken on the ground line are true and geometrical.

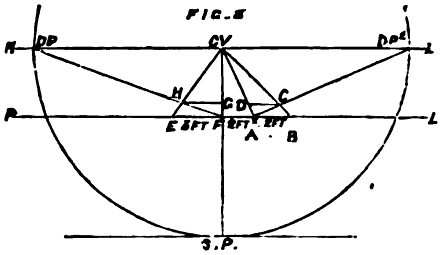
It must be remembered that man has not an unlimited field of vision right and left, unless he moves his head. The angle of vision is limited to 60°, and a spectator looking along the line of direction towards the C of V can only see to the right and to the left above and below that line 30°, or, in other words, 30° all round. Therefore, the line of direction is the axis of the cone of visual rays—the eyes of the spectator being the apex and the circular base being on the picture plane (see fig. 2), so that objects coming outside the circle become distorted, and to see more we must stand farther back. It is not necessary to draw the base of the cone in every drawing, but it must be borne in mind.

Sufficient theory has been given for the present: we will begin with the practical part, under the conditions adopted by the Science and Art Department examinations, some of whose second grade papers I intend to introduce. Let the scale be ¼-in. to the foot, making the picture line and horizon line 5ft. apart, the station point being 12ft. from the centre of vision.

Assuming the reader to have some knowledge of practical geometry, we will begin.

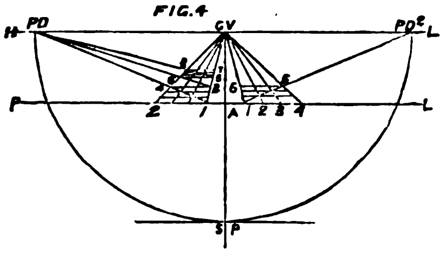
Here we have two planes lying on the ground, one of them parallel to and touching the picture line, 2ft. to the right, it being 2ft. square.

FIG. 3



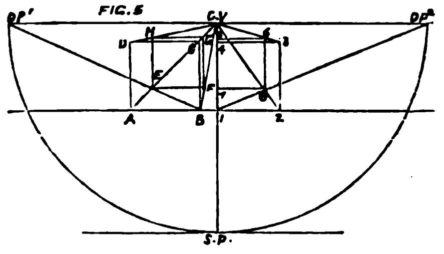
Set off A 2ft. to right, and B 2ft. more. Run off lines from both to the C V, to cut off on the retiring line B C, 3 ft. from A. Run off to the P D^2 to the right, and B C is the perspective length of A B; draw the line C D parallel to the P plane, and the figure is complete. On the left is another plane, 3 ft. square; but instead of being removed to one side, one edge, F G, is exactly in a line with the spectator. Set off F E 3ft. on the PL. From E run up to the C V; take a line from F to the P D^1 to left. The intersection H is the point through which to draw the line to form the back edge of the square.

FIG. 4



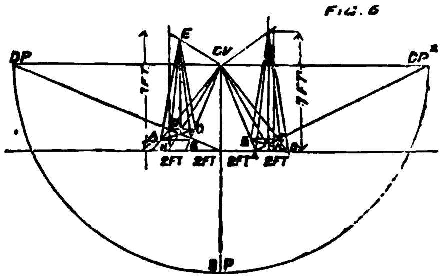
Let the student now reverse the planes, putting the large one to the right and the small one to the left under the same conditions.

Ex. 3, Fig. 4, is a series of horizontal planes—we will call them pavements; that on the right begins 1ft. to the right. Set off from A 1ft. to the points 1, 2, 3, 4, each being 1ft. apart; from them run off to the C V. From 1 run off to P D^2. Now the intersection on line 2 is 1ft. within the picture; 3 is 2ft., and on line 4 is 3ft. Rule horizontal lines through the intersections, and the pavement is complete. This is a very instructive exercise on horizontal planes. I leave the other to the skill of the reader, they being the same size, the second lot being 4ft. behind the other. If the student cannot see this clearly, complete the first without regard to those behind, and from point 3 draw a line to the D P, which will cut off the required distance, and proceed as before. We will now leave the planes and commence with the solids. Scale, ¼in. = 1ft. eye, 5′; station point, 12ft. Ex. 4, Fig. 5, 1ft. to left of spectator draw a cube of 4ft. side.



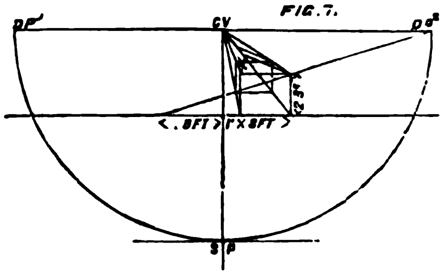
Make point B 1ft. to left of line of direction; from B to A equal 4ft., and as the cube is on the P L, describe a square which will be the real size, and from the angles, A, B, C, D, draw lines to the C V, and from B draw a line to the D P^1, which will cut off the length of the retiring side A E. Make E F parallel to A B, erect perpendiculars from these points, and the figure is complete, leaving the one to the right to the ingenuity of the student, it being the same size, but one side coming on the line of direction. Ex. 5, Fig. 6, is a pyramid of 2ft. side, its altitude being 7ft., the nearest side 2ft. to the right of spectator.

FIG. 6



The one to left is similar to the last, but is removed 2ft. into the picture. Find the bases, as in previous examples; at the intersection of the diagonals erect a perpendicular of an indefinite height; now set up the true height at H, and vanish up to the C V; the intersection on the axis of the pyramid is the point to which the sides may be drawn.

FIG. 7.

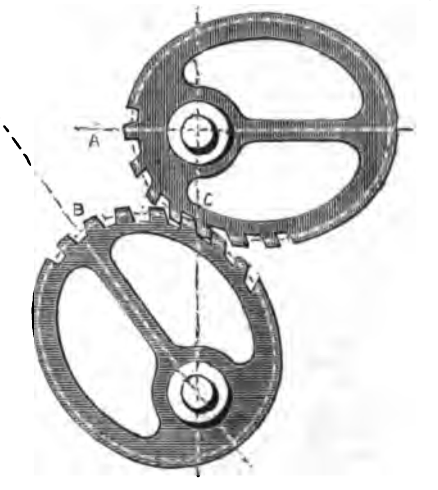


Ex. 6, Fig. 7, is a box of which the dimensions are given, the lid being open 1ft. Produce a similar one to left, and remove it 1ft. within the picture.—

J. W. Bedford.

ELLIPTICAL GEARING.

[56] Sir,—I send a drawing of a pair of elliptical wheels made as they ought to be, but never are. It is troublesome to set the teeth out, as each side of every tooth should be of the form that would suit a circular wheel of that particular radius; also pricking the pitch off the pitch line (represented by a dotted line), makes the teeth come a little thinner on the side of the wheels than round the ends, which does not signify, as the same teeth must come into gear with each other at every revolution, and so you may set them out as thick or thin as you please. Also it is to be observed that if at one end of the wheel a tooth comes exactly on the centre line, as is the case in the drawing at A and B, then the number of teeth must be odd. If for any reason an even number is required, then, at the ends, the *side* of a tooth must come on the centre line, as is the case with the tooth at C, and the wheels must be put on the shafts heads and tails together. There is no objection to making the tops and bottoms of the teeth square if preferred, and there is no necessity for any contrivance for keeping them in gear, which ordinary elliptical wheels do require. Proved.—J. K. P.



UNEQUAL STEAM PRESSURE.

[57] Sir,—With your kind permission, I purpose replying to Mr. Wood, *seriatim*, on the above topic in Vol. X., No. 258, page 606, where I think he has treated

us to a somewhat elaborate but erroneous lecture on unequal steam pressure, when contrasted with the general opinion entertained by the most eminent engineers of this 19th century; for they one, and I may venture to say *all*, believe in equal steaming.

Mr. Wood, at the outset of his last letter, says that we may have unequal steam pressure by having one valve right and the other too late, and the engine would be working right then to all appearance.

Now I have examined Mr. Wood's theoretical *diagrams*, which I will now explain. No. 1 has got an average pressure of 17lb. No. 2 has got an average pressure of nearly 13lb., that is 4lb. more on one side of the piston than the other, yet Mr. Wood has pronounced this engine as running right to all appearance.

After that we have diagrams No. 3 and No. 4, represented as being taken after the valves had been altered ¼in. at the cross-head, and of course must be the improved ones. We have no account of any more work being added to the engine at this juncture, yet the engine is actually taking 6lb. more steam on the piston at each half-stroke; whereas if he had obtained by the alteration a continuous and steady motion, he would have required less, consequent on the fact that he had dispensed with the back-lash, or jars in the machinery, produced by unequal steaming.

If Mr. Wood cannot convey his thoughts to paper without the use of diagrams, it would be much better if he would be more careful in filling them up properly, or otherwise put the proper scale to them. In No. 1 figure, at the beginning, we have ⅜in. representing 14·5lb. A little higher up the figure we have ¼in. and 9lb. marked. In No. 2, we have at the beginning ¼in. 1-32nd and 18·5lb. marked. If Mr. Wood can read this scale by measuring it, I must say he's an expert, as it is neither 1-10th, 1-20th, 1-30th, 1-40th, or 1-50th scale; perhaps he knows what it is. According to Mr. Wood's items, we have in No. 1 figure, at the commencement of the stroke, the steam coming on very easy, a pressure of 14¼lb; in No. 2 we have only 13¼lb. (one lb. less) and 1-10th of the piston's stroke late, which amounts to a severe shock at the extreme points of suspension. We will suppose this engine to have a 50in. stroke, divided by 10, which gives 5in. the distance the piston would have traversed down the cylinder before any steam could be admitted to support the piston's motion. In this case we have unequal steam pressure, amounting to 4lb. more on an average underneath the piston than at the top side. We have the greatest prime mover applied at the proper time. On the other side we have the least prime mover, coupled with the evil of the piston being moved down the cylinder 5in., it making a partial stop at this point; therefore a portion of the least prime mover has to be absorbed at this portion of the stroke in obtaining that regular speed and steady motion which has been lost by unequal steaming and unequal application of the prime mover. Yet Mr. Wood has pronounced this engine to be running all right. I would ask Mr. Wood why he was called in to alter this engine if it was all right. The proprietors would not call any one in to alter their engine unless their suspicions had been aroused unfavourable to its proper working. As Mr. Wood seems rather dull in apprehending the bad effects of unequal steaming and unequal application of the prime mover, and confounding the good by real assumption of the bad, I will just give another simple, but I hope it will be an effective, illustration of this gigantic power unequally applied, which Mr. Wood is now advocating. We will suppose half a dozen gentlemen to enter some engine-room when the engine is running. This should-be steady motion, which now presents itself to their view, is nothing more nor less than effects produced by a current of alternate causes. If the engineer, one amongst the six, can discover, by any instrument known, or by his own practical touches on the machinery, that these effects are unequal, he knows then that the alternate current of causes must be the same. When they have discovered that the visible effects are unequal, such as irregular motion, and jars in the machinery of any kind, the least scientific amongst the six will come to the conclusion all at once that, as the visible effects are unequal, the alternate current of causes must be also. Scientific men never expect anything else as a rule, much less engineers. Again, when "Inquirer" put forth his query, the subject he sought, I believe, was equal steaming. Mr. Wood perhaps, venturing outside his own avocation, tried to supply him with the requisite information to obtain this end. After this he comes in the corresponding field advocating and supporting with the greatest tenacity of purpose unequal steaming, and in such a manner as to astonish every engineer I am acquainted with. Yet under these unfavourable circumstances, an engine is said to be running all right. So according to Mr. Wood's version of the steam-engine, it will work right any way. He wants to know whether "Inquirer's" engine (high pressure) is doing three-fourths of the work; if so, he must differ from me. There is no doubt of that: he will differ, and very much too, on the whole. I never said they were getting this amount of power through it, but simply used that rather high figure to convert him (Mr. Wood) to the practice of equal steaming and equal straining, which is quite as necessary to be attended to as the former. Mr. Wood says that I seem to have an idea that the steam ought to be worked up in the high pressure engine cylinder. I have no such thought as that, and the lap I recommend would not work the steam up any more than what would remove the compression, and perhaps not that if they did not get an equal application of the prime mover (steam). But if the steam cannot be worked up effectually in the low pressure cylinder, it must be worked up in the high pressure. Again, he states that "Inquirer's" high pressure cylinder should be 15in. diameter, and the steam kept on the piston ¾ of its stroke. The pair combined, low and high pressure, would then give out a steady motive power. As the high pressure cylinder is to be 15in., it will be about 16 nominal horse-power. We will suppose that we get 4 times its nominal horse-power from it, which is pretty fair rating for compound engines—*i.e.* 64 horse-power indicated; steam being cut off at ¾ of the stroke. Mr. Wood should have told "Inquirer" where he must cut the steam off in the low pressure engine to obtain the same amount of equal force, as it is just as necessary to know the latter as it is the former, if he must secure equal straining, and that steady motive power which he says would be given out. Again, he must bear in mind that if the engines don't give out equal indicated horse-power, he cannot possibly get equal strains from the same unequal sources. In compound engines, the object of the engineers should be to divide the strains in the working materials in addition to working the steam up from a very high boiler pressure to the lowest one practicable in the low pressure cylinder. Therefore, if the engine was properly constructed, and full of *simplicity* in the original design, they would get more practical results out of the steam (with the same sized engine) than they would out of the single engine with the advantage of the strains being more equally diffused in the working materials; whereas in the single engine, or expanding the steam in one cylinder, the whole power, as it were, being concentrated at the extreme points of suspension, is sufficient to break it down in very many cases. We will just illustrate this case. Suppose we have got a pair of engines compounded, and we were getting five times their nominal power out of each engine; that would be ten times the nominal power for the single engine if you dispensed with one; so the engine we kept on working would have to be of very strong build indeed to sustain the severe strains at the extreme points of suspension; the other portion of the stroke it would be running nearly without strains. Again, he says the diagrams in No. 236, as stated before, are not so good to form judgment from as those in No. 242, inasmuch as the back pressure is not marked on them.

I answer, the indicator has not failed to delineate in this case the back pressure in the original figures any more than it has in the figures in No. 242, only the originals have been taken with a much stronger spring attached to the indicator piston, consequently they have a much less scale. If, when the indicator is fixed and the atmospheric line is made, then the form of the figure—the division between the atmospheric line and the figure—is the back pressure in high pressure engines. If the indicator does not mark the back pressure, then the operator simply takes the form of the figure and omits taking the atmospheric line. In that case the paper would be minus the back pressure, but the originals have got both line and figure. Again, I can't see what the back pressure has had to do with the information Mr. Wood has imparted to "Inquirer" previous to this controversy; for not one jot of information has had any reference to that part of the figure which he deems so difficult to understand. He says that in my next (meaning this) instead of saying that "Inquirer" must put ¼in. of lap on his valve, I shall perhaps say ⅜in. or ⅛in. No; I shall not do that. What does he mean by this assertion? Does he mean because I have made a little mistake that I have falsified *myself?* I think if Mr. Wood will just reflect over this last assertion of his, he will discover that he has exceeded the bounds of justice and not done as he would like other correspondents to do unto him. Again, he says that if I had had an extensive practice with laps and staffs, and the indicator, I should not call them guess work.

And so it seems from this assertion that improper language would have been more congenial to Mr. Wood's feeling than proper, for in this case had I used the singular term (lap) instead of the plural (laps) he would not have attacked me on this point. Again, if he knew anything about engineering shop rudiments (which it is very evident he does not recognize), his feelings would have revolted at an assertion of this sort, inasmuch as staffs and lines of the most exquisite nature, both in the drawing office and in the workshop, have for this last century in particular formed the base of all the engineering processes of our greatest progressing engineers. Must this greatest perhaps of all sciences be abolished at the instigation of one man, whose practice is so little in this direction that he has never been able to enjoy it—"no, never."

Again, as far as guess work is concerned, I never said that the use and practice of the indicator was guess work. It is of Mr. Wood's practice that I say if it does not remind us of the words guess work, it certainly does not indicate any very fine engineering qualifications. Next week I shall enter into the use and practice of the indicator. EDWARD MALBON.

"ALEXANDRA'S" DESIGN FOR A SALEABLE UPRIGHT PIANOFORTE.

[58.] SIR,—I fear, so far from making that portion of the case of a piano which is above its keys of the unusual, though not unprecedented, form which our Princess proposes, it would render the instrument yet more unsaleable than an ordinary cabinet 6ft. high, at least until it became fashionable; for anything in the fashion, however it may sin against good taste, is certain to become popular with her sex. I, for one, should be very sorry to make a set of four, or even a pair, on speculation. Besides, I thought I had clearly explained in my last letter, that a man who understands his business—who does nothing without a why and a wherefore—who don't trust to bellymen, *i. e.*, sounding board makers and string coverers, to do as *they* please—finds no difficulty in making a good bass to a piano 4ft. high.

"Alexandra's" design is not novel. It is simply the tail-end of a short horizontal grand stuck upright. Harpsichords and upright grand pianos were made of similar form during, if not before, the eighteenth century—not to mention that the form, as figured, of the Clavicytherum, the oldest stringed instrument with keys of which we possess a representation, is very similar in design. About 1845 Mr. Mardon constructed a piano of similar form.

The Euphonicon pianoforte patented in 1841, by Steward, whose design for a grand lately appeared in the ENGLISH MECHANIC belongs to this class, but it has no external case. Its strings are exposed to the air like those of a harp, being supported on a very ornamental metal frame. To my taste the design does infinite credit to the patentee.

Personally, my perhaps uncultivated taste prefers the ordinary tall cabinet pianoforte, when its case is well designed, and all its parts duly proportioned, to either the Euphonicon, which, from the exposure of its strings to the atmosphere, must be very liable to get out of tune, or the elegantly designed piano of Mardon. The whole generation, with the single exception of the upright oblique grand, which had two bent sides, have, to me, a lopsided character. But this is a mere matter of taste, and as, with some personal suffering, they taught me at school a small smattering of Latin, I will say—"*De gustibus*," &c.

However much increasing the length of the strings may improve the bass, it don't in the slightest degree improve the treble. Now, as I know very well how to make excellent basses with strings 3ft. 6in. long, though it is far easier to make yet better basses with strings 5ft. long, there is no inducement to make instruments taller at the bass than at the treble end. It is the improvement of the latter which is the great, if not the one thing needful.

With regard to what I somewhat presumptuously termed the harmonium of the future, I must plead that I am a mere suggestor. If "Alexandra" fancied she heard the familiar "ring" of the Blacksmith's anvil in my letter on "The Harmonium," 'tis no wonder after a friendly intercommunication *of 22 years* on this and kindred subjects; and I accept *her imputation* as, though an unintentional, yet *a graceful compliment*. I am not a harmonium maker. *In regard to the manufacturers of those instruments, I bear a similar relation* to what my old friend the "*Harmonious Blacksmith*" bears to the members of my own *vocation*, excepting that I trust I am rather less "*crotchety*" than he is. *But n'importe.* I make him pay me for his crotchets at a far more liberal rate than the public pay for their crotchets, and quavers too, when they can purchase three of Beethoven's pianoforte sonatas for the ridiculously small sum of 1s., or a whole set of 45 of the same composer's delightful waltzes at a similar price.

W. T., Pianoforte Tuner and Repairer.

BICYCLE RIDING—A SURGICAL OPINION AS DESIRED.

[59] SIR,—I am an experienced hospital and general surgeon, and not a bad anatomist. I believe that bicycle riding is less likely to produce hernia or rupture than running, leaping, rowing, or other violent exercises which cause tension of the abdominal muscles with full extension of the thighs upon the trunk. On the contrary, I believe that the position in bicycle riding is that least likely to produce the injury. This opinion is founded on the anatomy of the parts, and as a practical test I would invite communication from any person who may have become ruptured by bicycle riding.

The origin of the prejudice is that the old dandy-horse was highly calculated to cause the accident, but in its use the feet pushed the road at a point behind the vertical line of the body, and so the abdominal rings become most exposed to danger.

I am, in a small way, a bicycle rider, and encourage its use *in moderation*. I have frequently advised it for exercise and recreation for those engaged in office business with small salaries not affording a horse.

I could make my own bicycle much more useful, if popular prejudice did not still consider such undignified for professional men. The proposed broad band round the waist, like the soldier's belt, tends to rupture.

Ireland, July 11. COUNTRY SURGEON.

THE HARMONIUM.—"J. C. P." AND "ALEXANDRA."

[60] SIR,—In reply to "J. C. P.," who requires information about the best forms of reed organs, I am sorry to say I have not much of that same to communicate, but the little I have, he is quite welcome to. I may add, that the reference I make to patents, &c., may very probably put him on the track of additional information. Myers's patent, containing a specification of the means of varying the pitches of reeds throughout the entire compass of the instrument at once, is No. 8164, price 1s. 10d. I have not much faith in the possibility of carrying this out in practice, because, from the difference in the lengths of the reeds in the bass and treble, and the fact that those differences in length are not the only means employed to produce the required succession of sounds, I cannot conceive how to make the compressers, which alter the vibrating length of each reed in an Eolophon or harmonium, so that they shall raise or lower the pitch of each one reed the required amount in relation to the others; but if "J. C. P." procures and reads this and the other authorities I shall refer to, he will cheaply acquire an amount of information which I could not communicate without occupying a larger space in the ENGLISH

MECHANIC than I should be justified in doing on a subject of not very general interest. Indeed I have lately occupied so much of that space on musical and other subjects, that I think it is quite time I exercised a wise discretion and occupied less of it with my many lucubrations. I have not quite forgotten Mr. Spence's designation of me as "the universal letter writer."

Day and Mundies' patent, No. 5062, price 10d. (my own Eolophon is constructed on their system of air chambers or short pipes composed with free reeds). Wheatstone's patent, No. 10,041, price 2s., describing a combination of reeds and air chambers in the form of stopped pipes placed a considerable distance *above* the free reeds, which, under these circumstances, induce powerful resonances in the masses of air contained in those pipes or air chambers, will afford him much practical information and food for thought. Yet more is contained in Wheatstone's patent, No. 10,041 price, 2s. on what may, in contradistinction to *free*, be fairly termed *string* reeds; for although Wheatstone was not the first inventor of these (Professor Robison was;—see his Mechanical Philosophy edition of 1804), he was their great improver, for he showed how they could be made to utter not only the reed tones proper to them but also to cause the vibrations of a *table d'harmonie*, or true soundboard, and thereby compel it to utter its own sounds in unison with, and in addition to the reed tones. While on Wheatstone I have much pleasure in bearing testimony to the fulness and lucidity of his specifications: he leaves nothing to the reader's imagination, but makes, by his drawings and unusually clear descriptions, the matter plain to the "meanest" capacity—my own for instance.

May I presume to give "J. C. P." just one little bit of advice, and that is to endeavour to carry out our Princess Alexandra's idea, and make an harmonium which shall deserve—from the great variety of the timbre of its different ranks of reeds—the title of wind "organ?" Nothing palls like monotony. No doubt the harmonium of the future suggested by my friend "W. T." is not a small affair; but then his ideas are based on his familiarity with such instruments as the organ at the church of St. Sepulchre and similar anything-but-small instruments, but I think I can see pretty clearly that both he and the Princess are quite right in their demand for variety of timbre, so I should recommend "J. C. P." to go in for something like it, and provide bellows—Qy. *more than one*—large enough to enable him to add half a dozen ranks of reeds at any future time when he has tired of the familiar tone of his first loves.

Before commencing operations, let me earnestly entreat him carefully to examine the professional harmonium advertised in several Nos. of the ENGLISH MECHANIC, and probably deservedly commended by Mark Ellor; also the best productions of Alexander, Ramsden, Evans, and last but not least, of Herman Smith, who has afforded the readers of the ENGLISH MECHANIC so large an amount of practical information —which I trust "J. C. P." has read—and who promises yet more, for which I hopefully and anxiously wait. I also recommend him to use every opportunity of picking up knowledge by reading and observation of the practice of the masters of this art, on the principle of the wise precept, "in all thy gettings get knowledge." (N.B. If you can get money also, so much the better) too. For many years I have carried this precept out in the matter of "strynged" musical instruments, the pianoforte especially, but I am yet, notwithstanding a pretty extensive experience—very glad to avail myself of the practical experience and ability of my fellow correspondent "W. T." (By the way I see, "Alexandra" says, that when writing about his harmonium of the future, he signed "R. T.") to carry out my crotchets; for after all, we amateurs, however clever we may be, or rather think ourselves, at the thinking business, are usually poor hands at the practical.

THE HARMONIOUS BLACKSMITH.

THE MANICHORD—QUERY, WHAT IS IT?

[61] SIR,—This instrument, and many of its predecessors, is figured in Rimbault's "History of the Pianoforte," and he thinks it was simply an extra long and superior kind of clavichord. The manichord must not be confounded with "ye mono chordis," which seems to have been simply a name prevalent in Scotland and elsewhere for the clavichord. I have little doubt the manichord was a species of clavichord, differing from the ordinary instrument of that name in the construction of its tangents or string strikers.

Probably there were two clavichords, the one with clothed tangents and the other with its tangents of uncovered metal. I strongly suspect the latter is the instrument whose name used to be written clarichord, from the French word *clair* (clear), for its tones would be much brighter than those of one whose tangents were clothed, even if only with vellum. The fact that no clavichord with clothed tangents has come down to our time is no proof that such never existed, for their clothing may in the course of perhaps centuries have perished, just as the clothing of the action of the piano often does in a few years, with the assistance of moth.

Although I have not seen an ancient clavichord with clothing on its tangents, I have seen a modern one. About two years ago one of this kind, of German make, which belonged to the late Mr. Prowse, was sold by Messrs. Puttick & Simpson. I traced it to the possession of the bandmaster of the Royal Artillery, but could not recover it. I suspect this is properly a modern manichord, and that by simply taking the leather coverings off its tangents, it would cease to be one, and become a clarichord.

THE HARMONIOUS BLACKSMITH.

THE EARLIEST OF PIANOFORTES.

[62] SIR,—Considering that the keyboard was employed to open the valves or pallets which admit air to organ-pipes at least as early as the ninth century, it seems rather improbable that the same contrivance (probably reduced in width to suit the fingers instead of the fists of the never-to-be-forgotten "organ-beater," whose descendants are far from extinct until this day) was not employed to put in motion the strings of musical instruments designed on the model of the harp or the cythera. At a period of probably a thousand years ago it is quite likely that this was done in those eastern countries in which the pipe and free reed organs have been known in a more or less complex form from a period anterior to any historic records we are acquainted with. Our ignorance of such records is at best only negative evidence of their non-existence, or that stringed musical instruments, sounded by manuals, had not been constructed—an assumption based on the too common fallacy of making our ignorance a measure of possibilities. As well might it have been assumed that America did not exist, because centuries elapsed before Columbus re-discovered that division of the earth; and, as the knowledge of its existence had died out, a geologist of the period, with that turn for hypothetical speculation, if not for logical deduction, which distinguished the predecessors of Lyell, might have learnedly proved (to his own satisfaction at least) that (like Venus anno domini) what used to be termed the fourth quarter of the world had just risen from the sea. N.B.—Mathematics had not at that early period been sufficiently developed to enable us, by a very different kind of calculation to that denominated the differential calculus, to "kalkalate" that Australia was a *fifth quarter* of the globe. It would be well for us if our astute Chancellor of the Exchequer could, by a similar "kalkalation," repeatedly convert four quarters' taxes into five, for then a handsome surplus would be the normal condition of revenue, and we might hope John Bright's summum bonum of earthly happiness, "a free breakfast-table," might soon be realized. Verily our stout Quaker thinketh of carnal things.

The earliest keyed musical instrument with strings of which we have any record is the keyed cythera or clavicytherum; and its earliest known representation exhibits it standing upright, just as if some clever fellow of the period did what was afterwards patented in England about 1800—viz., put keys to a harp. Unfortunately the patent rolls of that early time, when clavicythera were made for love or money, have not been found either in that receptacle for *unseen* antiquities, the British Museum, or anywhere else that I am aware of; so I cannot at present determine the interesting question, whether King Nebuchadnezzar, when tired of the cares of state, set us the first recorded example of "monarchs retired from business" (by the way, I fear Dr. Doran forgot him), and wisely recruited his exhausted energies by a diet "intirely vegitable," as those innocent advertisements of vegetable rank poisons express it—I was saying that whether he, under the circumstances of his forced residence in the country (I mean when like my horse he was "put out to grass" for the season), solaced himself with his clavicytherum as Queen Elizabeth said she did with her virginal (I fear in her case female vanity had something to do with it), we have unfortunately no means of ascertaining; for the writings of the harmonious blacksmith of that early period have (if ever they existed, I have not seen them) as certainly perished as those of the somewhat garrulous person who had that title imposed on him in early life will do when something better is written (N.B.—Doing this would be far from difficult) to more worthily occupy the place in our journal which his writings don't deserve.

In the clavicytherum the strings were treated like those of the harp, the lute, the guitar, and modern unsuccessful students are "until this day"—*i. e.*, they were *plucked*. I only hope the latter, who are not invariably saints, utter as sweet sounds when they undergo (for their good) this very needful process, as the musical instruments enumerated do, and that the said students don't become "instruments of wrath," or ever utter sounds associated with the idea of "condemnation." When the clavicytherum was laid on its side it became the spinet, and when the spinet was put into a rectangular case it became the virginal. Both gradually developed into the harpsichord, certainly the king of its class; but perhaps I am a partial judge, and I confess to a weakness for one of my early loves. It is not needful I should describe so comparatively well-known an instrument here, for I have done so at pretty considerable—perhaps rather too great—length in my appeal for the earthly salvation of ancient musical innocents from the Herod-like destruction they undergo from the modern Goths and Vandals, who work their wicked will on them, to the great sorrow of collectors, who would be willing to pay almost any ransom to rescue them from their captivity among those barbarians.

The whole generation of harpsichords, spinets, &c., whose strings are plucked by plectra not held in the hand, or by the finger itself, were deficient of the power of expression, until other means of causing the vibrations of these strings was resorted to. The example of the various harmonicas, as for instance, that formed of pieces of wood (probably the most ancient of all), which has risen from the dead with a new *Greek* name, Xylophone (N.B. It has very little "phone" in the musical sense, and its sounds have a strong family likeness to those elicited when Punch's wooden cudgel comes in contact with the almost humanly wooden head of another puppet—it is far inferior to the old wooden harmonica in the East India Museum) and yet more that stringed harmonica the santir, which we call dulcimer, naturally led to the substitution of a hammer for a plectrum, and this produced the first "forte piano," with keys, for, in truth, all the harps, lutes, cytheras, and dulcimers, were true pianofortes in the musical sense—*i. e.*, they were capable of expression, and, therefore, piano fortes in the musical sense of those words.

The earliest pianoforte with keys of which we know any examples is termed the clavichord, probably from clavis, a key, and chorda, a string. I have before fully described this instrument, so I refrain from vain repetition. Whether the hammer which strikes the string be rigidly fixed in the key or detached from it, so long as it is a hammer, it enables the performer to vary the loudness of the sounds—*i. e.*, to play with expression, which a plectrum moved by a key does not, hence all hammer instruments are true "forte pianos."

It is by no means certain that, although the earliest now known, the clavichord was the earliest of hammer instruments; it is at least probable that some action more resembling that of the drumstick, or the striker held in the hand of the dulcimer player, preceded the tangent. Making the striker or hammer perform the function of a bridge rather seems a refinement which could hardly occur to a performer on the dulcimer who was compelled to lift up his striker immediately after he had struck the string with it, or he would have produced the effect termed *blocking* by pianoforte makers. Perhaps on the principle that all discoveries are said to be accidents—which, by the way, is a gross error, they are far oftener the result of profound thought and careful experiment—the tangent of the dulcimer may have been suggested by the falling of a hard body (a thing I hope I never may become, I prefer being sneered at as a "*soft* body," if sympathy for the suffering of others deserves that title) across the string, and at once putting it into vibration and, by shortening its vibrating portion, raising its pitch. It did not require a remarkably clever artist to transfer this effect by employing a striker—*i. e.*, the tangent, fixed in the key. I think (although but a "soft body") I could have done nearly as much myself; but then it is so extremely easy to set the egg upright when some one—too often utterly forgotten—has broken its end ready for you. Many great reputations are very cheaply made in this way; but man has a perverse proclivity to set up idols and shams for worship.

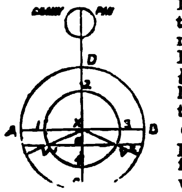
The earliest hammer harpsichords or pianofortes, in the modern technical sense of the word, of which any known record exists, are those made by Christofali, of Padua, in or before 1701. In these (which are fully described, and their action figured, in the "Giornale de' Litterati d' Italia," A.D. 1711) the hammer acts like a drumstick, or the striker employed to vibrate the strings of the dulcimer—*i. e.*, they *rotate* on a hinge or centre. So, in the modern technical sense, Christofali was the first pianoforte maker on record. It is remarkable how far this early Christian father of pianoforte makers, yclept Christofali, was before his time; for he especially says that this kind of harpsichord ought to have *much thicker strings* than those of the ordinary sort. He also anticipated some of the most supposed comparatively modern important improvements in the action, especially the escapement of the hopper or hammer lifter, and allowing the hammer to fall into an acute-angled receptacle, thus preventing it from rebounding to the string by a contrivance which is in principle the same as that afterwards re-invented by Robert Stodart, and patented under the name of the check.

I have already said that to produce a true forte piano, in the musical sense, the hammer need not be detached from the key. Neither is it absolutely essential that it should rotate on a hinge or centre: in a word it need not, except as a matter of practical convenience, be *a lever*. It is obvious that if the tangent of the clavichord were guided by two sockets, similar to those which guide the damper wire-stickers of a piano, and its edge kept at a right angle with the string, it would act even better than it does when fixed in the key; for then its path is not quite rectangular, but really a circular arc whose centre is the key balance. Like such a tangent, a sticker, whose top surface might be of wood, either clothed with leather or felt, or not clothed at all, similarly guided, could be employed to strike the string; and if the key were prevented by a back touch or otherwise from lifting the supposed sticker with rectangular motion quite up to the string, its path would be completed by its momentum—it would *strike* and *rebound* from the string. This extremely simple action was not I believe evolved out of the depths of my consciousness, as Kant would have expressed it; but, if I am not mistaken, it was actually used by Marius, in one of his three claviciens à mallet A.D. 1716. It seems to be the rule "in that case made and provided," that old things shall be re-invented and letters patent obtained for them. This not very valuable invention, in a practical sense, was no exception to that good old rule; for, in 1787, Master Humphry Walton (not him of the clock) patented a combination of it with the ordinary hinged or centred hammers. It does, indeed, seem a strange way of striking the strings of a piano to do it by means of punches—for this is just what Walton's perpendicular hammers are—which punches are themselves struck by ordinary hammers. The much older plan of hitting the strings with the hammers themselves seems at once simpler and more effective, but we must not be too severe on poor Walton: perhaps he was actuated by the best of motives; and, as he was prevented from using the check by R. Stodart's then existing patent right, he benevolently devoted his ingenuity to contrive something producing the same result as Stodart's invention, not within the *purview* of his patent, which might afford the musical public similar advantages without that public being wholly dependent on Robert Stodart. Nevertheless, Master Walton seems to have been a prudent man, and by no means entirely under the influence of benevolent feelings and self-sacrifice; for, if he relieved his contemporary musical clients from their entire dependence on R. Stodart, he did not fail to take out a patent for his invention, thereby making his musical clients *dependent on himself*. Perhaps one who diligently searches that mine of information, *involuntary* self-sacrifice, and, let me add, what the phrenologists term "acquisitiveness," yclept the Patent Records, might light on certain and sundry similar instances of that very moderate example of the manifestations of benevolence and self-sacrifice which was exhibited by Humphry Walton, whose pursuits, however selfish, were at least not open to the reproach of cruelty to animals, like those of his namesake and piscatorial predecessor, Isaac.

Robert Stodart patented the check for grand pianos in 1777. So slow are the race of pianoforte makers to adopt even proved improvements, that it was not until 1825 Messrs. Broadwood patented its application to square pianofortes. After this example of snail's progress, I should be a bold man, indeed, if I could expect any of my supposed improvements to come into use during this century; and I should be a very ancient fogy, indeed, were I to live to see the commencement of the next. We are told to cast our bread upon the waters, which is no doubt a moral duty—especially if we take reasonable care that it is bread, and not a stone that we cast; but, in some cases, it requires a great "many days" before it can be expected to reappear, and the old fogy don't expect "dis child" will live to see it.

THE HARMONIOUS BLACKSMITH.

SETTING AND FINDING THE POSITION OF ECCENTRICS.—TO "PAUL PRY."



[63] Let A, B, C, D, represent the end of the shaft, 10 in. diameter; let 6 in. be the travel of valve, which is the diameter of the inner circle, 1, 2, 3, 4. Let the lap = 1 in., and the lead ⅛th of an inch; add the lap and lead together, and set it off from X to O; draw the line, 5, 0, 6. A line drawn from the centre through points V1 and V2 to the circumference is the centre of the keyway of the sheaves. The above is used for marine engines, and is quite proper.

JOHN W. BEDFORD.

SHORTHAND.

[64] SIR,—"W." says that Pitman's system "is founded on philosophical principles." Most decidedly Lewis's is, and (to quote "W.'s" words) "its alphabet may truly be called the alphabet of nature, as it contains a symbol for each simple and distinct sound in our language." Lewis says in his book—"In shorthand the characters must be simple, and yet so perfectly distinct in their expression that no one character can be mistaken for another. Those characters that are most easily written and joined must be assumed to signify the letters or the sounds most frequently used, the more unusual sounds being represented by the less simple characters." He explains his method of obtaining the characters, and points out the reasons for making use of those of certain forms, and rejecting others. With "W.'s" remarks on phonography I entirely agree; but Lewis's system is as much one of phonography as Pitman's—both systems are phonetic. Pitman's is the most well-known, owing to the existence of those periodicals enumerated by Mr. Cridland; they are the life-blood of the system, and were they to be discontinued, I believe it would fast lose its popularity. Mr. Cridland would doubtless have been as successful with Lewis's system as he has been with Pitman's, in a considerably shorter time. It does not at all follow that the most popular system is the best, Lewis's is comparatively unknown on account of its expense. Mr. Robinson admits that in Pitman's system a case may occur (though rarely) "where the grammatical construction of the sentence would not be a guide to the reader where thin and thick strokes were not observed;"—as Lewis does not use thin and thick strokes, no such case can possibly occur in the use of his system. Mr. Robinson goes on to say that the "prolific resources of phonography would provide for the emergency," but does not state how. This is rather vague. The last sentence in Mr. Cridland's letter is—to say the least—peculiarly worded.

Let us compare the two systems, taking the vowels first.—Pitman makes great use of the dot, and in his preface calls it one of the briefest signs. This is correct as regards space, but not time, for as much time is occupied in forming a dot as three or four letters, because of the utter impossibility of joining it to another character; he uses a thick dot to represent the sounds *ah*, *a*, *e*, as in *alms*, *ape*, *eat*, and a thin one for *a*, *e*, *i*, as in *at*, *et*, *it*, a short thick stroke for *au*, *o*, *oo*, as in *all*, *ope*, *ooze*, the same stroke thin for *o*, *u*, *oo*, as in *on*, *up*, *full*, each of these in three different positions; also three small ticks, one of them at three different inclinations, all of them to be put in either one of two positions for the "compound vowels" *i*, *oi*, *ow*, as in *ice*, *oil*, *owl*, *new*, *wine*. "When a vowel is placed on the *left* hand side of an upright or sloping letter, or *above* a horizontal one, it is to be read *before* the consonant; and when on the *right* hand side of an upright or sloping letter or *below* a horizontal one, it is read *after* the consonant;" there is thus a great chance of misplacing a vowel. Lewis is obviously right in stating that "when the writer is in haste, it is impossible to be very exact in the placing of the points, and the misplacing of one will deceive the reader more than the entire omission of it." It will be clearly seen from the above-quoted rule, that when compared with Lewis's system Pitman's has *six* positions for the vowels—viz., three on each side of the consonant—whereas in the former system it is not of the least consequence on which side of the consonant the vowel is placed. It is inserted as near its proper situation as convenient, otherwise its position is immaterial, whether top, bottom, or middle, above or below, right or left hand side; it is often more convenient to place a vowel on one side than on the other—this cannot be done in Pitman's. Lewis has five small distinct characters—all made with the same facility as a dot—for the vowels, but none for the diphthongs, for which he uses the characters representing the nearest vowel sound. I always employ a short vertical stroke to represent any diphthong not having the sound of a single vowel; not the least difficulty is experienced in reading the dictation a long time afterwards, although Pitman's "long," "short," and "compound" vowels are entirely avoided. It is simpler to insert two vowels, such as *au* in the Lewisian system, as the *characters only* have to be remembered, than one diphthong (*au* for instance) in Pitman's, in which the *position also* has to be studied. Pitman also has four characters representing in different positions twelve double letters formed with *y* and *w* as *yah*, *yoo*, *wau*, &c., "they are written *heavy* for LONG and *light* for SHORT vowels, as in *yates*, *youth*, *walk*, &c.," Lewis has no such complex divisions. These characters as regards place, are subject to the same rules as the vowels, each class of which is subdivided into *first*, *second*, and *third place* vowels, according to their position. Pitman says "When a vowel comes between two consonants it is possible to write it either after the first or before the second. To secure uniformity in the writing of phonographers, the following general rules are established:—First-place vowels are written after the first consonant. Second-place vowels are written after the first consonant when they are *long*; and before the second when they are *short*. Third-place vowels are written before the second consonant. The rule for a second-place short vowel does not apply when the second consonant is the circle *S*." Can there be nothing simpler than all this?

Let us now compare the consonants and peculiarities of the two systems.

Pitman uses eighteen *different* signs to represent twenty-four consonants or combinations of consonants. Eleven of these are used twice—thick and thin—mostly representing similar sounds, but *r* and *w*, *l* and *y*, *ng* and *n*, have the same characters respectively, thick and thin, although greatly differing in sound. Five consonants have each two different signs, and *h* has three different signs.

Lewis has seventeen different signs to represent seventeen consonants, and ten other signs to represent ten double consonants of frequent occurrence, such as *bl*, *br*, *gl*, &c. Some of the signs are the same in both systems, but they do not represent the same letters. Pitman gives the sound *Zh* a character; how often is it required? He has also given *ng* a character; these letters mostly occur in the terminations *ang*, *ong*, *ing*, or *ung*, for which Lewis uses the characters for the vowels *a*, *o*, *i*, *u*, placing them in the most convenient position below and at the end of the word; it is seldom necessary to write these terminations in shorthand. The prefix *con* or *com* is expressed in Pitman's system by a *light* dot at the comencement of a word, and the affix *ing* by a *light* dot at the end of a word; there is no short distinct method of expressing any other prefix or affix in this system. Lewis uses ten signs representing twenty prefixes, and eight other signs representing nineteen affixes, so that in many long words the primary and terminating syllables may each be written with a single stroke of the pen—the affixes are always joined to the word. Pitman writes the aspirate *h* either by a small dot prefixed to the vowel sign—thus bringing two dots close together!—or by either of the two other characters. He also uses a little tick at the commencement of the word for the same purpose. Lewis uses one simple character, which is written in much less time than the dot, and is all that is requisite. In Pitman's system *n* is added to a letter by a "*final* hook on the left-hand side of a descending straight letter, or following the direction of a curved letter;" *l* and *r* may be added to other letters by an *initial* hook, and *w* before *l*, as in *well*, may be also thus expressed. "When a *thin* consonant is made half length, that is, one half of its usual size, it acquires the additional power of *t*, and a *thick* letter halved expresses *d*. The letters, *n*, *m*, *l*, *r*, are made *half length* to express the addition of *t*, and are then thickened to express *d*. When a verb ends in *t*, the past tense (if formed by adding the syllable *ed*) is written by shortening *t*. A vowel placed after a half-sized consonant is read before the added letter." Why all this complication? Lewis has nothing of the sort.

Lewis has eight "key symbols," which are extremely useful—one stands for &c., another for viz.—one points out where a proper name occurs—another where there is an omission, &c. Pitman has nothing corresponding to these. Lewis uses a small long-hand *q* placed after a question, for a note of interrogation. Pitman has a double sign, to make which—as given in the "Teacher"—the pen must be lifted *twice!* It must also be placed *before* the question, which is obviously not so convenient as after. He represents TWENTY-FOUR small words by his "grammalogues or letter-words," and the word *that* "by the shortened sign for *th*." Lewis represents FIFTY-FOUR by his "definite contractions for small words," and FIFTY-FOUR other words of frequent occurrence by his ticked characters, which are merely the symbols for the consonants and double consonants, with the addition of a small tick. There is thus not the slightest difficulty in remembering them. A very useful feature in Lewis's system is the possession of figures, which are formed from parts of the long-hand figures. They may be written separate or joined. I could point out other advantages in Lewis's system, but have already occupied too much space. Many advocates of Pitman's system will say it is "simplicity itself!" and that any one who cannot master it is a fool. Perhaps so; but what reason is there to burden one's mind with its above-mentioned perfectly unnecessary rules and regulations, when a much simpler and yet more complete system is equal to it in rapidity—if not superior? It may be all very well to say this letter proves the completeness of resources of Pitman's system over the Lewisian or any other system; but it must be remembered that this so-called completeness, with its concomitant rules, may be carried to any extent, and render the system even more complicated. I have remarked on every feature of both systems, and have quoted from the eleventh edition of "Pitman's Phonographic Teacher," to avoid mis-statements; but should there be any above, I hope to be corrected, as my only object is to direct "Hermit" to the best system, and cause him to avoid all which, like this, are as "Mac D" remarks "complex and unsatisfactory." Dryden writes, "to ignorance all is wit that is abusive." I hope no one will favour me with wit of this kind by way of an answer.

In conclusion, let me ask—Does any one of your correspondents know Lewis's system? If so, will he be kind enough to point out any complexity in it?

FRANK W. GRIERSON.

THE CULTURE OF THE MUSHROOM.

[65] SIR,—"J. T. P.", 4250, p. 383, should first procure a quantity of horse droppings, free from straw and stones, and pile them into a heap, which must be patted down firmly, and allowed to heat; when well warmed all through it should be shaken out and again made into a heap, changing the sides into the middle. After two or three of these "heatings" the dung will become sweet, which may be known by placing a piece of glass on the heap, and if the water that condenses on it is clear, the material will be fit to form into a bed. The bed may be of almost any dimensions, but a rounded form is best, as giving a greater surface from which to gather the mushrooms; some say 2ft. broad by 2ft. thick, rounded off, others 1ft. or 2ft. thick, sloping to nothing. It must be put together rather firmly, and should be neither too hot nor too dry. In a few days the heap will in all probability heat violently, and when the temperature has fallen to 70° or 75° Fahr., will be about the best time to put in the spawn. After the insertion of the spawn, which should be broken into pieces the size of hen's eggs, and placed in holes about 9 in. apart, the surface of the bed should be patted together with a spade, and then covered with a layer of straw about 6 in. thick. In about ten or twelve days examine the bed, and if you do not see the thin white filaments of the mycelium spreading out from the lumps of spawn it is certain that the heat is not sufficient, or the spawn is bad. If the former the whole bed had better be pulled to pieces and remade; if the latter, procure fresh spawn, which should be placed in different holes to the first. But if the spawn has begun to run you may proceed to cover the bed with an inch or an inch and a half of good loam, which should be patted close and gently watered, and the covering restored. This form of bed will do for a cellar, outhouse, cupboard, or the open air, but if the latter it should be covered with straw at least a foot in thickness. When the mushrooms are gathered a little earth should be placed in the holes whence they are taken. As to the kind of spawn to use, I think the French is undoubtedly the best, as what is generally bought at the seedsmen's is too hard and dry, whereas the French is in thin flakes, cut from heaps full of mycelium. Droppings obtained from a mill track, invariably contain spawn, and have only to be placed in small heaps to produce abundant crops of mushrooms. In the neighbourhood of Paris these delicious fungi are grown in caves either underground or excavated in the side of a hill, and even in deserted slate and stone quarries, as at Frépillon, Méry-sur-Oise, where at one time no fewer than 21 miles of beds were in full bearing. Of course in these comparatively warm subterranean caves a bed does not require any covering, but yields abundant crops for two, three, and even four months.

There is, in fact, scarcely any kind of waste space where mushrooms might not be grown—in pots and old tubs under the stage of greenhouses, on shelves in stables, indeed, in any situation where sufficient dung can be placed to heat, or merely enough for the spawn to spread if artificially warmed.

SAUL RYMEA.

CHEAP GAS.

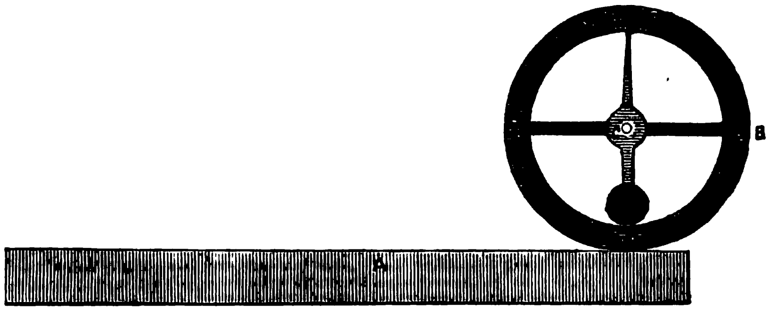
[66] SIR,—I think there is some truth in the old adage, "experience makes fools wise."

After thirty years spent in the manufacture, distribution, and the testing of coal gas, I may pretend to possess some information on this subject.

I have, at the present time, to superintend the distribution and consumption of gas to the amount of £6,000 per annum; and one of my chief duties is to see that the largest amount of light possible is obtained from a limited consumption of gas.

I would at once adopt the mode of improving common coal gas by carburization, if I had the smallest hope of obtaining any real lasting benefit from it.

"C. D. C.," in his letter (p. 354) says, respecting my answer to query 3819, "That I am certainly not well informed upon the real facts and principles involved, and it would have been better had I given my opinions, and then invited those of some of the talented chemists who have contributed such valuable



A USEFUL TOOL FOR TREATING INCLINED OR LEVEL SURFACES.

articles in the pages of the **ENGLISH MECHANIC**. I must confess that I am not a talented chemist; and it may be also true that "C. D. C." is right in his remark that I know nothing about the carburization of gas. Be this as it may, I will now add some of the facts I do know respecting improving common coal gas by the means of carburization. For nearly two years the process of carburization was tried in the city of London public lamps, under, I believe, the direction and inspection of Dr. Letheby, and yet was abandoned, and has not again been adopted. Great economy, with increase of light, was at that time promised, according to the theory and estimate of the projectors.

To ensure economy in the consumption of gas, the ordinary burners, consuming five feet per hour, were changed to those which would only consume three feet per hour. Of course the gas company's bill was materially diminished. But what about the increase of light? very often the streets of the City of London were in comparative darkness, and so loud became the complaints of the public that the authorities were compelled to order the removal of the carburizing apparatus and to restore the ordinary five-feet-per-hour burners.

I am well acquainted with the fact that within the last three or four years the principle of carburization has been revived with all the pretensions to originality. Many fresh patents have been taken out. The apparatus now in use no doubt are superior to those formerly employed. But the main difficulties still exist,—namely, the irregular evaporation of the liquid, and consequently the uncertainty of the light obtained from gas passing through the vapours of the carburizing liquids.

The following is an account of an experiment made by an able chemist in order to ascertain the rate of evaporation of liquid hydrocarbon. The material chosen was the spirit of petroleum, as light as it could be procured, being about ·700 specific gravity. 8lb. of the above were placed into a suitable vessel in such a manner as to expose a large surface for evaporation, and on passing atmospheric air there-through by means of a motive-power meter, a very large and rich flame, giving off abundance of smoke, was the result. This at the commencement, when adjusted to 5ft. per hour, gave a light equal to sixteen candles, but speedily the flame became perceptibly less; in a short time it was diminished to a remarkable extent. After twenty-six hours merely a blue light was obtained, and at the end of forty-eight hours no flame whatever existed, as all the volatile constituents at the temperature had evaporated. On re-weighing the residue, barely one-half of the total quantity had been available. This clearly demonstrated how easily people may be deceived by a carefully prepared experiment, for at the commencement the air was so highly charged with carbon as to occasion the greatest surprise; but as this was of such short duration on account of the very small quantity of the highly volatile material, the experiment was very deceptive, and the process of carbonizing the air utterly useless. In conclusion I may add, my former remarks in No. 269, page 260, were not made without well considering the subject, and as I am in no way interested in any gas company, or the manufacture of gas, my object is not to make large gas bills.

I have one of Evans's photometers with all other accessories for the analysis of coal gas at my command. Very recently I tested a new carburetting apparatus, but failed to realize anything like 50 per cent. saving. 20 to 25 per cent was the very highest average I could obtain. Against this there remains the uncertainty of the light obtained from the carburetting process, the expense of apparatus and naphtha, the attention required, and last of all, and not the least objection, the dangers to be guarded against in the use of highly inflammable petroleum. Every gas consumer is not a practical chemist. L. M.

PRACTICAL TELEGRAPHY.

[67] SIR,—Knowing your readiness to assist inventors to make known their inventions to the British public, I venture to send you a few lines concerning a telegraphic invention which is quite highly spoken of this side; it is an improvement in relay magnets, invented by William Smith, of Cincinnati. It is not easy to describe without drawings, and they are not to hand, but perhaps your readers will understand when I say that the connections of the relay are so arranged that the main circuit is divided, half passing through each helix, and coming together again on the opposite side. The advantage of this arrangement appears to me to be that the resistance is reduced to one-fourth, whilst each of the two helices will exert its magnetic influence in conjunction with the other, and the soft iron armatures will be acted upon as usual. The arrangement is claimed to be a considerable improvement, and the inventor will be glad to give particulars. H. J. C.

Washington, June 21.

PROF. PRITCHARD AND MR. PROCTOR.

[68] SIR,—It will be in your remembrance that a day or so after sending my letter headed "unfair criticism," I wrote, begging you to remove all but the defensive portions of the letter. Contrary to my expectation, the letter had already been sent to press at that time.

I wish now to point out that I may have been over hasty in attributing wilful unfairness to Prof. Pritchard. He may have *misconceived* (not *misinterpreted*) the sense and spirit of my work. In this case, an apology will be due to him, which I shall be most ready to make.

The case is now reduced to a very simple issue. I have submitted to Prof. Pritchard what I take exception to in his review, pointing out where and how he has misconceived my meaning. If he admits that my objections are valid, my obvious duty is to admit that I have unjustly charged him with unfairness. If he maintains the justice of his criticism, in the face of the evidence, I shall have no course left open to me but to maintain the justice of my counter criticism.

I need hardly say that I would infinitely prefer to resume my belief in the wisdom and justice of an astronomer whom I have for many years regarded with sincere respect and admiration.

RICHARD A. PROCTOR.

THE SYMBOL π.

[69] SIR,—In answer to "Gimel," both the statements in "Todhunter's Trigonometry" are correct. The symbol π is often used to represent the ratio, (3·14159·—) between the circumference and the diameter of a circle; and the circular measure of two right angles is equal to 3·14159 . . . Since the technical expression "circular measure" is applied to that mode of measuring angles in which the unit is the angle whose arc equals the radius, it follows necessarily that the circular measure of two right angles will be represented by the ratio of the arc of a semicircle to the radius, and this is, of course, equal to the ratio of the circumference to the diameter—a ratio invariably expressed, as Todhunter remarks, by the symbol π.

RICHARD A. PROCTOR.

MR. LOCKYER AND MR. PROCTOR.

[70] SIR,—In a note to *Nature*, signed "Editor," Mr. Lockyer asserts his view of the corona is not what I state it to be; and he proceeds to describe his view precisely as I have described it in "Other Worlds than Ours." He goes on to remark that I have misrepresented Dr. Gould's statements, simply because I have indicated a different interpretation than that which Dr. Gould has given. It happens, as I have but just found out, that Dr. Curtis and Professor Harkness (both mathematicians of repute), indicate their nonacceptance of the interpretation put by Dr. Gould on their common labours. Both of them also indicate precisely the same reasons for rejecting the atmospheric glare theory of the corona, which I have put forward.

But the strangest part of Mr. Lockyer's note is that in which he remarks that, "surely Mr. Proctor is old enough (*sic*) to see that by attempting to evolve the secrets of the universe out of the depths of his moral consciousness, he simply makes himself ridiculous." In this way he describes reasoning of mine founded on observation, and strictly mathematical in its character. Probably he has not considered how large a share of modern astronomy has been *evolved* this way. Copernicus, and Kepler, and Newton, did not themselves observe the facts they reasoned upon, nor would Neptune have been discovered had Leverrier and Adams been unwilling to apply mathematical reasoning to the problem.

Mr. Lockyer has not always exhibited such contempt for mathematical reasoning. I once "evolved from the depths of my moral consciousness," the fact that in certain parts of Saturn the sun is concealed by the rings of the planet for such and such intervals of time. This remark, so far from seeming ridiculous to Mr. Lockyer, struck him as worth appropriating, and accordingly it appears in his "Elementary Lessons of Astronomy," with nothing to show that Mr. Lockyer himself had not discovered it, unless the extent of his acquaintance with mathematics be supposed too clearly indicated throughout the book for any one to credit such a result to him. Considering that in this and other instances Mr. Lockyer has been willing to profit by (if not to take credit for), my mathematical examination of observed relations, his suddenly discovering that they are ridiculous, when they happen to oppose his theories, looks more than suspicious.

RICHARD A. PROCTOR.

A USEFUL TOOL FOR TREATING INCLINED OR LEVEL SURFACES.

[71] SIR,—I submit to your readers a useful little tool for treating inclined or level surfaces. It will be found useful at lathe or planing machine, in setting the work at various angles. It consists of a good parallel strip of steel, A, upon which is erected a circular brass plate, B, with indices marked on it, through the centre of which passes a small screw pin, upon which the needle, C, freely revolves.

W. GYNGELL.

NATURAL SCIENCE IN MILITARY EDUCATION.

[72] SIR,—In connection with the subject of Natural Science in Military Education treated of in a letter (signed "T. R. J.") lately in *Scientific Opinion*, permit me to offer the following observations:—

Eight years ago Colonel Dixon, R.A., treating of Military Education, wrote thus—"In fact it must march with the times and advance at the same rate as general education and intelligence advance." About that time so much greater attention was given to military education (or, rather, the high value of scientifically educated officers was so much more fully and honestly recognized by the authorities) that staff appointments were no longer given hap-hazard, according to caprice, favour, and family-ties, but officers specially educated were only chosen, and the Staff College itself was built, with a laboratory, &c., and the students placed on a better footing than before. Awakened interest in the cadet department of the Royal Military College, Sandhurst, had also about that time led the authorities to modify the plans and subjects of studies there in accordance with modern requirements. Classics had disappeared from the curriculum; and geology and chemistry (natural philosophy and physics) had been put within the reach of those who wished to follow out their taste for natural science, and of those who recognized its value in every-day life.

This reaction, on the part of the military rulers, from former carelessness for science and neglect of educated officers, produced good results. I learn that fourteen hundred gentleman cadets have gone out into the world with some knowledge of the natural and experimental sciences, often grounded on a native taste, which would otherwise have been starved, or on previous teaching, which would have borne but little fruit. Of two hundred and fifty staff officers I understand that upwards of fifty have studied geology, and others chemistry, practically and theoretically. The other branches of learning in either college have, of course, been mathematics, military arts and science (the latter founded chiefly on geometry and the science of numbers), drawing, some modern languages, and military history, in greater or less degrees.

Some old-fashioned minds, brought up in the belief that English gentlemen are under any circumstances equal to the exigencies of military service, whether commissioned from the nursery, school-room, billiard-room, or hunting-field, were reluctant to allow geology and physics a part in the general training of military men. Had they not hitherto successfully blundered on, pluck, persistency, and common sense carrying them through battles, campaigns, and administrations, with such losses, mishaps, and entanglements as were considered inevitable, and gloriously smothered by accepted triumphs?

The practical advantages that have accrued to those who have studied natural science at the Military College will as yet have been chiefly found in healthy employment of body and mind, and in the satisfaction of intelligent views of natural phenomena. That military men appreciate and relish this source of useful pleasure is well known to students of Indian, African, and West Indian geology, which they have largely helped to elucidate. Sir Charles Napier was not content to conquer the Beloochees; he insisted on having a geological report on the structure and mineral condition of their country, and he had it well made by a gallant officer in spite of difficulties. Lately the *Geological Magazine* welcomed an artillery officer as adding to our knowledge of the geological history of St. Helena, and increasing the bounds and influence of natural science. Lastly, General Portlock, Colonel Dixon, and Captain Hutton have urged their brother officers to cultivate geology and allied branches of science as of practical value in many ways. Indeed, one of them says, "As geology is the most useful of all the sciences to a soldier, so is a soldier's profession the one of all others best adapted for its study."

To say nothing of the great advantages commanded by a military officer, in having a knowledge of the nature of things, in being acquainted with the conditions, actions, and reactions of air, water, and earth—of heat, magnetism, electricity, &c., surely the man who has to fight nature at all points, in all parts of the globe, on all occasions, and that not for himself alone, but in the interests—the vital interests probably—of his company, his regiment, or army, and of the nation itself, requires more intimate knowledge of physical geography and geology, of mineralogy and natural history, than of high mathematics and ancient classics. He requires an educated eye and mind, not merely seeing the features of ground, but recognizing their meaning, their persistence or limitation, and their indications of internal structure, and not merely amusing his art faculties with light, shades, and tints of landscape, but reading the character of beach, cliff, hill-side, and mountain tops, valley, gorge and pass, spring, marsh, lake, river, and ford, so as to be able to master difficulties, avoid mishaps, and benefit by circumstances. He requires, too, a ready hand for other implements besides the sword. He must hammer the rocks, and study their characters at hand with the magnifier, as well as discern their nature from afar with his field glass. How else can he know what stone to choose for road metal, for instance? and without the blowpipe he can scarcely determine the useful mineral or valuable ore that may turn up along his route.

Such geological knowledge has been of late years taught at the Royal Military College, but the recently published Report of the Royal Commission on Military Education recommends that the cadets should not be taught natural science, but be allowed to study classics instead, because (it states) the large public schools, from which it is thought desirable that cadets should come, do not teach physical science, but, teaching classics and mathematics, give such youths the limited means of taking a place in competitions by those alone. Few cadets, however, it appears, join the College from the large public schools, and those chiefly from Cheltenham, where a "Modern Department" exists in vigorous life; and, whatever the desiderated pluck, dash, and wealth of public schoolboys may be, surely the more liberally educated students from other sources will beat them out of the field of competition, whatever limitation may be set to the subjects of study. But not only are there many schools and colleges that have instituted a "Modern Department" of science and literature (and that, be it remembered, largely in consequence of the improvements in military education requiring candidates with wider and sounder knowledge), but the large public schools have of themselves begun to add physics, chemistry, and natural history to their teaching.

Thus the Royal Commission proposes a retrograde movement in national education, puts aside the study of a science valuable to the military man, and slurs the scientific character of the age.

The report certainly suggests that at the Staff College geology be still taught, but as an art (if so be it could), "practical and without mineralogy," a play without a plot, a biography without a life, "cram" without meaning, facts without explanation. This, too, the report recommends to be taught by the chemist, already occupied with the arts of photography, telegraphy, torpedo-making, &c., and with such philosophic chemistry as time will allow, and the tastes of his students will require. Indeed on the proposed system the staff officer will have no obligatory study of pure science of any kind, and science in the line and staff of the British army will be officially reduced to schoolboy physics, amateur philosophy, and rule of thumb. Why should this be? Surely there are more schoolboys and candidates for the cadetship that have a taste for natural philosophy and geology than for classics. Let their tastes be cultivated. Surely the scientific culture of officers should not be neglected because some know little of its real value, or fear that the Staff College may become "a sort of fool's paradise of abstract learning and science"—(Lord de Ros in the Report). At all events, they leave science to take care of itself without any honours being offered, or even credit given to its student, who is tempted to leave it for work that places him high on the college list. Surely the cry of "too much work" is not true; the intellectual effort of military studies is not intense. There may be too many subjects before the student at a time. If it be so, let a good selection be made for individuals. Let means be provided for the cultivation of strong natural tastes and good acquirements, let special studies be fostered, and there will be less complaint of idleness in the cadet, and of superficial knowledge in the officer. Such good results, however, can scarcely be expected from a Royal Commission (however earnest its members may be) that comprises no representatives of natural science, and has not asked for any information from experts or authorities in such matters. **MEM.**

THE FLUTE AND FLUTE-PLAYING.

[73] SIR,—I have felt much interest in the letters which have appeared in your most valuable journal from Messrs. Leftwich, "Sable," and "Orion" upon flutes; and with your permission I now venture to offer a few remarks upon that subject myself; and in the first place I beg to state, that although, as a London professor, I have had flutes from most of the principal firms, yet I have no business connection with any one in particular. I shall not enter into the question whether the Boehm system is better than any other; no doubt it has some advantages; but when "Orion" says "that there are many passages which cannot be played in a creditable manner on the old flute," I cannot help thinking that his acquaintance with flute players must be limited, and I would recommend him to examine the fantasias of Nicholson, Frisch, Kuhlau, and others: he will there find difficulties which were played on the old eight-keyed flute, and in the hands of the many fine players whom we have had they were either "struggled over nor botched."

There are many professors now living who remember the late Charles Nicholson, and they one and all concur in saying that his playing surpassed all that they had heard before or have heard since. I had the pleasure of being a pupil of the late R. S. Pratten, and at that time he played on the eight-keyed flute, as made by Messrs. Rudall & Rose, and in my opinion he never played better than he did then, for it seemed to me as if difficulties were unknown to him; and who is there in the musical world who does not remember the charming solo playing of the late Mr. Richardson, the bird-like quality of the tone, the perfect execution, and the correct intonation in his hands of Prowse's flute? I could name a host of others of the past, but I will come to the present.

Did "Orion" ever hear of Mr. Alfred Wells, who has been the solo flute in that magnificent band of the Crystal Palace for about fourteen years. In that orchestra music of the most difficult character is executed in the most splendid manner, and yet the gentleman I have named above plays on the poor old, but much abused, eight-keyed flute, and I do not think that any one will accuse him of "botching or struggling" over the passages, be they ever so difficult, whilst in tone and intonation I do not think it would be any easy matter to surpass him.

With regard to the old flute being out of tune, I am willing to admit that in its construction it is imperfect; but in the hands of a good player, with a correct ear, its imperfections disappear, whilst in the hands of an indifferent performer even an instrument perfect in its construction (if such a thing exists) can be, and very often is, played out of tune.

It is the instrumentalist more than the instrument that must be in tune.

I myself play on Siccama's flute, and have done since 1847; in fact I was the first professor who adopted it; and as my instrument is one of the first models made by the above gentleman, I prefer it to any other. It is simple in its construction, very well in tune, and a good tone, and quite loud enough for any flute (for I think, with one of our great conductors, that one does not want to play the trombone on the flute), and the fingering of the old flute, with a few exceptions, can be used, whilst there are also other fingerings which simplify the execution of certain passages. The Siccama flute is now made and sold by Messrs. Chappell & Co., and by Mr. Hanson.

I have no doubt that on the Carte Boehm flute many passages are much more easily fingered than on the old flute; but there always appears to me to be a great difficulty to overcome in acquiring the use of the open keys for the thumb of the left hand; and to talk of every passage being easy on those instruments is simply a mistake.

With respect to the price charged by Messrs. Rudall, Rose, & Carte for their flutes, which "Orion" thinks is high, I do not think that it is possible for such exquisite workmanship to be executed for a smaller sum.

With respect to the flute invented by the late Mr. Clinton, I never could see any advantage in it over the Siccama flute, and it is more complicated in its mechanism.

As I dislike writing under an assumed name, I beg to remain,

HENRY CHAPMAN, Professor of the Flute.

THE SUN'S PARALLAX.

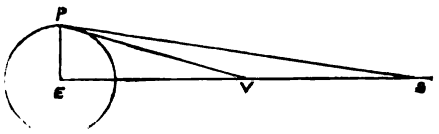
[74] SIR,—"Veritas" asks me, on page 308, whether an angle at the centre of a circle is a measure of an arc of that circle. If the radius be known it certainly is so. His second question is, "Is the tangent an arc of that circle?" I do not know why he asks this, but, of course, the answer is "No." I cannot imagine that any one with any knowledge of trigonometry can want a proof of such a self-evident fact as that angles are not proportionate to their tangents.

Having answered his questions, may I ask him whether he really intended to write the following:—"And in every case the sine of any angle is to unity as the cosine of the same angle is to the tangent of that angle." Let us follow this out and see to what it leads. We have

$$\sin A : 1 :: \cos A : \tan A$$
$$\therefore \cos A = \sin A . \tan A$$
$$= \frac{\sin^2 A}{\cos a}$$
$$\therefore \cos^2 A = \sin^2 A$$
$$\text{or } \cos A = \sin A$$

which is absurd.

I will now show him what I meant in the letter to which he refers. Let E be the centre of the earth, V



that of Venus, and S that of the sun. Let P be a point on the earth's surface, such that P E V = 90°; and let all the lines be in the same plane. Then E V = distance of Venus = E P cot. P V E, and E S = distance of the sun = E P cot. P S E; therefore the distance of the sun : distance of Venus : : E P cot. P S E : E P cot. P V E, or, as cot. P S E : cot. P V E; therefore the distances of these bodies, (and of any others) are proportional, not inversely to their respective parallaxes, but directly to the cotangents of their parallaxes, or inversely to the tangents of those angles. I am unable to test this result numerically, because I have no tables calculated to so small a quantity as one second, much less to a fraction of one; but I am confident that the parallax thus found will be that which is generally accepted to be true. **HUGO.**

AN ENGLISH MECHANIC COLONY—HONEY-BEE EMIGRATION.

[75] SIR,—I am glad to find that the thought expressed by your correspondent "Alexandra," page 390, exists in more minds than one. I have long expressed the belief that our present system (?) of emigration is not only careless and thriftless, but most reprehensible. The harum-scarum way in which our population is now leaving us, each one to shift for himself—an army (in numbers) all pioneers, without organization or concerted design—indicates a singular want of providence and forethought on the part of our legislators.

Where shall I emigrate? what shall I be required to do? what shall I want when I get there? are questions which meet the eye in every popular publication, and advisers are as numerous as their interests are diverse and multiplied. Since we profess to be so fond of what is natural, let us take an example from the crowded hive. The honey-bee emigration is organized beforehand, the note of preparation is heard long in advance, and they go, carrying with them the habits and discipline of their birthplace, and adopt a new home under the security of mutual aid and protection afforded by the aggregation of trained industry and preconcerted design. At present the energies of our emigrants are often wasted by being scattered, and individual toil is exhausted in hopeless conflict with difficulties easy of removal by conjoined assistance.

Our emigration parties should be arranged long before starting, and should as far as possible represent a slice of the mother country, or at least of all the useful and economic departments of it. For example, some block of land with sea or river frontage, say, five, ten, or fifty miles square, is surely still attainable in our colonial territories, and by government sanction or possibly charter. Such a place—the new colony of "Alexandra" for instance—is deemed to be available for settlers, and is allotted to a council formed of emigrants, constituted before leaving England. *That council would then invite co-operation. Persons of tastes and habits opposed to the tone of their leaders would of course not offer themselves. Tory leaders, for instance, would hardly get Radicals to associate themselves; teetotallers would join teetotallers; high church leaders would only get those of the same class of thought;* so that those associated would be for the most part of congenial habits and dispositions. The position of life of those fitted for the colony would be another basis for selection. It would not do to have a preponderance of one or two classes: a majority of shoemakers or of blacksmiths, or of any other calling, would be guarded against. The parson, the doctor, the lawyer, the magistrate, the police, &c., &c., should all be subject to selection beforehand. And all this could be done without ignoring the rights of property or invading individual claims, the one to 100 acres, the other to 1,000, as his means might be. The great evil of male emigration, to the exclusion of families, and which tends now so largely to demoralization both at home and abroad, would be obviated, as it would assume the possibility of families emigrating in their entirety, and not the adult males only as now. It is a lamentable fact, and one greatly damaging to the welfare and interests of the community, that, large as is already the excess of females in England, it is yearly becoming greater through the excessive emigration of males. What a tale of endurance and misery does this one fact unfold, which would all be obviated by "honey-bee emigration," that is in "swarms," not in single and solitary departures, which the present pioneering necessities encourage or demand!

To illustrate once more. Let us suppose that a dozen earnest men—intending emigrants—firstly, by correspondence and agreement among themselves, apply to the Colonial Secretary for such a grant of land as I have described, and having obtained it, publicly announce their forthcoming departure this day twelve months, who can doubt that all the essential requirements of a village would at once be forthcoming. A little slice of England—a true hive of industry—would at once establish itself, without that dreary, heart-sickening despair which must sometimes paralyze the efforts of isolated inhabitants in a new and thinly-peopled country. Joking a lady about the new plan, I was told that if the first swarm was to consist of 1,000 I need only trouble myself about 500, for the "better half" would be forthcoming at once, aye, and with money too.

For the sake of the female population of this country I rejoice to believe that they would willingly join in such an assured and organized movement; and, if nothing else prompted the wish to promote it, regard for them is to me avowedly an incentive to bring it under notice. The question is wider and deeper than at first appears. If, from the daily increasing disparity in numbers between the two sexes, marriage is simply impossible to tens of thousands of the women of this land, and if amongst those who are to be so blessed the larger proportion await that happiness in obedience to civilized requirements which discourage early marriages, let us, by a system of emigration in which they may join, help to place them in positions in which early marriage is both wise and honourable—where, in fact, it may be their happiness to obey the Divine injunction, "Increase and multiply, and replenish the earth and subdue it." **M. D.**

IRON IN BATTERIES.

[76] SIR,—I see that "Sigma" has somewhat modified his previous opinion as to the use of iron in batteries.

About three years ago, owing to the difficulty I experienced in getting thick rolled zinc, I tried iron as a substitute, and obtained results so unexpectedly good, that I have continued to use it ever since. My first trials were with cast iron plates, the battery arrangement being the same as Groves's—viz., platinum with nitric acid, and the cast iron in solution of salt; this gives very good action for a few hours, but at last the cast iron becomes covered with a plumbagine deposit which stops the current until it is entirely removed. Latterly I have used wrought iron either in plain water, weakly acidulated water, or solution of salt. Of the three I think the latter gives the strongest current; but there are some peculiarities about the behaviour of iron in this solution, which require to be studied. Frequently, but not always, the iron plates, after being taken out of the saline solution and allowed to dry, will refuse to act, and continue inactive until dipped in an acid solution for a short time. The same thing does not happen when the iron is used with acid, and for this reason I give the preference to the use of weak acid solution, or else to an arrangement of saline and acid solution in each alternate cell, changing the plates from the one cell to the other after each removal.

It appears to me that the nitrous acid fumes are in this battery absorbed to a great extent by the iron solution in the outer cell, as I do not find them affect the atmosphere of the room much. Will "Sigma" say whether this is likely to be the case. I am under the impression that nitrous acid gas has a strong affinity for iron solutions. If I am right it could probably be got rid of altogether by closing up the porous cell and leading it by a bent pipe into the outer solution. The first effect of the battery action appears to be to give a blue colour to the nitric acid. What is the cause of this? Is it owing to the formation of ferro-cyanuret?

I had overlooked the description of Slater's battery until "Sigma's" last paper called my attention to it. His description, however, differs considerably from that given by "D. F. K.," page 132, in which the chief novelty appears to be the use of nitrates in the outer cell with the iron, nitric acid being used as usual with the carbon in the porous cell; and it is claimed that by adding nitrates and nitric acid to each respectively in proportion to the work done, the constancy of the battery can be maintained. "Sigma's" description differs materially from this, the nitrates being used exclusively in the inner cell instead of nitric acid, which is no novelty. I have failed altogether to keep my batteries constant by adding nitrates and other oxygenous salts to the exhausted solution in the porous cell. Even fresh nitric acid has but little effect unless the old liquor is completely emptied out of it. I attribute this to the endosmosic action which converts both the inner and outer solutions into a thick black liquid. Even plain water becomes equally black after a time, and at first sight it appears to me that the use of nitrates in the outer cell is a step in the right direction with a view to constancy. Altogether, having regard to the cheapness of iron as compared with zinc, I am inclined to think that it has not received as much attention as a positive element as it deserves.

"Sigma's" great courtesy in replying to enquiries, not always very reasonable, cannot be too often acknowledged by the readers of the ENGLISH MECHANIC.

July 4. THOMAS C. HAINES.

EMIGRATION.—CANADA.

[77] SIR,—I can scarcely imagine a more perplexing position to be placed in than that of "Cotton Clerk," and having been in a somewhat similar one, can fully sympathize with him. Where is he to go? One lauds South America, but others come forward who, agreeing with him in some things, still relate others equally true that would seem to put emigration to that place out of the question. Australia, New Zealand, and Natal find supporters, and although nothing is said against climate in these cases, distance is urged as an objection. The Western States of America seem to find most supporters, and to judge by what some of them say, it is a very land of milk and honey. But these firm advocates of western life do not tell us that, in addition to Indians, who make periodical forays into the settlements, murdering and scalping the poor emigrants, there is the continual pistoling, gouging, lynching, and cheating of the *civilised* white Indians to contend with. Not a word is said for Canada. One regards it as afflicted with a severe winter, but does not tell us that most of the western states are so afflicted; and that on the unsheltered prairies of the west is almost unbearable. Hot summers and cold winters are not peculiar to Canada, but are the rule in North America generally, the States as well as British possessions, these seasons being far more marked there than in England. I was glad to see the letter of "F.R.G.S." in support of the British colonies, and I think he is on the whole right.

Still, to those who are not lovers of the sea, a voyage to Australia is a serious consideration. So if those of your correspondents who contemplate emigration are not good sailors, or if they don't like the idea of eating roast monkey while they themselves are being roasted under a tropical sun in South America, or if Indians, red and white, and border ruffians are an objection, why not turn their thoughts to Canada. Land may be bought there at very cheap rates, near markets, wild or cleared, and free grants of 200 acres may easily be procured in available situations, the terms being in either case nearly the same—an obligation to clear a certain portion of your allotment in a given time. That part of the bargain completed, the settler becomes undisputed owner of the soil. This is not, as some think, a life-long work, but can by industry be accomplished in a short time, and sufficient in a few years may be brought into cultivation to make any man of moderate expectations well off. There is not much difference in quality between the free grant and other lands—you may buy nearer a market. Easy access to markets is of vital importance to those who are farming large tracts of land, but not so much so to those who are in a small way, and who usually dispose of surplus produce at their own door, or trade it at the nearest store. Canadian farmers can always get a fair price for their produce, without much trouble. This is very different to many of the western states, where some time ago grain could not be sold at any price, but was either allowed to rot or burnt. This is not fancy but a fact.

The Canadian winter is cold, but there is plenty of fuel at your very door, game is not plentiful, but the rivers swarm with fish. There is a peaceful population, crime in some districts being unknown, there are properly constituted courts of law where the judge chews not, neither does he smoke in court. A man working there for himself, as he is obliged to do here for a master, will find a very different result; he will be paid in produce as he goes on, and the more he toils the better will he be, for every acre he clears and cultivates not only represents present gain, but future independence; his land will be gaining value yearly. It is truly a working man's country, and in it he thrives and lives in health and comfort. To those who are blest with bodily health and strength, and especially those who have grown-up families, and have a little money saved, I would say go to Canada.

If any of your numerous correspondents are thinking of Canada, I will gladly send more particulars as to cost, capital required, or any other information of which I am possessed. MASKELONGUE.

COTTON SPINNING.

[78] SIR,—If I understand the "Harmonious Cotton-Spinner" rightly, he has now discovered a slight draught between the lap roller and feed rollers, in the make of engine in which he challenged me to find a draught; and on becoming aware of the fact that the fluted rollers take up more length than plain ones of the same diameter, he, it appears, instructed their carder to "counteract the difference by nailing slabs of wood ¼in. thick round the lap roller," making it 6½in. diameter instead of 6in. as before. He will perhaps be surprised when I tell him that there is still a draught between the rollers, for, supposing the feed rollers were plain rollers 1¾in. diameter, in order to get the real working diameter we must add to them the thickness of the lap between the two feed rollers; if we take this thickness at ⅛th of an inch, which I think he will allow is reasonable enough,

we should have a draught of $\dfrac{48 \times 1\frac{7}{8}}{14 \times 6} = 1{\cdot}07.$

I am well aware that machines are frequently altered after leaving the maker's hands—sometimes for better, sometimes for worse. I have seen fluted rollers turned down into plain ones, and lapped with card fillet, but the wheels have been changed in order to keep the relative speeds as before.

He asks me how "I would account for a carding engine working with the same arrangement he quoted, with rollers covered with fillet instead of being fluted." In ascertaining whether there is or is not a draught between the rollers, I told him in my last letter that with fluted rollers, I should take out the taker-in, and measuring the lengths delivered by lap roller and feed rollers, notice the difference between the two. Where the rollers are covered with card filleting, I should not take out the taker-in. I should merely break off the lap from the roll at 1½ yard from the feed rollers (of course with the feed rollers out of gear), put the wheels into gear, and after the lap roller had revolved twice, throw them out again, then measure the length of lap left, and see how the difference between it and 1½ yard corresponded with the length that two revolutions of the lap roller would give. This is the only practical way to settle the matter. He says "I am wrong in the statement about the length fluted rollers will take up." If he thinks so, why does he not make the trial as suggested, which can be done in ten minutes, and forward the result for the benefit of your readers? If he is not willing to do this, perhaps some one else will test the matter and decide between us. From what he now says, it appears that he has not been dealing with the "practice," but the "theory of cotton spinning." Had he told us this at first, we should have understood him much better. I certainly did not think that any one would have taken "Mutual Improvement's" question to be one of "theory," neither would anyone suppose, on reading "H. C. S.'s" first and subsequent letters, that he was dealing wth theory only. I and others had stated that *there is* a draught between lap and feed roller. He said *there is not*, and challenged me to the proof in any one of the 150 engines, particulars of which he gave. I call this dealing with the question practically.

Theoretically I agree with him that "there ought not to be a draught there," but practically it is found that a draught is necessary for reasons given before, added to which I may mention that there is sometimes such a "plague" as the lap "licking," which a slight draught has a tendency to prevent. I grant him that in most of the books published on cotton spinning, the draught is taken between feed rollers and delivery rollers, but like Mr. Slater, I am no believer in books on cotton spinning, especially in any I have seen by recent writers on the subject: most of them are merely condensed reprints from works of former writers, who wrote at a time when the engine was not fed with a lap, as at present. Formerly the cotton was spread by hand on a feeding cloth, or lattices, much in the same way as is now done on the feeder of a lapping machine. At that time it might be quite proper to begin at the feed rollers in taking the draught of the engine. "H. C. S." will find that all our writers of works on cotton spinning do not begin at the feed rollers, as he supposes. I am not acquainted with many, but if he will look into "Scott's Practical Cotton Spinner," which I suppose is considered a standard book, he will find that he begins at the lap roller, and gives the "draught between lap rollers and feed rollers 1·08. But supposing there was no draught between the rollers, I think it best to begin at the lap roller on account of the difficulty there is in finding at what rate the feed rollers, whose surfaces are not plain ones, deliver the lap to the taker-in.

I referred "H. C. S." to the maker of a yarn tester, as I did not wish to encroach on your space with a description. I thought then, as I think now, that if he thought proper to write he would perhaps get better information than I could give, as there may have been improvements made since it came out, now some years ago, of which I know nothing.

I owe Mr. Slater an apology for having commented on his method of taking draughts, before I had given that attention to his second letter which I ought to have done had I been aware that in it he had resumed and continued the subject treated of in his first letter. My remarks applied to his treatment of the question in his first letter. I can assure him I had not noticed the paragraph in his second letter to which he has drawn my attention in his last communication. Had I read his second letter more attentively there would have been no need for my comments, as I find we agree almost exactly in our methods of taking draughts.

I hope Mr. Slater will not be scared away by the "ghost" he has risen, or that he will be in the least disheartened by the numerous attempts made by the "lads" to pin him into a corner, there is no harm at all in them, it is only a way they have of seeking information, and they would be no worse at all for a little "peppering" if our Editor would allow it. Some 18 months ago, under an altered *nom de plume*, I had the pleasure of a passage at arms with one of them. I found no harm in my assailant, although some ugly thrusts had to be parried, and I have no doubt but that both of us were better after the encounter.

Factory lads are not at all thin-skinned, they care nothing about a little rough handling now and then. They are used to hard knocks: it is rather an amusement for them, and one way they have of enforcing their arguments. Under your excellent management they will mend their manners, as you cannot afford to indulge them at the expense of your other contributors, especially now that your space will become more valuable by the accession of strength from the contributors to *Scientific Opinion*.

I should be very sorry if I thought that anything I have said has given offence to Mr. Slater. I have read his letters with great pleasure, especially the one on page 330, wherein he gives some sound advice, and which I think goes a long way towards explaining the poser which he set us to think out for ourselves. There are also some very good reasons given why he advocates the arrangement of draughts he gives (in advocating a more equal distribution of draughts he does not stand alone: similar views are held by a great many. Scott in his book, for a total draught of 6·12, gives the draughts for three lines of rollers thus—"between back and middle 2·25," "between middle and front 2·72,"), and also why he condemns a "considerable" draught in draw boxes at the engine head. New beginners in the study of the art of cotton spinning will do well to think over the matter in that letter. I have no doubt his letters have proved highly instructive to a great many engaged in cotton mills, by whom they will be much appreciated. Mr. Slater is very well able to take care of himself, so I will conclude with the hope that he will at once lay the "ghost," and pass on to something of more substance.

B. W. R.

[We have no objection to "factory lads" chaffing each other or "peppering" each other. But unfortunately they cannot do so here without occupying space which some who are not much interested in the sport think might be more usefully appropriated.—ED. E.M.]

COMPARATIVE TEMPERATURE DURING JUNE, 1869 AND 1870.

[79] SIR,—I beg to send you the temperature 2ft. below surface last year and this for June:—

1870.		1869.	
June 1—3	52°	June 7	52°
„ 4	53°	„ 8	54°
„ 5—12	54°	„ 12	53°
„ 13—14	55°	„ 18	52°
„ 15—21	56°	„ 25	53°
„ 22—23	57°	„ 27—30	54°
„ 24	58°		
„ 25—30	59°		

C. J. R.

SILK BOLTERS.

[80] SIR,—"Onlooker" says that in my description of silk bolters I assert there is not more than one-third the silk in actual use, the rest being taken up with rails and ribs. What I wrote, and what any one at all conversant with silk bolters knows to be a fact, is, as I stated, that there is no more than one-third of the silk in the present silk bolters that is effective in dressing, simply because, for instance, in the size of bolter he mentions there are six rails. Now each of these rails, continually as they reel, revolves, carries the meal up with them to nearly the top of the reel, from whence it drops to near the bottom, so that while the rails are carrying the meal up the silk is doing nothing, and is for nearly half the revolution of the reel, as the only part of the silk that does any dressing is where the meal drops, which is about half way between the ribs to the next rib, by which it is carried up again; so that if I had said that only half the circumference of the silk did its proper work in dressing, I should have been nearer the mark. E. DAVIES.

A SQUARE-BAR MICROMETER.

[81] SIR,—I am afraid the letter of "Omicron," page 379, if it does not actually mislead "F.R.A.S.," will not increase his information. If my recollection serves me rightly, Mr. Cooper does not call the apparatus he used in determining the co-ordinates of the stars in the "Markree Catalogue" (and described in the introduction to that work) a "bar micrometer," but a "square-bar micrometer," which is likely enough to be a very different instrument, as no doubt the name refers to the arrangement of the bars, Mr. Cooper's bars themselves being by no means square ones. The name was given to it, I should say, much in the same way as it was to the old rhomboidal micrometer of which La Caille made such good use, and of which instrument Mr. Cooper says his is a modification.

Why does not Mr. Holden write to Messrs. Cook & Sons, and ask them for the information he requires? He might then know exactly what the instrument is, and be able to enlighten some of us through the medium of your very excellent journal.

HENRY T. VIVIAN.

THE CAUSE OF STORMS.

[82] SIR,—I should very much like, with your approval, to write a paper on this subject (in accordance with Mr. E. Jones's suggestion), when I have concluded my paper on "Comets and Meteors."

RICHARD A. PROCTOR.

REPLIES TO QUERIES.

[2637.]—ELECTRIC LOCOMOTIVE.]—A look at one in an instrument maker's window will be better than a lengthy description, which, for a mere toy, would have little interest to others. There is, or was, one at Negretti & Zambra's, Holborn, close to Hatton-garden, now on the new viaduct.—Sigma.

[2647.]—COLOURED PRINTS.—"Blackburn" will get these at any large stationers'.—Saul Rymea.

[2653.]—SULPHATE OF ZINC is made by washing the calcined and effloresced sulphide of zinc, or blende, and evaporating till the liquid crystallizes.—H. U.

[2652.]— SULPHATE OF ZINC—Is manufactured by dissolving zinc in sulphuric acid, and crystallizing. Vast quantities are thrown away in the form of battery solutions, and as a residue from the making of hydrogen gas, especially by plumbers who use the lead-soldering process.—Sigma.

[2658.]—CHEMICAL SOLUTION.—I have some of the same precipitate set by me for examination, when I have time at disposal for it. I suspect it is an oxychloride.—Sigma.

[2665.]— INDICATOR.— Apparently the querist means "shocking" coils, as shown in the streets and elsewhere, rather than what are more usually called induction coils (though they are really the same things differently made). It is a purely mechanical matter, and may be made by leading a cord from the handle, by which the tube is drawn out to the arbor of the indicator. I have seen a similar index fitted to a magnetic electric instrument, to show the distance to which the armature is withdrawn. It only indirectly indicates the force of the current by really showing the condition in which the instrument yielding is placed, but has itself no connection with the electrical action.—Sigma.

[2668.]— SKETCHING FROM NATURE.—"Typograph" can get acetate and muriate of cobalt at Mr. Cox's, Ludgate-hill; Messrs. Mottershead, Manchester, and of most drysalters. I don't know the price, but they will send catalogues of chemicals for a stamp.—Saul Rymea.

[2669.] MAGNETISM.—The answer to this would be a treatise, and should accordingly be sought in works treating of the subject.—Sigma.

[2699.]—CROQUET RULES.—"W. F." can obtain these of Messrs. Routledge, Broadway, Ludgate, E.C. I do not understand what he means by "marking" boxwood rings.—Saul Rymea.

[3764.]—EBONITE.—The shape of articles made of this substance cannot be altered after once casting.—Saul Rymea.

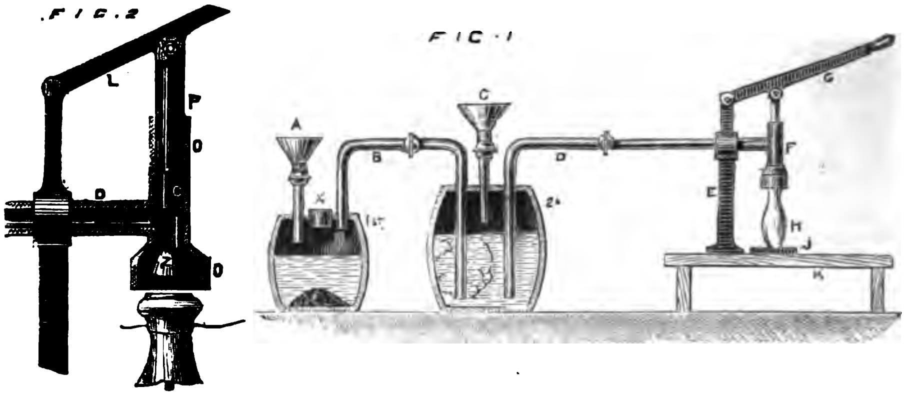
[3805.]—REDNESS.—The flushing of the face of which "Rouge" complains is constitutional and may be relieved by a strict attention to diet. Has "Rouge" tried the effect of "making up his mind" not to let his face turn red?—Saul Rymea.

[3811.]—GUAIACUM.—The wood and gum of this tree were at one time considered specifics in syphilitic diseases, and the gum is still used for a variety of purposes in medicine. As to which is the best way to obtain all the medicinal properties of herbs, infusion or distillation, that would of course depend on the nature and properties of the particular herb.—H. U.

[3811.]—GUAIACUM PLANT.—The querist asks for some particulars about the guaiacum "plant." Might this not be a mistake? There is a guaiacum "tree," lignum vitæ, a tree of the West Indies, 40ft. high, the wood of which, remarkable for its hardness and toughness, is much employed for pieces of machinery, and the scobs and raspings used in medicine as a sudorific; its resin is also used medicinally. Botanical name, *Guyacum Officinale*, Zygophyllaceæ; the tree can be seen at the Kew Gardens, in the tropical stove. The name of guyacum tree is sometimes given in British Guiana to the Tonquin bean tree, *Dypetrix odorata*. If the querist means "Guaco," I beg to say under that name have been introduced in the trade the stems and leaves of the Guaco plant of Columbia, and in its native country as an antidote for snake bites, and recommended in Europe against cholera; Botanical name: *Mikania Guaco*, Humb. and Bonpl. The stems of *Aristolochia cymbarum* are also imported sometimes under the name of "Guaco."—Bernardin.

[3828.]—KID BOOTS.—"Old Scrub" should try sour milk to keep the leather soft.—H. U.

[3851.]—HARNESS.—I thought "Equestrian" would have had a host of replies to his query 3851, or I would have answered it before this. He does not say whether it is harness or riding-saddle and bridle, but I will give directions for both. If it is harness, let him wash it perfectly clean with warm water and soft-soap, and, when dry, apply neat's-foot oil and black dye, mixed (he can mix them by adding a small quantity of salts of wormwood), when they will be well blacked and pliable. Then apply on the top of the straps either Harriss's or Wrigley's Composition (I prefer the latter), and he can keep his harness in good condition, and have it look well. At the same time, by applying the oil and dye to the bottom or under parts of the straps, and composition to the top, they will always be pliable, and have a good polish on the top. If it is a riding-saddle, let him wash in cold water and soft-soap until free from dirt; then apply soft-soap with a woollen cloth (about two tablespoonfuls would be enough for a saddle), which will dry in. If he wants his saddle to have a yellow appearance, he must infuse a pennyworth of hay saffron in about four or five tablespoonfuls of water, and apply before the soft-soap; when he has applied the soft-soap, let him rub on to a piece of woollen cloth a piece of bee's-wax till he gets a thin coat on the cloth, and then finish his saddle off with it, rubbing till he gets a good polish. He don't need to fear for his "inexpressibles;" if he does, let him try it before mounting with his white pocket-handkerchief; if anything comes off, it is the fault of not washing clean at the beginning, and not the bee's-wax. If he puts it on as "New Subscriber" recommends, he might be afraid, or if he put oil on, as "Banting" advises; but I think "Banting" is "chaffing" a bit. He says, "If he can," apply a little neat'sfoot oil "where there is no wear" it will be all the better. I have made and repaired a good many, but never yet found out where the parts lay that had no wear upon them. I am afraid "Banting" don't know much about the dressing of hog skins, or he would not advise oil for a riding-saddle. Saddler.



MACHINE FOR MAKING SODA WATER, GINGER BEER, ETC.

[3865.]—LABEL MATRIX MAKING.—The gun-metal matrix is stamped by dealing it a heavy blow with the steel die.—H. U.

[3877, 4421.]—RETINNING CAST-IRON WARE.—By first thoroughly cleaning from all grease, &c., with caustic soda, then, if at all rusty, with diluted sulphuric acid, then making hot, and rubbing with sal ammoniac, and raising the heat sufficiently to melt the tin, which is to be evenly spread over with a wad of cloth or tow. The tin should be free from lead, though, I believe, a small portion of lead is commonly used, as it makes the tin melt easier and run more freely.—Sigma.

[3887.]—SEWAGE.—"Sewer" should get "The Sewage Question," by F. C. Krepp. London: Longman's.—Saul Rymea.

[3898.]—AIR GUN.—If W. Jones must have a walking-stick air-gun, he must buy one. He will find it a deal cheaper than making it.—J. K. P.

[3901.]—SLATE CISTERN.—"Salmo Salar" had better get his cistern cased with thick wood, or some day it will split altogether.—Saul Rymea.

[3908.]—BRASS CIRCLE.—"Scorpio" will find it an endless job to perform with the compasses. He had better take it to some one who divides for the trade. See my letter (608) p. 198, Vol. X.—J. K. P.

[3969.]—ELECTROTYPING.—"Herbert" will not be able to take electrotypes in brass, as that metal is a compound; but he may take them in iron. Messrs. Harrild, of Fetter-lane, have a patent for a process which they call "aciertype," and certainly the "electros" are very clean and hard, and will stand the chemical action of coloured inks. Perhaps "Sigma" could tell him how to deposit iron as an electrotype. Silver, of course, is done in the ordinary way; but I suppose that is too expensive for "Herbert."—Saul Rymea.

[3960.]—THE BLOOD.—J. G. Jackson will find flowers of sulphur, taken in either treacle or milk, a good purifier of the blood. Decoction of sarsaparilla is possibly better, but considerably more expensive. Dandelion tea and nettle tea are likewise supposed to be useful. But the best way to purify the blood is to prevent it becoming impure, by attention to diet, cleanliness, and a proper control of the passions.—Sarkos.

[3971.]—DISPLACEMENT OF SHIPS.—"G. B. D." will find the following method for computing the displacement of ships to be sufficiently near for practical purposes. 1st, separate the part of the model of the ship that is to be immersed from the part that is to be above water, then weigh the former and make up a rectangular block equal in weight from the same sort of material as the model is made with, which of course is the same in bulk as the immersed part of model. Now, find the cubical contents of the block by multiplying length, breath, and depth continually together, and dividing the product by 35 you will have the displacement in tons in ordinary sea water.—W. Felton.

[4084.]— BOAT STEERING.—"Excelsior" should steer his whale boat with an oar. On the west coast of South America these boats are much used, and are always steered in that manner. I have tried to adapt a rudder to them, but it has been always a failure. They are often fitted with a centre board, which makes them hold a better wind.—West Coaster.

[4078.]—TESTS FOR TOBACCO AND NUX VOMICA.—"Barbados" seems to have rather an indefinite idea about the manner of testing for vegetable alkaloids when he asks for the tests of Nux Vomica. The alkaloids belonging to the strychno tribe are as follows:—Firstly, Strychnia and Brucia; secondly, the less important Cacotheline, Igasuria, Antidysenterica, Sabadilla, and Colchinea. Inasmuch as all these prementioned bodies are contained in Nux Vomica, it would be rather a complicated experiment to ascertain the existence of those substances which together constitute the properties of Nux Vomica. I should therefore strongly advise "Barbados" merely to test for the most important acting principle, viz., Strychnia or Strychnine, a few of the tests of which we subjoin:—When pure it is turned yellow by concentrated nitric acid, and yields a nitrate of a new substitution base, nitro-strychnia. If Brucia be present, as is usual in most commercial specimens of strychnine, the colour produced by nitric acid will be deep orange or red.—2. A minute quantity of strychnia, with concentrated sulphuric acid, and a fragment of peroxide of lead, or what is still better, of potassic dichromate gives a beautiful violet tint, which gradually fades into a pale rose colour; other oxidizing agents produce a similar effect.—3. With solution of auric chloride, salts of strychnia give a bright blue colour.—4. For testing minute quantities of strychnia in compound organic liquids, a simple method was practised by Curveillé, which consisted in rendering the liquid alkaline with potassa, and adding 2 per cent. of chloroform, and well stirring; the chloroform takes up the strychnia, and appears in the crystalline form on evaporation. Brucia or brucine may be detected in Nux Vomica by the following:—1. Mix with tartaric acid and add hydro-sodic carbonate and the negative result will distinguish it from strychnia. 2. If a little stannous chloride be added a beautiful violet colour is produced.—If concentrated nitric acid be be poured on brucia it emits a colourless gas, which has a smell resembling that of apples. Should "Barbados" require the tests for the less important alkaloids, which I have not thought needful to enumerate, I shall at any time be happy to furnish them. Tobacco, like Nux Vomica, contains among other less known alkaloids nicotine or nicolytia, and hyoscyamine. Nicotine may be distinguished by the following tests:—1. By the addition of perchloride of mercury which forms a white precipitate.—2. A like result is produced by acetate of lead.—3. And also by both the stannic and stannous chlorides.—4. Cupric salts with an excess of nicolytia give a blue colour similar to that produced by an excess of ammonia.—5. When gaseous chlorine passed through a solution of nicotine a blood red liquid is produced.—Walter J. Nicholls.

[4096.]—MACHINE FOR MAKING SODA WATER, GINGER BEER, &c.—In answer to "*D. W. L.*" I send the above drawing and description *for making soda-water*, ginger-beer, or any *other aërated waters. It consists* of two barrels; the *first is smaller than the second*, and is for producing the carbonic acid gas, from common unslaked lime and diluted sulphuric acid, which are admitted by the bung X and the pipe with funnel A; the gas is conveyed by the pipe B into the second barrel which contains the water to be aërated, which rising through the water to the top of the barrel forces the water up the pipe D which is connected with the bottling apparatus F, (a section of which is seen in Fig. 2), G the lever, E the support, H the bottle, J a bed for the bottle, K the stand. In Fig. 2, D is the supply pipe from the barrel, and is connected with another pipe or cylinder at right angles, which is widened at the bottom for the reception of the bottle neck intended to be filled. The pipe or cylinder contains a cork C, above which is a nicely fitting piston P; also in the widened part is a ring of india-rubber, against which is pressed the neck of the bottle to prevent the liquid from spilling. The bottling or corking apparatus is worked in the following manner. As soon as the bottle is filled by the supply pipe D, the cork is quickly forced down by the lever L, and the piston P into the bottle B, which is fastened down directly; all the bottles are wired ready for filling.—Joe.

[4101.]—DIFFERENCE OF TEMPERATURE BENEATH TREES.—If "K.'s" senses did not deceive him the fact is curious, and well worth further and more accurate observation. The only cause which seems to be assignable is that the foliage of some trees evaporate faster, and so cools the surrounding air more perceptibly than others. If "K." has time and opportunity to test this he may readily do so by a wet and dry bulb thermometer placed beneath the trees which appear to have this remarkable effect. If the thermometers so placed stand at different heights the effect is due to evaporation; if they do not vary it must be attributed to some other cause, probably draught, causing coolness by evaporating the moisture on the skin, and arising from local causes or from density of foliage rather than from any chemical or analogous effect produced on the air by the trees themselves.—J. B.

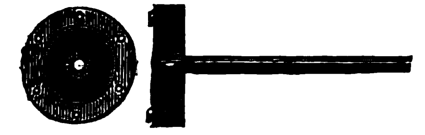
[4110.]—MAGNETISM.]—In the case put by Mr. Preston, no doubt there would be a greater attraction displayed by the cut ring at the points of severance. This is easily explained by the ordinary theories of magnetism, and even more perfectly by that which I set forth in my electrical papers. The force depends on the molecules, and is exerted by all of these on surrounding molecules in the ratios of their nearness and capacity for magnetism; as long as the iron ring is complete, the molecules composing it are in the closest possible union. Therefore their actions are almost completely confined to the ring itself, just as with a magnet at some distance within its extremities; but when it is cut the opposed faces are no longer any closer to each other than to the iron filings put in contact with them, and their influences will therefore be partly diverted to the filings. The effect of charge with the Rhumkorff coil would greatly depend on the state of insulation of the battery and instrument from the earth, but it is well known that static charge can be produced by putting one pole to earth; in fact it is so with even a single battery cell or any electromotion, the degree or tension of such charge depending on the electromotive force of the arrangement.—Sigma.

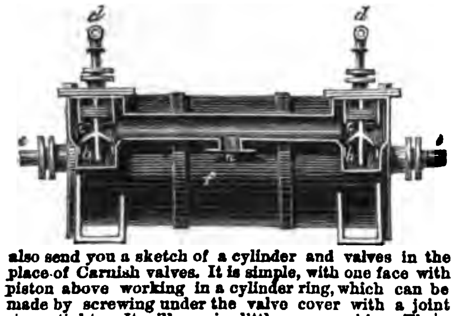
[4118.] — PROBLEM. — THE FOLLY OF ALGEBRA.—Without entering into the merit or "folly" of Algebra, "Gimel" has not correctly stated the answer to the "problem." If a gentleman applies £187 annually to the payment of interest and principal of a mortgage debt of £2000 at 5 per cent. interest, it is not true, as "Gimel" assumes, that "there would remain £87 per annum" for the payment of the debt. This would be so *in the first year only*. Thus, the payment of £187 in the first year would consist of interest £100, principal £87; in the second year, interest (on £200 minus £87) £95 18s., and principal, £91 7s.; in the third year, interest (on the further diminished debt) £91 1s. 7d., and principal £95 18s. 5d., and so on; the interest diminishing every year, and the further payment of principal correspondingly increasing. It will be seen that this "problem" is certainly capable of solution (whatever shorter methods may be used) by the very simplest rules of arithmetic.—R. M.

[4129.]—NETS.—I think a polite note with a stamp enclosed, addressed to Mr. James McQueen, the landlord of the hotel at Tighna Brinagh Kyles, of Bute, near Greenock, will enable "Scolopendrum" to get a barrel of old nets, quite good enough for garden purposes. They stand well, and I used to get my supply at about 1½d. or 2d. per pound—in fact, the price the papermaker pays for them to bleach into pulp. As to the preservation mixture—time past the fishermen used oak bark; since it has risen so high in price, I learn their *modus operandi* is to boil a proper quantity of catchen, put the nets in while the water is hot, and let them rest till they think they are duly saturated, then lift them and stretch in open air to dry. It's labour lost now-a-days to make your own nets, for human fingers cannot compete with machinery at net-making; the cost too is low. If our friend "S." will look in your London Directory he will find plenty of A1 makers. One, Allen, about Euston-square, can give a first-class job; I do not know him, but I can speak confidently as to his work.—Joe.

[4134.]—STAINS ON CLOTH.—Let "H. A." take two ounces of the best logwood (*ground*) and boil it in one quart of rain water for five minutes. Also, in another vessel, dissolve one ounce of soft soap in half a pint of boiling water. Then mix the two solutions together. Then strain through a cotton cloth, to remove the logwood grounds from the solution. Whilst the solution is hot sponge the parts affected with it very freely. Then hang it up to dry, when he will find his trousers no longer spotted but jet black.—W. L., Turton.

[4148.]—RAMSBOTTOM'S PISTONS.—I send you a sketch of a piston which will do for "One in Need." It is simple and efficient. It is made simply with a block ring, to take out of the cylinder to change the rings. I also send you a sketch of a cylinder and valves in the place of Carnish valves. It is simple, with one face with piston above working in a cylinder ring, which can be made by screwing under the valve cover with a joint steam-tight. It will require little or no packing. There should be a small pipe to each valve to take the water should there be any. *d d* valve spindles, *c c* pistons, *b b* valves, a steam pipe, *e e* piston rod of cylinder, *f* cylinder. Further information will oblige.—Wm. Harrison.





[4150.]—BOILER FEEDING.—I think "Amicus" might feed his boiler by the old method, which was to have a pipe (say 10ft. long) fixed upright on his boiler, over a hole over which a valve fits, opening outwards. When it is required to let water into his boiler he must raise the valve by means of a rod passed up the pipe—the water in seeking its own level will pour into the boiler (in spite of the pressure) until the air can counterbalance the water, which, when it has done, more water should be poured into the pipe, if it is required to have more in the boiler.—W. H. Thorpe, Reading.

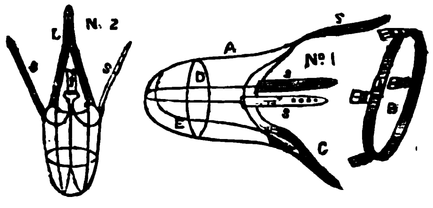
[4159.]—VINEGAR.—If "E. H." will look up any work on brewing, or any good cookery-book which treats of the same, he will find the proportion of malt required to the gallon of water for the production of good ale. The same proportion would answer for his vinegar. The first stage in the production of vinegar from *wort*, or the juice of any fruit or vegetable containing sugar or starch, is to induce the vinous fermentation. This can be brought about by a free exposure to atmospheric air at a suitable temperature, but can be at once induced by the addition of a little yeast. To convert the vinous fluid into vinegar in the ordinary way is a very tedious process, and consists in allowing the bungless casks containing it to stand for a period, it may be of many months, under a free circulation of air, until the fermentation entirely ceases. A number of years ago, in a foreign southern land, I happened to be sojourning with a family having large and noble possessions, amongst which were three immense orchards entirely of apple-trees. (The peach-trees were of too small a value to be so congregated, and were planted in the fields and by the roadside.) It was the time of autumn, and it was a puzzle to any one to make out what was to be done with all the apples, as there was no possible market for them, the estate being far inland. At last the fruit-harvest came; the orchard gates were thrown open, and the whole available population, biped and quadruped, was utilized to *reap* the fruits. Scores of bushels lay wasting on the green turf, and the very pigs would often split up the fruit merely to recover the seeds it contained. Well, the apple mill and cider press having been put in order, dray-load after dray-load was carted away to be ground and squeezed and boiled and bottled or casked into cider, apple-butter, and, last and largest of all, *vinegar*. Of course those to be dried were peeled, cut, and cored by a little machine for the purpose. I can assure "E. H." it was a jolly time for the negroes—the slaves, I mean. They were excellent judges as to the progress of the first stage, the vinous fermentation; and it was difficult to determine as to whether those dark children of the sun or their glittering, flashing rivals, the myriad insects of every hue, enjoyed the apple-harvest most. But now for the vinegar. I found my friends, who had had a cooper at work for some weeks, had no other idea but to fill their casks and allow them to stand for months under a shed until the vinegar should become fully *aged*. This part of the process fairly exhausted my patience, and I at once set to work, with the assistance of the cooper and a couple of negroes, to construct an apparatus which now, after this long preface, I shall describe in a few words for the delectation of "E. H." Take a barrel of goodly size, put in the bung, drill the bottom full of ⅜in. holes with a centre-bit, set it on end 6in. above a kind of hopper, the latter with a lip to conduct into stock casks at a lower level. Fill the cask loosely with shavings, put in the head, also drilled full of holes; hang a lot of worsted threads through the latter holes, so that the fluid can trickle down upon the shavings. Now elevate the cask containing the vinous fluid sufficiently high upon a gantree, and, by means of an ordinary tap to regulate the flow, allow the fluid to percolate *slowly* through the fermenting-cask. As the fluid passes over a vast surface, it is exposed to the action of the air as the latter rushes up in the opposite direction (a good deal of heat being evolved). The acetous fermentation proceeds at a rapid rate, the process being repeated if necessary.—Alexandra.

[4167.]—EMIGRATION.—"Kansas Emigrant" should send for Trübner's "Catalogue of Scientific Works;" he will there find names of books such as he requires. I have seen a small work on Kansas recently in a bookseller's. I forget the author—he should enquire.—Alexandra.

[4169.]—RUST JOINTS.—There are various recipes for the treatment of cast iron borings, of which a so-called "Rust Joint" is to be made. In all such operations simplicity is to be commended for many reasons. Let "Amo Vobis" first prepare his joint by bringing the inner joint rings of the flanges together—screwing up the bolts firmly—in this condition there should be an annular space between the flanges of from ¼in. to ⅜in. in width, a strand of rope-yarn or any soft fibre should now be stuffed to the bottom of the joint, so as to prevent the jointing material from being driven through in the process of calking. A good hammer, a calking-iron rather thinner than the joint, and a flat piece of wood or sheet iron should be in readiness. Now take a suitable quantity of fine cast-iron borings, free from dust, and which may be passed through a sieve to remove large pieces; next dissolve a very small piece of sal ammoniac (chloride of ammonium) in water, say a drachm to a quart, (in the absence of sal ammoniac to mix up the borings with, the urine of any animal does quite as well). Now mix upon a flat board, or in a pot or pan, the borings, with sufficient of the fluid to cause them to adhere together in lumps when compressed in the hand. It is now ready for use. By means of the calking iron, and the piece of board or plate, stuff the moist material into the joint to a depth of 1in. or so from the bottom, all round; now calk it down with the iron and hammer until it sounds perfectly solid, as though it struck against solid iron (this is the most important of all). Now again repeat the process of filling, then the calking, and so on, until the joint is filled to the very surface. It requires a considerable time, and the most careful hammering, to make a perfect joint, as, if there is the slightest trace of softness, steam is sure to escape, and gradually increase the leak. The joint should rest for at least twelve hours before being put under pressure. It will be observed that immediately after mixing the borings with the saline fluid it becomes quite hot, showing that powerful chemical action has been set up, the fact being that the immense surface of the innumerable particles of iron already in contact with the atmosphere, at once, through the presence of the moisture, and the destruction of the balance by the presence of an unstable salt, begins to absorb the oxygen of the air. Now it must be observed that as the oxide of iron is being formed, it is held in solution by the still undecomposed chloride of ammonium, which accounts for the mixture remaining black for a time. This is useful in so far that it gives time for the operator to complete his joint before the solid oxide is really deposited. At this particular stage, were steam or water turned upon the joint under pressure, it is clear that the solution of iron-oxide would all be washed out and leave the clean borings all but useless; but when time is given for the complete decomposition of the ammonia chloride, and the gradual evaporation of the component gases, the oxide is as it were precipitated, and forms a solid cement between the particles of iron. Rust joints very often prove a failure through a neglect of principles. It is evident that an over-dose of sal ammoniac, a very common error, must be a source of failure—that the rust cannot form during the presence of the free salt.—Matrix.

[4188.]—CHARCOAL BISCUITS.—An easy way to make them is to subject ordinary biscuits to a current of superheated steam between 500° and 600° Fahr. Provided an issue is kept open for the steam as large as the area of the pipe introducing it, I know of no danger attending its use. Steam of the temperature above given will carbonize a piece of deal ⅜in. square, in a uniform manner to its centre. The substances carbonized should of course be protected from the air until they get cool. —Associate.

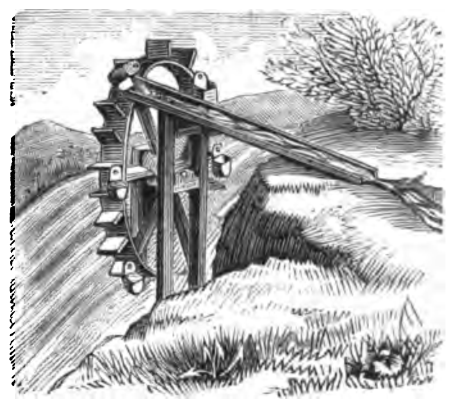
[4191.]—DOG-MUZZLE.—I enclose a sketch of dog-muzzle that would suit "Bunting" (4191). It will allow the dog that wears it to drink easily and prevent him biting. No. 1 is a side view; A, wirework, *s s s* face and cheek-straps; C, bottom strap, split 3in. or 5in., according to size of dog; B, neck-strap; D, ring made of rather stronger wire round the jaw; E, space between two bottom wires, to allow dog's tongue to lap up the water. I have strapped many of them, and know they answer the required purposes very well. Saddler.



[4193].—COINS.—No. 1 is a curious blundered production of probably some English die sinkers; for "Hispaniola" is the name of Cuba, a Spanish possession, and has nothing to do with the Brazils.—D. T. Batty.

[4195.]—SENSITIVE FLAMES.—"F. W." asks for information regarding sensitive flames, and the apparatus used in producing them. The latter is simple, the former not quite so simple; for it will require considerable space to enumerate all the properties of these remarkable phenomena. The apparatus would consist of a gas-holder, or bag for containing the gas (hydrogen, carbonic monoxide, &c.), a burner with suitable tubing attached, and a series of different sized tubes. The theory generally accepted for the production of singing flames is the successive explosions produced by the intermittent combination of the atmospheric oxygen with the issuing jet of hydrogen gas. The note produced by the apparatus, when in action, does not essentially depend on the length of the tube used—it is influenced also by the size of flame, as the following experiment will show:—A tube, 25in. long, was placed over an ignited jet of hydrogen; the sound produced was the fundamental note of the tube. A tube, 12½in. long (half the size of the previous one) was brought over the *same* flame, but no sound was obtainable. The flame was lowered, in order to make it as small as possible, and the tube last mentioned was again brought over it. It gave a clear melodious note, the octave of that obtained with the 25in. tube. The 25in. tube was now brought over the same flame; it no longer gave its fundamental note, but exactly the same as that produced from the tube of half its length; thus we see that although the speed with which the explosions succeed each other depends upon the length of the tube, the flame has also a *voice* in the matter—that to produce a musical sound, its size must be such as to enable it to explode in unison, either with the fundamental pulses of the tube, or with the pulses of its harmonic divisions. M. Von Schaffgotsh's experiments form the subject of a very interesting paper upon *sensitive* flames, and Prof. Tyndall has followed in his steps with (as might be expected) additional results, which were published in the *Philosophical Magazine* for July, 1857, a few extracts from which I will subjoin *pro verba*. He says, "In the first experiments, I made use of a tapering brass burner, 10¼in. long, having a superior orifice, about 1-20th of an inch in diameter. The shaking of the singing flame within the glass tube, when the voice was properly pitched, was so manifest as to be seen by several hundred people at once. I placed a syren within a few feet of the singing flame, and gradually heightened the note produced by the instrument. As the sounds of the flame and syren approached perfect unison, the flame shook, jumping up and down within the tube. The interval between the jumps became greater, until the unison was perfect, when the motion ceased for an instant. The syren still increasing in pitch, the motion of the flame again appeared, the jumping became quicker and quicker, until it finally ceased to be discernible. While repeating and varying these experiments, I once had a silent flame within a tube, and on pitching my voice to the note produced by the syren in the tube, the flame, to my great surprise, instantly started into song. Placing the finger on the end of the tube, and silencing the melody, on repeating the experiment the same result was obtained." That the shaking of the flame to which Prof. Tyndall refers proceeds in exact accordance with the beats is beautifully shown by a tuning fork, which gives the same note as the flame. If the tuning fork is loaded, so as to throw it slightly out of unison with the flame, when the former is sounded and brought near the flame the jumpings are seen at exactly the same intervals as those in which the beats are heard. When the tuning fork is brought over a resonant jar or bottle, the beats may be heard and the jumping seen by a thousand people at once. By changing the load upon the tuning fork, or by slightly altering the size of the flame, the quickness with which the beats succeed each other may be changed, but in all cases the jumpings address the eye at the same moment that the beats address the ear.—A. E. Tucker.

[4199.]—IRRIGATION.—The most economical expedient I could suggest to "George" for raising a supply of water for his meadow is represented in the accompanying rough sketch. I have seen it in operation, the little buckets formed of bullocks horns, working away day and night, quietly and gracefully, far from any habitation, and giving no trouble. The sketch requires no description. If "Robert" cannot fall in with a party near home to undertake the construction, and he furnishes me with his address through the Editor, I will forward estimate.—Matrix.



[4206.]—CHROMATIC FAIRY FOUNTAIN.—This is produced by dissolving various salts in strong spirits of wine. Chloride of copper, which gives green, and chloride of strontian producing red, are chiefly used; but chloride of calcium and other salts may be used. Sulphates do not answer because they are mostly insoluble in spirits. The spirit is forced out of the jet, either by heat, or better by means of strong pressure by condensed air, and spreading over the walls or ceiling to which it is directed is there fired, and produces the well-known beautiful effect.—Sigma.

[4218.]—LEVEL.—"Apprentice" can fix his glass tube with whitelead or plaster of Paris, or gum-water thickened with plaster of Paris. Of course, it is as well to fix it as nearly true as you can at first, but it will require adjusting, by scraping the bottom of the wood true after the cement has thoroughly set.—J. K. P.

[4223.]—DEFECTIVE BATTERY.—The silver is to be soldered to a strip of copper at the top by the usual tinman's solder and chloride of zinc. If the silver is coated with mercury, it must be heated red-hot with a Bunsen's burner or otherwise; platinizing is a most simple process if carefully conducted, but it is usually done too quickly, and then it is soon destroyed. It is possible, however, that zinc may be deposited on the silver, which often happens in compound batteries when one cell has neutralized its acid; in this case, the only way to remove it is to dissolve it off in acid, placing it in contact with one or two clear silver plates.—SIGMA.

[4227.]—PIKE-FISHING.—I am afraid an amateur angler out for only a day's pike-fishing is not likely to obtain much sport unless he has a friend who knows the water. But as "Citizen" wishes for apparently complete instructions I will do my best to help him. If the water is fairly clear of weeds spinning is the most killing, as it is likewise the most attractive, method of angling for pike. The requisites are a rather stiff rod, a reel, and running line of about 60 or 80 yards of plaited silk, with a stained gimp trace. Now take a nice medium-sized gudgeon, and insert the tail-hook of your spinning-flight through the fleshy part of the tail bringing it out as near the tail-fin as possible. Draw the tail up till it nearly forms a right angle and fasten in position with the small reversed hook. Pass the lip-hook through both lips—the upper one first, as the bait is a gudgeon—and you are ready to try whether there is a fish that will be tempted. The flying triangle of hooks should lie loose alongside the bait, and not be hooked into the fish in any manner. I presume "Citizen" will purchase a spinning-flight, and does not therefore require information as to the method of making it; but I would advise him not to have one with too many hooks. Now let him take the rod in his right hand, and unwinding some yards of line, which will lie loose at his feet, with a swinging motion send his bait into the stream and holding his rod near the surface, begin drawing in the line with his left hand, and between each draw make a backward motion of the rod with the right hand. The object of this is to keep the bait constantly moving. Don't take the bait out of the water until it is quite close to the bank, as Mr. Jack will often make a rush for it just as the tempting morsel is about to be withdrawn. In hot weather work near the top of the water, in cold at the bottom. Supposing a fish makes a bite you had better strike at once; as the matter is still disputed (some anglers say you ought to let the pike retire with his prize and not strike till he has "shook the bait") you may try both methods. When once your fish is hooked never allow the line to be slack, but keep a strain always on it, and if he gets amongst weeds the line being tight may cut its way through them, but if slack you will be sure to lose your fish. When your fish is exhausted draw him gently to the bank and gaff him if you have that implement; if not, grasp him tightly behind the shoulders and pitch him on the bank, but be careful, as a pike has very sharp teeth, and will let you feel them if you give him a chance. The haunts of pike vary according to the season of the year and with the nature of the water; but it usually prefers a still unfrequented spot, plentifully supplied with weeds and flags. The neighbourhoods of reeds, docks, bulrushes, and the broad-leaved water-lily are its favourite resorts. The pike spawns generally about March or April, and in rivers they begin to get into condition again about June; but in still waters they are some time longer. On the Thames pike-fishing is illegal between the 1st of March and the 31st of May. Trolling differs from spinning in being the only method in which you can fish for pike in water that is so overrun with weeds or bushes and stumps that a spinning-bait cannot be worked. For trolling, a pair of hooks are placed close together so as to lie on either side of the bait's head; their shanks are weighted with lead and affixed to a gimp trace, which is passed through the body of the bait and made fast to the line. The motion of the gorge-bait in trolling is principally produced by its descent headforemost when thrown in, and the subsequent raising and lowering in circles; but, in fact, the bait should never be allowed to remain still. In "trolling," time must be given the pike for swallowing or pouching the bait before striking, which will sometimes occupy him as much as 10 or even 15 minutes, according to some authorities; but it is just as well to try a gentle reminder now and then, in case it should not be a fish after all. It is rather ludicrous to see a man with his hook fast in a stump, waiting for the pike to "pouch" before he strikes.—A. T., Staines.

[4230.]—A GENERAL ROD.—I do not think "Pedestrian" can have a better rod than the one recommended by Mr. Pennell, which he has proved. It consists of two ash butts, 3ft. 2½in. long; the one 3⅝in. in circumference at the thickest part, the other, 3⅛in.; at the top, just below the ferrule, they should be respectively 2 5-16ths and 1¾in. in circumference. The 1st, 2nd, and 3rd joints should each be 3ft. 2½in. long, with circumferences at thick ends of 1¾, 1⅝, and 1in., tapering to 1⅛, 1 3-16ths, and ¾ respectively. The "trolling" top should be 2ft. 10in., with a circumference at thick end of 1in., whilst the fly top should not measure more than 11-16ths round. The bottom-fishing top may be 2ft. 8in. long, with the same thickness, but the spinning top should be only 1ft. 3¼in. in length. The total lengths of the various rods that can be made out of these joints will be as follows:—a double-handed fly rod, 15ft. 1¼in.; a single-handed fly rod, 12ft. 4in.; a trolling rod, 12ft. 4in. By changing the top joint of the double-handed fly rod for the "bottom" fishing top, it forms an excellent rod for worm or creeper fishing; and by substituting the spinning top it does admirably for trout fishing with the minnow. By taking away the large joint and butt, and using the smaller butt, a useful single-handed fly rod is formed, which Mr. Pennell prefers to any other in his possession. The joints and tops should be made of greenheart, and the butts of ash; use hammered brass ferrules, as they are much the cheapest in the long run, and not liable to break; and by all means have the bottoms of the joints double brazed to prevent sticking from damp. By double brazing I mean not only that the part which fits into the ferrule should be covered with brass, but also the plug at the bottom or extreme end of the joint. The number of rings on the various joints is a matter of individual taste, but the "trolling" should certainly have more than the other tops.—HAMPTON WICK.

[4241.]—BRICK OIL. — Brande says:—"These, (fat) oils cannot be volatilized without decomposition which takes place at a temperature of about 600°. . . If the vapour be collected, it is found acrid, sour, and empyreumatic; it was formerly employed in pharmacy under the name of "philosopher's oil," and as it was often obtained by steeping a brick in oil and submitting it to distillation, it was also called "oil of bricks." (Brande's "Manual of Chemistry," page 1129.) Lapidaries and gem engravers use it with their diamond powder, according to Holtzapffel (see Vol. III, *passim.*) He says it is obtained by putting a red-hot brick into oil, but I cannot find the passage.—J. K. P.

[4249.]—COIN.—Austrian medal of Francis I. and Maria Theresa.—BERNARDIN.

NOTES AND QUERIES.

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[4259.]—LONGITUDE.—What would be the simplest and most practical way for a person with an equatorial, unfurnished with a transit instrument of any kind, of ascertaining his longitude with any degree of correctness?—H. A. C.

[4260.]—MAGNITUDE OF STAR.—Has not the star the 3rd of the triple 5 (Σ 2379) Aquilæ increased in point of magnitude in the last two or three years; for I see it, with 8½in. aperture and power of 240, *considerably brighter* than the debilissima of H between ϵ^1 and ϵ^2 Lyræ, though Webb speaks of one as of the 14m. and the other two 13m.—H. A. C.

[4261.]—COTTON SPINNING.—I want to know what the distance should be from centre to centre between the 1st and 2nd, 2nd and 3rd, 3rd and 4th rollers of a drawing frame, to work fair open Egyptian cotton, to spin 80's and 90's weft; also how a draught of eight ought to be divided between them. Perhaps some of your correspondents interested in cotton spinning will favour me with their opinions. I wish "B. W. R." would favour us with a rule for equalising draughts. I have thought over the matter but must confess I cannot find out what he means.—COUNTRY LAD.

[4262.]—CORNISH ENGINE.—I thank "J. K. P." for his answer to my query; it was the engine valves I wanted to understand, and I do now. I should like the drawing of cataracts if he will send it to the ENGLISH MECHANIC. Another thing I want to know is the rule for the parallel motion, especially the extra piece used in some engines to carry the plug-rods.—F. P.

[4263.]—ENGINEERING.—Will some kind brother reader answer the following question:—What steam power would be required to drive one pair of 4ft. stones in a mill in order to grind five bushels per hour?—A PROVINCIAL MILLER.

[4264.]—MATHEMATICAL.—I shall feel very thankful if some one will answer this question:—"The water in a canal lock rises to a height of 18ft. against a gate whose breadth is 11ft., calculate the total pressure against it."—SCHOOLBOY II.

[4265.]—FIXING AND COLOURING PRINTS ON GLASS.—Will some of your correspondents tell me the best method of fixing prints on glass, and then painting them from the back, giving them the appearance of painting on glass, and should it be oil or water colour.—LALLA ROOKH.

[4266.]—WATER GILDING.—Would some brother reader refer me to a good practical work on water gilding, naming the publisher and price?—J. C. S.

[4267.]—RE-WORKING VULCANIZED RUBBER.—Can any brother reader inform me if I can dissolve and re-work into sheets, say 1in. thick, a quantity of old vulcanised rubber? I have noticed other correspondents seeking information respecting this popular material. Could not some of our London friends give us a good description of the treatment in manufacturing vulcanized rubber, and oblige.—ECONOMY.

[4268.]—GILDING.—Will any of your numerous correspondents kindly inform me of a receipt that will cover brass or other metallic ornaments with a thin coat of gold, by simply dipping them in the solution, also what will clean them fit for that purpose?—A. W. F.

[4269.]—ASSOCIATE OF ART DEGREE.—Will Mr. J. Harrison, A.A., kindly favour me with further particulars, or where I am to apply for them, in respect of this degree, as to when, were, and what forms, &c. &c., are necessary at each examination, and whether it is open to public competition or not?—A. W. T.

[4270.]—CHEMICAL.—Will some kind subscriber tell me the simplest way of reducing caustic magnesia, carbonate soda, and caustic potash to the metals magnesium, sodium, potassium?—XENOPHON.

4271.—A TRIGONOMETRICAL DIFFICULTY.—Will any gentleman be kind enough to assist me out of the following difficulty? Mr. Todhunter, in *Trigonometry for Beginners*, p. 85, says:—

$$``3\,(3\log.3 - 1) + \frac{4}{5}\,(4\log.3 - 2) - \frac{5}{4}\,(2\log.3 + 1)$$

$$= \left\{9 + \frac{16}{5} - \frac{5}{2}\right\}\log.3 - 3 - \frac{8}{5} - \frac{5}{4}$$

$$= \frac{97}{10}\log.3 - \frac{117}{20} = \bar{2}.7780766.''$$

Now I cannot understand the process by which he gets $\frac{16}{5} - \frac{5}{2}$, &c. Please explain in full.—POOR LAD.

[4272.]—CRUCIBLE.—What crucible will best stand a strong fire and a very penetrating flux, such, for instance, as what is generally called glass of lead, &c., and what is the best method of annealing crucibles?—STUDENT.

[4273.]—SPLITTING WHALEBONE.—Can you or any of your correspondents kindly tell me how to split whalebone? Also the kind of whalebone most suitable for the purpose, and where obtainable?—ENQUIRER.

[4274.]—CUPELLING.—What is the best and most practicable method of cupelling?—STUDENT.

[4275.]—TESTING GOLD.—Is there a better method to ascertain the purity, &c., of gold than simply testing it by the application of pure nitric acid to its surface?—STUDENT.

[4276.]—GUTTA PERCHA.—Will any of our kind correspondents inform me if it is possible to dissolve gutta percha to a liquid state, and if so, and I pour it upon or into anything, will it become as hard as it was before dissolving it.—A POTTER.

[4278.]—FRENCH METHOD OF DETECTING ADULTERATION OF OILS.—TO "BERNARDIN."—In his note on vegetable oils, Bernardin speaks of a French method for detecting the adulteration of oils. He would oblige me by explaining it more fully.—E. V. D. S.

[4279.]—Why are dry gas meters preferred in this country to wet ones, whereas on the Continent the latter are generally used?—E. V. D. S.

[4280.]—AQUARIUM.—Could any correspondent of the MECHANIC tell me how to prevent the water of an aquarium from getting greenish, and what kind of plants would grow in it?—E. V. D. S.

[4281.]—MAP PROJECTION.—Will any brother subscriber kindly give the rule for projecting the world according to Mercator's projection?—IGNORAMUS.

[4282.] — CONTINENTAL SCHOOLS. — Having a numerous family of boys to educate, with a certain but limited income, and not being myself engaged in any business, would any of your numerous readers kindly assist by informing me where on the continent I could obtain a first-class mercantile education on the most economical terms, in a healthy situation, where I could myself remove to and reside, where house rents and living are cheap.—ANXIETY.

[4283.]—WARPED CABINET LID.—I have in my possession a veneered stationery cabinet, the lid of which is slightly warped. Can any brother reader inform me how to get it back to its original state without causing the wood to crack?—J. B.

[4284.]—ALABASTER GLASS.—Would Mr. J. Leicester be kind enough to put me in the way of making alabaster glass, as the recipe given on page 408, Vol. X., turned out a very hard green glass. I also want to know how I can analyze glass, or where I can get it analyzed?—J.

[4285.]—GAS MUFFLE FURNACE.—Could any correspondent give me a sketch of a gas muffle furnace?—J.

[4286.]—ALLOYS FOR TIN FOIL.—Will some reader inform me the composition of the alloys for tin foil, the same as they wrap tobacco, cocoa, &c., in?—E. S. WOOLLETT.

[4287.]—COTTON SPINNING.—Can any of your numerous readers inform me what work I should consult for the building of a mule head stock for cotton spinning?—J. P.

[4281.]—FORCE PUMP FOR IRRIGATION.—My son is a tea planter in India, and is sadly in want of some means of watering his tea plants in a dry season. Can any brother reader inform me what is the best portable force pump, and what kind of hose is most suitable to an Indian climate? Also, the price, and how far the water can be thrown?—W. B.

[4289.]—DANIELL'S BATTERY.—I should feel much obliged if "Sigma" would kindly give me instructions for keeping a common Daniell's battery in good working order. I believe it is similar to those used at telegraph stations—copper and zinc plates, with plain water, and crystals of sulphate of copper. My use for it is to control my transit clock in the observatory here by the astronomical clock fixed in the cellar of the dwelling house. I find that the zinc plates soon get foul, and the action is uncertain. It has given me some trouble for a long time past. At one time the permanent magnets are in fault, at another the battery; and any instructions that would save me all this annoyance, would be very valuable.—H. C. K.

[4290.]—FOOD.—Can any reader recommend a good work on food. I mean as regards its action and value in cases of dyspepsia. I remember seeing a book advertised called (I think) the "Dyspeptic's Hand Book," which I believe would suit my purpose very well.—TAU TAU.

[4291.]—MAGNETIC BATTERY.—Our ever ready and obliging editor, in reply to my query on How to Make or Construct a Magnetic Battery, referred me to back numbers; but the only information I obtained was from Raymond Willis, p. 209, Vol. X, on the "Utility of Magnetism," but who further expresses his hopes in the magnetic battery being one day invented. I have always been under the impression that such did exist, but if any of your scientific princes can set me on the right track, I shall esteem it an exceeding great favour; and at the same time how to obtain a strong current.—BERIRO,

[4292].—FRICTION IN STEAM CYLINDERS.—Mr. P. Jensen, whose able articles on the "Friction in Steam Cylinders" are now appearing in our columns, will much oblige me if he would explain how the formulæ given on page 294 are derived, or refer me to any book where Mr. McFarlane Gay's formulæ are given. On page 345 Mr. Jensen describes several lubricators—Ramsbottom's, Roscoe's, Wilson's, Clement's, and Schauwecker's—without, however, giving illustrations of them. He (or some reader acquainted with these different forms) will greatly favour me, and I have no doubt many readers of the ENGLISH MECHANIC, by sending sections of these lubricators with letters of reference attached to the different parts.—A CONSTANT READER.

[4293.]—MILLERS.—I should be obliged to any of my dusty brethren who would favour by giving their experience on the comparative merits of balance versus fixed rynds.—2. Information as to the most approved apparatus for cleaning and preparing Ghirka and similar wheats.—J. S.H.

[4294.]—BREWING.—A brother reader gave a plan how to brew a small quantity of ale. I have tried his plan, but it is no finer now than when it was brewed some weeks ago. Will any one oblige me by saying how it can be brewed so that it will fine without the use of finings, as they so soon turn it sour.—W. Wood.

[4295.]—HARMONIUM.—IMPERFECT TUNING.—Will Mr. Hermann Smith kindly tell me the true cause and remedy for the following defect, which I find to be almost invariably the case in harmoniums. Take the octave for instance, tune it quite perfect with medium pressure of wind, then with greater pressure, lower note will betoo flat, and with less pressure, lower note will be too sharp. With the double octave, this is still more perceptible and mostly worst from middle of key-board down to base. It is the same with other intervals besides the octaves, but not so easily detected because of the tempering of thirds, fifths, &c. — Amateur Tuner.

[4296.]—GALVANIC BATTERIES.—Will "Sigma," or some kind fellow-reader, tell me the relative proportion of surface that bichromate, Smee's, Bunsen's, and carbon, and zinc-in-sulphuric-acid batteries must have to give off the same quantity of electricity as Grove's battery. —J. S.

[4297.—GALVANOMETERS.—I shall feel very grateful if "Sigma" will tell me the best form of galvanometer or other instrument for showing the strength of the secondary current in ordinary induction coils that give no spark.—J. S.

[4298.]—CHLORIDE OF SILVER.—What is the reason of chloride of silver turning blue after evaporation?—E. H.

[4299.]—SILVERING CLOCK DIALS.—Will a "Morayshire Man" explain more fully the process of silvering clock dials. I have tried his process without success, the the result being a dark deposit on the dial which the varnish does not improve, the silver also seems to rub off again.—E. H.

[4300.]—SAUSAGES, Etc.—Will some kind reader inform me how to make sausages, polonies and potted meat, such as commonly sold by pork butchers.—Sackless.

[4301.]—DISSOLVING VIEWS.—Your correspondent who a few weeks back said he had had seven years experience in painting dissolving views would greatly oblige me and doubtless many others of your subscribers if he would kindly say the mode of procedure. Any useful hints from any source gladly received by this Scribbler.

[4302.—MADAGASCAR MATTING. — I find this matting advertised in several papers by MM. Bontor and Collins, 185, Oxford-street, but have not seen it. I wish to know the material it is made of? I suppose is the same as the Rabannes matting made with the fibres of the palm-tree (*Jagus raffia*).—Bernardin.

[4303.]—CAST IRON.—Is there existing a special work on the different sorts of cast iron? Particulars will oblige.—Z. D.

UNNOTICED QUERIES.

In future, if any query remains unanswered for four weeks, we shall insert the number and subject of the query in this list, where it will remain for two weeks, if not previously replied to. We trust our readers will look over the list, and send what information they can for the benefit of their fellow-contributors.

"Sigma" has answered 2637, 2652, 2653, 2665, 2669, 3877.
"J. K. P.," 2643, 3898, 3906.
"Bernardin," 3811.
"H. U.," 2652, 3811, 3828.
"Saul Rymes," 2647, 2668, 2699, 3764, 3805, 3887, 3901.

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USEFUL AND SCIENTIFIC NOTES.

THE DANGERS OF CHEAP CONFECTIONERY.—Why is it that, after eating a few only of these beautifully coloured sweets, our child should always suffer the pangs of colic, although he often surreptitiously abstracts twice the quantity of loaf sugar from the cupboard, and is none the worse for it? The answer has already been given by many authorities, to the effect that there is no more unblushing and licensed poisoner in the world, than the unscrupulous manufacturer of cheap confectionery.

FLIES ON HORSES.—The *Journal of Chemistry* gives the following as a preventative of horses being teased by flies:—Take two or three small handfuls of walnut leaves, upon which pour two or three quarts of cold water; let it infuse one night, and pour the whole next morning into a kettle, and let it boil for a quarter of an hour. When cold it is fit for use. No more is required than to moisten a sponge, and before the horse goes out of the stable, let those parts which are most irritable be smeared over with the liquor, namely, between and upon the ears, the neck, the flanks, etc. Not only the gentleman or lady who rides out for pleasure will derive pleasure from the walnut leaves thus prepared, but the coachman, the wagoner, and all others who use horses during the hot months.

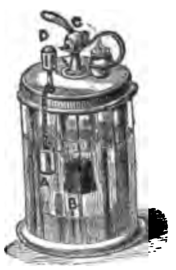
THE CONTINUOUS CURRENT IN HEMIPLEGIA.—Dr. Althaus mentions the case of a man, aged fifty-two, who, whilst writing, suddenly lost the use of the right arm. There was complete paralysis of forearm and hand, and nearly complete anæsthesia of hand and fingers. A current of twenty-two cells of Daniell's battery was applied to the left hemisphere for one minute on several occasions, and the same was applied to the radial and ulnar nerves, with the effect of restoring the power of the affected arm completely.

REPOLISHING JEWELLERY, Etc.—Mr. A. Allan, writing to the *Scientific American* says that after making a number of experiments he is convinced that a solution of cyanide of potassium in water is equal if not superior to any compound that can be used for cleaning jewellery, the liquid cleaning all those parts of the work which neither brush, buff, nor thread could reach. Here is the method: dissolve one ounce of cyanide of potassium in three gills of soft water, turn up the end of a piece of brass or iron wire into a hook, attach to it the article to be cleaned, and immerse it in the solution, shaking it backward and forward for a second or two, then take it out and rinse well in clean water. Wash it with warm water and soap to remove any film of cyanide that may remain; rinse again, dip into spirits of wine, and dry in boxwood sawdust. The advantage of dipping in spirits of wine is the immediate drying of the work without any sticking of the sawdust to it. When done with the solution, put it in a bottle and cork tightly. It may be used again and again for some months. Care should be taken not to wet the fingers with the solution and not to inhale the odour, as the cyanide is a violent poison.

STEEL AND IRON RAILS.—A correspondent of *Engineering*, writing on the advantage of steel over iron rails, after describing the condition of a steel rail which had undergone two years and nine months of almost incessant shunting operations, where iron lasted only from three to six months, says:—"No small advantage of steel over iron side-rails to points consists in the gradual wearing down of the former, which permits the adjacent point rail to lie close, whereas side-rails of the latter material often crush inwards, causing points to be out of gauge."

SOFT SOLDER, AND SILVER SOLDER.—A strong easy-flowing and white solder for jewellers' use (according to a correspondent of the *Scientific American*) is composed of lead one part, and tin two parts. When the lead is melted put in the tin and then throw in a small piece of resin as a flux. In soldering fine work wet the parts to be joined with muriatic acid in which as much zinc has been dissolved as the acid will take up. It is cleaner than the old method of using Venice turpentine or resin. To make silver solder, put into a clean crucible pure silver two parts, clean brass one part, with a small piece of borax—melt and pour into ingot. The solder flows easily and clean.

THE EYE.—One of those "facts not generally known' is mentioned by Dr. Baden in a recent communication to one of the Parisian journal. It is that in every eye there is a spot necessarily afflicted with blindness—that where the nervous fibres of the retina join in a bunch to make their way to the brain. The truth of this is easily ascertained; draw a small cross on a piece of paper, then, to the right, at a distance of about two inches and a half, make a blot of about the size of a common wafer; close your left eye and fix your right one on the cross; now bring the paper slowly nearer and nearer to the eye; when it is at the distance of about eight inches the black spot will become invisible, but on continuing to approximate the paper it will appear again.



IMPROVED "DOBEREINER" HYDROGEN LAMP.—Dobereiner's hydrogen lamp, though not exactly a novelty, may be welcomed by many of our readers as an attractive and useful piece of apparatus for the class-room or laboratory. A glass bell of air is connected with the cover of the vessel, which is also of glass, and contains water acidulated with sulphuric acid. The cover being attached, the bell becomes surrounded by water, which rises in it when the air is allowed to escape. This is effected by pressing down the small lever (C) at the top. In the bell a piece of zinc (B) is suspended, which decomposes the water when it is reached, and thus in a few minutes hydrogen gas has taken the place of air in the bell. The lever being now pressed down, the hydrogen is forced on to a piece of spongy platinum in a cage (D), which, becoming red hot, inflames the gas, and by the same movement the wick of the lamp is brought into the current and instantly lighted. (A) is a protecting shield for the platinum. Messrs. Mottershead & Co., of Manchester, have recently imported from France a number of these lamps.

FINE VARNISH FOR WOOD.—The varnish applied to Connecticut clock-cases, wooden picture-frames, and other cheap objects, is made by mixing two pounds of copal varnish with half an ounce of linseed-oil varnish, and the mixture is shaken often to mix it well. The wood is prepared with a thin coat of glue-water, rubbed down with fine pumice-stone. In light-coloured wood, a light pigment, such as chalk, is added to the glue-water; in dark wood, an equally dark pigment is added. After drying, the articles are rubbed with a solution of wax in ether, thereby acquiring a high polish.

THE VALUE OF CHLORAL.—This comparatively recently discovered anæsthetic has been found of great value in the treatment of the insane. As a hypnotic it deservedly ranks with opium, and often procures refreshing sleep when the latter remedy has failed. Its use has proved most beneficial in mania, especially of the recurrent form with absence of sleep and restlessness. Patients who have passed sleepless nights, in spite of the ordinary treatment of opium, henbane, &c., have after a dose of chloral hydrate passed a tranquil night, with undisturbed rest. One of its great advantages consists in the fact that it does not cause headache, loss of appetite, or sickness.

DRYING TIMBER.—M. Violette, in a recent report on some experiments in which he has lately been engaged, says that steam at a temperature of 482° Fah., is capable of taking up a considerable quantity of water. he exposed several sorts of wood for a period of two hours, to a current of steam at 7½ lb. pressure to the square inch, but which was raised to a temperature of 482° before the experiment was finished. The wood was weighed before and after it was exposed to the steam, and it was found that elm and oak decreased in weight 1-2, ash and walnut 2-5, and pine 1-3. The wood showed a change of colour during the process. The walnut became very dark, and showed a tarry matter formed in the wood, which was found to have a preserving effect on it. It was found that wood thus exposed to steam at a high temperature, became stronger, and that its power to resist fracture was increased. Oak was increased in strength 5-9th, walnut ¼, pine 3-5th and elm 1-5th. By this process the fibres of the wood were drawn closer together, and maple and pine treated by steam at a temperature of 487°, were rendered far more valuable for musical instruments, than by any process heretofore known.

AMOUNT OF DYES YIELDED BY COAL.—According to Chateau, 100lb. of coal tar yield 3lb. of commercial and 1·5lb. of pure benzole, from which 3lb. of commercial nitro-benzole are obtainable. These 3lb of nitro-benzole yield 2·25lb. of rosaniline, from which 3·37lb. crude aniline red and 1·12lb. of pure fuchsine may be produced. As, therefore, 100lb. of tar give 1·12lb. of pure fuchsine, and 100lb. of coal only 3lb. of tar, 3,000lb. of coal are required to produce 1lb. of fuchsine. The total consumption of coal in Europe for the manufacture of gas, being about 160,000,000 cwts., this quantity might furnish 53,000 cwts. of fuchsine.

MORE CONGRATULATIONS.

(*Continued from page 312.*)

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83. THE following is the concluding portion of a letter from Mr. Proctor in the last number of *Scientific Opinion*:—

"A word as to the journal into which *Scientific Opinion* is to be merged. I believe a great career lies before the ENGLISH MECHANIC. It has long had an enormous circulation; and amongst its subscribers I could name many of the leading men of science of the day. But some time ago it was not doing so well as could be wished. Excellent letters from a Fellow of the Astronomical Society, and other thoughtful students of science, were swamped by a number of silly articles and letters calculated to ruin the journal, despite the large array of its supporters. All this has now changed. Not suddenly, but with care and forethought, the whole tone of the publication has been modified. The natural result has followed. Men of science are no longer ashamed, as a year ago they might well be, to appear in the columns of this widely circulating journal. On the contrary, they feel that it supplies them with the opportunity of supplying useful information to an enormous circle of readers. And thus it has happened that, referring only to the subject in which I personally take chief interest, letters or papers have appeared, within the last two or three weeks alone, from such well-known astronomers as Webb, Penrose, Lockyer, and Birt; while 'F.R.A.S.' continues to supply his valuable contributions.

"The ENGLISH MECHANIC deserves success by its pluck and energy, and by the care and skill with which (at least during the last few months) it has been conducted."

84. "JOURNALISTIC AMALGAMATION.—It is announced that there is to be an amalgamation of our contemporaries *Scientific Opinion* and the ENGLISH MECHANIC, or rather that the former is to be absorbed into the latter. In repeating this announcement we gladly bear testimony to the great ability and tact displayed by Dr. Henry Lawson in editing *Scientific Opinion*, the third volume of which is nearly completed. Of the ENGLISH MECHANIC we have merely to say that it has recently been so improved, and in general style and management has been so altered, that, except in name, it is totally changed from what it was little less than a year ago. It bears evidence of having a masterly hand at the helm."—*British Journal of Photography*.

85. "I have long been a silent lover of the ENGLISH MECHANIC, and think it quite time to congratulate you on the very able manner in which it has been conducted of late."—J. W. DINSDALE, Feversham, near Cambridge.

86. "Allow me to congratulate you on the way in which you merge all the lesser scientific publications in yourself, and thereby benefit both your and their subscribers."—ARTHUR UNDERHILL, Carlton Chambers, 12, Regent Street.

87. "Your paper is worth taking in and reading now, which, for the amount and scope of scientific reading of all kinds, makes it at once the cheapest, the most useful, most interesting, and most impartial of the scientific periodicals."—CORNELIUS E. CARDEW, 27, Eglinton-terrace, Crosshill, Glasgow.

68. "You are a perfect python, sir, in the manner of your swallowing. I see another journal, and from what I can judge a good one, too, is incorporated. Without exception yours is the cheapest and best scientific journal issued. I am sure that I simply utter the feelings of all our readers when I say that I hope your journal may live long to grace the scientific literature of Great Britain. May the ENGLISH MECHANIC and the sun never set over her realm."—E. CHAMBERLAIN, 8, Mount Vernon, Guernsey.

89. "Accept my hearty congratulation for the 'great fact' you are producing. I should think there was nothing like it before."—S. R., Lutterworth.

90. "It has sometimes struck me whether the President of the Council, and the men who direct the educational machinery of the country, know what an instrument our MECHANIC is in promoting the useful sciences and developing the industrial resources of the commonwealth."—SAUL RYMEA, 24, New-street, New-road, Mile-end.

91. "What a difference in the ENGLISH MECHANIC of 'yesterday' and 'to-day'! What will it be to-morrow?"—W. H. THORPE, Reading.

92. "For some time past it has been my pleasure and profit to read what some of your correspondents call 'our paper.' I have watched its gradual growth till it has become an institution based on mutual assistance and encouragement, and now, to increase its efficiency, you announce the absorption of *Scientific Opinion*."—J. R. D., Coventry,

93. The ENGLISH MECHANIC is becoming quite an institution of the country.—D. F. BATTY, 9, Fennell-street, Manchester.

DOMESTIC RECEIPTS.

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THE following receipts are taken from the *Food Journal*. But why should we not have original contributions under this head? We venture, therefore, to appeal to our readers—and, as a matter of course, to our lady friends—to send us, as the result of their experience, useful receipts for tasty dishes for all classes. We somehow feel confident that the appeal will not be made in vain.

PRESERVATION OF MILK.—The following method of preserving milk is given in a French technical journal as discovered by MM. Graphin and Rogier. To each litre (1¾ pint) of new milk add 1¼ ounce of bicarbonate of soda or potash, then close the bottle and place it for about four hours in a hot water bath, heated to just below 194° Fahrenheit. When the bottles are withdrawn from the bath, dip them in melted pitch, and the milk will keep for a long time without alteration.

WHAT TO DO WITH THE REMNANTS.—Many prescriptions have been given for the employment of the cold remains of a joint; but, with the assistance of Baron Brisse, we offer a new method likely to produce a more tasty result:—Cut some mushrooms in small slices and steep them in butter. They must then be boiled in stock with a bouquet of herbs, containing a head of garlic in the centre. When the mushrooms are cooked, skim the fat off the sauce, and add capers, anchovy, and a very little vinegar or chopped pickled cucumber. Thin slices of cold roast beef must then be placed in the sauce, and warmed, though boiling should be carefully avoided. When these injunctions have been strictly executed, it is then incumbent on the cook to taste the sauce, and sprinkle the quantity of salt and pepper necessary to insure a good flavour. In serving, let the pieces of meat be placed on the dish in the shape of a crown, and the gravy poured over the whole. The bouquet is of course carefully removed.

[We will, in a future number, give other recipes for utilizing cold joints.]

SAGO JELLY.—Boil well a teacupful of sago in 3¼ pints of water; when cold, mix ¼ pint of the juice of fresh fruit or raspberry syrup (rhubarb syrup will do); boil five minutes, and sugar to taste.

JUGGED HARE OF COLD MUTTON.—Cut up the mutton into thick, square pieces, resembling the back of a hare; season with pepper, salt, allspice, pounded mace, and a little nutmeg; put into a jar, with an onion, a clove or two, a bundle of sweet herbs, a piece of coarse beef, and a tumbler of porter. Tie the jar down with a bladder or strong paper; put it into a saucepan of water, up to the neck, but no higher; keep the water boiling five hours; before serving, boil the gravy up with a piece of butter and some flour; if the meat gets cold, warm it in this, but do not let it boil.

ANSWERS TO CORRESPONDENTS.

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⁂ All communications should be addressed to the EDITOR of the ENGLISH MECHANIC, 31, Tavistock-street, Covent Garden, W.C.

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The following are the initials, &c., of letters to hand up to Tuesday morning, July 12, and unacknowledged elsewhere:—

T. J. O'C., "Pro Bono Publico," Richard Bliss, S. M. Drach, A. Varley, Light Purse, C. H. B., A Working Smith, H. G. Newton, R. P., R. W. M., S. Shaw, Good Words, Easy Back, H. A. C., T. Fletcher, C. Brandon, Artemus Ward, A. S., Aquibas, T. C., Antomeden, J. B., A Draughtsman, Cyanide, Omega, Capt. Baster, Sans Chemise, Ignorant, C. H. S., R. P. S., J. Dronkers, W. Holmes, R. S., J. Edgell, Nobody, J. W. Ashcroft and Co., Rev. E. Kernan, T. P. Lilly, F. H. L., Veritas, J. Harwood, H. M. W., Jos. Broadhead, E. T. S., G. S. Cole, J. G. Miller, I. A. Ball, J. E. R., Geo. Davis, A. Gandebert, J. Cooper, M. and Co.—"Sigma," A. G. P., E. M. W., C. H., A. Atkinson, W. Uppingham, J. M., F. C., J. Turner, W. B., R. H. T., T. M. B., R. R. S., W. H. R., A. Underhill, F. & Son, E. Hutchinson, J. H. Hall, T. B. Brett, J. Hastings, H. P., A. S. C., J. B., "Microscopical Jottings in Town and Country;" "The World; Its Formation and Antiquity;" Review of Mr. Proctor's "Star Atlas;" Magara, Amateur Philosopher, Lucidus, "Saturn, &c.," by F. R. A. S.; Carful, E. H. May, Student, A. Stocker, Walter J. Nicholls, Geo. Horrocks, J. P. S., Fred. Davies, T. S. Conisbee, Geo. Richardson, G. C., John Bury, T. Bros. J. and L., J. B. S., S and Co., J. H. and Co., Rev. V. R., Geo. Plant, Rosebud, H. James, Col. S., F.R.S., Rev. E. D., Busy Bee.

J. H. T.—Your "Tourist Trip" is not sufficiently scientific.

W. R.—The numbers were sent from this office.

J. R. RENDELL.—A host of correspondents have taken up "Gimel's" challenge. We dread entering into the controversy.

C. D. C.—See letters in answer to yours. There are more to come.

ALEXANDRA.—Thanks. The demands on our space have prevented the insertion of your letters.

JAMES P. RYAN.—Your letter on "link motion" is in type, but the illustrations are lost. Will you kindly forward copies?

BERNARDIN.—There was an "Oil Trade Review," but it does not now exist in a separate form.

R. WILDMAN (Colne).—The advertisement looks suspicious. It shall not appear again.

C. TOWNLEY.—The insertion of your letter might subject us to an action for libel; in fact, the greater the truth the greater the libel. In our endeavour to protect our readers from dishonest advertisers we have recently been put to trouble and expense. All we can promise to do now is to caution our readers not to part with their money unless they have the goods on satisfactor[illegible] reference or security. Let us have proof th[illegible] advertiser is dishonest, and we will no longe[illegible] his advertisement.

THE MICROSCOPE.—C. C. Smith says "Having noticed the comparative absence of answers to microscopic questions in the MECHANIC, I beg to intimate my willingness to afford any information in my power on the mechanical manipulation of the microscope as the result of many years' experience." Mr. Smith has our thanks for his kind offer.

T. H. B.—We should be glad to hear from you on the bee question. No. 152 can be had of the publisher.

ELECTRON.—The first Atlantic Cable (of 1857) contained seven wires, was 6-10ths of an inch in diameter, and weighed one ton per mile. The cable of 1865 is 1-16th of an inch in diameter, contains seven wires, and weighs 35½cwt. per mile. The cable of 1866 contains seven wires, is 1-16 of an inch in diameter, and weighs 31cwt. per mile.

JOE.—Plaster of Paris is not so generally used now for stereotyping because of the inconvenience to which compositors are put by its employment. It is still, however, used for electros. Your second query can be answered by enquiring at any respectable stationer's.

A NEW SUBSCRIBER.—Be sure our readers will judge your receipt by its merits and not by opinions passed on it by other contributors.

YOUNG ASTRONOMER.—We do not know the respective merits of the telescope you mention. The maker you name, however, is a good one and reliable, and if you wrote him, stating your wants and means, he would probably advise you as to which was most suitable.

YORK.—We don't know such a book, and scarcely see what you want with one, if, as you say, you have our back numbers.

R. V. GOULD.—The question has been asked and answered before in our columns. Paraffin was recommended among remedies for destroying ants.

E. T. SCOTT.—Your advertisement *did* appear in No. 275.

INDUCTORIUM.—A communication from Mr. D. Forbes in this week's "Sixpenny Sale Column," requires your attention. We should be glad to describe your coil, as it would save you and our readers trouble.

A. SEPHTON.—Try J. R. Willis, 29, Minories, London.

J. S. H. AND OTHERS.—Mr. Seebohm Ultzen's address is 21, Mark-lane, London.

A FIVE YEARS' SUBSCRIBER.—Cassell's "Technical Series" would suit you.

W. LEFFLER.—The Patent Office Library, Southampton-buildings, W.C., is open daily. It is entirely free to the public, the only formality necessary being your signature in a book at the door as you enter.

ANXIETY.—The question has been asked before, and the opinions elicited seemed to agree that it was impossible to eradicate "tatooed marks" from the skin.

T. RUSSELL.—Ventriloquism can only be improved and developed, and not *acquired*. It is a natural gift.

DELICATE.—We cannot understand your query. What do you mean by "Essence of Composition?"

TO MILLERS.—Mr. Thomas Evans writes to say that nothing was farther from his intention than to say anything offensive to a stonemason, and he considers the editor "rather too sensitive;" perhaps so. At all events Mr. Evans did not, in any way, mean to offend.

ENGLISH MECHANIC COLONY.—J. W. Dinsdale, of Feversham, near Cambridge, wishes to inform "Alexandra" that he should be happy to assist him in forming the new colony.

ENGLISH MECHANICS' SOCIETY, MANCHESTER.—The Secretary writes "I have pleasure in informing you, Mr. Editor, that we have, with your permission, elected you an honorary member of our new society."

INDUCTORIUM would oblige by sending the proffered information on the intensity coil at his earliest convenience, as a large number of correspondents are asking for it. Space is at his disposal.

ANDER.—As we said last week, Mr. Piggot's suggestion for a bicycle was an unpractical one. Send photograph.

J. P. CAUSTANS says he will send us diagrams in a few days which will settle the question as to the convexity of the earth. We thought it was settled.

MATHEMATICS.—We have several elaborate papers on mathematics and algebra, including two from C. H. W. Biggs and two or three from Gimel, and one from J. H. T., but we shrink from inserting them, first, on account of the space that elaborate mathematical demonstrations necessarily occupy, and, secondly, on account of the difficulty of printing them correctly without allowing time for the authors to revise proofs, which is not easily done in a rapidly-printed weekly paper.

J. M. T.—Your warm congratulations on the absorption of *Scientific Opinion* have been echoed by dozens of other correspondents. We shall have another incorporation to announce soon.

R. A. PROCTER.—Too late.

J.T.H.—Letter rejected on account of its length.

A. TOLHAUSEN.—Report came too late.

NEXT WEEK.—The Bicycle, by Husband; Swimming, a Summer Pastime; Microscopic Investigations and Polarized Light; Pre-Adamite Earth; Cheap Gas; Geometrical Approximations; Lunar Cosmology; Emigration; The Earth's Centre of Gravity, by L. Hewitt; Tricycle, by J. Hastings; Electro-plating and Gilding; Power of Hooks and Strength of Ropes, &c., &c.

THE *ENGLISH MECHANIC* LIFEBOAT FUND.

Subscriptions to be forwarded to the Editor, at the Office, 31 Tavistock-street, Covent-garden, W.C.

Amount previously acknowledged	£190	8	1
O. Hogarth	0	2	6
Collected by "Feu Follet"	1	0	0
J. Hastings	0	2	6
W. H. C.	0	5	0
	£191	18	1

The English Mechanic

AND

MIRROR OF SCIENCE AND ART.

FRIDAY, JULY 22, 1870.

NOTICE.

WE have no sooner incorporated *Scientific Opinion* than we have another announcement to make. Next week the *British and Foreign Mechanic* will be amalgamated with the English Mechanic and Mirror of Science.

THE WORKMEN'S INTERNATIONAL EXHIBITION.

THIS Exhibition was opened by his Royal Highness the Prince of Wales, at the Agricultural Hall, Islington, on Saturday last. It is actually, as it has been described to be, a thoroughly artistic and industrial show, perfectly cosmopolitan in its arrangements, abundant in interest, varied and attractive in its contents. The original idea, we believe, was due to a man who has ever been the friend of the industrial order, a nobleman of high taste and great sympathy with labour—the Earl of Lichfield, who has manifested an intellectual understanding of the interests involved through his positive comprehension of the relations that exist between technics and science. We have no space to bestow upon compliments, or we should advert to the generous manner in which the whole undertaking has been favoured by those who are not personally concerned in it, and the admirable style in which the organization of the operative class has been employed to complete its success; but in the first instance the goodwill of those engaged has been its own reward, and in the second the works exhibited are more triumphal as tests than any indiscriminate laudations that could be awarded to them. We think it right, however, to signalise for future example this distinctive Exhibition. It was projected at a meeting of London artisans, but it was promoted also by their employers. They did not desire to occupy their Field of the Cloth of Gold alone; but they invited—let us not say challenged—the first ingenuities of Europe, the artisans whom circumstances only prevent from being artists, and who, indeed, are artists if Cellini was one, to compete with them in that which is a great and distinctive object of our time—to make industry at once most capaciously useful for mankind in regard to its necessities, and also beautiful in relation to something higher than mere facilities of use. The Exhibition at the Agricultural Hall includes eighteen classes additional to the fine arts department. With reference to the last, we may at once say that it involves a serious mistake. The number of pictures, which, if genuine, would be gems, is perfectly irreconcilable with what we know of the works purporting to be displayed. It is quite idle to tell us that those famous Michael Angelos, Titians, Raffaelles, Giorgiones, Tintorettos, Correggios, Vandykes, and Murillos, Caraccios, and Da Vincis, have been brought to the Liverpool-road, Islington, from Dalston and Epping. In point of fact, a single glance at them shows that they are copies or replicas. But this was not the fault of the Working Men's Committee. Their intention was, and it has been well carried out, to display the degrees of inventive ingenuity and of manipulating dexterity which individual artisans, without capital and often without credit, can illustrate through their own unaided ideas—unaided, we mean, except by their serious, patient, personal studies. We trust that the men who exhibit at Islington, after surveying the competition between themselves and others, will be enabled more sagaciously to judge about the comparative value of their notions.

Thus there are two classes of exhibitors at the Agricultural Hall who illustrate different views of the value attaching to such emulations. The one appears to regard complex ingenuity as the height of excellence, while the other looks upon industry as being worthless, unless practically applied. We confess to a difficulty in deciding upon all cases between the two. It seems hard that a person trained as a wheelwright should not try his skill upon the manufacture of a piano, and yet it seems an obstacle in the workman's way that he should go out of his path, and, while he is bound to make bricks, devote his intuitive instincts to cathedral clocks and towers. A large proportion, we are sorry to say, of the talent proved in industrial exhibitions has been thus, if not wasted, misdirected, at any rate so far as the exhibitors themselves are concerned. But the council, most judiciously, have restrained within legitimate limits the ambition of eccentric genius. The eighteen industrial denominations are—the inventive, machinery, decorative art, furniture, ornamental metal-work, glass and china, building appliances, fancy work, articles for personal and domestic use, cutlery and arms, scientific apparatus, watches, saddlery, and miscellaneous leather work, food, raw materials, and miscellaneous, followed by a horrible confusion of the Fine Arts. With the object, patently, of those who exhibit in a complete understanding of the Exhibition and its meaning, we cannot but cordially sympathize, and with pleasure we notice that many exhibitors who have travelled over half Europe with their inventions without satisfactory success come here, undiscouraged, to persevere with them. Mr. George Warriner, for example, is indomitable in his claims; and should England be dragged or driven into war he would be the unchallengeable cook of the British army. In anticipation of a day when politics shall be made secret, several gentlemen suggest patent ballot boxes. In expectation of a time when women's rights shall be conceded in full, labourers are provided with the means of cooking their dinners in the field, having no resources at home; and, as if prophetic of the recent weather, Mr. John Wilkins has designed "a summer pillow." We have to note, moreover, Mr. George Galloway's "plan for crossing streets with safety;" Mr. Robert Hatt's "gent's ankle shield," whatever that may mean; and, with the deepest gratitude, Mr. Charles Loton's "mutes for subduing the tones of the cornet." It will be remarked that in all these competitions there is a total of curious and not very practical ingenuity pitted against another total of that which is capable of being turned into value. It should be remembered by exhibitors who, disengaging themselves from their actual class, venture upon new experiments, that they have to learn from these very exhibitions how far their personal speculations may serve them. It would speedily be found that the toil of years devoted to complicated yet useless purposes will not avail them so far to procure even a certificate of merit, whereas an improved safety lamp warning the approach of gas, an easy workman's shoe, a cottage cooking apparatus, a washing, or a life-saving, or a smoke-consuming apparatus, is worth ten times more than a steam-boat, rat-trap, or a bicycle telemeter, or a cylindrical revolving rampart, or an electro-magnetic music leaf turner. In the world of theory and speculation we reach a great many impossibilities; and in the world of mechanics we arrive at a great many more. Thus, if we were to put faith in all the mechanical geniuses who exhibit themselves at Islington, we might believe even in such a monster as Mr. Ireland's Prince of Wales's "Trotting Horse Perambulator;" but if, on the other hand, we, being impartial and only interested in the progress and prosperity of men and classes devoted to industrial pursuits, could persuade them at all, we should urge them not to apply their perseverance, or that which may even be styled the poetry of their conceptions, to forms or improvements of things now utterly and for ever obsolete. It is astonishing to see in the same department with the most perfect breech-loading small arms, patterns of lances, boarding pikes, javelins, the barbarous Danish gun, the matchett, which has gone out of use for a hundred years; specimens of letting in gunlocks by hand, equally out of use; and, as if the contrast could not be made forcible enough, side by side with central-fire and the vertical grip. It would almost appear as if some of our working-class exhibitors would wish to retain a great deal of that which is old, while approving of that which is new. The sewing machine, for example, is entirely novel. That exhibited by the Messrs. Judkins is as new as the last eclipse of the moon; and yet here are exhibitors going back in gunnery to the ancient days of cleaning rods and feathering paddle wheels, and cramp keys and black stocks, and, *credat Judæus*, flint locks! Now as an antiquity, this may be interesting, but as a matter of practical value the mechanical concoctions of this kind are of no more importance than the old-fashioned watchmaker's mandril. Indeed, this brings us to a promise that we shall carefully present to our readers an account of the tools exhibited now at the Agricultural Hall. This department is of an interest which can scarcely be over-stated. It comprises mandrils of the newest form, improved drills, specimens of glass and china riveted, ratchet braces, turning engines for ivory, moulding apparatus, gold beaters' skin, and especially benches and tables at which tailors and shoemakers can stand to their work. The habitual sitting of men in this department of industry has been productive of consequences most fatal to their class. It is impossible, although it would be pleasant, to enumerate by name the artisans whose works are conspicuous, in this series particularly. It is a series which comes rarely before the eye of the general public, but the sight of a tool ought to tell us much of the life which is led, and of the education which is required, and of the intelligence which is given by the artisan to his work. How many of us in our common ways understand laying down the draught lines of millstones, the dressing of these stones, the manipulation of the spirograph, the mortising chisel, the filesmith's rasp, the bloodstone burnisher, the Irish contrivance for breaking flax straw, or, let us say, as a more simple instance, the sculptor's stool. Some of these are reckoned as tools, and some as machinery. In the latter class we look abroad, and we do not find anything which is equal to the workmanship of our own countrymen, although there are characteristic peculiarities in the foreign manufacture. So Italy has a railway carriage with a first and a second floor; a raft with a safety cord for rivers; engines for crushing olives; wire-drawing machines for the envied work of Genoa, and little model factories, exhibited by the Castellani of Rome, to produce those Roman jewels which were worn, at least in their similitude, by the Imperial wantons of Nero's time, and are now equally prized, although, perhaps, not equally understood, by the less critical connoisseurs of the Corso Sterner; and more directly interesting to the mechanic are the illustrations of the application of cast and wrought iron to building purposes, a study which is exhausted, if exhaustion be possible to any branch of science, in the fourth edition of Sir William Fairbairn's standard book. That "the literature of the forge and the foundry is not less important to national progress than the literature of art," is a sound axiom; but art can never be divorced from true industry. Whatever men love they will seek to beautify. It is only in crude colonising days that buildings without symmetry, wood without paint or polish, and a general disdain of luxury are tolerated. And beauty is luxury, whether it be simple or cheap, or costly and ostentatious. What work can be imagined more enjoyable than that of these Italian artisans cutting shells and stones into cameos, in the style of the great Donatello, master of Michael Angelo, shaping, chasing, even weaving gold and silver, striving to purify every outline, soften every touch, make tender every tint, and, if so we may speak, hallow their labours by practical poetry! Ferdinand Vechi, G. B. Gatti, J. Vaselli, and M. de Lama, representing the Gatti firm, though himself conspicuous as a photographer, may be enumerated: others, indeed, including a large list of English names, deserve personal recognition; but admirably as the council have carried out their plan, they have committed a strange blunder in the catalogue issued on Saturday last. We trust that no copy of it in gorgeous binding was presented to the Prince of Wales. It is literally worse than worthless, and does justice—we employ a mild phrase—neither to the exhibitors nor to the public. Now, there is no excuse for shortcomings of this kind. The council could not insist upon Belgium being in time with her contributions, or France (which has other matters to think of), or Denmark (which may also be slightly preoccupied); but they might surely have insisted upon a summary of the exhibition, classified and indexed, which, pretending to be official, should not be a deception. Upon one point, however, we are bound to offer, on the part of the mechanical exhibitors, an explanation. In the first class, or that of inventions, they are all British subjects, and we were requested to state that the objects not displayed are merely kept under a veil until the bill for protecting them from piracy shall have the Royal Assent. This might have been procured in ten minutes, but, in such matters, there appears to have existed no management whatever. Even the orchestra platform was empty, because no license to use it had been obtained. We notice these points, since they must be of importance to all future industrial exhibitions. The show is so creditable in itself, and so deeply interesting, that hitches of this sort are blameable in the extreme. Passing, however, from a disagreeable topic, we may observe one announcement which is still of interest to workmen. There is to be a "Workshop Competition." "Workmen are invited to enter their names as competitors. When a sufficient number of names have been entered, arrangements will be made for a series of competitions. The council are also willing to arrange for trials of skill in other branches of handicraft, for which intending competitors should at once give in their names." Here is a novelty deserving of all support. It is, perhaps, the wisest possible use to make of an international exhibition. And we must add that a most liberal spirit has been evinced by the English exhibitors, who are, of course, in a majority. They saw the Italian concourse, they acknowledged its richness and beauty, they gave it precedence. Not that it bears away the palm in point of newness, or utility, or the method of improving the ease and comfort of the life of mankind, because it betrays an ancient origin in its Roman splendour and its Tuscan grace; but that, being most lavish of art, and precious in substance, it stood, as it were, on the step of the industrial throne. As to their own contributions, in detail we must not attempt to describe them now. They are of an infinite variety. Amid Saturday's bell-ringing, trumpet flourishes, songs, wedding marches, coming and going of courtly crowds, crush of people, confusion of ceremonies, bewilderment of catalogues, excitement of exhibitors, and thronging of visitors round the more popular stalls, it would have been vain to undertake a critical view of the Exhibition under its strictly industrial and artistic aspects. We hold this duty in reserve, however, and it shall not be through want of will if we fail in rendering justice to deserving competitors.

MICROSCOPICAL JOTTINGS IN TOWN AND COUNTRY.

No. III.

I THINK we may now for a short time wander from the sea-shore and pay a little attention to the land-work of microscopy. A few days since, a break occurring in my usual business hours, away from home I strolled along the line of rail, botanizing with a brother microscopist. Our "takes" were not numerous. *Orchis maculata*, remarkable only for its "pollen masses," we secured in large quantities, and this indeed was the real object of our stroll. My companion called my attention to clumps of the burnet (*Poterium sanguisorba*), and we set to work to search for the very rare brand (*Xenodochus carbonarius*), which is *sometimes* found on that or on the "great burnet" (*Sanguisorba officinalis*). In this we were not successful, but we found a great number of leaves bearing another, and a very interesting fungus, the *Aregma acuminatum*, and also a yellow fungus, the *Lecythea Poterium*. Probably as the best season for collecting micro-fungi is now nigh at hand (July to November), I cannot do better than chat for a while about them. Some of my readers have seen on bramble leaves in the autumn, certain black spots on the under side, accompanied with reddish purple spots on the upper, and have, I dare say, at times asked themselves some such question as this, "What causes them?" Let them in the approaching autumn select a leaf so distinguished, and subject it to microscopic examination. The examiner must place the leaf on the stage of the microscope, and throw a good light on the leaf by the bull's-eye condenser. With a half-inch objective, or a *good* inch, he will see that the black spots are composed of small cylindrical bodies, with short stalks arranged in small tufts. With a penknife let him remove one of these tufts, place it on a slip of glass, cover it with thin glass, and moisten with water or glycerine, and he will see that these cylindrical bodies are multiseptate or are composed of a number of little chambers or cells (four), that the terminal joint is apiculate, and that the peduncles or stalks are bulbous at the base. He may conclude that he has found the *Aregma bulbosum*, of which the technical description, as given by Mr. Cooke, is "*A. bulbosum*—hypogenous, with a dull red stain on the upper surface; spores in large tufts" (*relatively* large) "four septate, terminal joint apiculate; peduncles incrassated and bulbous at the base." If a friend wish to work at the brand he can apply a little diluted nitric acid (1 in 5) to the spores, and carefully observe the effect produced. He may also test them by sulphuric acid (1 in 3) and sugar. By means of the nitric acid test he will probably find that the cylindrical body consists of an outer membrane, which is nearly transparent, and encloses a number of cells, which give the body the appearance of being jointed. There is, I think, little doubt that these cells are formed by what we may term hour-glass contraction of the primal cell-wall, and that the whole has its origin in the small yellow spores invariably found intermixed with the Aregma, and by some botanists raised into a distinct genera (*Lecythea*.) The burnet brand differs somewhat from that of the bramble as will be seen by the following description, which we take from Cooke's "Rust, Mould, and Mildew." "*A. acuminatum*—hypogenous, scattered in *minute* tufts; spores multiseptate, terminal joint acuminate, peduncles equal." A vast number of most interesting objects may be secured by dint of careful and patient observation by any one who cares to use his faculties to this end. I may briefly allude to a few before I pass on. *Aregma mucionatum*, on roses, differing from *A. bulbosum* in having 5 to 7 "cells," in being scattered over the leaves in minute tufts, the terminal joint being mucionate and the stalk fusiform. The raspberry brand, *A. gracile*, is not so common—has 7 to 9 cells, terminal joint apiculate and peduncles slender. The strawberry brand is more common, is scattered in minute tufts, is multiseptate, has terminal joint obtuse, peduncles equal, and rejoices in the name of *A. obtusatum*. The whole of these may be mounted dry in shallow cells, or the spores may be mounted in balsam for minute observation—glycerine is better, but is less trustworthy as regards permanence, and is infinitely more trouble. The smuts and mildews of our cornfields are worthy careful notice. The *Puccinea graminis* of the learned, or mildew of the unlearned (the latter, by the way, is most indiscriminately used to designate most diverse fungi), furnishes a beautiful object for moderately high power, and abounds on the leaves of grasses. Of *Puccinea* there are upwards of 40 species to be found on one or another of our commonest plants. "The spores are uniseptate and supported on a distinct peduncle" (Berk.). The name is derived from the Greek, and simply means "closely packed," the spores being closely arranged together. The Sedge mildew (this must not be confounded with the smudgy sedge rust (*Ustilago longissimus*), the polygonum brand, the ground ivy brand, the *P. compositatum*, *P. vincæ*, *P. galiorum*, are amongst the most common and most easily to be found.

H. P.

THE WORLD: ITS FORMATION AND ANTIQUITY.

By Arthur Underhill.

(*Continued from page* 362.)

Chapter IV.

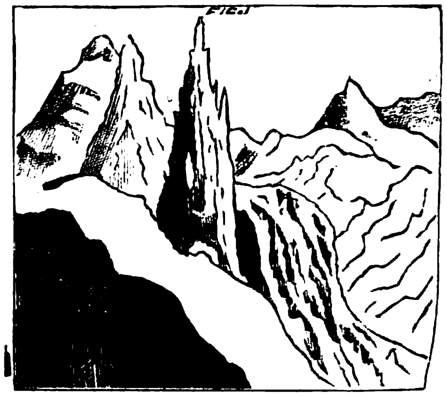
I ANNOUNCED, at the conclusion of my last chapter, that I should in this number treat of the superficial or surface accumulations of the earth; but I have since thought that it would be better to commence at the other end (if I may so express it). I shall therefore proceed to describe the igneous or amorphous rocks, which play so distinguished a part in the drama of creation.

Igneous rocks are divided into three groups or systems, called respectively the *granitic*, *trappean*, and *volcanic*; and each of these systems is again subdivided into different species of rocks, each however bearing the characteristics of its system.

Granitic rocks are easily recognizable from their appearance, being always of a highly crystalline character, and from looking like a conglomeration of minute particles or grains (whence the name granite, from *granum*, Latin for grain) of different coloured substances. They are found in all parts of the globe, and form by far the greater portion of its bulk,—here appearing in huge masses of mountain country whose rugged surface is wholly destitute of any vegetation of a higher nature than mosses and lichens, and which elevates its summit in sharp outlines far above the surrounding country; there overlying the strata in flat masses of slab-like figure; at once place found in the form of huge pikes, tors, aiguilles, or needles, as on Dartmoor, and on a still grander scale in the mountains adjacent to Mont Blanc. At another, forming promontories and reefs, which stretch far into the ocean, and render the navigation difficult and dangerous.

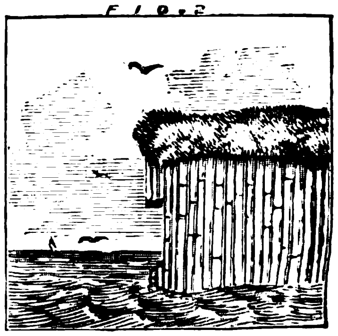
The principal species of granitic rocks are those called *granite proper*, *syenite*, *hypersthenic granite*, *protogine*, *porphyritic granite*, and *serpentine*. Ordinary *granite* has been described in chap. i., and therefore requires no explanation. *Syenite* is formed from felspar, quartz, and hornblende, a dark vitreous substance; *hypersthenic granite* consists of quartz and hypersthene, a green flat crystal; *protogine* is ordinary granite, in which the mica is supplanted by talc; *porphyritic granite* is where large crystals of felspar are mingled with ordinary granite; and *serpentine* is a conglomeration of all kinds of small pieces of mineral substance. Granite is a most durable rock, and is on this account much used in engineering works. When granite appears in the form of needles, as in the Aiguille Dru (see Fig. 1), at Chamounix, it is evident that it could not have taken such a shape, if it had been formed in the open air, and the only way by which it could have assumed such a peculiar shape, appears to be that it was originally injected through the strata, as yet in a soft and yielding state, and was there gradually cooled down as in a mould; in course of time, however, the floods and rivers wore away the softer casing, leaving the hard granite in its present form, the wonder and admiration of all who see it.

FIG. 1



Trap Rocks are generally found in the form of terraces, from which fact the name trap is derived. The trappean system embraces a great many varieties of igneous rocks, which run from the hardest basalt to the soft and earthy claystone porphyry. Basalts are nearly always found arranged in columns or pillars, and constitute some of the most curious and most beautiful tableaux in nature. (See figure 2.) Staffa (a small island on the west of Scotland) is a mass of basalt, and is guarded on every side by these mighty palisades, whose height is in many places several hundreds of feet. At one side of the island a huge cavern burrows under the land, forming, as it were, a natural cathedral, in which the clusters of columns supporting the heavy arched roof of the cave, the immense size of the place, and the architectural regularity of structure, impress the beholder with far more awe and admiration than the most glorious temple built by man. The Giant's Causeway, on the north coast of Ireland, is another instance of basaltic formation.

FIG. 2



Greenstones and clinkstones are other species of trap rocks; they are more granular than basalt, and do not often occur in columns. *Amygdaloid* and *trachyte* are more earthy and rough, and contain crystals of other minerals; *trap tuffs* are a kind of igneous conglomerates; *claystone porphyries* are earthy, with felspar crystals.

All the trap rocks appear to have had a volanic origin, and their different structure arises from the different modes and times of cooling. Thus it has been experimentally proved that a melted mass of trap rock will, if suddenly cooled, assume a columnar structure; while if, on the other hand, it is allowed to cool gradually, the result will be trap tuff, or some earthy form of the system; and thus, by varying the time and mode of cooling, it may be made to assume nearly every variety of trappean rock.

This system gives to the localities where it occurs a most picturesque appearance, combining a bold and hard figure with the beauties of luxuriant foliage and vegetation, nourished by the fertile soil formed from its decomposition. I may mention that the rock on which stands the town of Stirling is of the trap system.

Lastly, we come to the igneous formations of our own epoch, such as pumice stone, ashes, and scoriæ, hot mud, &c. Volcanic rocks are of modern formation, and are even now formed from time to time. They, like the olden igneous systems, are injected from the interior of the globe, and in their birth display some of the grandest, though albeit the most devastating operations, of nature. The eruptions of Vesuvius, for instance, are generally accompanied with frightful convulsions and earthquakes, which upheave and rupture the solid strata, forming large chasms, and finally pouring down from the crater immense streams of molten matter called lava (sometimes extending a mile in breadth and 50ft. to 60ft. in depth), which bury in their burning embraces everything, city or cottage, river or forest, which opposes their progress. This lava, when cold, assumes an appearance somewhat similar to the earthy varieties of the trappean system. Some parts of it, however, which I may perhaps compare to the froth or scum of a rapid river, becomes pumice-stone. Ashes and scoriæ are expelled from the interior of the crater, and fall on to the earth's surface. Hot indeed, but yet in a solid state, they are often propelled to an immense distance; thus a shower of ashes expelled from the crater of Hecla, in Iceland, fell in and around the Orkney Isles, having travelled a distance of about 400 miles.

As I said before, the volcanic rocks are formed in the same way as the older igneous systems, and in consequence they exhibit many of the same phenomena—at one place upheaving the crust, and rupturing the strata; at another, overlying them in flat slab-like beds; here filling up chasms caused by earthquakes—there running headlong into the sea, and forming large promontories and reefs, in the formerly deep water. By a series of such eruptions, a mountain of a conical form is reared, mostly composed of ashes and scoriæ. In course of time the reef becomes overlaid with sedimentary matter deposited upon it by the water; this will in time harden, and exhibit the phenomenon so often found in the old strata of the sedimentary rocks traversed by igneous veins and masses.

Although there are now volcanos in three or four places in Europe, still there are remains of extinct ones all over the continent, and the earthquakes which from time to time happen in Spain and elsewhere, show that volcanic energy still exists there. In the new world, however, volcanos are plentiful, and in South America are continually in play, causing frequent earthquakes, which although not often fatal, still oblige the inhabitants to be very careful as to the mode of building their houses. Lava streams move however very slowly, and cool very slowly too; so much so, indeed, that it sometimes takes several years before a lava stream cools sufficiently to allow of solidification. The pace is very slow—sometimes only a few yards per day. The surface cools first, thus forming a huge mineral pipe, through which the fiery flood passes.

I have now reviewed the igneous formations, and in the next chapter shall commence with the earliest stratified rocks.

(*To be continued.*)

THE FLUTE AND ITS VICISSITUDES.

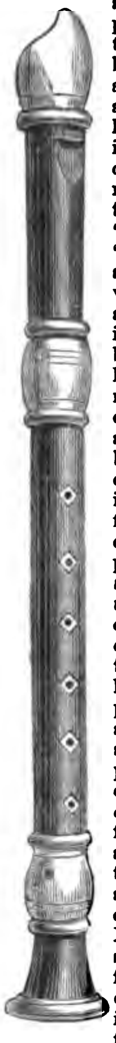
By Sable.

"Nothing extenuate, nor aught set down in malice."

Introduction.

As I follow the flute in its fortunes, and offer illustrations of the various changes through which it has passed during the last fifty years, having no desire to provoke, I shall take no part in controversy. I am much indebted both to the Editor and contributors of this truly valuable periodical; and I would, in my poor way, offer some slight acknowledgment for their kindness and courtesy. Among the most distinguished of those who shed the bright light of science on its pages stands "F. R. A. S.," and I wish, like him, to preserve my *nom de plume*, and thus I trust to exonerate myself from any motives of ambition—indeed, that is a long way behind me now. To interest those who are able to use and enjoy this elegant instrument, and perchance to guide beginners past some of those self-created difficulties into which they are so liable to fall, often from attempting to accomplish, in a few months, that which asks the perseverance and discipline of years—and to pass some wearisome hours usefully—this is the motive which induces me to write. Enough that the controversial war did long and hotly wage to the vexation and perplexity of players, and to the cost of many talented and eminent men, who sacrificed something even more precious than gold. All honour to each one of them! Once upon a time the flute was a very bad instrument; now it is as good as any one can reasonably desire; from its peculiarly intractable nature, it will never be more perfect than it is, and it must be a man's own fault, or rather the fault of his *pocket*, if he does not possess a really fine flute. As I cast a backward look at the best years of my life devoted to its study, I cannot help contrasting the flute of 1830 with the flute "of the period," and as I do so, I offer my grateful thanks individually to those who have expended time, patience, talent, and money to make it what it is.

The flute is as old as the—no, not quite as venerable as the hills, but it is as old as the Pyramids. Some cane flutes were discovered in one of them, having, it is said, eight finger-holes, and although the person who found them could not tell how they were sounded, I dare say some of our English mechanics would readily have solved the problem, and made them discourse some sweet, if not elaborate music; for the poorest of the flute's relations has within itself the very germ of melody. The following circumstance will vouch for what I say:—Some time ago, while on a visit in ———, I rambled on a July afternoon until I found myself in a shady lane, and I *found*, too, I had *lost* my way. A cottage stood at no great distance, and I bent my steps thither to enquire my road, and to ask for a little water, for I was very thirsty. A comely woman, with very bright black eyes and a very white cap, civilly offered me a seat, saying, "an' kindly welcome, sir." During her absence, I cast a look about the tidy room, and on an antiquated bureau I saw lying—yes, a flute. It was a poor little thing, but it was a flute for "a' that." I took it up, it might have cost a shilling; so roughly was it made that I was fain to take out my penknife and trim off the ragged fibres around the inside of the embouchure. I put it to my lips, and by altering the direction of the stream of breath for nearly every note, I managed to elicit from it the two first phrases of Rossini's "La Carita" with a sweetness that surprised me. I may mention that it had a D sharp key, but it was on the open-keyed system, and refused to remain shut. I replaced the little flute, and began to be impatient for the return of my hostess. Soon she entered with a glass of milk, saying as she handed it to me, with true feminine grace and kindness, "I was hoping as you'd play again, sir. I do love the flute, *it's a sound of itself*. I wish our Charley had a flute like to that one, but he's going to get a better one than he have after hops are gathered." I assured the good dame I had played on the little flute and no other, and the look of surprise with which she regarded me "was worth a small annuity" to witness. She was right, the flute is a sound of itself; it stands quite alone, the "strings," "reeds," and "brass" are all well supported by their own proper bass; yet the flute has ever maintained its place in the orchestra because its valuable services could not be dispensed with. The flute has been ruthlessly and of necessity somewhat unfairly handled: no other instrument if we except the pianoforte has undergone such mutation; but as the virginal, spinet, clavichord, and harpsichord gradually passed into the present pianoforte, the keyboard remained unaltered, no perplexity or difficulty was here presented to the performer. Its compass was increased and the touch and quality of tone improved, and the player was enabled to get more expression from his finger ends. But in the flute the natural progression of the diatonic scale was broken, and it varied with every new form of the instrument; new fingerings were introduced, a difficulty was removed from one region to generate two or more in another, and the touchstone of practical experience proved that theory and experiments had placed the flute in a still more unsatisfactory condition. Is it then any wonder that it should have been regarded with a suspicion amounting almost to dislike? That it has not of late years met its once cordial reception in the orchestra and drawing-room is not surprising. The promise of a flute accompaniment in the latter has seldom failed to provoke a quiet smile, the "twilight of a smile," often sarcastic, and unpleasant allusions have been made to the lugubrious performances of Dick Swiveller, or a ruler or a stick has been seized by the "funny man" of the party, and the conventional bowing, ludicrous pigeon-like attitude assumed. Beginners should beware of this, it is a rock on which many split, it is fatal to tone and tune, and produces that wheezy sound, and that alternate elevation and depression of pitch so unendurable to refined and cultivated ears. In such a position it is impossible to intone correctly with flute or voice, because the windpipe is bent and the air cannot pass freely, and the lungs are embarrassed. I know from experience in many instances how easily pupils may drift into this ungraceful and ruinous habit, and the toil it gives them to free themselves from it. "Many a man" says Rockstro, "after much patient toil has laid aside his flute disheartened, and with disgust, thinking there was an inherent defect in himself or his instrument, when all the while the bar to progress lay in some bad habit which a timely hint from a master would have saved him from contracting." It is impossible to articulate perfectly *in* tune with a bad flute, yet a well-disciplined lip can cover many defects; and it is equally possible to *blow* a good flute *out* of tune. Tone, style, and execution are matters of study, patience, and example; but *intention*, the *perception* and *interpretation* of the great masters, are more or less individual gifts which proclaim the true artist. When I took up the flute as a student (a long time ago) I had no one to oppose my own sweet will: I studied as I liked, and consequently I had a vast deal to unlearn. Music and painting are twin sisters, before one can be a master *one must have a master*. However, to save others from similar vexations, I will offer a few brief hints on the attitude of the player, the position of the instrument and the formation of the embouchure in my next article, and I trust they will be received in the same spirit in which I put them forth. I close this paper with the drawing of a once rather popular instrument, the flaûto dolce or flute-à-bee. It was neither more nor less than an incapable flageolet, with an imperfect register, but a pure and vocal sound. Its extinction I believe has been lamented by some musicians. It is figured in the descriptive catalogue of M. Carl Engel, and is amongst the musical curiosities in the South Kensington Museum. It is made of tortoiseshell, and is stated to have belonged to Rossini. It is worthy of remark that its body is cylindrical and not conical.



(*To be continued.*)

SCIENCE FOR THE YOUNG.*

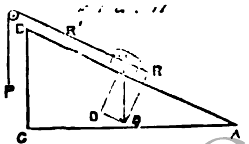
By the Rev. E. Kernan, Clongowes College.

(*Continued from page* 365.)

Application X.

Inclined Plane.

I. The theoretic inclined plane is a surface perfectly hard and smooth, forming an angle to some other surface. There are three "essentials" in an inclined plane, Fig. 77: the length, A B; the height, B C; and base, A C.



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II.—Principle of action. A body M, Fig. 77, laid on the length A B of the plane is acted upon by gravitation Q along the line M Q. The force of gravitation can be decomposed into two: one M O, perpendicular to the *length* A B; the other, M R parallel to A B. Now M O, or the "*normal*," as it is called, has no effect whatever as to the motion of M down the plane; hence M R is the whole force to be considered. Therefore a force M R^1, equal and opposite to M R, will keep M at rest.

The principle of the inclined plane is, then: that the length of the plane opposes part of the force acting on the body, leaving only a certain quantity to be balanced by the power P.

FIG. 78.

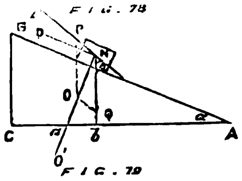


FIG. 79.

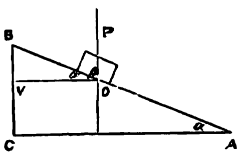
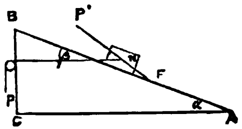


FIG. 80.



III.—Conditions of equilibrium. They are all contained in one small formula $\frac{P}{W} = \frac{\sin a}{\cos \beta}$. In this formula P, Fig. 78, is the power exerted; its direction is along the line N P, but for the moment no intensity is marked by *length of line;* W the weight of the body; a the angle of the plane, β the angle of the rope, with the "length" A B. The proof of this formula is simple, and just represents the amount of knowledge supposed in this series. *Construction.* The forces P and Q not being parallel act upon the body at a point N. Draw N O^1 perpendicular to A B, *i.e.*, "normal" to the "length" of the plane. As Q represents in direction and intensity the action of gravitation, and as the direction of the power and the normal are determined, a parallelogram completed gives the representative intensity-length of the normal and power. Draw, therefore, Q O parallel to N P, and O P parallel to N. Q. The gravitation and weight being one and the same thing, the power and weight are represented by the lines N P and N Q. *Proof of formula.* The lines being proportional to the forces

$$\frac{P}{W} = \frac{N P}{N Q}.$$

Sines and sides opposite being proportional, it follows that

$$\frac{P}{W} = \frac{\sin N O P}{\sin N O Q}.$$

Substituting the alternate (equal) angles,

$$\frac{P}{W} = \frac{\sin Q N O}{\sin P N O}.$$

But Q N O = a (similar triangles a N b and B A C).

$$\because \frac{P}{W} = \frac{\sin a}{\sin P N O}.$$

Now sin P N O = cos P N D (D N drawn perpendicular to O N)

$$\because \frac{P}{W} = \frac{\sin a}{\cos P N D}.$$

Finally P N D = β (N D is parallel to A B).

$$\because \frac{P}{W} = \frac{\sin a}{\cos \beta}.$$

With this formula all questions possible on the inclined plane can be answered, by resolving the equation for the unknown quantity. Thus, $P = \frac{W \sin a}{\cos \beta}$, $W = \frac{P \cos \beta}{\sin a}$, &c. The conditions of equilibrium, without the help of simple trigonometry, must be studied in a set of different cases, each having its own formula and special train of reasoning; with the formula just established, all possible cases are included in three or four suppositions. The simple evolution of these will show what a quantity of knowledge is securely stored up by remembering the short formula $\frac{P}{W} = \frac{\sin a}{\cos \beta}$. Suppose:—

(1.) $\beta = o$,—*i.e.*, the cord forms no angle, is parallel to A B (fig. 77) cos β = radius = A B the length of the plane. Sin a in this supposition may be replaced by the *height* (H) of the plane. Hence the common formula (*c*). Sin a is always the height, but H can never stand for sin a unless when cos β is in a *line* like H.

$$\frac{P}{W} = \frac{\sin a}{1}$$

$$P = \frac{W \sin a}{1}$$

$$(c)\ P = \frac{W H}{L}$$

(2.) $\beta = n$—*i.e.*, the cords form some angle (fig. 78) represented by the indefinite quantity n. Cos β may be represented by $1 - m$. m indicates the diminution of of the value of cos β. As none of the elements of the plane enter into this supposition, an ordinary formula is not possible. But the value of $1 - m$ (cos β) is at once found when absolute value is given to n. From the inspection of the formula in its general shape, it is evident that as β increases P must increase (the divisor cos β *decreasing*) until

$$\frac{P}{W} = \frac{\sin a}{1 - m}$$

$$P = \frac{W \sin a}{1 - m}$$

(3.) Cos β = sin a—*i.e.*, when the power acts perpendicular to the horizon, then P must be equal to the weight. That the power is acting along a perpendicular to the horizon when cos β = sin a is easily shown. Draw O V (fig. 79) parallel to A C, the base, which is always taken as horizontal. Now the angle B O V = B A C or $a' = a$. But by the supposition cos β = sin a', therefore the angle P O V must be equal 90°. For the equality, cos β = sin a', is only possible when V O P is a right angle, or when P is perpendicular to the base. That the plane is of no service in this case experience is enough to teach; but there is a great satisfaction in finding it so clearly indicated by the formula: P = W.

$$\frac{P}{W} = 1$$

$$P = W$$

(4.) $\beta = a$. Hence cos β = cos a. But cos a = A C, the base (fig. 80). Here therefore again the height may be used instead of sin a. This is another of the ordinary laws P : W :: H : B. The common form in which this case is presented shows the power (the cord) parallel to the base, A C. But the formula proves that the law is *general;* therefore the force may be applied in any other direction in which the condition ($\beta = a$) is observed. Hence, the force may be applied along the line P' N, which can be so drawn that the angle P F B (β) = a.

$$\frac{P}{W} = \frac{\sin a}{\cos a}$$

$$\frac{P}{W} = \frac{H}{B}$$

$$P = \frac{W H}{B}$$

This being the first of the machines, it will be very well to state, in a marked way, their object, and to show how in the "present" machine the formula indicates the conditions for the better attaining of that object. In the plainest terms, the general object of these machines is to produce equilibrium with the smallest possible power. Hence the formula which gives P the *least value* indicates the most favourable conditions of equilibrium. There is something unusual to a beginner in this view of a formula which, if not minded, may suggest a wrong interpretation of the results. Therefore the *least* being the *best*, it is evident from inspection of the formula I., that case (1) gives the greatest advantage; for in that case cos β is the largest possible divisor. II. Case (2) comes next as long as it keeps from (4) $\beta = a$, which is the worst of ordinary conditions. III. After $\beta = a$, at each increase of angle there is a nearer approach to the machine being useless. These conclusions suppose that the plane elements do not change. How they should change to decrease P is also shown by the formula I. The smaller sin a (the smaller the angle of the plane), the smaller will be the quotient = P. Here is the practical experience: that the less the height of the plane the better. II. The greater cos β (the longer the plane), the greater the divisor, and consequently, &c. This falls back into the first, in practice: the height remaining unchanged, the longer the plane the less the angle. III. No lengthening of the base will give increase of power unless the angle be changed, for the relation of sin a and cos. a remains the same. These elements of the inclined plane serve to introduce a most important consideration regarding all machines—namely, *what is gained in power is lost in time.* Thus here, when the plane is longer with the same height, there is a gain of power, but a loss in the time required to move the body to the same height. Suppose the plane 500 ft. long and 10 ft. in height, the body has been only raised 10 ft. after the time spent in moving over 100 ft. Were the plane but 30 ft. long, with the same height, there would be a loss of power (P should be greater), but there would be a gain in time. This gain or loss suggests the announcement, even now, of a principle most important in practical mechanics, which is usually explained first, in another place. Still as a rigid demonstration of it cannot be given even there, its simple explanation is well obtained by means of the inclined plane. Such is its value that it is known under a special name—the principle o *virtual velocities.* The word "velocity" seem to *require* force in action, yet it is not so. Th principle is more easily understood by supposin action for the moment, but it applies in all i fulness to equilibrium, or more strictly is onl for forces not allowed to act. Hence in the nam the word "*virtual*," *i. e.*, the velocity which th force *could* produce if allowed to act. The examination of what takes place when a weight i raised along an inclined plane shows, in a simp and comprehensive manner, the main truth contained in the principle of "virtual velocities." body on an inclined plane has a certain weigh When it has arrived at the top it has moved w a certain velocity through a given perpendicu space. On the other hand the power which rai it has a certain amount of force, which could represented by a weight. When the body h been drawn up, the power, too, has acted with certain velocity, and through a given spa Take case (1), and let A B = 100 ft., A C = 1 W = 50, $P = \frac{W \cdot H}{L} = \frac{50 \cdot 10}{100} = 5$. Here th power 5 has to move through a perpendicu space of 100, as it must draw the weight over th length A B. In the mean time the weight only moves through the perpendicular spac A C = 10. Now multiplying the power by it space (50 × 10), and the weight by its space (50 × 10), there results an equality (1) 500 = 500; or (2), 500 − 500 = 0. Substituting i these equations the *possibility* for the *actuality* (the *posse* for the *esse*) of the result, the principl of virtual velocities signifies: *that in all machin there must be equality between the power, multiplied by its velocity, and the weight* (or work to be done) *multiplied by its velocity.* In the fractional form it runs $\frac{P}{W} = \frac{v'}{v}$; the power is to the work *inversely* as the possible velocities (v = velocity of P, v' velocity of W). Hence (2) P v × W v' = 0. This last formula will make intelligible the *general* expression of "virtual velocities" to be met with in books—$\Sigma (p \times v) = 0$—*i.e.*, the *algebraical* sum of all the pressures (forces of power or weight-work) multiplied by their respective velocities is equal to zero. This expression is in nothing essentially different from the formula (2). Instead of P v is the sum of all the forces which may constitute the sum of P—$p\,v + p'\,v' + \ldots\ldots$ Instead of $w\,v'$ is the sum of its constituent forces, which are also rendered by the letter (p) with different *indices.* The letter (p) is used for all, both power and weight elements, to express *pressure*—forces not in act —equilibrium.

IV.—Development. Inclined plane uses. Roads from one point to another raised above it. These are no more than very long inclined planes of small angle. Here occurs a technical term to be explained—for example: "*the road rises* 1 in 12." That signifies that at the end of *each* 12, the plane is *one higher* than at the end of the preceding 12. Suppose 1 = a foot, 1 in 12 signifies that the road is one foot higher at the end of every 12 feet. The same is the meaning of 1 in 20, 30, &c. From the principle of the inclined plane, it is evident that the great object in the construction of roads is to make the incline or "gradients" as they are now called, as gentle as possible, *i. e.*, a as small as circumstances will permit. Of great inclines there are some wonderful examples. The temporary railway over Mont Cenis is the greatest ever yet attempted with success by a locomotive. The "gradients" of the zig-zag inclined planes are 1 in 12 and 1 in 13. The aids to the power of the steam will be brought in under their own principles. The railway over the Western Ghauts in India had before the Mont Cenis the greatest incline. Crossing the Western Ghauts, in 15 miles there is an ascent of 1,800ft.*

The raising of great weights from one level to another is the second use of the inclined plane. Blocks of stone from the quarry, and ships hauled up into the dockyard are the chief practical examples on a large scale; on a small scale examples are without number, and too obvious to require special mention. On the Morris canal, New Jersey, U.S.A., there is an example of a novel use of the inclined plane. Instead of a series of "locks" this canal has a series of twenty-three inclined planes, varying in *height* from 35ft. to 100ft. The boats (carrying some 70 tons of coal) are drawn to the top of the plane by a rope wound on a drum 12ft. in diameter, and worked by water machinery. There is found to be a great saving of time as compared to lock lifting. The boa passes almost as quickly over the plane as over so much level water.[*]

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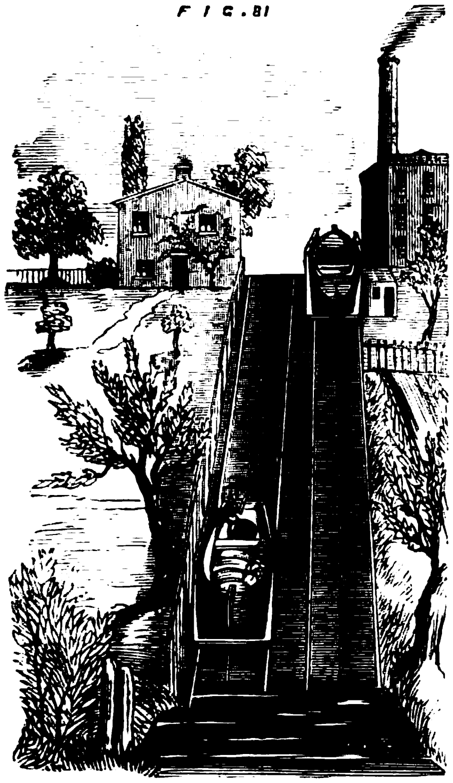
* *Engineering*, Vol. vi. p. 100.

FIG. 81



⌐ Sub-application I.—The wedge I., an inclined plane *forced under* a weight, has the same action as if the weight were drawn up along the plane. Some of the most ordinary uses of a wedge show that it is no more than an inclined plane driven by blows under some weight; or in more general terms, at an angle to some forces to be overcome. II. The wedge, when used for lifting, is a single inclined plane, the force is applied parallel to the base, by blows on what is called the "back" of the wedge (the "height" of the plane). For all effects of separation the wedge is a double inclined plane III. Theoretically, therefore, the wedge should be reducible to the formula of the inclined plane. But practically, the wedge requires attention to forces, the power of which can only be calculated more or less approximately. Thus the power (P) is usually exerted by a blow, the exact value of which it is very difficult to estimate. Then there enter elements, some of which it is almost impossible to bring under the control of mathematical formulæ. A good notion of the difficulty may be formed by reading in the ENGLISH MECHANIC, April 15, the article on the wedge, in the valuable series of papers on Friction, by Mr. C. Draper.

(To be continued.)

REVIEWS.

A New Star Atlas. By R. A. PROCTOR, B.A., F.R.A.S. London: Longmans, Green, & Co. 1870.

IF we may credit Clemens Alexandrinus, the first division of the heavens into constellations was made by Chiron some 1420 years before the Christian era. Pliny, however, speaks of astronomical observations found on burnt bricks ("*coctilibus laterculis*") among the Babylonians, ascending more than 2200 years B.C., while Alexander sent to Aristotle from Babylon a set of such observations reaching 1900 years back; and it is asserted that the Chinese and Indian observations extend back to a more remote period still. Reference in the Bible too, as in Job xxxviii., 31, 32, to individual stars and groups, indicates that various stellar configurations had been remarked, at a very early age. Knowing then, as we do, that hieroglyphics, or pictures, have always preceded writing, as the means of record employed by nations in their primitive emersion from barbarism, it seems only natural to believe that figures of star groups, of some sort, must date from the very hoariest antiquity. Quitting, however, the region of conjecture for one of ascertained fact, we find Ptolemy speaking of Polaris as "the star at the end of the little Bear's tail," Regulus as "the Lion's heart," &c.; and it is curious that this mode of description actually survived to the time of Halley, our second English Astronomer Royal; albeit, nearly 180 years before, that very voluminous writer, Piccolomini, in a work on the fixed stars and the sphere, had designated the stars of each constellation by letters, and even inserted some rude maps of them thus distinguished. Some 50 years later than Piccolomini, Bayer gained what has been called "cheap immortality," by a revival of this idea, and attached to the stars in each constellation, in the order of their brightness, the letters of the Greek alphabet, commencing with the capitals, going on to the small letters; and finally, on exhausting them, using Roman type for the remaining components of the constellation. The recognised constellation makers are Aratus and Ptolemy, and (perhaps) Bayer, Hevelius, and Lacaille. Others, including Halley, have made confusion worse confounded by poking in foolish little asterisms into the midst of a scheme already most exceedingly involved; and by adding where they might very well have subtracted, only made bad worse. There can be no doubt of the use of constellation-figures as a kind of *memoria technica* for those whose object it is to acquire a naked-eye acquaintance with the heavens; but those of Ptolemy were sufficiently confused, and interlaced in a sufficiently perplexing way, without requiring modern help to still further complicate the artificial divisions of the face of the visible sky.

The first stellar maps, worthy of the name, were those of Bayer, which appeared in 1603. Flamsteed's "Celestial Atlas," published in 1729, consists of 28 charts, and was the principal one employed by astronomers during the last century. Bode's atlas, published in Berlin in 1805, contains between 17,000 and 18,000 stars. Harding's, in 27 charts, gives more than 50,000. Since then Bessel's zones and Argelander's "Uranometria Nova" have appeared. Weisse's reductions of Bessel's zones contain nearly 32,000 stars, ascending to the 9th magnitude. The chief excellence of Argelander's maps consists in their containing a thoroughly revised scale of magnitude of stars, they having been by no means previously all classed exactly according to their apparent brightness. A large atlas has also been brought out in Paris, by M. Chas. Dien, within the last few years. A great drawback to the popular use of the majority of the works published during the present century is found in the fact that the stars in them are dotted down without note or symbol, and suggest the idea that a brush full of Indian ink has been rapidly drawn across a small tooth comb, while the latter has been held over a sheet of white paper. From 1830 up to the present year essentially *the* maps of the stars which have been in use for ordinary purposes in England are those of the Society for the Diffusion of Useful Knowledge, and, with certain reservations and exceptions, very excellent they are: that, however, they are defective in more than one point of detail everyone who has ever used them will admit. A compilation from them came out about the year 1842 under the title of "Middleton's Celestial Atlas;" this contains a most valuable adjunct in the shape of corresponding blank maps, presenting the stars white upon a dark ground, as we see them in the heavens. A very picturesque "Atlas of Astronomy" too was produced (under the editorship of Mr. J. R. Hind, F.R.S., superintendent of the "Nautical Almanac") some fourteen years ago by the great Scotch geographer, Mr. A. K. Johnston. It is beautifully printed and got up. The most glaring and obvious fault in all these atlases, without any exception, is the great distortion which exists when we recede from the very middle of the maps. To take the Useful Knowledge Society's maps as a typical example—they are drawn on the six interior surfaces of a cube, on what is known as the gnomonic projection. A popular notion of this construction may be gained if we conceive the stars to be accurately delineated upon the internal surface of a sphere, this sphere to be placed inside of a cube or box whose sides, lid, and bottom are tangent planes to the sphere (or, as one might say, the cube *exactly holds it*), and the eye being placed at the centre of the sphere, lines drawn from it through the various stars and produced until they pass through the faces of the cube, then the places of the stars will be marked down upon the inside of those faces at the points where our imaginary lines pass through them, and upon dissecting the cube we shall have six square maps representing the whole of the visible heavens. It needs a very rudimentary acquaintance indeed with mathematics to enable any one to see that while the configuration of the stars will correspond pretty accurately where the cube touches the sphere, *i. e.*, in the middle of the maps, when we get up to the boundaries of the maps, or to the edges and corners of our imaginary box, the distortion becomes unmanageable, and well known stellar configurations are twisted and cramped up so as to be unrecognisable.

The most prominent characteristic of the admirable atlas the title of which heads this notice, is the manner in which this grave defect is obviated, by the assumption that the sphere is contained not in a cube, but in a regular dodecahedron, thus dividing it into twelve equal and similar spherical pentagons, and by the employment of what is called the equidistant projection. For a detailed account of the method adopted we must refer to the excellent and readable introduction to the atlas itself. In practice the pentagonal boundaries of the maps are replaced by their circumscribing circles, so that the respective maps overlap, not at their extreme edges, but well within the area delineated. It is, of course, physically impossible to reproduce a spherical surface with absolute accuracy on a plane; but the amount of distortion in the particular species of projection adopted is so very nearly insensible as, for practical purposes, to vanish. It is only needful to compare the twelve circular maps which constitute the atlas with the two key maps prefixed to them, and drawn on the gnomonic projection, to see the enormous superiority of the former.

The scale of the maps being that of a 20in. globe, affords ample space for the delineation of detail, and the consequence is that many thousands of objects are charted without the slightest confusion. Some rude notion of the legibility (if we may employ that word) of the maps may be gathered from the statement that on map 2, α and β Andromedæ are 2·5in. apart. These maps have been very beautifully reproduced in photo-lithography by Mr. A. Brothers, F.R.A.S., to whom high praise is due for his share in the matter. Mr. Proctor has not, however, confined himself to the manifest improvements we have indicated; a very cursory inspection of these maps will reveal many others. He has discarded the rays which previous uranographers have always put round the images of the stars, and represents them as circular discs. A very simple and ingenious method is employed, too, in indicating the various magnitudes, and we may add that the adoption of Sir John Herschel's photometric scale enables him to indicate the relative brightness of the leading stars, an exceeding help to beginners, who may well have been often puzzled to see the smaller of two stars in a map the brighter one in the sky.

In the maps themselves, the constellation figures are abandoned. Deferring, however, to popular prejudice, our author has retained them in the index maps, where we may see a brown bull with bright yellow horns butting at Auriga, who is appropriately got up in pea-green.

The names of the constellations are put on small labels in those parts the most free from stars, and Colonel Strange's capital forms of numerals are used throughout. The hour circles and parallels of declination are marked in continuous lines—the lines of latitude and longitude in dotted ones. A very simple arrangement of arrows indicates the processional motion for 100 years, so that the maps serve, and will serve, for any epoch. The symbols employed to indicate nebulæ, clusters, binary and multiple stars, &c., are all of a very simple description, and the whole of the detail of co-ordinates and nomenclature, while perfectly sharp and distinct, is yet so relatively faint as not to distract the eye from the various discs representing the stars themselves.

Probably a difference of opinion may exist as to the expediency of the alteration made in the names of some of the constellations by Mr. Proctor. The chief objection to such alteration would seem to be that it throws a needless difficulty in the way of the beginner, who may be searching for some object from its name in a catalogue. For example, the incipient possessor of a "Nautical Almanac" might not quite recognize 12 Canum Venaticorum in "α Catulorum," nor Procyon in α Felis. And while mentioning this last asterism by the way, we remember that some former star-collector actually did insert a constellation Felis, somewhere under Hydra. We may add too, that if it be needful to alter Ursa Minor at all, we would indicate Ursula as more suggestive of its old appellation, than merely "Minor," a name equally pertaining to Leo Minor and Canis Minor, both of which figure here under a changed nomenclature.

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[*] *Scientific Review*, Vol. ii., p. 308.

The atlas is strongly but handsomely bound, is of a handy size for reference, and is sufficiently elegant in its external appearance to render it an ornament to any drawing-room table. For the especial purposes for which it was designed it is certainly not only unsurpassed but unapproached by anything which has hitherto appeared; and, while it will doubtless soon be found in every fixed observatory in the kingdom, its peculiar adaptation to the wants of the astronomical students unprovided with graduated instruments, will commend it to that large and increasing class of observers who merely possess moderate telescopes on ordinary stands. They may accept our assurance that in no other way can they acquire a familiarity with the face of the celestial vault so easily and pleasantly as through the medium of the work of whose leading features we have endeavoured to give some indication.

On the Manufacture of Beet-root Sugar in England and Ireland. By WILLIAM CROOKES, F.R.S., &c., Editor of the *Chemical News.* London: Longmans.

THE manufacture of sugar from beets is an industry which bids fair to become established in the United Kingdom; and from a conviction of its great national importance Mr. Crookes has been induced to prepare this elaborate work for the press. In the year 1747 Marggraf, a Berlin apothecary, made known at the Royal Prussian Academy of Science the fact that beetroots contained sugar identical with that derived from the sugar-cane; and although his proposals to extract it on a large scale, owing to a variety of causes, did not then meet with any success, within a century after its announcement his discovery became an important industry, and the extraction of sugar from beet is now one of the recognized manufactures, not only of Germany but of France, Austria, Russia, and Belgium. The original plant from which the beet of agriculture was derived grows wild on the coasts of the Mediterranean, in Spain, Dalmatia, and some parts of France. It is an unsightly bi-annual plant, known to botanists as the *Beta maritima;* and the common red beet is a variety of the same genus. The percentage of sugar contained in beet-roots varies considerably with the nature of the soil, the method of culture, and the kind of seed used. In a number of analyses made by Professor Voelcker, he found the amount of sugar to vary from 3·62 per cent. in a white beet, to 13·19 in a red, the latter manured with London sewage. Professor Church has found as much as 13·47 per cent. in Carter's prize nursery sugar beet, and Messrs. Vilmorin, of Paris, are reported as having seed which will produce roots giving 16 per cent. sugar. The chief requisites in soil upon which this crop is intended to be raised are a sufficient depth and ready penetrability by the plant. A good friable loam, and all soils which grow potatoes in perfection, are the most eligible for the growth of beets. Clay lands will be found equally well adapted, if the soil is judiciously prepared. It would, of course, be bad farming to cultivate the beet two years in succession on the same piece of ground; but it forms an excellent rotation crop with wheat, clover, and oats, or with wheat, flax, and turnips, all of which, according to Mr. Baruchson, are more abundant when beet forms the alternate crop. That this is especially the case with wheat all who have made the experiment can testify. One peculiarity of the beet, and one of its great advantages to farmers, is that, added to the fact that its leaves make an excellent fodder for cattle, the pulp, after extraction of sugar, makes a valuable feed for stock, and according to Prof. Voelcker, although he speaks with some reservation, one ton of the pulp as it comes from the presses contains as much nutriment which cattle can assimilate as 1¼ ton of the roots before the sugar is extracted, or as much as 2 tons of common mangolds. "In Belgium fattening beasts are sometimes fed upon nothing else but the refuse pulp of sugar manufactories." "A fair allowance of bean-meal or cotton-cake, and as much pulp as the cows will eat, produces both abundance of milk, and milk of good quality." Pigs will also do well upon it, if they likewise receive barley or pea-meal, or a mixture of both.

Having seen that the cultivation of the beet must be profitable, we will proceed with Mr. Crookes to inquire into the pecuniary aspect of the manufacture of sugar and spirit from beets. Of these, the latter seems the more profitable, but the distilling should be connected with the farming, and carried on simultaneously. Thus a Mr. Robert Campbell has erected a large beet-root distillery on his estate at Buscot Park. This agricultural establishment comprises about 5,000 acres of land, and the distillery supplies sufficient refuse to feed 12,000 sheep and 2,500 oxen. Mr. Campbell has obtained on the first trial about 40 tons of beetroot to the acre, with from 10 to 12 per cent. of sugar. A French manufacturer, M. Champonnois, has succeeded in extracting the whole of the sugar contained in the beet, and converting it into alcohol, and in keeping in the residuary product the whole of the alimentary principles which the beet contained. The value of the spirit extracted is not the only return for the original outlay; for on the land belonging to the distilleries of which Mr. Crookes gives statistics, the yield of wheat was increased from 19 hectolitres to 27¾ per hectare; and whilst these farms were found capable of rearing only 25,386, and fattening 6,955, head of cattle, they now rear 51,449, and fatten 46,656 head, besides giving employment to a vastly increased number of workpeople.

Mr. Crookes gives the following estimate of the expenses of a sugar manufactory, the first cost of which he puts at £13,157, and considers capable of producing at least 1,200,000lb. of raw sugar. The amount required for labour and material would be £12,620, which, together with taxes, insurance, and interest on capital, would make a total expenditure of £13,980. The realization from this outlay should, reckoning only 8 per cent. yield of sugar, reach £20,470, thus leaving £6,490 as the profit! Mr. Baruchson however, taking the yield of sugar at 6¼ per cent., estimates the return at upwards of 24 per cent. on an outlay of £30,630; but if the roots yield 8 per cent. of sugar, the extraordinary profit of 48 per cent. will be the result. Even taking these statements *cum grano salis*, it is sufficiently evident that profitable employment can be found for money lying idle; and we can confidently recommend this book to any capitalist in search of a remunerative speculation. Mr. Crookes has spared no pains to obtain all the most recent information; and his work contains, we imagine, the completest account of the manufacture of beet-root sugar ever published.

THE RESISTANCE OF PRISMATIC SECTIONS.*

IMPROVEMENTS in experimental methods have, during our epoch, kept pace with improvements in analytic methods. Formerly experiments were made upon pieces of small dimensions; and the constants which were determined were applied to the same materials, whether employed in the smallest or the greatest works. The old experimenters followed this method; Buffon with wood, Rondelet and Rennie with materials employed in masonry, Barlow and Tredgold with iron and steel, Vicat with mortars. They had in view generally the determination of four quantities—the specific gravity, which enters into the calculation of the proper loads, the coefficient of elasticity, the limit of elasticity, and the breaking weight. A fifth remained to be determined, that is, the limit of the load for actual construction consistent with durability. These experiments, repeated by a great number of observers, under the most diverse conditions, have thrown great light upon engineering art. The tables of Genieys, in the section on the resistance of materials, present an excellent *résumé* in a succinct form.

The problem of the reaction upon pieces at their supports which leads to particular cases, has been studied experimentally; and Rondelet, in his "Art de Batir," reviewing all the facts collected by his predecessors with reference to the compression of wood, has given a practical rule which indicates the successive reductions to which the limit of load should be subjected, as the ratio of the length of the piece to its least transverse dimension is increased. It follows from this rule that a piece twenty-four times as long as the side of its square section upon which it stands, will sustain only half the pressure which it would if reduced to the form of a cube. This subject has been taken up and perfected by the English engineers, whose experiments we shall now notice.

Among these experiments the most numerous and remarkable are those of Mr. Hodgkinson; the results of which were published in 1846, and which were translated in 1855 by M. Pirel in "Les Annales des Ponts et Chaussees." The experiments of Hodgkinson were intended to determine with precision the extreme resistance of steel to traction, to flexion, and to transverse strains, and to deduce from the observed phenomena the best form to give to solids made of this material. The old observers, always preoccupied with the use of formulas deduced from the theory of flexion, did not attach great importance to the phenomena attendant upon rupture, and the majority neglected to extend their experiments beyond the limit of elasticity where the formulas cease to be applicable. The observations of Hodgkinson sensibly enlarged the field of the old experiments.

About this time the extended use of metal in construction upon railroads, and especially the construction of the great iron bridges, Conway and Menai, were the occasion of new experiments, very numerous and interesting. The account of the observations, generally extended to the point of rupture, is contained in the monograms upon the construction of these great bridges of Stephenson.

All these results have led to more exact determinations of the specific constants relative to iron. They show that iron obeys the theoretic laws of transverse flexion for slight deformations; that the coefficient of elasticity is reduced in very large works; that the resistance of iron to crushing is generally less than the tensile resistance. The reverse is true of steel. Besides, the limit of elasticity of steel is greater for compression than for tension; while in wood and iron the limits are the same. The coefficient of elasticity for steel is not the same for compression as for extension—a singular anomaly, which makes rigorous calculation of flexion very difficult. MM. Collet-Meygret and Desplaces have deduced an interesting consequence from observations made on the Viaduc de Tarascon; it is, that in steel the sections do not show everywhere an equal elasticity, so that it is necessary to distinguish the shell from the portions near the surface, giving to each its special coefficient. The line of demarcation between the two regions seemed to be difficult to trace rigorously. Iron drawn into wire of a small diameter presents analogous phenomena; so that it has long been known that iron wires contain elements that resist extension—a property utilised in the construction of suspension bridges.

Hodgkinson has made a special study of the resistance of pieces under pressure at their abuttings; among these, upon steel columns. His empirical formulas give the breaking load of a hollow column in terms of its height, and its external and internal diameters. The load which a column can safely bear is fixed at a sixth of the breaking load given by the formula. He has shown by numerous experiments the influence of the shape of the base, whether flat or round; and also the effect of *renflement.* He has substituted a formula for wood instead of that given by Rondelet, and shows that the load supported by oak varies nearly as the fourth power of the least dimension divided by the square of the length. M. Sove has substituted more convenient formulas for solid columns of steel or iron; they lead without difficulty to the choice between iron and steel for a column of given dimensions.

The observation of the vibratory motion of elastic solids leads to the determination of the coefficients of elasticity. It is the only method applicable to their plates or to wires. To this class of researches belong the experiments of Wertheim, and those of M. Phillips upon the spiral réglant.

In a scientific point of view the experiments upon the resistance of materials have shown that the hypotheses assumed in the solution of the problem of the deflexion of beams cannot be regarded as absolutely true. It is almost impossible to determine the limit of elasticity. A metallic bar, once subjected to tension, does not return to precisely its original form when the tension ceases, and its elasticity has undergone a certain alteration. The limit of elasticity, as understood in practice, is that limit at which alteration becomes sensible by the coarse methods of experiment; but as these become more precise, it is seen that this limit gradually diminishes, and it would without doubt disappear if the processes were perfect. The limit of elasticity is certainly of great importance: but one should not pretend to determine it with a precision that cannot be applied in a practical problem. Late experiments have shown the existence of certain gaps in the theory, without filling them. They have shown the great complexity of the problems without suggesting the means of getting rid of it; so that the old theory of deflexion remains the only guide that can be confidently followed, while we wait for the perfect solution which is to come from future investigations.

ON ZYMOTICS.*

(*Continued from page* 394.)

WHAT, then, is the way in which the contagious matter is conveyed? Chiefly by emanations from the sick man. The clothes which he has worn, the bed on which he has lain, the furniture, carpets, and curtains of the room in which he has lived, all become the recipients of the contagious material, retaining it for months, or carrying it with them for miles. The contagious matter of small-pox and scarlet fever is particularly persistent. Clothes which had belonged to some one suffering from small-pox, and been laid by for months, have passed on the complaint to those who have had the misfortune to handle them. The poison of scarlatina is most difficult to eradicate, chiefly from the desquamation or peeling off of the skin, which occurs when the malady is passing away, and which is the chief medium for the dissemination of the contagious matter. The skin or cuticle comes off in very fine powder, which is extremely light, and penetrates into every corner of the room which dust can reach, accumulating on the cornice of the door, on the shelves of bookcases, or projecting parts of picture frames. The clothes which the sick man has worn are a frequent medium of contagion; it has been noticed that they have been sent for miles to people who were quite ignorant of the fact that they came from an infected place, and yet have communicated the contagion. Woollen clothes retain the infectious material much more than cotton, for the obvious reason that wool, from its structure, is much more likely to absorb the poison than cotton. Black clothing also retains the contagious material for a longer time than white; this fact is quite unexplained. It was first noticed at the military hospitals in Vienna, where it was found that when a soldier with a white uniform had recovered from an infectious disease, and was sent back to the barracks, fewer admissions into the hospital were made of his fellow-soldiers, suffering from the same disease, than when the patient's uniform had been of a dark colour.

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* Translated from "Exposé de la Situation de la Mécanique appliquée."

* Written by J. WICKHAM LEGG, M.D., and extracted from *The Student.*

The bed clothes and bedding, from the wool and hair which they contain, offer a large surface for the reception and retention of the contagious material. The carpets and curtains are frequently sources of contagion, because seldom disturbed. Drinking-water also conveys the infection; the emanations from the sick man, the water in which he has washed, &c., are too often thrown carelessly away, and unless properly disinfected, the contagious material may find its way into wells and cisterns, and thus spread the disease. Typhoid fever, which destroys on an average 10,000 people in the prime of life, every year in England, is almost solely propagated by the drinking water, as it is very slightly contagious to those who nurse or tend the sufferers. Dr. Snow, in his work "On the Mode of Communication of Cholera," has proved most conclusively that cholera is chiefly communicated by the drinking water, and but seldom through the ordinary means of infection. To conclude this subject, it must not be forgotten that each specific disease has its own specific germ. The poison of small-pox will not produce measles, but only small-pox; and an attack of small-pox offers no protection whatever against measles.

When the contagious matter meets with an individual in a condition favourable to the production of the disease (for, like the seed, the contagious matter must be placed in a fit soil before it can germinate), the individual thus attacked does not at once show symptoms of illness, nor indeed does he know that he is going to be ill, but there is always an interval, usually many days, between the reception of the poison, and the first feeling of malaise. This stage is called the *stage of incubation*, in which the disorder is latent within the patient; for there are no signs or symptoms by which it can be known that he retains within him the seeds of severe illness; he goes about his ordinary occupations, and feels quite in his usual health. This period of incubation varies in different illnesses; in small-pox and measles it is twelve or fourteen days; in scarlet fever it lasts from five to twelve days, never being less than five, or more than twelve, in duration. The knowledge of this fact may often be of practical use; if a child have been, by chance, to see another who has taken the measles or scarlet fever, the mother would know that all risk of the infection would be over in about a fortnight from the time of the visit. For this reason it is that travellers are detained so long a time in quarantine, lest any of them might be in the incubative stage of an epidemic.

The end of the stage of incubation is announced when the person begins to feel ill; what is called the *stage of invasion* has arrived, and this is the commencement of the illness properly so called; like the stage of incubation, this has a course of a certain number of days, varying in each disease. In scarlet fever the invasion-stage lasts only twenty-four hours, and is accompanied by feverishness and sore throat; in small-pox it lasts forty-eight hours, and there is also a great pain in the back, and the patient feels seriously ill. In measles this stage lasts three days, during which the child is feverish, and its eyes and nose pour out a fluid, which scalds the skin over which it flows. In whooping-cough, the stage of invasion lasts nearly a fortnight, during which time the child seems to have only an ordinary severe cough, without anything to announce its specific character. When the complaint is in the stage of invasion, no drug or medicine is known which has the least power to stop the illness from going on further into *the specific stage*, which, like the two preceding stages, has a sharply defined duration, beyond which it never lasts, and within which it never terminates, except by the death of the patient. The tendency of this stage is to end, after its specific duration, in the complete recovery of health. In no complaint is this better exemplified than in typhoid fever. Here the specific illness never lasts less than twenty-eight or more than thirty days; during this time the patient is feverish, with a temperature of the body often rising to 105° Fahr., and is delirious and entirely without appetite. If the patient only survive the twenty-eighth or thirtieth day, the fever and delirium go, the temperature of the body falls to the natural standard, 98° Fahr., and the appetite begins to return. This illustrates what was said about the power of curing disease, and the importance of an intimate acquaintance with its natural history. Here the physician is aware that he cannot cure, but at the same time he knows that if he can keep his patient alive over a certain day, the patient will recover; the only endeavour of the physician in this case is, then, simply to prolong life, to enable the patient to live over the critical day, and thus by simply endeavouring to *prolong* life, the physician often succeeds in *saving* life.

In this specific stage there are two symptoms, the specific process, and fever. In small-pox and measles, the specific process is the rash on the skin; in scarlatina, the rash on the skin, and the sore throat conjoined; while in diphtheria it is the sore throat alone, which is the specific process. This specific process is the essence of the whole disease, without which the disease could not exist, and the means by which the disease is propagated. The specific process itself is strictly local, never affecting all the tissues of the body generally, but limiting itself to one set of tissues, or to those analogous to it. Thus in small-pox, the local specific process is limited to the skin alone, except when it attacks, in grave cases, the mucous membrane, similar in structure to the skin, of the windpipe and air-tubes of the lungs. In diphtheria, the mucous membranes alone are involved, while in typhoid fever it is the adenoid tissue, which the spleen and some other organs largely contain, that is affected. Fever is a constant accompaniment of the local specific process; and by fever we simply mean that the temperature of the body, as measured by the thermometer, is greater than in health. The natural temperature of the body is 98° Fahr., but in fever it rises above this. The temperature of the body in health is maintained by a constant oxidation or burning of the tissues by the oxygen of the air, brought by the blood from the lungs. In fever, this process of combustion goes on more rapidly, and the tissues are burnt away at a higher rate, and thus an elevation of temperature is produced. A great increase in the products of combustion, which are eliminated from the system, takes place during the fever, or at its termination. This process of increased combustion readily explains the rapid emaciation which occurs in fevers. The great debility of the patient depends upon the exhaustion produced by the high temperature. According to Joule's law, every degree of increased temperature represents a certain amount of mechanical exertion. The Rev. Professor Haughton says: "The work due to animal heat would lift the body through a vertical height of eight miles per day; and it thus appears that an additional amount of work, equivalent to the body lifted through one mile per day, is spent in maintaining its temperature at fever heat. If you could place your fever patient at the bottom of a mine, twice the depth of the deepest mine in the duchy of Cornwall, and compel the wretched sufferer to climb its ladders into the open air, you would subject him to less torture from muscular exertion, than that which he undergoes at the hand of nature, as he lies before you, helpless, tossing, and delirious on his fever couch."

(*To be concluded next week.*)

WHAT IS ENERGY?*

Part III.

THE CONSERVATION OF ENERGY.

(*Concluded from page* 391).

It is well known that certain organisms of the animal world do not confine themselves to one state of being or to one order of existence, and the most familar instance of this roving habit is the caterpillar, which passes first into the chrysalis state, and after that into the butterfly. This habit is not, however, peculiar to the organic world; for energy delights in similar transmutations, and we have just seen how the eminently silent and invisible electrical current may occasionally be transmuted into the vivid, instantaneous, awe-inspiring flash of lightning. Nor is this element of change confined to our peculiar corner of the universe, but it extends itself to remote starry systems, in some of which there is a total extinction of luminosity for a while, to be succeeded by a most brilliant outburst, presenting all the appearance of a world on fire.

We shall not enter here into great detail regarding the various changes of energy from one form into another; suffice it to say that among all these changes of form, and sometimes of quality, the element of *quantity* remains the same. Those of our readers who are mathematicians know what is meant by variable quantities, for instance, in the equation $x+y+z=A$, if x, y, and z are variable and A constant, you may change x into y and into z, and y into x and into z, and in fact, perform any changes you choose upon the left hand side of your equation *provided that* you keep their sum always constant and equal to A. It is precisely thus in the world of energy; and the invariability of the sum of all the energies of the universe forms the doctrine known as the "conservation of energy." This doctrine is nothing else than an intelligent and scientific denial of the chimera of perpetual motion.

Recognizing the great importance of work, it was natural enough at an early stage of our knowledge that enthusiasts should endeavour to create energy or the power of doing work—that is to say, endeavour to construct a machine that should go on working for ever without needing to be supplied with fuel in any way—and accordingly, inventors became possessed with the idea that some elaborate system of machinery would, no doubt, give us this grand desideratum, and men of science have been continually annoyed with these projects, until in a moment of inspiration they conceived the doctrine of the conservation of energy.

It flows from this doctrine that a machine is merely an instrument which is supplied with energy in one form, and which converts it into another and more convenient form according to the law of the machine.

We shall now proceed to trace the progress of energy through some of its most important transformations. To begin with that one to which we have already alluded, What becomes of the energy of a falling body after it strikes the earth? This question may be varied in a great number of ways. We may ask, for instance, What becomes of the energy of a railway train when it is stopped? what becomes of the energy of a hammer after it has struck the anvil? of a cannon ball after it has struck the target? and so on.

In all these varieties we see that either percussion or friction is at work; thus it is friction that stops a railway train, and it is percussion that stops the motion of a falling stone or of a falling hammer, so that our question is in reality, what becomes of the energy of visible motion when it has been stopped by percussion or friction?

Rumford and Davy were the pioneers in replying to this important question. Rumford found that in the process of boring cannon the heat generated was sometimes so great as to boil water, and he supposed that work was changed into heat in the process of boring. Davy again melted two pieces of ice by causing them to rub against each other, and he likewise concluded that the work spent on this process had been converted into heat.

We see now why by hammering a coin on an anvil we can heat it very greatly, or why on a dark night the sparks are seen to fly out from the break-wheel which stops the motion of a railway train, or why by rubbing a metal button violently backwards and forwards against a piece of wood we can render it so hot as to scorch our hand, for in all these cases it is the energy of visible motion which is being converted into heat.

But although this was known nearly a century ago it was reserved for Joule, an English philosopher of the present day, to point out the numerical relation subsisting between that species of energy which we call visible motion and that which we call heat.

The result of his numerous and laborious experiments was, that if a pound of water be dropped from the height af 772ft. under the influence of gravity, and if the velocity which it attains be suddenly stopped and converted into heat, this heat will be sufficient to raise the whole mass 1° Fahr. in temperature.

From this he concluded that when a pound of water is heated 1° Fahr. in temperature, an amount of molecular energy enters into the water which is equivalent to 772 foot-pounds, that is to say, to 1lb. raised 772ft. high against the influence of gravity or allowed to fall 772ft. under the same influence.

He found again that if a pound of water were to fall twice this distance, or 1,544ft. under gravity, the velocity, if stopped, would raise its temperature 2° Fahr., and in fact that the rise of temperature under such circumstances is proportional to the height from which the pound of water is supposed to fall. By this means an exact relation is established between heat and work. Grove was the first to point out the probability of a connection between the various species of molecular energy; and the researches of Joule, Thomson, and others, have established these relations with numerical accuracy. No better example of the correlation of the various kinds of energy can be given than what takes place in a galvanic battery. Let us suppose zinc is the metal used. Here the source of energy is the burning or chemical combination of the zinc with oxygen, &c., in order to form a salt of zinc. The source of energy is in fact much the same as when coal is burned; it is the energy produced by chemical combination. Now, as we have said, the zinc combines with the oxygen a

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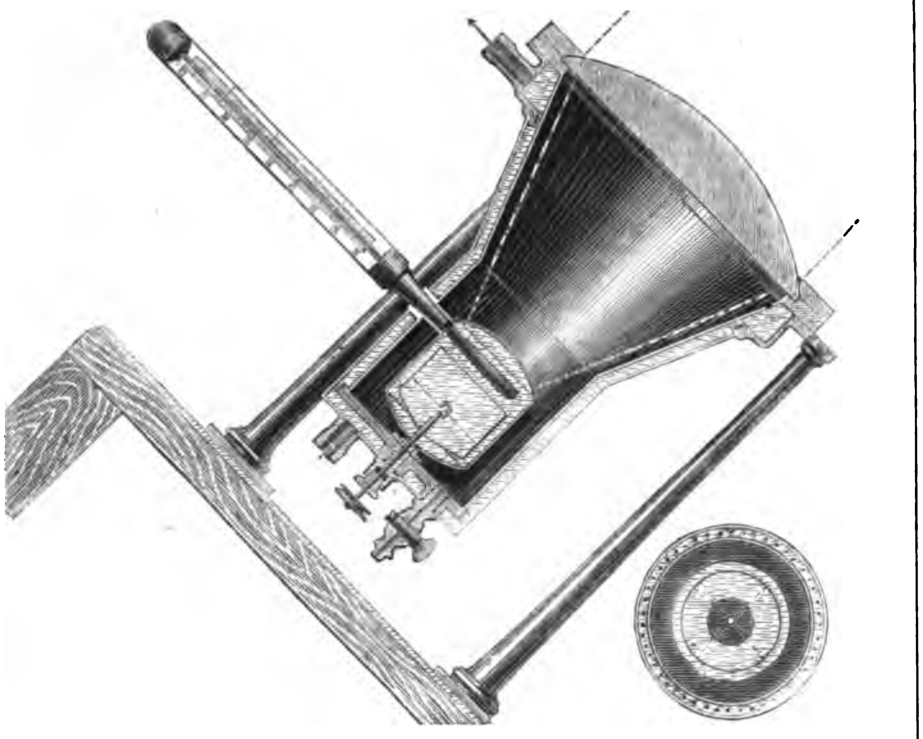
* By Balfour Stewart, in *Nature*.



THE SOLAR CALORIMETER.

sulphate of zinc is produced, but the result of this combination does not at first exhibit itself in the form of heat, but rather in the form of an electric current. No doubt a great portion of the energy of this electric current is ultimately spent in heat, but we may, if we choose, spend part in promoting chemical decomposition; for instance, we may, decompose water. In this case part of the energy of the battery, derived, as has been stated from the burning of the zinc, is spent in heat, and part in decomposing the water, and hence we shall have less heat than if there were no water to decompose. But if when we have decomposed the water, we mix together the two gases hydrogen and oxygen which are the results of this decomposition, and explode them, we shall recover the precise deficiency of heat. Without the decomposition, let us say that the burning in the battery of a certain weight of zinc gives us heat equal to 100, but with the decomposition only 80; twenty units of energy have therefore become spent in the decomposition, but if we explode the mixture of gases produced from the decomposition we shall get back heat equal to 20, and thus make the whole result of the burning of the zinc 100 units of energy as before.

In like manner, if our electric battery is made to do work, thus forming a kind of engine, we shall have the heat produced by the current diminished by the exact equivalent of the mechanical effect which we have obtained from this engine.

There is nothing for nothing in the universe of energy.

SOLAR HEAT.

By CAPTAIN JOHN ERICSSON.

IN a previous communication on this subject,* I adverted briefly to some experimental engines which I have constructed in order to ascertain the practicability of employing solar heat as a motive power. I also adverted to the imperfections of the methods adopted by certain physicists to determine the dynamic energy of the sun's radiant heat. Having in the mean time perfected the necessary instruments for measuring, with desirable precision, the dynamic force of solar heat under the varying conditions governed by the changes of altitude, seasons, atmospheric temperature, and the presence of aqueous particles in the air—elements of paramount importance in judging of the applicability of the sun's radiant heat as a motor—I intend to lay before the readers of *Engineering* a series of articles giving a brief account of my researches, to be accompanied by accurate illustrations of the instruments employed.

Apart from ascertaining the dynamic energy of solar radiation by accurately measuring the units of heat developed in a given time under the varying conditions adverted to, I have extended my labours to the determination of the true intensity of the sun's radiant heat. Accordingly, I have instituted a series of observations which enable me to estimate the loss of intensity during the passage of the rays through the atmosphere. By adding this to the ascertained intensity of the radiant heat on reaching the surface of the earth, and before it is affected by terrestrial radiation, I can determine the actual intensity at the point where the rays enter the earth's atmosphere. My attention was originally called to the important subject of actual intensity of solar radiation by reflecting on the limited amount of dynamic energy, about five units of heat per minute upon an area of 142 square inches, exposed perpendicularly to the sun's rays, while the thermometer idicated 150° above Fahrenheit's zero, or 610° above absolute zero. Preliminary experiments, conducted very carefully, having disclosed the startling fact that the real intensity of solar radiation marks a point on the thermometric scale several hundred degrees below the freezing point of water, I resorted to the expedient of concentrating the sun's rays by such a method that the degree of concentration could be accurately measured. Investigations, conducted in conformity with this method of determining the true intensity of the radiant heat, proved the temperature to be nearly identical with that shown by the preliminary experiments referred to. The extraordinary fact was accordingly established, that the intensity of the sun's rays before gaining by terrestrial radiation, is so feeble that fluid mercury contained in an exhausted shallow vessel covered with a thin lens of about 50in. focus, and exposed to the full power of a clear sun, will very rapidly become solid, provided the vessel is prevented from receiving heat from surrounding substances. It matters little whether the molecular action within the mass of mercury necessary to keep it in a fluid state is checked by the slower undulations of the solar ray, as waves of a rapid motion are checked by mingling with waves of less motion; or whether the molecular action within the mass of mercury is communicated to the surrounding cold vessel. In either case the reduced molecular force within the freezing mercury proves the inadequacy of the action produced by the sun's rays to maintain the metal in a fluid state.

Incidentally the experiments thus instituted to demonstrate the feeble power of solar radiation before its intensity is augmented by the intervention of the earth's atmosphere have established the fact that the surface of the moon, being devoid of any gaseous envelope, is at all times, even under the vertical sun of the long lunar day, intensely cold. This apparently irrelevant subject will be considered hereafter. In the mean time, illustrations and descriptions will be presented of the instruments by means of which it has been satisfactorily demonstrated that before the temperature is augmented by the accumulation of heat which results from terrestrial radiation and the presence of the atmosphere, the sun's radiant heat, as before stated, marks a point on the thermometric scale several hundred degrees below the freezing point of water.

Before entering on a description of the accompanying illustration of my solar calorimeter (a denomination adopted in preference to "actinometer," as its object is only that of measuring the amount of heat transferred from the sun to the earth), I deem it proper to say that I object to the inferences which Pouillet, Mayer, and others have drawn from our knowledge of the dynamic force of solar radiation on a given surface of the earth. Unquestionably the amount of heat transferred from the sun to the earth may be accurately computed by means of the solar calorimeter; but to infer from the point thus established that the sun parts with as great an amount of heat in *all* directions on an equal area as that which the earth during its orbital motion receives by intercepting and successively arresting the solar wave is a mere gratituous assumption. The practical mind refuses to accept a theory which involves such a vast disproportion between the means and the end, as the assumption that 200,000,000 times more heat is wasted than that which is employed to animate the planetary worlds of our system, more especially as the improbable and extravagant. not to say absurd, speculations which have been put forth by Mayer, Helmholtz, and others, all fail to suggest any mode of supplying the assumed enormous waste which does not point to a speedy extinction of the central force. I will return to this subject on a future occasion, when the consideration of the new motor, the solar engine, will be in order.

M. Pouillet's pyrheliometer being now generally known through Professor Tyndall's work on "Heat as a Mode of Motion," the imperfections of that instrument may be pointed out without minutely describing the method adopted by the French physicist in determining the amount of dynamic force which the earth receives from the sun in a given time. The radical defect of Pouillet's instrument is, that it cannot be used during winter when the thermometer is below the freezing point, as warm water would have to be used, in which case the loss of heat by radiation and convection would be so great as to render the task futile of accurately measuring the force of solar radiation. This defect of Pouillet's method is the more serious as the heat of the sun is most intense during the winter solstice for given zenith distances, not only on account of the diminished distance between the sun and the earth, but owing to the fact *that the sky is clearer* during a cold winter's day *than during the heat of* summer when the air *is charged with vapour*.

The loss of heat by radiation, in the *pyrheliometer*—loss of heat by convection, *accelerated by* currents of air—the absence of adequate means for circulating the fluid contained within the heater—the rude method of keeping the instrument perpendicular to the sun by hand—not to mention the disturbing influence of respiration and the radiation from the operator's body—are self-evident defects. Nor can we pass unnoticed the want of any direct means of ascertaining the depth of the atmosphere through which the radiant heat passes at the moment of measuring its energy. I need scarcely point out that computations based on *latitude*, *date*, and *exact time*, are too complex and tedious for investigations in which the principal element, the depth of the atmosphere, is continually changing.

It will be well to state at the outset that the solar calorimeter, and all my instruments constructed for investigating the mechanical properties of solar heat, are attached to a table which swings upon a horizontal axle, and which rotates round a vertical pivot, appropriate mechanism being applied for regulating the combined vertical and lateral movement in such a manner that the top of the table, composed of a heavy brass plate accurately faced, is at all times during observations kept perpendicular to the central ray of the sun. Hence, instruments, whose base is at right angles to their vertical axis, may be secured at any point of the face of the rotating table without further adjustment. A graduated arc is attached to one end of this table, provided with an immovable index; consequently, the sun's zenith distance may at all times be ascertained by a mere inspection, a very great convenience in an investigation which at every instant is dependent on the changing depth of the atmosphere through which the sun's rays pass. As this depth bears a fixed relation to the sun's zenith distance, it may of course be accurately determined by noting the position of the fixed index on the graduated arc; but as there is no time during investigations of this kind for computations, as already pointed out, I have constructed a graduated scale provided with a movable radial index, which, by being brought to the division corresponding with the observed zenith distance, shows the depth of atmosphere. It is proper to observe that in constructing this scale I have assumed the earth to be a perfect sphere of 3,956 miles radius. The error resulting from this assumption is, however, so trifling, that the described graphic method of ascertaining the depth of the atmosphere may, without appreciable discrepancy, be employed in all latitudes. The *solar calorimeter* consists of a double vessel, cylindrical at the bottom, and conical at the top, an 8in. lens being inserted at the wide end in the manner shown by the illustration above. The interior is lined throughout with burnished silver, and the space between the two vessels is closed at the top and bottom by means of perforated rings, as shown in the transverse section, the object being to distribute equally a current of water to be passed through the space between the vessels. Nozzles are applied at the top and bottom of the external vessel of suitable form to admit of small hoses being attached. A stop-cock with coupling joint is applied at the bottom, communicating

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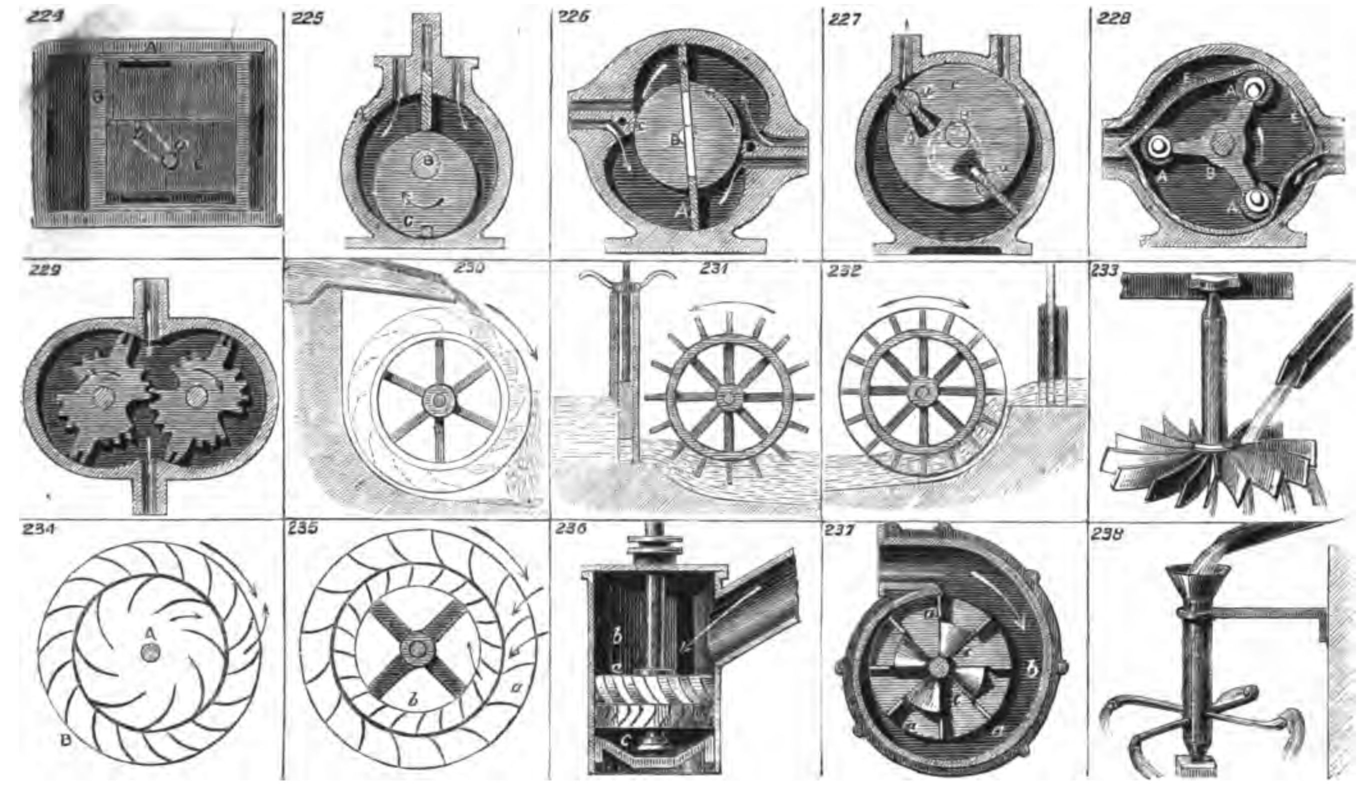
* See *Engineering*, vol. vi., p. 468.



MECHANICAL MOVEMENTS.

with the interior of the calorimeter, and connected with an air pump for exhausting the same. A cylindrical vessel, termed heater, with curved top and bottom, composed of polished silver, is secured in the lower part of the instrument, and provided with a conical muzzle at the top, through which a thermometer is inserted from without. Within the lower part of the heater is introduced a centrifugal paddle wheel, surrounded by a cylindrical casing divided in two compartments by a circular diaphragm, the lower compartment containing four radial wings or paddles, the diaphragm being perforated in the centre. The centrifugal paddle wheel revolves on an axle which passes through a stuffing box applied at the bottom of the double vessel, the rotary motion being imparted by means of a pulley secured to the lower end of the axle. The operation of this wheel, intended to promote perfect circulation of the fluid within the heater, is quite peculiar. It will be readily understood that by turning the wheel the centrifugal action of the fluid produced by the rotation of the paddles will draw in water downwards through the central perforation of the diaphragm, and force the same into the annular space round the casing of the wheel; thus an upward current will be kept up through this annular space uniform on all sides. This current, after reaching the top of the heater, will then return, first entering the open end of the casing of the wheel, and ultimately the central perforation of diaphragm. I have been thus particular in describing this system of promoting uniform circulation within the heater because a proper proportion of the actual mean temperature of the water contained in the same is the all important condition on which depends the accuracy of the determination of the number of units of heat developed. It only remains to be pointed out that the lens, which is so proportioned as to admit a sun beam of 52 square inches of section, is placed at such a distance from the heater that when the concentrated rays reach the upper end (painted with lamp-black) they are confined to an area of 3·25 square inches, precisely 1-16th of the sectional area of the sunbeam which enters the lens.

It will be obvious that the concentration of the radiant heat on an area of only one-sixteenth of that of the section of the sunbeam, removes a very difficult disturbing element from the investigation—viz., the great amount of heat radiated by the blackened surface of the heater, which, in the pyrheliometer, is sixteen times greater than in the solar calorimeter. But this is not all, while the sixteen times more extensive blackened surface of the former is exposed to currents of air, the disturbing effects of which can neither be controlled nor computed, error arising from convection is wholly removed from the latter, because the reduced blackened surface of the heater receives the concentrated radiant heat within a vacuum. The loss of heat at the bottom and sides of Pouillet's instrument, caused by convection and currents of air, is likewise wholly removed in the solar calorimeter by the expedient of operating within a vacuum. It will be seen, therefore, that the loss of heat by convection and currents of air has been wholly obviated in the solar calorimeter, while the loss caused by radiation from the blackened surface of the heater has been reduced to a mere fraction. It may be contended, however, that the loss by radiation of the polished heater against the interior polished surface of the calorimeter, although minute, is yet appreciable; and that some heat will be lost by conduction at the points where the heater joins the external vessel. Even these trifling sources of error, it will be seen presently, have been removed by the new method. A force pump and capacious cistern containing water are arranged near the calorimeter, a uniform temperature of 60° being kept in this cistern by the usual means of a warm and cold water supply. By appropriate hose and the force pump mentioned, a constant current is kept up through the space between the internal and external casings of the instrument; hence, every part of the latter may be brought to a uniform temperature of 60° in a few minutes. The process of measuring the solar energy is conducted in the following manner: The thermometer being withdrawn, the heater is charged with distilled water of a temperature of about 45°, after which the thermometer is again inserted. The table supporting the instruments should now be turned towards the sun and the paddle wheel put in motion. The indication of the thermometer must then be watched, and the time accurately noted when the mercurial column marks 50° on the scale, the observation continuing until the thermometer marks 70°, at which point the time is again accurately noted. The experiment being then concluded, the table should be turned away from the sun. It scarcely needs explanation, that during the elevation of the temperature of the water from 50° to 60° the instrument radiates *towards the heater*, and that while the temperature rises from 60° to 70°, the heater radiates *towards the instrument*. In each case the amount of heat radiated, that is, the gain and the loss, is almost inappreciable, since both the heater and the surrounding internal vessel are composed of polished silver. The amount of gain and loss of heat by *conduction* at the points where the heater joins the surrounding vessel, if appreciable, evidently balance each other in the same manner as the gain and loss by radiation.

The weight of distilled water at 60° contained in the heater, and the weight and specific heat of the materials which compose its parts, being ascertained, the number of units of heat necessary to elevate the whole 20° may be readily calculated. To this must be added the percentage of calorific energy lost during the passage of the sun's rays through the lens. The sun will represent a permanent coefficient for each particular instrument which may ever afterwards be employed to determine the dynamic energy of the sun's radiant heat. Obviously the indication will be equally correct during the winter solstice in a northern latitude with the mercurial column at zero as during the summer solstice within the tropics, when the thermometer marks 100° in the shade.

It must not be supposed that the same difficulty presents itself in ascertaining the loss of calorific energy of the rays of heat as that involved in a determination of the retardation which rays of light suffer during their passage through a lens. In order to determine the former we have only to compare the units of heat developed by the direct action of a sunbeam of a given section, with the number of units developed by another sunbeam of equal section during an equal interval and at the same time, acting through the lens, the retarding influence of which we desire to ascertain. I have constructed an instrument for this purpose by means of which the diminution of the calorific energy of the sun's radiant heat can be accurately measured for all lenses not exceeding 8¼in. diameter. This instrument will be delineated and explained at the proper time.

Referring to the experiments which have been made with the solar calorimeter, it is specially worthy of notice that the sun's energy, as shown by this unerring mode of measuring the force actually transferred to the surface of the earth, is never regular. The force of the radiant heat (call it molecular action) indicated by the increment of the temperature of the fluid in the heater of the instrument, is continually oscillating. At first I attributed this circumstance to invisible masses of light vapour passing through the atmosphere. More recent observations induce me to think that want of constancy in the evolution of the heat at the source may possibly be the true cause.—*Engineering.*

New York, June 21.

MECHANICAL MOVEMENTS.

(Continued from page 392.)

224. Root's double-reciprocating or square piston engine. The "cylinder," A, of this engine is of oblong square form and contains two pistons, B and C, the former working horizontally, and the latter working vertically within it; the piston, C, is connected with the wrist, *a*, of the crank on the main shaft, *b*. The ports for the admission of steam are shown black. The two pistons produce the rotation of the crank without dead points.

225. One of the many forms of rotary engine. A is the cylinder, having the shaft, B, passing centrally through it. The piston, C, is simply an excentric fast on the shaft and working in contact with the cylinder at one point. The induction and eduction of steam take place as indicated by arrows, and the pressure of the steam on one side of the piston produces its rotation and that of the shaft. The sliding abutment, D, between the induction and eduction ports moves out of the way of the piston to let it pass.

226. Another form of rotary engine, in which there are two stationary abutments, D, D, within the cylinder, and the two pistons, A, A, in order to enable them to pass the abutments, are made to slide radially in grooves in the hub, C, of the main shaft, B. The steam acts on both pistons at once,

to produce the rotation of the hub and shaft. The induction and eduction are indicated by arrows.

227. Another rotary engine, in which the shaft, B, works in fixed bearings excentric to the cylinder. The pistons, A, A, are fitted to slide in and out from grooves in the hub, C, which is concentric with the shaft, but they are always radial to the cylinder, being kept so by rings (shown dotted) fitting to hubs on the cylinder-heads. The pistons slide through rolling packings, *a*, *a*, in the hub, C.

228. The india-rubber rotary engine, in which the cylinder has a flexible lining, E, of india-rubber, and rollers, A, A, are substituted for pistons, said rollers being attached to arms radiating from the main shaft, B. The steam acting between the india-rubber and the surrounding rigid portion of the cylinder presses the india-rubber against the rollers, and causes them to revolve around the cylinder and turn the shaft.

229. Holly's patent double-elliptical rotary engine. The two elliptical pistons geared together are operated upon by the steam entering between them, in such manner as to produce their rotary motion in opposite directions.

These rotary engines can all be converted into pumps.

230. Overshot water-wheel.

231. Undershot water-wheel.

232. Breast-wheel. This holds an intermediate place between overshot and undershot wheels; has float-boards like the former, but the cavities between are converted into buckets by moving in a channel adapted to circumference and width, and into which water enters nearly at the level of axle.

233. Horizontal overshot water-wheel.

234. A plan view of the Fourneyron turbine water-wheel. In the centre are a number of fixed curved "shutes" or guides, A, which direct the water against the buckets of the outer wheel, B, which revolves, and the water discharges at the circumference.

235. Warren's central discharge turbine, plan view. The guides, *a*, are outside, and the wheel, *b*, revolves within them, discharging the water at the centre.

236. Jonval turbine. The "shutes" are arranged on the outside of a drum, radial to a common centre and stationary within the trunk or casing, *b*. The wheel, *c*, is made in nearly the same way; the buckets exceed in number those of the shutes, and are set at a slight tangent instead of radially, and the curve generally used is that of the cycloid or parabola.

237. Volute wheel, having radial vanes, *a*, against which the water impinges and carries the wheel around. The scroll or volute casing, *b*, confines the water in such a manner that it acts against the vanes all around the wheel. By the addition of the inclined buckets, *c*, *c*, at the bottom, the water is made to act with additional force as it escapes through the openings of said buckets.

238. Barker's or reaction mill. Rotary motion of central hollow shaft is obtained by the reaction of the water escaping at the ends of its arms, the rotation being in a direction the reverse of the escape.

TELESCOPIC WORK FOR MOONLIGHT EVENINGS.*

AN interesting lunar region, that has been very inadequately described, is found on the northern hemisphere of the Moon, between the well-known spot Plato and the lowest edge or limb of the Moon as seen in an inverting telescope. This region, which is situated between the craters Fontenelle, Timæus, and Epigenes, of Beer and Mädler, comes into sunlight about and just after the first quarter. Beer and Mädler speak of it as calculated to "throw the observer into the highest astonishment," and certainly as the Sun rises upon it and illuminates one after another the ridges of mountains which compose it, it is a magnificent spectacle. The three leading objects, the craters above-named, which may easily be found by means of Webb's index map in his "Celestial Objects for Common Telescopes," are the three angular points of the region. It is naturally divided into two distinct areas, and is bounded on the south by the Mare Frigoris. The western division consists of very rugged land, the principal feature being a bold promontory, more or less cleft, which stretches into the Mare Frigoris towards Plato. Between the rugged land on the west, and a very individualized depressed surface on the east, a sinuous mountain-chain extends from the promontory above-named to the fine bold eastern portion of the rim of Epigenes. This crater is an interesting instance of a feature by no means uncommon on the Moon, viz., portions of walled plains occuring in extensive lines of cliffs or mountains. In many instances the cliffs are interrupted or broken, so as to form extensive bays on the surfaces of the plains and bold promontories at the points of their inosculation. The west border of Epigenes forms a portion of another range, west of and nearly parallel with the before-mentioned chain of mountains. The western range rises to a considerable altitude on the west border of Epigenes, and is continued to a high mountain at the west end of a fine walled plain just west of the crater Anaxagoras. This plain is surrounded by high mountains, and is by far the grandest and most imposing object in this lunar landscape. It remained unnamed until the late Dr. Lee suggested the designation "Goldschmidt" as suitable for it. The eastern division of this region—which, as before stated, consists of a depressed surface—is not much raised above the surface of the Mare Frigoris on the south. The N.E. boundary forms a separation between two levels, as if a "fault" had occured in the line between Fontenelle and Epigenes. The lower level, which has upon it two short mountain arms stretching outwards from the N.E. boundary of the depressed surface, extends towards Anaxagoras, and is generally smooth. There is in its neighbourhood a well-marked crater forming a triangle with the N.E. angle of the depressed surface east of the rugged land and Fontenelle. Between this crater and Fontenelle an imperfect elliptical depression exists, and another may be noticed to the N.E. of this. Between the craters Timæus, Fontenelle and Anaxagoras, the observer will find three very distinctly marked and individualized formations, viz., the rugged land west of the mountain chain passing through the east border of Epigenes; the depressed surface on the east of the same mountain chain (the interior of this depressed surface contains several interesting objects); the third formation is the depressed surface extending towards Anaxagoras. To trace out these features, to observe during the progress of the illumination of the northern parts of the Moon's disc the changes in aspect which they undergo as the Sun rises higher above them, and as that hitherto unexplained and mysterious metamorphosis, which so gradually creeps over the surface, obliterating some objects and bringing out others not seen before, passes through its various phases, together with the gradual streaking of the landscape with the rays from Anaxagoras, form a pleasing and instructive occupation with the telescope while the Moon is passing from her first quarter to full; and to those students who prolong their watchings to "early dawn" the formations seen under the reverse light are full of interest.

CONSTRUCTIVE HOROLOGY.*

THERE is probably no branch of mechanical science which has of late years received so comparatively small a share of study or made so little progress in this country as horology.

To advocate the sudden adoption of such reforms as would to any great extent alter the character of the article produced, or revolutionize the present system of hand-finishing by the piece, would not be wise, but without going to this length there is room for vast improvement and much economy to be effected in the manufacture. At present every movement maker uses a different gauge (which he does not understand), and adopts a different calliper, based on his individual experience, the result of which is that there will be nearly as much difference in the same nominal sizes of two different makers as there is supposed to be difference between two consecutive sizes of watch movements. We say advisedly "supposed" difference, because the actual difference is not even established, and is as variable as the gauges generally made use of, which have an unmarked and undefined space of varied length, and give a result which cannot be definitely expressed by any known scale of measurement. The approximate difference, however, between the diameter of consecutive sizes of watch frames of the same make will be found to be ·07, or about the fourteenth part of an inch, which difference is so small that the various sizes of movements in finished watches are not readily determinable, and a greater multiplicity of sizes is created than there is any necessity for. In comparison with the Swiss system we have within the same range six sizes to their five, their sizes being regulated by the diameter of the dials in French lines, but even this division we hold to be somewhat smaller than it might be. It would quite suffice if the difference were established as the tenth of an inch in the diameter of the dials between each size, the diameter of the top and pillar plates, and all the other parts of the movement, being proportioned thereto by a gauge divided to the tenth and hundredth part of an imperial inch. This division would give us five sizes of watch movement instead of seven, now commonly made. Fixed diameters should also be determined for the balances, wheels, barrel, &c., and every flat movement of the same size should have the same height of pillar with its plates of the same thickness and hollows sunk the same depth, which will enable the manufacture to get the wheels, &c., pivoted to the gauges, thereby creating another important division in the work The calliper of every movement of the same size should also be the same size throughout, and all sizes should be of a calliper similarly proportioned to the fixed diameter of their dials. The exact radius of every wheel, barrel, and staff hole, also the position of every screw, stud, dial-foot, &c., and the outline of every bar and cock should be defined, which would, if generally adopted, admit of every separate part of the complete watch being a ready-made finished article, including balances, cases, dials, caps, and all other parts that have now to be made and fitted specially to each movement. It need scarcely be asked whether the general adoption by the trade of such a system would not at once and the same time make the trade less fluctuating, promote a more complete division of the labour, cheapen the cost of production, yet enable the workman to increase his earnings, produce greater uniformity in the style and finish of the work, and expedite the manufacturing process very considerably.

Having now at some length set forth what we consider should be done, it may be required that we should indicate the means whereby the general adoption of such a system might be brought about, and the details fully considered and determined upon.

The first step to be taken would be to fix upon the measure which shall determine the scale of sizes, the choice of which lies between—firstly, the French mètre, or millimètre, two of which are equivalent to ·078 of an inch, nearly; secondly, the French line, equivalent to ·089 of an inch, nearly; and thirdly, the 10th of an inch, to which latter measurement we have given the preference because it is English, and therefore a proper standard for the measurement of English watchwork. This gives a dial 1·5 or 1½in. in diameter, being proportionate for a full 8-size movement; the next size with dial 1·6in. in diameter, the movement proportionate to which would be equivalent to an 11-size movement; next size with dial 1·7in. in diameter, proportionate to 14-size movement; next size with dial 1·8in. in diameter, proportionate to 17-size movement; next size, with dial 1·9in. in diameter, proportionate to 20-size movement; which, within the range from eight to twenty, gives five sizes of movement, in place of the seven sizes usually made and expressed as 8, 10, 12, 14, 16, 18, and 20 sizes respectively, but 8, 10, 12, &c., what, no one can *tell*. *For larger or smaller* sizes the same scale *would be maintained; and that* the difference in size that *would be established* by the universal adoption of this scale of measurement would suffice for all requirements of the trade, may be adduced from the fact that Messrs. John Ryley & Co., of Coventry, have for the last three years successfully put the system in practice, having had all their movements made to plates giving the calliper exactly proportioned throughout to the sizes of dials indicated above, and their experience has proved it of immense advantage in reducing the manufacturing process to an easy working system, and ensuring uniformity not attainable by any other means, the system being adopted not only for the improved full-plate movements, but also for all the patent ½-plate centre-seconds and ¾-plate movements made and finished by them.

THE MICROSCOPE.*—CHOICE OF A MICROSCOPE.

MEDICAL and other students are at this time of the year purchasing a microscope with which to begin the investigation of animal and vegetable structures. Others who would wish to invest in an instrument are deterred by the expense on the one hand and by the fear of obtaining a worthless thing on the other. Too strong a protest cannot be made against the notions prevalent with regard to microscopes, and encouraged by most of the makers in this country. The handsome-looking instrument of great size, with its long tube and innumerable wheels, is not to be recommended to the would-be observer, even should he feel justified in the expenditure. The microscopes which are used in most of the German laboratories, where so much thorough work is done (to the writer's knowledge in Prof. Stricker's and Prof. Rokitansky's laboratories at Vienna, in Prof. Schweigger Seidel's at Leipzig, and in Prof. Claude Bernard's at Paris), are the little instruments of Hartnack, which do not stand above 10in. high, with a simple but large stage without any movement, no rackwork to the tube, but a sliding motion and a fine adjustment. The instrument is used in the vertical position with complete comfort, and when liquid is on the stage, this position being necessary, it is of considerable advantage to have a small microscope over which one can easily bend the head. Large microscopes, with their complicated machinery, are made to suit the optician who sells them, and not for the convenience of the observer. Those who wish to get a microscope should insist either on having one of these small and handy instruments made, or order one from M. Verick or M. Hartnack in Paris. Such a body having been purchased at a very minimum of cost, a larger sum may be expended on the really essential part of the apparatus—namely, the lenses. And here it will be found of great advantage to have the tube of the microscope not more than three and a half or four inches in length, for then the objectives of the continental makers can be used with the greatest advantage, though, with proper care as to the ocular or eye-piece, they may be used on our ordinary long-tubed awkward English microscope. It is almost incredible that the English makers of object-glasses continue to demand three, or even four, times the price for their lenses which foreign makers do for lenses in every respect as good. For two pounds an object-glass may be obtained of M. Verick or M. Hartnack, of Paris, No. 8, which is quite as good a glass and in some respects more pleasant to use than the one-eighth, for which English opticians demand eight guineas. Many persons anxious to work with the microscope are deterred by the price of really first-rate instruments in this country. What we urge upon them most earnestly is to purchase such a body with eye-piece as that described above—simple but strong and steady—for between two and three pounds, and to equip the instrument with the objectives of MM. Verick or Hartnack, say No. 2, No. 5, and No. 8, which can be obtained for another four pounds. We shall have occasion again to speak of the merits of English and foreign objectives, especially of the immersion object-glasses. At present we speak from personal experience, and desire to point out the convenience and cheapness of the small microscope-body, and the thorough excellence and immensely diminished cost of the French makers' object-glasses.

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* By W. R. Birt, F.R.A.S., in the *Student*.

* By Borthwick Smith, in *Horological Journal*.

* From *Nature*.

Cutting Sections of Tissues.—The method of "embedding," first practised by Stricker and Klebs, is now extensively used in Germany, and is of very great assistance to the practical histologist. It consists simply in surrounding the object from which sections are desired, with either paraffin, stearine, or a mixture of wax and oil. This latter is preferred at Vienna by Prof. Stricker and Dr. Klein, his assistant, and can be obtained of the exact consistency which may be desired; usually equal parts are to be used. A little tray of paper is made, and some of the wax composition in a melted state is poured in. The object to be cut is then placed in the tray, and more composition added, till the object is thoroughly enclosed. When hard, sections of the mass can be cut, the advantage being, in the case of thin laminæ or processes, that a complete support is offered by the surrounding composition, and a uniformly thin cutting may be obtained. For some purposes the microtome of Dr. Ranvier, of Paris, is very useful; it is similar to one recently brought out by Mr. Stirling, of the Anatomical Museum, Edinburgh. In this little instrument we have a flat piece of brass with a hole in the centre, leading into a cylindrical chamber, at the bottom of which a screw works. A piece of elder-pith is excavated, so as to hold the tissue to be cut; and when this has been well fixed in it, the pith is squeezed into the cylindrical box through the hole in the brass plate. A razor drawn along the surface of the brass plate cuts through the pith and the tissue it embraces, leaving a surface perfectly smooth and continuous with that of the plate. A turn of the screw, which works into the cylindrical box, now causes a certain very small thickness of the pith and tissue to project above the plate, and the razor again drawn across and pressed on to the surface of the brass plate, cuts a fine section, the exact thickness of which may be nicely regulated by the screw which pushes up the pith. This little instrument may be obtained at a small cost from M. Verick, 2, Rue de la Parcheminerie, Rue St. Jacques, Paris. It is not unlike an instrument described in English books on the microscope for cutting sections of wood, but its application with the use of pith, previously much in use for making sandwiches with delicate tissues which had to be cut, increases its value greatly. As to knives to be used in making sections, though some large knives are made on purpose, there is nothing better than a first-rate broad-bladed razor. Dr. Meynert has cut his immense collection of brain preparations with a common razor.

Staining and Mounting Tissues.—The method which is now very extensively used in German histological laboratories for the study and preservation of all kinds of delicate tissues, such as sections of the developing hen's egg morbid growths, fine injections, nerve tissues, &c., is as follows:—The section, either from a fresh specimen or from one preserved in alcohol, is placed in a solution of carmine in ammonia, from which all excess of ammonia has been allowed to evaporate, as tested by the smell. The solution is also carefully filtered before use, and diluted to a small extent. After from three to ten minutes or more in the carmine solution, the section is placed in distilled water and thoroughly washed for some time by blowing into the water with a small pipette. From this the section is removed momentarily to a watchglass containing distilled water and two drops of acetic acid, and then is placed in absolute alcohol. The water is thus removed, and in five or ten minutes the section may be placed in oil of cloves, which renders it very transparent. From this it is removed to the glass slip, and is mounted in a solution of gum damara in turpentine, such as is sold by artists' colourmen. At any stage in this process we can proceed back again by the same steps, ammonia being used in place of acetic acid, and re-stain, re-wash, or re-acidify as the case may be. If the staining is carefully managed and the subsequent washing a thorough one, most cellular structures are very beautifully and clearly brought out. Where rapidity is desired, and for the purpose of inspecting a specimen, it may be simply mounted in glycerine after the staining. The process above described is that of Gerlach and Stieda, and is preferred to any other by some observers of great experience. Thus Dr. Meynert, of the lunatic asylum at Vienna, who is throughout Germany regarded as the great authority on the histology of the brain, uses this method for mounting his sections of cerebrum, cerebellum, &c. It is very convenient to have little glass dishes with covers for each of the above-mentioned re-agents, so that the sections may be passed from one to the other and left covered up, if desired, for a day or two—the waste of re-agents involved in filling watch-glasses each time they are required being also avoided. If preparations have been preserved in chromic acid, they must be very well washed before staining, and very often cannot be made to stain well at all. Various methods are useful in various cases, but, as one of great general use, the carmine staining and oil of cloves clearing may be strongly recommended. Staining tissues with nitrate of silver, chloride of gold, and with bile-pigment are most important aids to the histologist, the merits of which have been recently much discussed, and of which we shall have a word to say from experience.

Glycerine Jelly.—This composition, which has been lately introduced, melts at a lower temperature than Deane's medium, and has a greater clearing action on the objects mounted in it. A small piece of the jelly put on a glass slip and warmed, soon liquefies, and is ready to receive any object, after which the cover is directly applied. For objects which do not require any great amount of "clearing," it is a most useful medium. Insects, worms, small crustacea, &c., may be mounted in this way excellently.

E. RAY LANKESTER.

SCIENTIFIC SOCIETIES.

THE OBSERVING ASTRONOMICAL SOCIETY.

HON. SEC—WILLIAM F. DENNING, Ashley-road, Bristol.

Report of observations made by the members during the period from May 7 to July 6, 1870, inclusive.

SOLAR PHENOMENA.—Mr. John Birmingham, of Tuam, writes:—"A remarkable obscuration of the sun was observed here on May 22. It lasted from sunrise to sunset, with a short interval in the afternoon of returning brightness. The sun was of a beautiful pink colour, though there was no fog whatever, and its light was so reduced as to permit a long observation of it through the telescope, without the aid of a dark glass. I am informed that the same phenomenon was noticed in the South of England on the next day (the 23rd), and on that day also, but late in the afternoon, it was observed at Rohrbach (Moselle), and described by M. Hamat in a letter to the Scientific Association; so that the cause of the obscuration, whatever it was, seems to have been moving eastward and southward." Mr. T. W. Backhouse, of Sunderland, reports that in May "there was a remarkable case of a solar spot making a revolution round another. It occurred with respect to the two largest spots of a group that was half away across the northern zone, on May 9. The smaller spot was south of the larger, on the 7th, at 8h., but preceded it on the 12th, at 21h., the line joining the two spots having rotated through an angle of 80° or 90° in 5¾ days. This movement continued to the 15th, but this would be partly apparent, owing to the group approaching the limb. By that time the larger spot was reduced to the size of the other. I cannot say whether the motion was a curved or a straight line, though it was probably the former; nor can I say which of the spots moved, or whether both did. They were about 22,000 miles apart on the 9th, at 3h., but on the 13th, at 20h., they were 32,000 miles apart. One spot must therefore have moved, relatively to the other, about 34,000 miles, in 4¾ days, or at the rate of 300 miles per hour." "Mr. T. G. E. Elger, of Bedford, says:—"The sun spots observed during June were, with the exception of one group, small and devoid of interest when compared with those seen in April and May. The largest spots were confined to the sun's northern hemisphere. Between the 8th and 15th the spots were all small; on the latter date there were only two groups on the disc, and these were insignificant. On the 19th a very remarkable spot was observed, it formed the *preceding* member of a large scattered group 2′ 52″ in length; its penumbra measured about 1′ 10″ in greatest diameter. At 10 a.m., an isolated mass of light, intensely bright, was remarked on the nucleus; this at 2 p.m. formed a "bridge" connecting adjacent sides of the umbra. The nucleus of this spot was very uneven in colour. At 5h. 15m. p.m., on the 19th, the *central* portion was noted as brown and the *border* as black, and on subsequent dates the variety of tint was still more marked. At 7 a.m., on the 21st., when the penumbra showed evident signs of cyclonic action, not more than half the area of the nucleus was black, the remainder was made up of patches of various shades of brown. The group disappeared at the limb on the 27th." The Rev. S. J. Johnson, of Crediton, observed numerous spots on the sun on May 13th. There were then four groups with penumbræ close together. W. H. Michel Whitley, of Penarth, says:—"June 21, I noted on the sun's disc one very large, round, and well-defined spot; on one side, however, the penumbra was invaded by two tongues of faculæ for a short distance, and in the centre of the umbra was a bright patch."

THE PLANET SATURN.—Mr. H. Michell Whitley repeatedly observed this object with his 6¼in. reflector. He says:—"June 21.—Air very unsteady, but after midnight better.—*The Ball:* Duller yellow than rings; equatorial zone yellow; north of this a pale red belt, and another further north again towards pole, much fainter, and about midway. Pole of planet bluish grey, edges of ball slightly shaded; no other spots or markings.—*Ring A:* Inferior in brightness to B; colour pale yellow; no subdivisions or markings on it.—*Ball's division:* Traced all round; widest and darkest, if at all, in W. Ansa; sharply defined in colour, it was not so black as the sky, but deeper than the crape ring across the ball; colour dusky.—*Ring B:* This ring was very bright for a short distance from its outer edge, which was very sharply defined; colour gradually deepens and light fades towards inner edge; outer edge lemon yellow; duller and deeper inwards; strongly suspected to be shaded, but no actual subdivision seen. No line of light on inner edge of ring which was not sharply defined.—*Ring C or crape ring:* Very delicate colour, dusky purple; I could with care, as a very fine object, trace the edge of the globe through it up to ring B., equally distinct in E. and W. Ansa. No markings of any kind upon it. June 28.—10h. to 11h. 15m., power 250, definition very fluttering. North equatorial ruddy belt very distinct. Equatorial yellow band the brightest part of the planet. Between the north equatorial ruddy belt and north pole, lay one or more very faint ruddy bands. *Pole:* pale bluish grey. No other markings. The crape ring very dark and distinct across the ball. July 2.—10h., definition very sharp, power 250, a glimpse observation. The two belts before mentioned very much plainer and darker than on June 21, 28, and not of such a ruddy hue."

LUNAR OBSERVATIONS.—Mr. John Birmingham, of Tuam, Ireland, reports that on June 6th he saw "a very marked central depression in the white spot of Linné, though the Terminator was so far away as the boundary between the Mare and the Palus Putridinus. The depression was rather east of the exact centre of the white spot, so that the western exterior slope was longer than the eastern." Mr. H. Michell Whitley has observed, with great care, many interesting and difficult lunar objects, and the results of his observations have been sent to Mr. W. R. Birt, F.R.A.S.

WINNECKE'S COMET.—Mr. George J. Walker, of Teignmouth, observed this body on June 5th, 6th, and 7th, and he says that "it looked like a tolerably bright nebula." On the 6th, at 14h. 18m., the comet looked faint, owing to the strong twilight.

METEORS.—Mr. G. J. Walker saw a splendid meteor on June 24th. It traversed the greater part of the sky, and was much larger and brighter than Venus. It was of a blue colour. Mr. Walker adds, "I think it appeared a little to the right of Altair, and passed near Vega, and on to the Pointers in Ursa Major; it had a magnificent train, and, I think, must have traversed an arc of about 120°. The time of its appearance, as well as I could make out from my watch, was 11h. 18m. Greenwich mean time, and it may have been 7 or 8 seconds making its sweep over the heavens. I did not hear any sound with it." Mr. H. M. Whitley observed a brilliant meteor on June 29th, at 11h. 30m. It was of the second magnitude—"pale yellow, velocity very great."

A NEW RED STAR.—Mr. John Birmingham has "frequently observed a red star in Cygnus, not, I believe, previously noticed; at least it is not in "Schjellerup's Catalogue" (Ast. Nach., No. 1591), which gives a list of all the red stars known up to 1866. It is of a deep red, of about the eighth magnitude, and is near a blue star of the same size. Its approximate position, compared with 32 Cygni, is about R. A. 20h. 15m. 37s. Declin. + 47° 27′ 28″."

OCCULTATION.—Mr. Walker witnessed the occultation of θ Libræ on June 11th, and found that the exact time of disappearance was 9h. 27m. 55·6s. Greenwich mean time.

EXPORTS OF MACHINERY.—During the first four months of the present year the value of the steam-engines and machinery exported from the United Kingdom showed a sensible improvement as compared with the corresponding period of 1869. Steam-engines were exported, to April 30th this year, to the value of £575,041, as compared with £409,492 in the first four months of 1869, and £431,472 to the corresponding date of 1868. The increase observable this year was chiefly attributable to the greater demand for steam-engines from Egypt, which took them to the value of £105,424 in the first four months of this year, against £29,054 in 1869, and £18,259 in 1868. General machinery was exported to April 30th this year to the value of £957,670, as compared with £848,934 in the corresponding period of 1869, and £725,960 in 1868. There was an increase this year in the exports to France, Spain, Egypt, and Australia; and a decrease to Russia, the Hanse Towns, Holland, Belgium, and British India.

AN ATMOSPHERIC TELEGRAPH.—A novel kind of telegraph, the invention of Signor Guattari, an Italian, was submitted to the inspection of a party of scientific gentlemen on Monday week, at a private house in Gloucester-st., Warwick-sq. The inventor aims at obtaining by the use of atmospheric power the same or better results than those attained by electric and magnetic forces To this end he charges a reservoir with compressed air and, by the operation of valves worked in the same manner as those in use in the ordinary telegraph system, sends pulsations through a tube, which pulsations are made to work upon the receiving instrument with an effect corresponding with that of the electric current passed along insulated wires.

LETTERS TO THE EDITOR.

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[We do not hold ourselves responsible for the opinions of our correspondents. The EDITOR respectfully requests that all communications should be drawn up as briefly as possible.]

, All communications should be addressed to the EDITOR of the ENGLISH MECHANIC, 31, Tavistock-street, Covent Garden, W.C.

All Cheques and Post Office Orders to be made payable to J. PASSMORE EDWARDS.

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"I would have every one write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks: a vice from whence great inconveniences derive their original."—*Montaigne's Essays.*

◆

IMPROVED TRICYCLE.

[83] SIR,—For the benefit of those who are interested in velocipede construction, I send a photograph and brief description of a tricycle, which, in my opinion, possesses some little novelty and merit. It belongs to a friend of mine, and has been used by him with great success for the last twelve months. As will be seen from the illustration, the single wheel behind is the driver, and the pair in front the steering ones. The frame or back, with spring and saddle, are almost identical, both in form and material, with those of the bicycle. It is worked by a pair of hand and foot levers, connected to a pair of 6in. cranks, at quarter centre. The crank axle is of steel, 8in. in length, and ⅝in. in diameter. It is loose in the nave, so that the cranks are at rest in going down hill. A small ratchet wheel, 2in. in diameter, is fixed upon the end of nave, while the axle carries an arm and catch, which work the ratchet (see Fig. 2). The steering lever is rigidly fixed to the swivel pin of front axle; it is 21in. in length, and has a hob, 5in. across, which is acted upon by the knees of the rider. The swivel-pin and barrel in which it works are inclined away from the rider at an angle of 22 degrees; this throws the weight to the inside in turning, and so ensures perfect safety in passing sharp curves. The wheels are 30in. in diameter all round; the driving one is hooped with iron, but the two front ones, not having much wear are hooped with leather instead. The distance between the front wheels is 37in. and between the front axle and hind one, 45in. A tall person would require a little more—say 48in. In appearance, this form of tricycle is very neat; being so narrow it partakes, in a great measure, of that gracefulness of form so peculiar to the bicycle. I am, however, bound to say that considerable precision is required in its construction: the back must be rigid, and the bearings, especially those of the swivel and driving wheel, must fit well. Therefore, I would not recommend anyone to commence making a similar one, unless quite sure of good workmanship. For those who are not practical mechanics, but who nevertheless contrive to build their own velocipedes, I would recommend a four-wheeler as being easier to construct, and not requiring the same rigidity or precision. With our Editor's permission, I will be happy to forward a short description of a light four-wheeler (57lb.) which I have used for nearly twelve months, and which has given me great satisfaction, especially in regard to the ease of propulsion. The weight of the tricycle above described, I may state, is 53lb.

FIG. 1

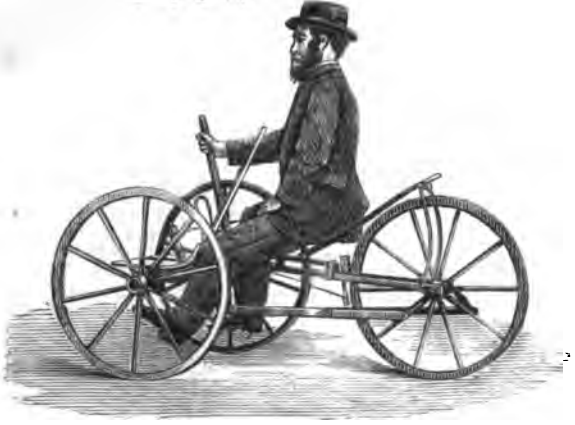
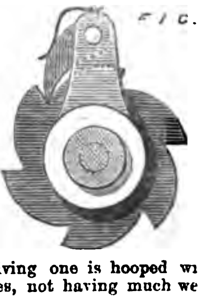


FIG. 2

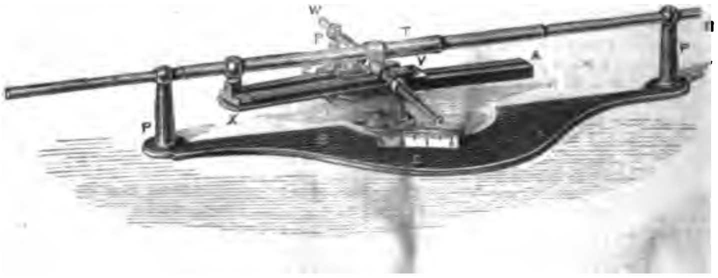


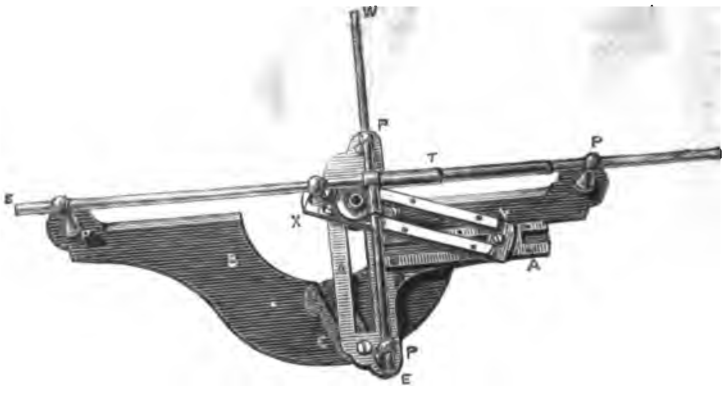
J. HASTINGS.

ISOMETRICAL DRAWING.

[84] SIR,—In answer to "Isometros" and T. Smith, I send two photographs of the instrument I mentioned on page 381. The base-piece B is of sheet iron with the upper edge straight and bevelled off very thin, and with a gap in the middle of about 3¼in. for the pencil to work round in Fig. 1. The base supports the expanding crank C, which is graduated to 8in. diameter along its edge, and also supports the pillars P P through the tops of which the long sheet bar N S (15¼in. long) slides. Under N S is another smaller steel bar E W, fixed accurately square with N S by being driven through holes in the ⊥ shaped brass casting T. The pin of the crank which is held fast by the screw seen over graduation 3 on the crank, works in a hole in the ⊥ shaped plate A A, which is slotted to take the pencil-slide, and has also two brass bars to form another slide fastened on by small screws, and this plate also has two pillars P P which slide on the cross bar E W. Now, postponing the consideration of the rest of the instrument, suppose the crank to be "rotated," as the Yankees say, it is clear that every point of the plate will travel round in a circle, while the plate itself remains always parallel to its original position as the steel bars slide freely in every direction—N-S. E.W., and if the pencil were fastened anywhere in the slot it would make on the paper underneath a circle of the same radius as the crank is set to. Now instead of the pencil being fixed in the slot, it is attached to the middle part of the lever X Y (which is 4in. long) by means of the large milled headed nut Z, and the two ends of the lever X Y slide respectively on the bar N S, and in the slide A. Now suppose the crank to be set going as before, it is clear that the pencil will be carried from N towards S, and back twice the length of the crank C, and as the end X of the lever X Y cannot move at all to or from E W, while the other end Y of that same lever does move East and West twice the length of the crank C, therefore the pencil which is attached somewhere between x and y will move E. W. a distance proportioned to how far Z is fixed away from Y. If Z is in the middle, then the breadth of the ellipse will be half the length, and if Z is at .578 of the distance of Y towards X, then the ellipses will be the isometrical projections of circles, as that is the decimal of $\frac{1}{\sqrt{3}} = \frac{1}{1\cdot73}$. The way to use the instrument is to set the crank to the length of the transverse axis of the ellipse required, and to lay the feather-edge of the base plate B accurately down on the line of the transverse axis, and to take care that the conjugate axis exactly cuts into a notch made in the middle of the gap in the base-plate close to the centre of the crank. Hold it firm and move the crank gently round half a turn or a whole turn as necessary. I have not tried, but should think that the mechanical arrangement No. 1, p. 5, vol xi., with a very long connecting rod, compared with the length of the crank, would be amply accurate enough for the purpose "Isometros" requires it for. With a short connecting rod the figure comes out perceptibly egg-ended, and my arrangement is based on that same movement, only with what is equivalent to an indefinitely long connecting rod.

J. K. P.





CHEAP AND GOOD GAS.

[85] SIR,—"C. D. C." in your issue of July 1, No. 275, has contributed a letter on a means to obtain cheap and good gas, in which he has been betrayed into the conventional habit of abusing the gas companies, when in reality the fault is much oftener to be found on the side of the consumer. He says that when the gas leaves the retorts it is rich in carburetted vapour, which the gas companies find it convenient to extract. If he knows anything about the condition of gas when it leaves the retorts, he will readily admit he would not care about its being supplied to him in that state, and I don't think he would find it more expedient to use it until some of the condensable matters and other things had been got rid of.

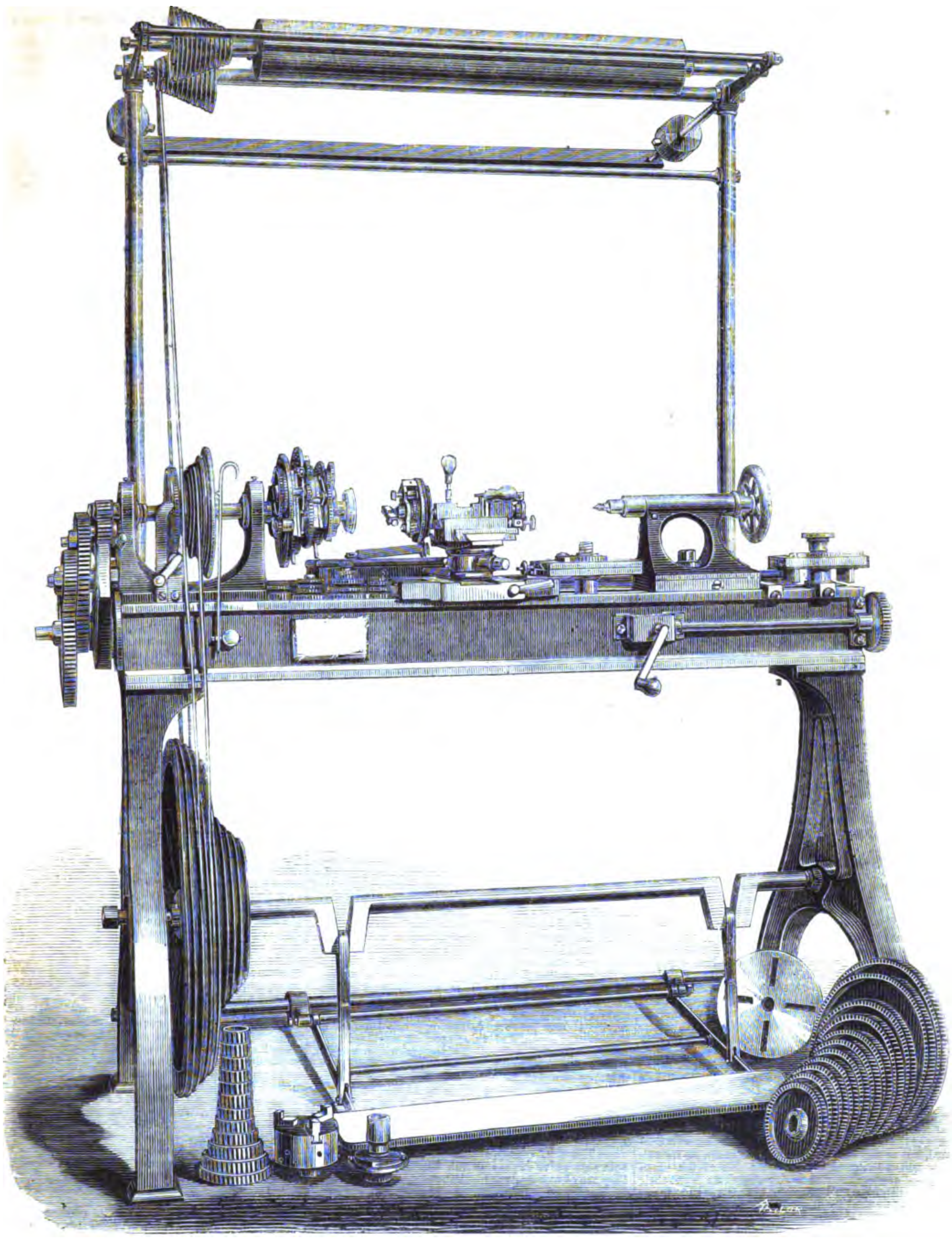
When gas was first invented, or rather applied to domestic use, it was supplied direct from the retorts, rich, according to "C. D. C.," in condensable matters, and the consequence was, tar siphons had to be attached to each burner, and after many trials, the idea of using it in such a state had to be abandoned, and now, expensive purifying plant has to be provided and worked, all of which, according to "C. D. C.," might be disused and the gas supplied cheaper.

Then again, the use of benzole is not only to impregnate the gas with hydrocarbon vapour, but to lessen the heat, and the carbonic acid and sulphuric acid fumes, which he says are all supplied by the gas companies and charged as gas. If he can invent any apparatus for heightening the illuminating power, and at the same time purifying the material, I venture to say it would be no less a boon to the manufacturers than to the consumers.

Then as to his example, it proves the truth of what advanced in the commencement of this letter—that the fault of bad illuminating power is more with the consumers than with the companies. There is an Act of Parliament to compel the manufacturer to keep his commodity at a good and uniform standard, but there is none to compel consumers to adopt the best means of using the material supplied.

He starts by supposing "common gas" to be used in his experiment. I suppose *he means that sent* out of the works at about 14 candles, *which is about the* value ordinarily used. How *is it that he only gets* 2½ candles out of it with his burner? *He is grumbling at* being supplied with an inferior article, and yet *he goes the* right way to work to make it worse still. If he *really* wants good results, why does he use a fish-tail burner, when they have been proved over and over again to be the worst kind possible for ordinary Newcastle gas? When his gas is carburetted by using 1¼ pint of naphtha per thousand—an item that will run up in large consumption—he only gets 7 candles, whereas, if he used an ordinarily good batwing, he would get about as much without any naphtha at all; and by using an Argand burner, he would, with a consumption of 4 to 5 cubic feet per hour, get a light equal to 13 or 14 candles, without any trouble; of course the loss in illuminating power would be in proportion to the distance he is from the works, and the state of the mains and services. I repeat, good burners are the only means of getting a really satisfactory result, either in power or cost; for he says, even with highly carburetted gas, the difference can scarcely be detected by the naked eye, and there would have to be reports, &c., made to the insurance companies; whereas with proper care with respect to burners and fittings, all this would be obviated, and without extra expense or attendance, and if people would only pay more attention to this seeming trifle, the companies would be less pestered and abused, and the consumer more contented.

LUCIDUS.



NEW LATHE, BY GEO. PLANT.

NEW LATHE BY GEO. PLANT.

[86] SIR,—You have published in your most valuable journal a print of one or two lathes by different makers, I therefore venture to enclose a photograph of one that has been recently built for me by Mr. George Plant, of Alsager. I trust the photograph will sufficiently explain itself, but as I am only, as in turning, an amateur, I will give you a few particulars. I have, of course, put as much as possible into the picture without any reference to the possibility of their being worked in combination, and this any turner will at once see.

The lathe is a screw-cutting one, with the usual change of wheels, the leading screw passing through the bed. The slide rest, when in gear, can then be either worked by the treadle, or if in spiral turning by the handle seen in front of the lathe. The head-stock has seven divisions, and the pointer or index is capable of being fixed in front, as shown, or at the back, which is often more convenient. The lathe has, of course, the usual micrometer screw arrangement, and the overhead motion, which latter has, by lever-sliding weights, a power of tightening or loosening the bands for driving the cutting frames. The photograph represents the geometric chuck on the mandrel, and the eccentric and elliptical on the bed. In the slide rest the elliptical cutting frame is placed. Beside these Mr. Plant has supplied the spherical and spiral chucks. All the other cutting frames, including the rose engine frame, were supplied by Messrs. Holtzappfel & Co.

HANBURY BARCLAY.

Handsworth, July 12.

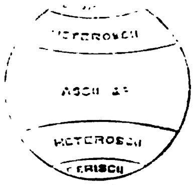
READINGS FROM THE GLOBES.—VII.

[87] SIR,—Although numerous wonderful and most important discoveries have been lately made by means of light, as may be seen by the papers contributed to your periodical, "What Stripes the Sunbeam," yet there is one thing connected with it which was known

not only to our immediate ancestors, but which showed itself to the gaze of all when first the beams of the sun began to shine; for shadow is obvious to the view of all, and, like its parent light, has been the occasion of wonderful discoveries. When a ray of light is intercepted by an opaque body it is obstructed in its course, and shadow is the consequence. If it were intercepted by a transparent substance it would be refracted with greater or less force, according to the density of the substance; but where the body is opaque, it is not refracted, but obstructed, and the ray on each side of the shadow still proceeds in a straight line, thus furnishing another proof that a ray of light passes along in a straight line. Shadow affords the means of explaining eclipses as well as of ascertaining the distance of the sun from the earth. We can also tell by means of shadow not only the time of the day, but the altitude of the sun, and consequently what sign of the zodiac he is shining in, for as it was explained in a former letter he gradually rises from a meridan altitude of 15° in our latitude, until he has reached the meridan altitude of 62°. When then his meridian altitude at London is 15°, he has just entered Capricorn; add to this 23½°, his greatest declination, and his meridian altitude will be 38½°, at which height he will be in the equinoctial, add another 23½°, his greatest north declination, his meridan altitude will then be 62°, when he has just entered Cancer; thus his difference of altitude on each side of the equator is equal to the extent of his declination. Now it is obvious to every one that when his altitude is low the shadow of any object will be long, as Cowper speaking of his legs, says:

> Mine spindling into longitude immense,
> Provoke me to a smile: the shapeless pair
> As they, designed to mock me, at my side
> Walk step by step along the plastered wall,
> Preposterous sight, the legs without the man.

The greater the altitude the less the shadow; and when the altitude is 45°, or half way between the zenith and the horizon, the shadow is exactly equal in length to the height of the object which throws it. Thus, if a man 6ft. high cast a shadow 6ft. in length he might then know that the altitude of the sun or moon was 45°. Hence it is obvious that there is a proportion subsisting between the altitude of the sun and the shadow. That proportion is expressed by the following formula: Length of shadow : height of gnomon :: R : tang. of the altitude. It is in consequence of this variation of the shadow that the ancients have divided the inhabitants of the earth into different names according to the shadows which they throw, as may be seen by the figure. The inhabitants of the torrid zone are called Ascii and Amphiscii—signifying without shadow, and shadows on both sides of them,—because when the sun is vertical, or exactly overhead, no shadow is thrown, which is at twelve o'clock in the day; and it is equally clear that the shadows of these people will be thrown both northwards and southwards, as for example, at the equator, when the sun is north of this line the shadows of those living there will be cast southwards; but when the sun has south declination, they will be thrown northwards. The higher any celestial object is, astronomers tell us, the greater the light and the more intense the heat, so that the vertical rays of the sun must dart with great force upon the heads of the inhabitants when no umbrageous tree affords its friendly branches to protect them. The inhabitants of the temperate zones have the name Heteroscii given to them, which is also derived from two Greek words, and signifies those people who have their shadows opposite to one another at twelve o'clock in the day. Thus we living in the north temperate zone always see the sun in the south at twelve o'clock, and as the shadow is always in an opposite direction to the sun, we cast our shadows northwards, and our Heteroscii are those living in the south temperate zone, who, seeing the sun in their north at twelve o'clock, must cast their shadows southwards; and of course the nearer we go towards the torrid zone, the shorter will our shadow become. Those who live in the frigid zones are called Periscii, because when the sun is above the horizon their shadows will go all round them. In the north frigid zone, for instance, at twelve o'clock in the day the shadows, like those in the north temperate zone, will be thrown northward, but as the earth revolves on its axis, its inhabitants will be carried to the other side of the north pole, and consequently at twelve o'clock at night their shadow will be cast southward. This may be easily understood by the direction of the shadow in our latitude in the summer time, for the shadow of the gnomon on a horizontal sundial will go round a large part of the circle, and if the sun were above the horizon all night it would then go completely round the dial. The inhabitants of the frigid zone, then, will cast a shadow in all points of the compass in the course of twenty-four hours.



T. S. H.

UNEQUAL STEAM PRESSURE.

[88] SIR,—As far as the use and practice of the indicator is concerned, I say that it will not tell the engineer everything about the steam engine as Mr. Wood pretends. For instance—a valve is 1-10th late, same as the figure Mr. Wood put in his last. The indicator did not say to him that he must move the excentric forward 1in. to compensate for it; or if he went to an engine that had no lap on the valves, and he saw that it would do with as much lap on as would cut the steam off at half-stroke, the indicator never told him how much lap he must put on to effect this purpose. Nor does the engineer expect it to do so, for he knows that this must be obtained by minute calculations on his part. If a man, "strictly speaking," must diffuse such knowledge as Mr. Wood has been attempting, he must not only have a thorough knowledge of the indicator, but he must know the traverse of the valves, width and depth of steam ports, and he must also know the amount of modification the valves have. To illustrate it we will take "Inquirer's" case. If his low pressure engine valves have more modification on the edge than required (which seems somewhat manifest in the figure), he would have to put them forward unnecessarily to compensate for what they are veed too deep, thus inducing an unnecessary amount of lap on the high pressure valves. Just to illustrate that the modification of the valve edge would alter the amount of lap on the high pressure valves, we will suppose that the piston required in the vee aperture of the low pressure engine valves an area of 6in., to compensate for them being late, the vee to be 6in. × 2in. on the edge, which would be an area of 6in., when the valve traversed from bottom of vee to the top 2in., what the piston required. On the other hand, we will suppose the vee in valve edge to be 4in. × 3in., which would give out the same amount of area as the first 6in.; but to effect this the valves would have to traverse 3in., instead of 2in., so that the excentric would have to be put forward *more* in the latter case than in the former, thus inducing more lap to be put on the high pressure valves in the latter illustration than in the former. Now, sir, I contend that Mr. Wood cannot, as he said at the outset, tell how much "Inquirer" must put his excentric forward, except he knows the precise amount of this modification. As he can't tell how much the excentric must be put forward, it is useless for him to say how much lap he must put on the high pressure valves.

Now, sir, the original information which he gave to "Inquirer" was too definite to admit the evasion which he has attempted in his last, by saying that it is an easy matter for any man who has a number of engines under his care to loose the excentric, and put it forward sufficient to make the low pressure valves steam soon enough, and then take the high pressure valve covers off, so that he could see what amount of lap these valves required. This information seems somewhat better than the original, but he would not most probably give it in this form, had it not been for what he considered my opposition. Again, the information is as much at fault, when given in this way, as the original. Though he can see the amount of lap that would be required on one side, when he turned the engine round to the opposite side, he would find to his disappointment that the other valve would either require more or less lap. He has not told us what he would do in that case. I expect he would do the same as many others I have met with—*i.e.*, put on unequal lap. Engineers of practical experience believe in equal steaming, but to effect this purpose they, unlike Mr. Wood, expect to get equal steaming and equal motive power, when they have equal aperture in valves, equal expansion, or cut-off, equal exhausts, and the exhausts to close up equal, on both sides. If engineers don't get equal steaming with this sort of valve setting, they at once inquire what is the cause. If they find it to be induced by unequal balancing of the working materials they at once set to and remove the cause, by putting sufficient balance at some convenient and effective point in the machinery. On the other hand, if they discover that it is induced by the angularity of the beam or the unequal angling of the valve levers, they at once set them right. But Mr. Wood adopts the earliest dodges almost on record—*i.e.*, of screwing this nut a bit and the other a bit, a practice I am happy to know has passed long ago into oblivion in the eyes of progressing engineers. It is impossible to get a good figure in this way, or equal steaming and equal strains in the machinery. Again, if any brother reader requires information through the medium of this paper on engineering, it would be far better for those parties who require it, and more credit to those who volunteer, to give it in as direct a manner as possible, instead of the way which I have just quoted. Again, he says in another place of his last, when illustrating his case, that the valves of No. 2 engine are ½in. late. Well, we will put the excentric forward, so as to make these last valves right. We shall then require ⅛in. of lap putting on the short slides. Now, sir, it does not follow that because both sets of valves are driven by one excentric that they are of one traverse; but they evidently must be if the low pressure valves want putting forward ⅛in., and then ⅛in. of lap putting on the high pressure valves to compensate for it. What I said "Inquirer" must do was that he must put ¼in. of lap on the exhaust side of his valves (supposing that they steam from inside). We will suppose that the valves are ⅛in. open on the exhaust side when in the middle of their traverse. Now let "Inquirer" put ¼in. on each side of the valves on the exhaust side, then the valves will cover the ports on the exhaust side ⅛in. Now let him shorten the rods between ½in., that will bring the exhaust of the valves to the same point from whence they started, ⅛in. open in the middle of their traverse. This done, he has put ¼in. of lap on the steam side of his valves, and not the exhaust, as Mr. Wood has said. The reason why I prefer lapping valves in this way is because very frequently the steam sides of valves are veed or have an uneven edge, which makes them more difficult to put bits on; but the exhaust side of the valves being always straight across the edge, or even, makes them very easy to put bits on. In fact, I have had bits put on nearly as soon as I could have the rods cut and pieced up again. But I don't look at time so much as I do good workmanship in these cases, for if a job of this sort is worth doing at all it is worth doing well.

I say, again, if "Inquirer" gets equal steaming with this amount of lap he will have no compression in his high pressure cylinder. (By equal steaming I mean equal valve apertures.) Mr. Wood's plan is that (as in the other case) the valves to be ⅛in. open in the middle of their traverse, to put ½in. of lap on the steam side by shortening the rods between 1in. If the valves steam from inside that brings the valves on the exhaust side ⅝in. open, when in the middle of their traverse. Yet he says the expansion is the same in both cases. Now, sir, as steam cannot be expanded in any cylinder with slide valves attached without making them longer on the face, it is evident that Mr. Wood completely stultifies himself. In cylinders that are steamed from inside by slide valves, expansion can only take place from the point where the steam is cut off to the point in the valve's traverse where the exhaust side of the valve comes in actual contact with the cylinder port, thus taking away the steam from the piston.

Just to illustrate this I will suppose that we have an engine whose traverse is 9in. and the ports 3in., the valve face to be just sufficient to cover the ports—*i. e.*, no lap on either side. This arrangement would carry the steam on the piston the full length of the stroke pretty near at the same pressure as at the commencement. This is what we understand as no expansion. Well we will put 3in. of lap on these valves, not in the same way as an engineer, but in the same way as Mr. Wood advises us—*i. e.*, by shortening the rods between 6in., that would make the exhaust side of the valves wide open when in the middle of their traverse. A serious position that. This arrangement would cut the steam off at half-stroke with 9in. traverse; and as the valve-face had not been lengthened at the very identical spot where the steam was being cut off for the purpose of expanding it in the cylinder the valve would open on the exhaust side, and thus prevent expansion of steam from taking place. The valves, as well as exhausting sooner, return in their own traverse sooner, in the same proportion as he added less by shortening the rods between. Yet Mr. Wood tells us that the expansion is the same in both cases. The difference there would be in these two cases is that Mr. Wood's mode of lapping valves would be to strain the machinery without any profit the first part of the half-stroke; the last part, the engine would have to run without any motive power behind the piston to support its motion. In fact, the engine would be incapable of running if it had any work to do. He wants me to tell him how to lap valves without increasing the pressure at the commencement of the stroke. I have no idea that I can do that as a rule, except in engines that have no lap on the valves and the vacuum is very bad; but under such bad circumstances as these we may lap valves to a certain extent without increasing the pressure at the commencement of the stroke. Again when I lap valves (unlike Mr. Wood) I expect it to be a profit by reducing the terminal pressure in a greater ratio: hence the gain. Mr. Wood's practice is such that it strains the machinery when there is no chance of the terminal pressure being in any degree altered for the best. In No. 254 I find him giving "Relivot" information similar to that which he has been dealing out to "Inquirer." Without knowing anything about the peculiarities of the engine's construction, he says "Relivot" must put ⅛in. of lap on the steam-side of his valves; but in the next breath he says he must cut as much off the exhaust side of these valves. Now, sir, this would have the effect of straining the machinery without in any degree altering the terminal pressure. For just as much sooner as he put the excentric forward, to compensate for the lap, it would begin to exhaust. There is nothing gained by lapping valves in this way except unnecessary strains, as far as expansion of steam is concerned. Again, he talks about the practice and use of the indicator being a *fine art*. I say that the practice and use of the indicator is a science, not an art; hence science is knowledge. Art is the application of that knowledge to practical purposes. When the engineer succeeds so far with the use of the indicator as to understand its delineation on the paper, then, and not till then, will he be able to convert its teaching to practical purposes. Now, sir, I contend that such information as Mr. Wood has been giving to "Inquirer" and "Relivot" cannot be diffused without knowing the particulars of the engine's construction. Again, he boasts of his superior knowledge of diagrams, and of the many of your numerous readers who can speak to his good judgment of the same. Well, we let parties speak when the spirit moves them in this direction. As far as my judgment goes the very figure which he gave to "Inquirer" and specified to be good, a progressive *driver* would scarcely consider worth his notice; and I should think it would be much less so with a progressive engineer.

EDWARD MALBON.

PRE-ADAMITE MAN.

[89] SIR,—Would it not have been better had J. Sargent, jun., enquired into the above subject somewhat more ere he challenged public discussion in the columns of your valuable journal—a journal, let me say, which I have always found to be devoted to the notice of really useful and instructive subjects of general interest to its readers. Surely your correspondent cannot have read the "Book of Books," and compared the narrative of the Creation with the opinions enunciated by our best modern geologists and palæontologists, or he would never have made such an application as he does in your last number now before me. Had he done so, instead of doubting the truth of the Biblical account, he must have been compelled to acknowledge the perfec-

tion of the divine order of creation, inasmuch as man could not possibly have existed at the same period as those monsters shown in the fossil state at our British Museum, and by models in the grounds of the Crystal Palace, the earth not being then in a fit state for his reception.

Man being the crowning work of God, required that every subordinate thing should be previously perfection; and let sceptics sneer as they will, every new discovery only tends to re-verify the truth of the Mosaic description—leaving out all theory as to the duration of each "day" mentioned therein.

Had man existed with the Ichthyosaurus and Plesiosaurus, &c., undoubtedly we should have found his bones as well as theirs, but such is not the case; and so far as I can learn, no instance has been noted of the discovery of human remains in any deposits except those of very recent times.

As one who signed the declaration of students of the natural sciences in connection with the scriptural account some four years since, I am not disposed to enter into any argument as to the truth or error of the latter, but I would certainly advise Mr. Sargent to look carefully at the subjects I have named and take—say Richardson's "Geology and Palæontology," published by Bohn, at about 5s., and make comparisons. If those do not convince him, I am afraid that no number of letters in the English Mechanic will do so.

T. S. Conisbee.

[90] Sir,—I see in the English Mechanic for 8th July that one of your correspondents wishes for a discussion of this matter. By "Pre-Adamite Man" I suppose he means pre-historic man. The use of the phrase "pre-adamite" is rather unfortunate. With Adam we have nothing to do, and we only raise a certain hulla-balloo if we speak of his predecessors. In our discussion of matters on natural science we have naught to do with what is called theology; that is a science to itself—having in it much that is true and much that is false. Adam *may* have been the first man or he may not. Science does not care to ask. All Science wants to knew is, Whence did man come and when? The latter of these questions is the one your correspondent, I presume, wishes to raise. I suspect few will at this day restrict the period of man's existence upon the globe to the six thousand years until now prescribed to it. The numerous discoveries of flint flakes made within the past few years—the conclusions to which learned and thorough students of ethnology and geology have been forced to come—new truths learned from comparative philology and new insights gained into man's geological relations—these and other things have led most of our leading men of science to at any rate this conclusion, that the age of man as a species is not to be reckoned by thousands of years. Were it not that the opinion forces itself upon us that this subject is not the one best adapted for discussion in a journal designed for workmen rather than speculators, we might proceed to fill pages with a *précis* of what has been done in this department of science. Those who wish to make themselves thoroughly conversant with the subject can do so in the pages of Lyell, Page, and others. To those who only wish to know the general conclusion to which scientific men have come perhaps the following may be of use. I extract it from Page's "Man—Where? Whence? Whither?" "Historically we can have no certain evidence of the outgoings and incomings of those early races which preceded all history. Even were tradition reliable and history certain, it is as impossible for the race as it is for the individual to trace itself back to its origin. We can only arrive at a notion of man's antiquity by inductive reasoning from the evolutions of nationalities, the growth of language and the progress of civilization; and the induction for all pre-historic time must be founded exclusively on the discoveries of geology. Geologically there is the amplest evidence of man having been an inhabitant of western Europe for ages preceding the popularly received chronology. Man's occupation of Europe does not fix the measure of his antiquity in northern Africa and Asia, to which everything points as the region from which the races of Europe were descended; and the discovery of pre-historic remains in Asia cannot be regarded as the earliest indications of the human race; but geology must seek for the earliest traces of man in the regions that are now occupied by the lowest varieties—thus implying an antiquity for the human species that cannot be expressed in years and centuries, but only relatively to other geological events." We may, I think, regard this as the conclusion which geology forces upon us—viz., that man has existed for ages, but that he is the *last* of the series of organized beings as he is the greatest.

H. P., Hull.

PEDESTRIAN TOURS.

[91] Sir,—I have been a subscriber to your delightful and ever-improving periodical for nearly two years, and have derived much valuable assistance from it in my efforts as an amateur astronomer. I am glad to see the subject of pedestrian tours now engaging attention, and I write in the hope that I may be able to give, as well as receive, some information. For several years past I have spent my summer vacation in rambles through various parts of England and Wales, and can therefore speak practically as to the best mode of successfully carrying out such an expedition, and of the delight which may be derived from it. I have just returned from a week's ramble through Sussex, in which I have been *solus*, and during which I have visited many places, having walked upwards of 100 miles. In 1866 I took nearly the same route as that mentioned by your correspondent "B." in your last number, except that I started from Rhyl, and extended my walk through Conway and Oswestry, as far as Shiffnall.

I have no doubt that many of your readers would like to undertake such a tour if they knew how to arrange it inexpensively. When I did the above-mentioned trip in company with a friend, we spent 11 days in walking, and I find from my diary kept during the tour that my share of the expenses came only to £2 1s. 8d. If we had adopted the plan suggested by "B," of breakfasting at a good hotel, our expenses would have been very much heavier. Our method was to sleep at an inn, to start on the first thing in the morning, and prepare all our meals out of doors with portable apparatus which we carried in our knapsacks. If any one wishes for information with regard to this apparatus, I shall be very glad to give it through your pages.

I want to get a hint or two, from any reader who has had experience in such tours, as to the best sort of boots or shoes for walking. I can walk any distance without becoming leg-tired, but with ordinary covering for the feet I get blistered feet, and this very much interferes with the enjoyment of such trips. In return, any information which I can furnish to intending tourists, either as to routes, places of interest, good and cheap houses for sleeping, or arrangements with regard to provisions, &c., will be most gladly given.

Brighton, Sussex. Scholasticus.

A CURIOUS SENTENCE.

[92] Sir,—The following is a curious sentence, and if you think it worth inserting, it will, I have no doubt, interest many of your readers.

"Sator Arepo Teret Opera Rotas."

English:—Cease from your work. The sower will wear away his wheels!

1. It spells backwards and forwards the same.
2. The first letter of each word spells the first word. The second letter of each word spells the second word, and so on with the third, fourth, and fifth letters.
3. Beginning with the last word, the last letter of each word spells the first word, and so on with the fourth, third, second, and first letters.

Reg. Pilkington.

Heads-buildings, Bridgnorth.

LUNAR COSMOLOGY.

[93] Sir,—A continued series of critical observations of the surface of the moon, by the aid of superior telescopes and repeated examinations, do not tend to establish the feeling that any corresponding physical resemblance upon the surface of the earth can be identified with the surface of the moon or suggest like causes of operation; but, on the contrary, in nearly every particular the surface of the moon is different to the surface of the earth, and also in the smaller gravity of the materials and the absence of meteorological influences in altering the surface during vast periods of time.

Probably appropriate lunar names will ultimately be used to distinguish remarkable and special appearances, and the words "*seas*" and "*volcanoes*" will disappear from the fanciful and poetic descriptions intended to represent popular resemblances to types on the earth. It is contended that the moon, as it at present exists, is the union of what once were vast numbers of small spheres, with fluid interiors, of different sizes; that rings surrounded the earth like the rings round Saturn; that these rings were composed of an aggregation of small satellites; and that the whole identical mass of matter in a half fluid state has by the coalescence of the materials been united into one moon, and left traces of the multitude of small hollow spheres in the numerous craters and circular ridges, in the form of wrecks, which in some respects slightly resemble the craters of volcanoes, on the surface of the moon.

It is possible that the diameters of the small satellites varied from ten yards to 20,000 yards, and an ideal section of the moon in any direction would reveal the mechanical amalgamation of a variety of fractured spheres, and indicate the antecedent conformations. Perhaps any general inspection of the sectional interior of the moon would confirm the theory. The transformation of these flat rings, composed of an aggregation of small spheres or satellites, into one moon by an operation of gravity is one of the grand events of the past in lunar cosmology.

The vestiges left on the surface of the moon are chiefly the shattered remains of former small hollow globes, and these significantly indicate the relative proportion of thickness of the outer crust or shell and the relatively fluid matter in the centre of each small sphere. Probably the pleasure of tracing back some of the changes on the surface of the moon will appear as interesting as any intelligent investigation into natural history when contemplated as the work of immutable laws and the proof of design.

As a theory, the *modus operandi* will supply matter for discussion, such as the mineral characteristics of the interior fluid mass of each sphere, the distribution of the fluid masses over some parts of the surface of the moon constituting an appearance of flat planes, settlements, and floors, but still thickly filled in with the vestiges of former fragments of outer shell, and partially submerged in what was once relatively fluid mineral matter liberated by the fracture of the outer shells. In some directions, and radiating from a centre, these fluids give the appearance of the streams of lava from a volcano by the last distributions and settlements of the typical lava of the burst shells of the spheres or satellites.

At the same time that this great convulsion took place, an equally salutary provision was made upon the surface of the earth in the precipitation of the entire mass of the waters of the ocean for the first time on the surface of the globe, and providing a permanent medium of ultimate stability in the liberty of this mighty ocean pendulum. From this period meteorological changes took place, and the full developments of organized beings, by suitable climates, in almost infinite variety and in systematic order, adapted to the prepared conditions of the surface of the earth, were perpetuated by selection.

Littus habet Conchas.

SHIPS' PUMPS.

[94] Sir,—Permit me to thank "G. A. S." for his reply to my query, "The Goat and the Grassplot." I wish the above gentleman, or some one conversant with the subject, would inform me what he considers to be the best purchase for ships' pumps. The wee-gee and fly wheel are the best I know, and answer the purpose generally; but if a vessel spring a leak either will soon exhaust a crew, which I know from experience, having had to keep 22 hours at the latter purchase, after my crew were exhausted, in 1865. I have materially assisted the wee-gee by making a pendulum of a 12lb. shot; but something much better than that is needed, leaving steam out of the question. Capt. Baxter.

85, Crane-grove-terrace, Holloway-road.

THANKS.

[95] Sir,—I feel that I shall be doing no more than to echo the sentiments of your optical readers by returning sincere thanks to your talented correspondent, the Rev. T. W. Webb, for his able exposition of the abstruse and difficult intricacies upon which optical definition depends. Such information from such an authority, and in a style so felicitous and unassuming, must, I am sure, elicit the warmest admiration of all, while it constitutes a painstaking and truthful analysis of principles which are generally too imperfectly understood, but are nevertheless of the highest optical importance.

W. Purkiss.

THE OPTICAL BRICKLAYER'S TELESCOPE.

[96] Sir,—I am afraid that "Optical Bricklayer" may be a long time discovering the merits of his 7¼in. mirror, unless he adopts a more systematic method of proving its figure. Perhaps the valuable letters of Mr. Webb may help him to do this; if not, I would advise him to test it by the process described in the last volume of the Mechanic, pages 332 and 357. This will set his mind at rest once and for ever as to the actual figure his mirror has.

The heavenly bodies are, perhaps, as a rule, about the most unsatisfying things which can be selected *as tests* of a powerful telescope, and while stars may no doubt render important service in the process of testing, on account of the almost infinite parallelism of the rays which proceed from them, why they should be considered *test objects* when focussed in the ordinary way, I am quite at a loss to know, and why it is that objects that are so exceedingly sensitive to atmospheric inequality as to be always changing, should be selected as standards of comparison is an enigma that I must leave to others to solve.

It certainly seems feasible that a *test* in order to become so ought to be as exempt from change as anything can be, and not be subject, as a star is, to endless distortions and caprices of the atmosphere. In this particular a thermometer bulb in sunshine has no doubt an advantage over a star, but a watch dial can scarcely be a test of definition with a large telescope, although it may be a moderately good test of achromatism in the case of a refractor; but, whatever test is used, the proper time for its observation (even with terrestrial tests) is of great importance. Noon is generally a very bad time. Perhaps the best time of all for steadiness is generally about one or two hours before sunset, especially after a cloudless day. "Optical Bricklayer" need not be at all surprised he cannot get on with Saturn. I may tell him, as an example of this, that two evenings since I was looking at Saturn with a 9in. reflector, and 3in. refractor simultaneously, and I got decidedly better definition with the 3in. than with the 9in., although the defining and separating power of the mirror is more than double that of the refractor. This simply shows how much atmosphere and aperture have to do with definition. As to stars, a power of 120 on a 7¼in. mirror, is scarcely enough at any time to give clear and sharp discs. Double that power would be far better if the mirror is truly figured; but, with every precaution, doubts may still arise, unless a mode of testing is used which does not depend on atmospheric conditions.

W. Purkiss.

SECRET CODE FOR TELEGRAMS.

[97] Sir,—I purchased in London the other day a small work described as "A Secret Code for Telegrams, &c.," which I find has been extensively advertised and recommended. I think, however, that the author should acknowledge that his system is merely a *rechauffe*, with some very useless condiments, of one of the many methods given by Bishop Wilkins, in his "Mercurie, or the secret and swift messenger." The four imposing puzzle pages of alphabets at the end of this "Secret Code" made me at first believe that something new was concealed under them, but by using the worthy bishop's method I succeeded in producing the exact cypher of this modern writer, using his own sentences as examples. The method adopted by Wilkins is to write down, first the alphabet in its ordinary form, and

under the letter A to write in a vertical line the letters of any selected word, completing the several alphabets as below—key-word "mines."

A	B	C	D	E	&c.
M	N	O	P	Q	&c.
I	J	K	L	M	&c
N	O	P	Q	R	&c.
E	F	G	H	I	&c.
S	T	U	V	W	&c.

If it were required to write the word babe the first letter would be N, which stands under B in the first line, the next I, which is under A in the second line; the third O, which corresponds to B in the third line, and the fourth I from the fourth line. The next letter would be taken from the fifth, and then the first, second, &c., would be used again in order. Our "Babe," then would be NIOI. The cypher words would be always of the same length as the key-word, a space being left as the last alphabet is used. The difficulty of this cypher consists in the fact that the same letter has several different signs; thus B is first N, then O, whilst A and E are both represented by I. This cypher is described in full in the edition of Wilkins, published 1802, vol. ii, p. 39. It has only one objection, however, which is this, that if any particular word be certain of being found somewhere in the cypher, such as a proper name, or the title of a racehorse, &c., the whole can be unfolded in a few minutes. If a few details of this method would amuse your readers I will willingly write again. I have no wish to injure the sale of the little book, which is cheaper and more easily procurable than Wilkins's, and contains also an ingenious notion as to numerals, which I have no right to publish. I do not doubt his good faith, and can fancy his exclaiming

Pereant, qui mea ante me dixerint,

or, in the vernacular,

Confound the nasty scribes, and those who taught them,
Who thought my thoughts before I ever thought them!

CRYPTOGRAPHER.

ELECTRO-PLATING AND GILDING.

[98] SIR,—I think M. Schneider [4228] will find the following a most efficacious method to pursue for electro-plating and gilding. The solution of silver used for plating consists of cyanide of silver dissolved in cyanide of potassium, which may be prepared in various ways. The method generally adopted is as follows:—Metallic silver is dissolved in four parts of nitric acid, diluted with one part of water; the diluted acid is heated in a vessel, and the silver is added by degrees. M. Schneider must avoid breathing the fumes which ascend, as they are highly deleterious. The metal being dissolved, the solution is emptied into a larger vessel and diluted with water. To this is added a solution of cyanide of potassium, so long as a precipitate is formed. This is cyanide of silver. When the precipitate has settled, the liquid is decanted, and the precipitated cyanide of silver is thoroughly washed so as to effectually dissolve out the soluble salts. A solution of cyanide of potassium is then added to the precipitate until it is all dissolved. The resulting liquid constitutes the cyanide of potassium and silver, and forms the plating solution. It ought to be filtered previous to using, as there is nearly always formed a black sediment composed of iron, silver, and cyanogen, which, if left in the solution, would fall upon the surface of the article receiving the deposit and make it rough. The cyanide of potassium used to dissolve the cyanide of silver may be so diluted that the plating solution, when formed, shall contain 1oz. of silver in the gallon.

Articles that are to be plated are first boiled in alkaline ley, to free them from grease, then washed from the ley, and dipped in dilute nitric acid, which removes any oxide which might be formed upon the surface; they are afterwards brushed over with a hard brush and very fine pumice (known by oilmen as F F F F). The alkaline ley should be in a caustic state, which is easily effected by boiling the carbonate with slaked lime, until, on the addition of a little acid to a small drop of the solution, no effervescence occurs. When the lime has settled, the clear liquid is fit for use. The ley should have about ¼lb. of soda ash, or pearl ash to the gallon of water. The article being thoroughly cleaned and dried, has a copper wire attached to it. It is then dipped in nitric acid as quickly as possible, and washed through water, and then immersed in the silver solution and attached to the battery, as at A in Fig. 1. In large manufactories, where a great many things are plated, a Bunsen's battery is used, but fo amateurs a Daniel's would be best. The article is instantaneously coated with silver, and ought to be taken out, brushed, and replaced. In the course of a few hours it is taken out again, brushed and polished. Fig. 2 will illustrate the plan pursued in large establishments. D is a large vat containing solution; B and C are two brass rods placed along the top of the vat and to each of which a wire from the battery is attached. The advantage in this arrangement is that you can have more than one rod across the vat from each pole as *a*, *a'*, *b*. This plan is generally adopted when there are a great many articles and it becomes necessary to use more than one plate. If the object has been already plated and part of the silver has worn off, the whole ought to be separated. The solution used for stripping off the silver is composed of strong sulphuric acid (vitriol) to which a little nitrate of potash is added; the article is laid in this solution, which will dissolve the silver, without materially affecting the copper, &c.; saltpetre is added by degrees, as occasion requires; and if the action is slow, a little heat is applied to the vessel which contains the stripping solution. The article should then be polished, cleaned and treated as above.

FIG. 1

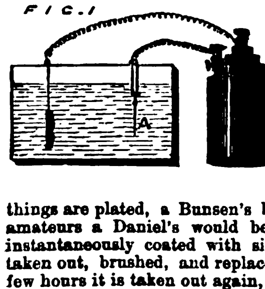
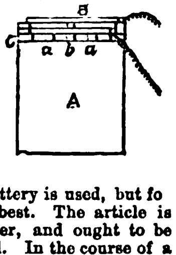


FIG. 2



The solution for gilding is made by dissolving gold in four parts of nitro-muriatic acid; water is then added, and the solution is treated with cyanide of potassium in the same way as silver. The solution should be heated when used. It is advisable to plate all articles before gilding. Three minutes will be quite sufficient to gild any article.

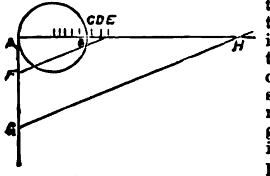
Before regilding articles which are partly covered with gold, or when the gilding is imperfect, and the articles require regilding, the gold should be removed from them by putting them into strong nitric acid, and when the articles have been placed in the acid, by adding some common salt, not in solution, but in crystals. The articles should then be polished and treated in the usual method.

Thus far, Mr. Editor, I have endeavoured to answer M. Schneider, and shall be willing to reply to any further queries that I am able.

258, Kingsland-road. WALTER J. NICHOLLS,

SQUARING THE CIRCLE.

[99] SIR,—Seeing that one of your abler correspondents in last issue of the ENGLISH MECHANIC has tried so impossible a task as that of squaring the circle—I mean the rectifying of the circumference of the same figure—you will no doubt allow me to give to those interested in the subject a more precise and perhaps more valuable construction through the medium of your columns.



I refer myself to figure annexed, so as not to encroach too much on the space offered to your subscribers.

A diameter has been drawn through a circle, and produced in the direction of H, the radius divided into five equal parts, and three of these separate parts carried from B to C, D, and E, so that if the diameter be represented by *d* and the radius by *r*,

$$A\,C = \frac{11r}{5}\ ,\ A\,D = \frac{12r}{5}\ \text{and}\ A\ E\ = \frac{18r}{5}.$$

A G is a perpendicular to the said diameter, and F a point on the same, fixed so that A F = *r*, and A G may equal the linear distance F C. F has been joined with E, and through G a parallel to F E (G H) has been drawn, intersecting the prolongation of the said diameter in H. A H represents exactly up to the 5th decimal incl. the rectilinear length of the circumference, for by similar triangles A F C and A G H, we have

$$A\,F : A\,G = A\,C : A\,H,$$

or substituting known magnitudes for the above quantities, and remembering the Pythagorean proposition as well as the construction, we receive

$$r : \frac{r}{5}\sqrt{146} = \frac{13\,r}{5} : A\,H,$$

$$\text{or } A\,H = \frac{\frac{r}{5}\sqrt{146} \times \frac{18r}{5}}{r} = \frac{13r}{25}\sqrt{146} = \frac{13d}{50}\sqrt{146}$$

$$A\ H\ = \frac{13\,d\ \times\ 12{\cdot}0830460}{50}$$

therefore, taking the diameter to be unity, we have

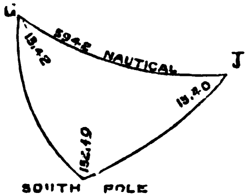
$$A\ H\ = 8{\cdot}1415919\ \ldots\ldots$$

which result shows a difference in the first seven decimal places, when compared with the Ludolphine (π) of seven units in the seventh decimal, and not already in the second, as in Mr. Proctor's solution.

A MEMBER OF THE ENGLISH MECHANICS' SCIENTIFIC AND MECHANICAL SOCIETY.

GREAT CIRCLE SAILING.

[100] SIR,—Seeing in the MECHANIC that "T. S. H." and "L. M." had found the distance from Cape Good Hope to Port Jackson to be 6,815 miles and 6,824 respectively, and having travelled that distance several times, and always reckoning it to be under 6,000, I computed the distance, and found the results as figured.



Well, this did not agree with theirs. I tried it again, and again still the same results. I then computed it by "Mercator's" principle—(*i.e.*, supposing the earth to be a plain), and found it to be 5,729 miles, which comes nearer to Mr. Dyer's distance, but it should be remembered that angle J is much too small to give this distance correctly. I felt rather annoyed at my work not agreeing with theirs, but as they were not sailors, they had perhaps used English miles instead of nautical, and on converting my 5,942 nautical miles into English, it gave 6,833, which agreed very well with "T. S. H." and "L. M."

Scarborough. W. W. LARKIN.

ANIMALS AS FELLOW BOARDERS.

[101] SIR,—I beg to send you a few additional observations to Mr. Van Beneden's highly interesting paper on "Commensalism," which was lately reprinted in *Scientific Opinion*:—

Is not the burrowing owl (*Pholeoptynx hypogæa*) an animal which ought to be mentioned as an instance of commensalism? In the prairies of the far West it lives in the "villages" of the prairie-dog. (*Arctomys ludovicianus*). It is reported that even rattlesnakes are abundant in these "villages," and that the quadruped, the bird, and the reptile may often be seen in harmonious juxtaposition. In the pampas of South America a closely allied species (*P. cunicularia*) associates with another burrowing rodent, the vizcacha (*Lagostomus trichodactylus*). (P. L. Sclater, in *Nature*, II., 12; Brehm, "Illustrirtes Thierleben," III., 601. 602; *Azara, Apuntam*, I., 214).

I have repeatedly found *Amphisbæna flavescens* (Pr. Max.) ("*Culebra de dos cabesas*," or two-headed snake) in the nests of a species of ants called in this country "bachaco" (*Atta cephalotes*, L.). The Amphisbæna feeds on ants, as is clearly proved by the contents of its stomach. It is, however, more than probable that the reptile and the insect are not in an exclusively hostile relation. The "bachaco" is a remarkably strong and audacious insect, a giant of the myrmidonian tribe, and the number of inmates in one nest being very large, it would no doubt be an easy matter for them either to drive out or to kill the sluggish intruder. Richard Schomburgk ("Travels in British Guiana," I., 240), mentions a similar association between *Atta cephalotes* and another reptile, which he calls *Cæcilia annulata*. (Is this *Cæcilia lumbricoides*, Dand., or *Siphonops annulata*, Spix.?)

A great many insects are *found in ants' nests*, amongst them many bettles, *either only during their* larval condition, as, *for instance, the rose chafer* (*Cetonia aurata*), or *during their whole life, as many* brachelytra (*Myrmedonia homechusa*). *Claviger foveolatus, Dinandra Maerkelii*, &c. The last two beetles are perhaps no true fellow-boarders in the colonies of the ants, but a kind of "domesticated" animals, reared and kept by the ants on account of certain substances which serve as food to their hosts.

A case of true commensalism among mollusca came not long ago to my notice. A small bivalve shell, *Sphærium modioliforme*, Anton (which, I may add *en passant*, is the *only* fresh water bivalve I have hitherto found near Caracas), lodges in the deep umbilical cavity of the shell of an *Ampullaria*. It is the form called by Philipps *A. crocostoma*, which however appears to be identical with the old *A. effusa*, Chemn. This shell is exceedingly common in our rivulets and ponds, but though I have examined hundreds of specimens, I have found not over two dozen of shells of *Sphærium*. It is certainly convenient for so small an animal as this bivalve is to attach itself to a larger species, provided with more developed means of locomotion.

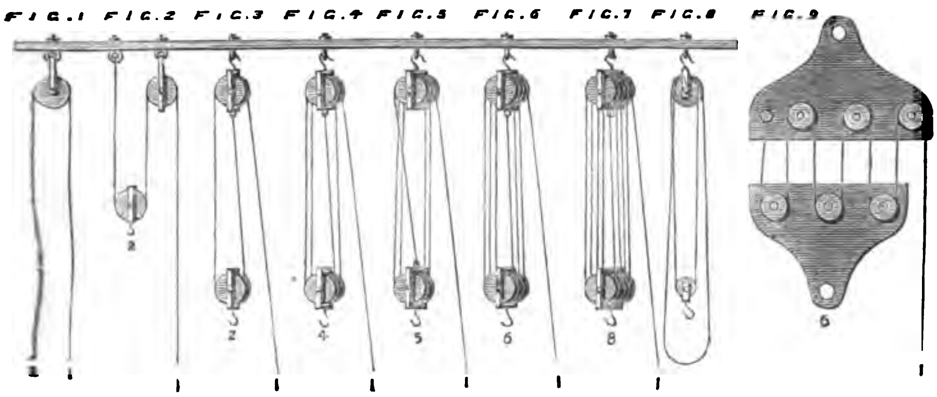
Caracas, June 16, 1870. A. ERNST.

THE AMALGAMATION MOVEMENT.

[102] SIR,—Although hitherto I have been but a silent reader (and that merely cursorily) of your contemporary, the *British and Foreign Mechanic*, I cannot allow the present opportunity to pass without congratulating you, and in particular the readers of that journal, on its approaching amalgamation with "our" MECHANIC, in whose extended sphere of usefulness I am confident they will find what has hitherto been wanting in their own periodical. The MECHANIC is no longer the "rough casting" it came to its present editor's hands, but is now the finished article that superior skill and refinement alone could make it. After endeavouring in vain to enlighten the universe, your contemporary must feel indeed highly honoured by being merged in the blaze of the ENGLISH MECHANIC. I for one congratulate it on the honour it has achieved, and the pleasure it must feel in joining the goodly company of *Scientific Opinion* and *The Mechanic* in the world-encircling arms of our *Alma Mater*—the ENGLISH MECHANIC. The readers of the *British and Foreign* while, perhaps, regretting that *sic transit gloria* "to-day," may with renewed vigour exclaim, "To-morrow to fresh woods and pastures new!"

SAUL RYMEA.

[103] SIR,—It is said that the *British and Foreign Mechanic*, after a troubled existence of nine or ten months, is about to terminate its not very glorious career by permitting itself to be merged in "ours." Well, I am not surprised at it; in fact, from what I have heard for some time past, I expected it would have "paled its ineffectual fires" before this. Better late than never. Though the individual dies the nation lives; and though scientific journals perish individually, the ENGLISH MECHANIC, by some means or other, absorbs the best portions of their animating spirit. Who would have thought that your paper, with its unassuming title, would have grown so rapidly, and attracted to itself by virtue of its central power so many of the lesser intellectual luminaries? You have, Sir, achieved a great success; you have, as Mr. Proctor says, "an enormous circulation," and you are exerting, no doubt, a salutary influence over large numbers



POWERS OF BLOCKS AND STRENGTH OF ROPES.

of our countrymen. You are becoming, if indeed you are not, as Mr. Batty (of Manchester) says, already, "an institution." I have been casting my eyes about to see what other scientific journal you are likely, to absorb, but as I do not know which are weak or which are strong, I will indulge in no speculation on the subject, and conclude by cordially congratulating you on your deserved success.

A Benefitted Subscriber.

THE LINK MOTION.

[104] Sir,—I find in your paper of July 1st a letter from Mr. Harrison, in which he questions the truth of Mr. Baskerville's theory as regards the link motion. Now I advise Mr. H. before he so emphatically contradicts Mr. B., to carefully examine Mr. B.'s diagram of the link, in your paper of June 17th. The link is there represented in "middle gear," and it is evident that the excentric rods must lose length in the direction of the motion line when they change from position A to position B, the loss being due to their angularity when in position B. Those letters refer to Fig 1.

FIG. 1

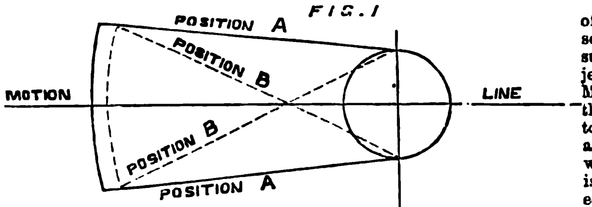
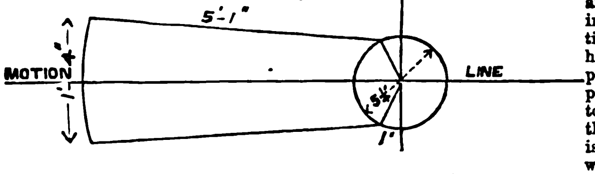


FIG. 2



Throw of excentric	5¼"
Advance of excentric	1"
Length of rod	5' 1"
Length of link	1' 4"
Lap of valve	⅞"
Lead of valve	¼"

I send for Mr. H.'s instruction a diagram (Fig. 2) of a link motion. If he lays it out in two opposite positions in "mid gear," he will find that the valve, or in other words the middle of the link, will move exactly 2¼ inches.

James F. Ryan.

P.S.—A great many of your readers are anxiously looking for a few good letters on iron girders and bridge work in general. If one of your clever correspondents would give us a few good rules on strains and the proportions of girders, he would confer a favour.

CLINTON'S PRIZE MEDAL EQUISONANT FLUTE.

[105] Sir,—Pray suffer me to thank "Justitia," page 376, very cordially for his generous and manly letter, which is a credit to both his head and heart; it is a refreshing contrast to that of "Orion." I expected Mr. Leftwich, or some more able champion than myself, would soon enter the lists *in veritatis et justitiæ causam.* "Orion" did not think much of the fine flute of this distinguished composer and performer. A little sober reflection would have saved him from writing that letter in which he did himself a greater injustice than he inflicted on Mr. Clinton's memory. "Justitia" has left me little to add in favour of the Equisonant. Personally I know *this* of it. Its tone is beautiful if it be *fairly* elicited; its notes are equal in strength, tune, and firmness, and its great recommendation to flautists of the Nicholson school is, that its scale of fingering is natural, differing so little from the eight-keyed flute that it can be adopted with ease by ordinary players. These are advantages not to be overlooked. I need not, I am sure, remind "Orion," whom I strongly suspect to be in "the profession," of the great value of "harmonics" to the *soloist*, enabling him, as they do, to produce those dashing and sparkling effects so charming to the ear. I know "personally" that the Boehm flute has them to a great extent—in many passages they are indispensable to its system; but the Equisonant has them to a still greater extent, and the tone is much clearer and purer. I have spoken the truth, but I do not expect that any manufacturer or professor will acquiesce in what I have said if it be against his interests.

The late Mr. John Clinton was a great master, his magnificent transcription of Meyerbeer's exquisite cavatina, "Robert, toi que j'aime," and own graceful and brilliant "Grande valse—Reve d'un Bal," are enough to establish his fame, to say nothing of a host of original works of which his reviewers have said sufficient. He lived but to see the only prize medal awarded to his flute "for improvements on the system of Herr Boehm," his early colleague.

Sable.

POWERS OF BLOCKS AND STRENGTH OF ROPES.

[106] Sir,—I enclose a few diagrams of blocks and tackles which might be of service to many of our readers requiring such mechanical appliances. This subject has already been alluded to in our Mechanic, p. 67, Oct. 8, 1869, but is there so imperfectly treated that I venture to bring it before you again in fuller detail and form. Fig. 1 is the single pulley, which only changes direction. Fig. 2 is an arrangement which gives power equal to 2 to 1. Fig. 3, the same, but is more convenient for being portable, and gives the first impression that the increase of folds gives the same proportionate increase of power. Fig. 4 having two sheaves in each block gives power equal to 4 to 1. Fig. 5 gives a power of 5 to 1, Fig. 6 a power of 6 to 1, and Fig. 7, a power of 8 to 1; thus showing that the increase of folds is the increase of power, and that the weight suspended in lower block is equally divided over all the suspending folds alike; and the weight required on the fold to suspend a given weight in the blocks is in proportion to the number of folds suspending lower block. Fig. 8 is Weston's patent blocks. The lifting power is given by the difference in diameter of top block sheaves, and the peculiar cross on the chain; motion given to which either adds to, or takes from the length suspending weight.

And further to illustrate the principle of gaining power by blocks, Fig. 9 is a modification of Fig. 6, showing that by suspending 6 cwt. a strain of 1 cwt. will be the result on any part of the line. The figures in the illustration correspond to the balance of power attained.

To the above it is necessary to subjoin a table of the diameters, circumferences, working strains, and breaking strain of hemp rope for the above purpose. The rule to be observed is the working strain in cwts. on the old, multiplied by the number of folds suspending under block will give the number of cwts. which said block is safe to lift:—

Dia.		Cir.	W. Strain	B. Strain.
¾in.	=	2⅜in.	4·5 cwts.	1·5 tons
⅞ ,,	=	2¾ ,,	6 ,,	2 ,,
1 ,,	=	3⅛ ,,	8·1 ,,	2·7 ,,
1⅛ ,,	=	3½ ,,	10·2 ,,	3·4 ,,
1¼ ,,	=	4 ,,	12·9 ,,	4·4 ,,
1⅜ ,,	=	4¼ ,,	18 ,,	5 ,,
1½ ,,	=	4¾ ,,	22 ,,	6·3 ,,

One third of this sum in *tons* is breaking strain. Say a pair of blocks two and three sheaves with 1⅛ in. rope, what is the working power and breaking strain on blocks and fold? On table working strain is 10·2 × 5 = 51 cwts. working strain on blocks, and divided by 3 is 17 tons, breaking strain on blocks, and this divided by 5, the number of folds, gives 3·4 tons as breaking strain on fold.

J. Hovell.

ACCUMULATING AND UTILIZING POWER.

[107] Sir,—Will you allow me space to make a few remarks upon your correspondent's query upon the above as contained in your journal of the 1st inst. which I have just seen? "River Plater" asks if it is possible to accumulate sufficient power, whether by means of horse or wind, as to be available at some future time. I shall not attempt to answer such, but will state what I heard in the River Plate (Buenos Ayres) in 1857. When locomotives were first introduced on the Western Railway, a native asked me what was the power of each locomotive. I told him so much. His reply was, "How so: I do not see any horses in the machine? where do you put them?" and when the steam was issuing from the funnel, a cry was set up it was "white magic." There are such objections as your correspondent points out, attending the cost of coal, but to wait until the plantations are large enough to supply the fuel consumption is absurd, because colonization increases in a much greater ratio than the fuel (trees) can, being only planted lately.

To invent a machine that shall have a spring (so to speak) capable of being wound up to supply power for even the next day, for such a thing as a Fowler plough, would be attended with considerable difficulties. Now to accumulate the power of horse or wind to such an extent is impossible. Water power is considered the most available from day to day. Under ordinary circumstances we can depend upon it, yet in the River Plate provinces such is not at all to be depended upon. I have crossed the "Somberambom" when my horse could skip across, and in a few months I have ridden fifteen miles through water before coming to the same river. Having spent several years in this country I am enabled to speak from experience.

I should try and introduce the "Aydon Liquid Fuel" as being cheaper, a more ready generator of steam, and far better for transportation.

There are other materials for fuel in the sister empire far better, and less expensive, than coal.

J. G.

TO MILLERS.

[108] Sir,—Perhaps some of your correspondents will give me their opinion respecting fast or moderate grinding—say, whether they prefer six to eight bushels per hour, or from three and a half to four bushels per hour. It is my opinion in fast grinding you lose your colour, also your length. But there may be some one that can tell how to get both. I have heard a great deal about Bovill's cold blast and exhaust; the cold blast I am hard of believing in. But, as I say, perhaps some of your more intelligent correspondents may give me their opinion respecting it. Also, what length should you have a silk for (say) six pairs of stones grinding (say) four bushels per hour.

A Subscriber.

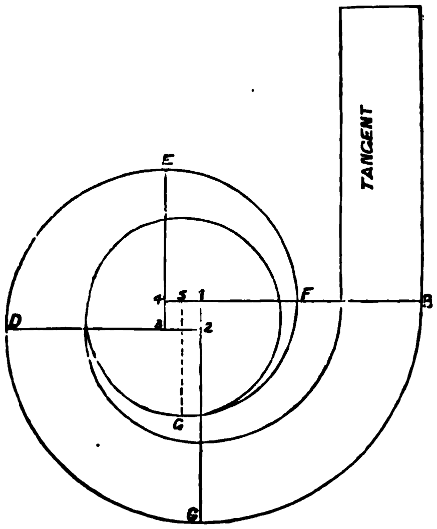
THE SUN'S PARALLAX.

[109] Sir,—Referring to "Hugo's" letter upon the sun's parallax, on page 402 of the English Mechanic of July 15, 1870, before answering that letter, will you be kind enough to allow me to ask "Hugo" to test or verify his figure by actual calculation, as he says "he is confident the parallax thus formed will be that which is generally accepted to be true?" The mean parallax of the sun is given by some at 8″·91, and by others at 8″·65, &c., &c. "Hugo," I submit, is bound in honour to give by actual calculation what he considers the "true" mean parallax of the sun, because he has said that which has been given by "Veritas" is not "true;" otherwise, how does he know?

Veritas.

HANDRAIL SCROLL STRUCK FROM FIVE POINTS ONLY.

[110] Sir,—Enclosed you have an illustration to strike out a handrail scroll (or curtail block). Should you think it worth inserting in your valuable paper you are at liberty to do so. First make a parallelogram 1-10th part from D to B, the width to be ⅔rds of the 1-10th. Draw a line 1 to B = 5½ times 1 to 4. Describe with radius 1, B to C; 2, C to D; 3, D to E; 4, E to F; 5, F to G, from centre of parallelogram and describe a



circle. The inner line of the rail is described parallel to the outer one; this will always give the open space required for the hand.
Cymro.

THE "PHŒNIX" VELOCIPEDE.

[111] Sir,—Having been greatly interested in seeing the numerous and varied descriptions of velocipedes which have been illustrated and described in the pages of your interesting and valuable paper, I wish to offer to your readers a brief outline of a three-wheeler, the capabilities and qualities of which I have fully tested during the last twelve months. I have named it the "Phœnix," partly on account of several important parts having been used in a somewhat similar machine made by my father over twenty years ago. It is constructed to carry two persons; the front wheel (3ft. diameter) is fitted with a steel axle and cranks; and is mounted in a fork with a steering handle on the top, exactly similar to the front part of an ordinary bicycle. The two hind wheels, each 3ft. 6in. diameter, are firmly fixed on the ends of separate axles; the inner ends of these axles working in one bush fitted in the frame, gives the appearance of being only one axle. On about the middle of each of these axles is fitted a steel ratchet wheel, and loosely over these are cases having each three pawls; these cases have grooves on the outside in which are secured the ends of strong catgut cords, in which passing over the cases go down to levers or treadles provided with india-rubber footsteps; the levers are also connected together by a catgut cord, which passing over a roller, so the descending lever lifts the other. The advantages gained by this arrangement of three wheels are—great facility of steering, especially turning sharp curves, as each wheel being on a separate axle they work independently of each other; the ratchet wheel and lever arrangement for driving the hind wheels gives a powerful and convenient mode of working for the second rider; and there being no dead points (as with cranks), in whatever position the levers are placed at stopping, they are right for starting. In going down hill he can rest his feet on the steps, as the wheels can go independently of them. It will be seen from the description of the front part that the rider thereon works and steers just the same as on the ordinary bicycle. For two riders I consider it to be the best machine I have yet seen or read of, and shall be glad to learn the opinion of my fellow readers of the English Mechanic.
W. D. R.

BICYCLE RIDING.

[112] Sir,—Your correspondent "N. O. Lamborne" asks for answers to several questions which, as a practical bicycle rider having had fifteen months' experience, I think can be easily answered. It does not require any great amount of practice to enable any lad to ride on a smooth road. A week, with an hour each day, would be amply sufficient. Of course some care must be exercised, but nothing extraordinary. If the bicycle is bad the best of riders could not prevent it wobbling, but unless the road is an extraordinarily bad one this would not happen with a good machine. There is no danger to a practised rider when passing a waggon in a narrow road, for the bicycle has an advantage over any other vehicle in that it can run in so little space, besides being able to run into the grass if that skirts the road, or into the gutter if in a town road. I never saw any danger of falling in turning a sharp corner, but cannot say if there would be if going at great speed, which is a dangerous proceeding with any vehicle. Power over the machine is lessened, but never lost with a good rider, and if the front wheel rubs the thigh it is an evidence the rider needs practice. It is possible, but not likely to happen to a good rider, to put his leg through the front wheel any more than the hind one.

The comparison between the sitting on a low chair placing the feet 18in. forward, and then trying to rise may perhaps apply to a case where the seat of the bicycle is far back on the spring, but in my machine you are so well forward that one may almost say they sit over the front wheel, which, by the bye, I believe is rather a rarity, although a great benefit to the rider.

I shall believe in ruptures when I have some personal knowledge of their having resulted from riding.

As regards personal injury in jumping, or rather bucking, on to the bicycle there is no necessity to do so with the majority of machines.

Upon coming to a very steep hill you have only to ask yourself which would be the easiest, to work the machine up to it, or get off and walk it up, in which latter case there is no need to dirty oneself. I think I have answered most of the questions, if not all, fairly, but I must say that the space you have granted this letter is wasted, for had "N. O. Lamborne" asked any bicyclist the same questions I have no doubt he would have obtained the same answers. I quite agree with those correspondents who speak of the nonsense so often sent you respecting the new machine. I feel sure that many who write never sat on one for five consecutive minutes, and believe that many who abuse it gave up just when they were getting into the use of it, for I have never met with any one who had ridden a machine for any length of time but who would say with me, "Bless the man who invented them," and rejoice over the many happy hours they have experienced since becoming practised riders.
E. S.

MILLSTONE BALANCING. FEEDING BOILERS.

[113] Sir,—Kindly allow me space in your valuable paper for a little say on mill-stone balancing.

I often wonder that no one has noticed the fact that mill-stones are usually balanced by digging a hole in the back and filling in with lead in order to counterbalance an overplus of weight in a bur or burs in the face at the opposite side. Now, as the lead is 5in. above, and the heavy bur or burs (intended to be counterbalanced) 5in. below the centre of the bar or bale, the consequence must be that as soon as the stone gets into a swing, centrifugal force must bring the lead down and the heavy bur up, just as the balls of a governor have a tendency to rise to the level of fulcrum on which they are hung; now, if my dusty brothers who are troubled with stones being out of standing or running balance, will only dig out a hole between the hoops as near as possible to the nipple of the slow spindles, and pour in the necessary weight of lead, I do not doubt they will find the stone cured of its tendency to roam. I have known millers who prefer the plan to balance boxes, because it is not possible to get out of order.

In reading Jas. Baskerville's criticism's on Llah's water heater, which I thought an excellent plan for feeding a boiler with one pump, I trust I shall not be intruding if I describe a water heater which I put up in 1863, and have still at work—the engine, a 10-horse beam. I pump the cold water directly into the exhaust pipe, a few feet from the cylinder, the exhaust pipe going horizontally to the heater or depositing reservoir, as it may be called, as the water is really heated by the exhaust steam, driving it into the heater in the shape of a fine spray, thereby heating it nearly, or quite, to 212 degrees, as can be proved by drawing out of the suction pipe of the hot water pump through a tap, when a pail full of water so heated will register 207 degrees; by this means the water deposits its silex in the heater instead of carrying it into the boiler. My heater is 7ft. long by 14in. diameter, lying in a line with the exhaust pipe, and I can hear the spray blown to the end at every stroke of the engine. I have an overflow pipe at the middle, also one rising to the open air. I condense many gallons of water by this means, and save fuel. I have seen somewhere that 9 degrees of heat in boiler-feed is equivalent to 1 per cent. of fuel saved, so conclude that I save 18 per cent., besides the advantage of having soft water for the boiler. I am obliged to clean the exhaust pipe once a year from silex, as I once had it form so thick as not to be able to drive one pair of stones with 45lbs. of steam. I also find it necessary to have the heater a little above the hot water pump, or it will not draw.
One Eye.

PROFESSOR PRITCHARD'S REVIEW OF "OTHER WORLDS."

[114] Sir.—As an old reader, may I be allowed to enter a word of protest against that practice of indulging in personalities, which every now and then crops out in your "Correspondence" column? Although it may be highly entertaining and gratifying to the taste of some, I think I may say with truth that it is quite otherwise to the majority of your subscribers.

I think Mr. Proctor has shown very bad taste in criticising Professor Pritchard's review of "Other Worlds." In the first place, for answering the critique at all, since if it be an unfair one the merits of the book itself will themselves answer the criticism, and if the review did not do it an injustice, why, the less said about it the better. Then, in the second place, I do not think it was exactly the right sort of thing for Mr. Proctor to insert letters upon a review (which appeared in another publication) in the English Mechanic, which perhaps Professor Pritchard does not ordinarily see. It seems very much like trying to steal a march upon Professor Pritchard. I am afraid that Mr. Proctor is very thin-skinned.
Charles Brandon.

THE BICYCLE.

[115] Sir,—As a votary of the bicycle I ask the liberty of answering N. G. Lamborne's questions on this subject (page 376). The number of his questions must be an excuse for brevity in my answers.

With an hours daily practice one will learn to ride over a smooth road without falling in a week. The twisting motion on a bad road would no doubt arise from the inexperience or carelessness of the rider or his desire to avoid all stones so as to save his machine (and India rubber tyres) from getting over them. If the curvilinear motion was in reality to keep the rider from falling he must not have been up to much and ought therefore to be free from all judgment. There is the same danger that the fusee will touch one's nose in lighting a cigar as that a bicycle rider will run into a carriage; in all such cases take care, trust in Providence. There is no fear, to one up to it little possibility, of falling in turning. By the ex-position of the crank in turning mechanical power may be lost, but not such as to cause any inconvenience to an adept. The "power over the machine" is not lost by any ex-position of the crank. In common turning the wheel does not rub against the thigh. It is only in very short turning that it does so. Bicyles are now provided with leg-guards which do away with all thigh-rubbing. There is no more chance or danger of the foot going through the spokes while riding than of one foot catching behind the other when running or walking. No resemblance whatever. The thrust in a bicycle is between a forward and a downward pressure. The force is similar to that required to push the chair backward with the foot resting on a low firm stool. The same danger above exemplified. A railway guard in stepping from a moving train runs a similar danger. He *might* slip. Very likely. The papers delight in these things. Railway accidents, &c. Place the hand on the spring somewhere behind the saddle and walk alongside. Or, if the hill is very steep, rest the elbow of one arm upon the saddle and guide with the other hand. The saddle is as good as any walking stick. "Lugging" is a word that cannot be used to the bicycle unless it is made on the waggon principle.

Bicycle riding being comparatively speaking something new, is looked upon by John Bull in his usual philosophic style. That wary gentleman accepts nothing in a hurry. Shaking his head, his story is "It may be all right, but I don't know yet." He very well exemplifies "Novalis's,' statement that to become properly convinced of any fact you must first have disbelieved it and disputed against it. That is his plan of welcoming all novelties. The French are different. They are at once enthusiastic, and the bicycle is the machine for them. It is *their* machine. But though John Bull is too solid and conservative to trust himself at once on two wheels, yet he is turning round, so much so that I'm convinced he will in a few years adopt the bicycle as a useful and pleasant mode of conveyance.

When I got a bicycle and began to practice on it most people hereabouts pronounced it as folly. "A great deal of hard work," and that it "would have its day" was the usual cry; but twelve months have altered their opinions, for upwards of two dozen fellows of our small town have since become riders.

In further answering "N. S. L." I may state that undoubtedly the bicycle is a better machine in every way than the three or four wheeler. I speak from my own knowledge. Let "N. S. L." and all his proselytes learn thoroughly the use of the bicycle—which, it is evident, *he* knows as yet little about—and they will at once discard the multicycles. It requires less exertion to drive. The force applied is direct and in the proper and most natural and easy direction. It is safer and quicker in turning—with many other indisputable etceteras.

I have never yet gone fifty miles at a stretch, but in this respect I'm behind many of my brother riders. But I can ride over most hills, although over some the sweating (not so much the labour) is great.

There is still one "moot point" to be settled which "S. James" (page 374) has already laid before your readers. We want an impartial and well grounded medical opinion which must be given in full length, with causes, effects, and reasons, whys and wherefores all annexed. For my part I can say that I have ridden continuously for hours together and never felt any evil or rupturous effects.
Husband.

THE FLUTE.

[116] Sir,—In this week's English Mechanic I see that a correspondent, "T. S. G.," advises "Stiff Fingers" to play in certain keys and to produce some of the others by the tuning slide. He says "the music being in D flat he should by means of his slide tune to the D flat of the piano." It is quite evident that "T. S. G." has had but little experience, or he could not have advised such a course. The smaller a flute is, the nearer the holes and keys must be together. In a piccolo, for instance, the distance between the holes is only *half of what it is in* the concert flute. If a flute is lengthened *by the tuning* slide, it must play out of tune—*particularly in the upper* octave. The tuning slide is only *intended to alter the* pitch very slightly, say ⅛, or at the *most, ¼ of a tone.*
J. R. Rendell.

SWIMMING, A SUMMER PASTIME.

[117] Sir,—I wish to thank "T. S. H." for his verification of my determination of spherical route of circumnavigation, and in reply to his call for a few notes on swimming, I beg to offer a few from my own experience. I had a wish to learn this art from early life, but my avocations led me generally inland, and to places where practice was impossible, till I had passed the middle term of human life. At last I came to within a mile of convenient water, and although my past limited experience led me to suspect that I was specifically *heavier* than water, as my efforts to swim were always brought to a termination by the sinking of the whole body, head included, below the water, still I *resolved* to bring the matter to a test of a whole season's daily practice before considering my suspicion confirmed. For some time this was like to be the case, but at length, in one of my daily trials, I found my head, quite unexpectedly, above water. I was at a loss then to assign a satisfactory reason for this result, for I had often struck with both hands and feet precisely, so I thought, in the same way, with a different result. Be this as it may, I never sank after this, and I found myself on each successive daily trial able to accomplish a few more strokes, till at length I swam on one occasion, fifty minutes without feeling cold or fatigue, and without touching the bottom. I need hardly say that the practice still continues to be a source of refreshing enjoyment to me: but although I can swim quite comfortably for a long time, when allowed to do so leisurely, still I find myself a *slow* swimmer whatever efforts I choose to make. I am at a loss to explain to myself the reason why; but the reason of my early failures, the sinking above referred to, I now conceive to be that I unconsciously kept my head in line, or nearly so, with my body, whereas there ought to be an angle somewhere about 135 degrees between the axis lines of the body and the head. This angle is not quite so easy a matter to obtain as could be wished, and here lies the difficulty, in my opinion. We experience in learning to swim, a difficulty peculiar to man as distinguished, by form, from many animals that swim with ease on the first trial; and hence also the desirableness of learning to swim on the side and back, in which position the angle at the back of the neck becomes 180 degrees, and the position is consequently one of complete rest. Not only is it a position of rest, but the body floats without any tendency whatever to sink, with no muscular effort in either arms or legs; a very slight effort in the muscles of the loins being all that is necessary, so far as I can judge, to preserve the linear position of the body from head to feet. In this position there is about 1in., vertical section, of the face that positively *will not sink.* The effort to throw the head under water results in a deeper immersion of the forehead with a greater corresponding elevation of the mouth, and thus the position is a most happy one to rest in for any required time, or even to wash the feet and body generally with both hands, for it appears to me generally certain that the floating of the body does not depend, in any sensible degree, on the position of the arms so long as they are kept under water. I conclude generally that to swim swiftly and gracefully is a difficult matter for most men; but that every man's body *will float,* and that almost any action with feet and hands, all four at once, or any pair at once, will produce progression, more or less swiftly and gracefully according to the symmetrical action of the whole system.
M. L.

M. de Lesseps is reaping the reward of his ingenuity. He has been fêted everywhere, and is shortly to be presented with the freedom of the City of London.

EXTRACTS FROM CORRESPONDENCE.

◆

GAS.—"J. G." says:—"I do not however agree with your correspondent's remark that, 'Carburetting Gas' is at present not a practical process. The Commissioners of Sewers for the City were so alive to the benefit derived by such process that they ordered 1800 to be fitted to the street lamps according to the principle of Mr. J. Ridd finding a saving of about 30 per cent. by their adoption. Mr. George Glover, the gas meter manufacturer, also proved the benefits to be derived by their adoption, the illuminating power caused by their introduction was about 43 per cent. The Midland Railway Company have had them fitted to their pendant lamps at the new station at St. Pancras, beside which numerous private firms have adopted this improved system, thus proving that your correspondent's remarks are not tenable."

CURIOUS QUESTIONS.—"J. B." says:—"In reply to R. Gould's first question (page 378), *there will be no difference* because the ball, atmosphere, and all else on the earth's surface partake of the earth's motion, "orbital" and rotatory, which consequently in no wise affect the *relative* motions or positions of such objects and the earth *inter se*. Secondly, if the word 'space' is intended to mean 'as measured on the earth's surface,' there will *be no difference*, but if it be taken in any other sense the difference will be so much, plus or minus, as may be caused by the earth's motion during the flight of the ball."

TRADE AND COMMERCE.—"Sigma" concludes a long and elaborate letter on this subject thus:—"Last and most crushing of all, we have had five-and-twenty years' experience of the working of free trade and ought now to be in a position to judge of its effects.' True—what is the total population now and twenty-five years ago, what the total income or even the average income of the nation? If free trade is a losing game, gradually impoverishing us, how were our railways made; where did the shipping come from which covers every sea; whence came the capital sunk in establishing colonies for our extra numbers? In fact has the supposed loss diminished our capital, and how? In London alone each year a new city is built. Walk through its bounds and count how many miles of houses there are requiring large incomes to support. Whence those incomes, whence our increasing national revenue? Take a fair view of the present and twenty-five years ago. Look on this picture and on that, and verily if these results be the inevitable consequence of annual loss and impoverishment, then, but only then, is free trade a failure."

POWER LOOMS.—"J. W." says:—"I hope shortly to be able to furnish you with drawings and description of some valuable and beautiful improvements in power looms which I am now patenting. I have had two of our principal English machine makers here to see them within a few days, including Platts, of Oldham, who appear to attach importance to the invention—and I expect to be in Manchester next week with the view of exhibiting the machines and of arranging some licenses."

REPLIES TO QUERIES.

◆

[2637.]—ELECTRIC LOCOMOTIVE.—There is not I believe as yet discovered any *practical* mode of obtaining motion from electricity which is capable of being utilized. The reason being that the law of "magnetism" which seems to be the only form in which it can be employed is that the force varies *inversely as the square of the distance* from the magnet, which obviously reduces its available power to within exceedingly narrow limits and consequently almost forbids its use as a mechanical power.—J. B.

[2642.]—FISHING RODS.—"A Young Tyke" requires hints how to make a fishing rod about five yards long. The very best advice I can give is "don't." Such work is done by skilled workmen so cheaply that it don't "pay" to do it oneself. I have been guilty of that folly in my *youthful* (? verdant) days; but long ago I became a good boy and "didn't do it *no* more." If "A Young Tyke" had any idea what it would cost him for the mandrels, or triblets, on which the ferules must be hammer hardened (or their mouths will become anything but musical *trumpets*), the tools required to bore out the joints, the difficulty of making one joint go straight into the other (unless you do as I did—viz., bore them in a suitable wooden pillow-block, which I had to make for the purpose in the lathe), and the time it takes an amateur, who is seldom so much of an expert at such operations as even my humble self, to do this work he would thankfully receive my good advice, "*don't*"—and not set to work on operations as little worthy his time as grinding specula, or lenses for O. G.'s and eyepieces, would be worthy to occupy the time of an observer like our "F.R.A.S.", which I suspect might be more nobly and worthily employed in reviewing "The Fuel of the Sun," or viewing that luminary himself. Some advice I tender. Don't make a rod, or have one made—unless it is to be only one of several rods—so short as five yards. Make it seven yards while you are about it, and have two extra short extra butts made to it, one to receive its largest joint, and the other the next joint. You will have, supposing the rod has five joints (never have more), seven yards; six yards, and four and a half yards, quite sufficient variety for all purposes. The best kind of wood is, in my opinion, well-selected South Carolina bamboo cane. A north cane top, with a point of split jungle about a foot long I prefer to any other, but a good *hard* piece of south, although from its numerous channels ugly, answers very well, and north is difficult to procure sufficiently long and taper to make a first rate top a yard long.—THE HARMONIOUS BLACKSMITH.

[2643.]—IRON PRISM.—Original size of prism is 3ft. long by 9in. wide, and deep plate required will be 54in. square by 1in. thick.—J. B.

[2643.]—IRON PRISM.—If I understand the question aright a square prism of iron containing 2,916 cubic inches is to be flattened into a square plate of uniform thickness, containing the same number of superficial inches, required the size of iron plate. Therefore $\surd 2916 = 54$ inches = side of square plate 1 inch in thickness.—HARRY G. NEWTON.

[2643.]—IRON PRISM.—How can a superficies which consists of square inches be equal to solidity, which is a cubic measurement. Also what has the shape of the prism to do with the form of the plate that has to be made out of it, which latter we are told is to be square and of uniform thickness?—J. K. P.

[2652.]—SULPHATE OF ZINC.—Extract. "Sulphate of zinc, or white vitrol, $ZnO,SO^3 + 7HO$ is prepared by dissolving the metal in dilute sulphuric acid, or more economically by roasting the native sulphuret or blende, which by absorbing oxygen becomes to a great extent converted into the sulphate of oxide; the mineral is then thrown into hot water and the salt is obtained by evaporating the clear solution. This salt closely resembles sulphate of magnesia in appearance, it has an astringent metallic taste, and is sometimes used as an emetic; the crystals are more soluble in cold than in hot water. This salt forms double salts with the sulphates of potash and ammonia."—HARRY G. NEWTON.

[2668.]—SKETCHING FROM NATURE.—At Johnson & Son's, 18a, Basinghall-street. Acetate of cobalt, 2s. oz.; muriate, 1s. 6d.—R. SEDGFIELD.

[2677.]—HYDROGEN GAS FOR BALLOON.—Many more *details* are needful to enable a truly correct answer to be given to this query. The weight of the ballon, the height of the barometer and the purity of the gas must be first ascertained. But assuming the gas to be pure, its specific gravity is 0·555 as compared with one of atmospheric air, consequently 1,000ft. of gas will support in air 41·399lb., and if your correspondent will calculate on this basis the number of feet of gas which will lift himself and his balloon the weight of *which last* he must assume or ascertain, the cube root of that quantity divided by 3·141 will give him the radius of the *spherical* balloon which will contain it with sufficient accuracy for his purposes, which I venture to presume are not practical.—J. B.

[2694.]—ENGINE CHIMNEY.—I am of opinion that a chimney 25 yards high having a flue 3ft. in diameter will do the work required by "A Subscriber."—K.

[3716.]—RELACQUERING BRASS WORK.—Brass is dipped by passing it quickly in and out of the nitric acid. If the action does not take place during the first second the leaving the articles in longer only turns them black. The process should be thus to dip articles bright: Scrub them after taking them out of the soda water with sand and a brush, then briskly pass them through the acid, and immediately wash them in a pail of clean water or hold them under a pump. If not quite clean after the first dip scrub the part again, and put through the process a second time, only remember that the oftener they are dipped the more dead the colour will become. A little urine to dip articles into before passing through the acid and after scrubbing has sometimes a very good effect; eventually dry out by stirring articles up in a bin of sawdust. The quicker these processes are gone through the brighter and better the work will become.—WM. HOLMES.

[3716.]—RELACQUERING BRASSWORK.—In the first place, if the brasswork is very dirty, and not come clean enough for the acid to act on, it should be left in the acid for some time, then dipped in fresh acid; but before being dipped in the fresh acid, he must take care that all the dirt is removed before being dipped again. The reason of the articles turning black is because they are not properly clean before dipping, the old acid will make very good pickle.—W. SEABROOK.

[3726.]—CHROME BLACKS.—"For 10lb. of wool or woollen cloth," boil one hour in a solution of 4oz. chrome, 4oz. of bittartrate of potash (cream of tartar); then wash out of this solution, and boil in a solution of 10lb. of logwood for one hour.—R. R., Rochdale.

[3738, 3766.]—BAROMETER TUBES.—Without knowing of what the film is composed it is difficult to say what will remove it. But a strong solution of soda, with or without heat, would be very likely to do so if well shaken, and some small shot inserted in the tubes at same time might by their friction expedite the process. The tubes may be filled by inserting the mercury by little and little into the siphon end and shaking it so as to allow the air to escape through it, or the air in the tube may be rarefied by heat, and if the lower end be then plunged in mercury, the air as it contracts in cooling will draw it in and this process must be in either case repeated till the tube is quite full, when it should be held upright so as to allow the excess of mercury to run off. For philosophical purposes greater care, and more adjustment and calculation, is needed than can be explained in few words.—J. B.

[3781.]—PHOTOGRAPHY.—There are various changing boxes made for the dry process, but they are all rather difficult to explain without several drawings. "P. M.'s" best plan would be to call at some maker's, and examine one. The vertical developing-bath is never used nowadays: it is a wasteful plan. If "P. M." finds a difficulty in getting the developer to flow over the plate, let him add to each pint, from one to two *grains* of common gelatine dissolved in a little warm water. It will then flow readily, without streaks and markings, which are sometimes difficult to avoid without the gelatine.—R. S.

[3807.]—PAINTING STONES IN JEWELLERY.—If "T. G." will examine the setting of any coloured stone, he will find that the silver foil placed behind it is lacquered of the same colour as the stone is intended to be. Some stones are capable of having an artificial colour imparted to them by heat.—A. S. C.

[3832.]—BURNISHING PLATE.—The tool he requires is an ordinary steel burnisher, which can be obtained at any tool shop. He must rub the scratches well with it, and he will soon find them disappear.—W. SEABROOK.

[3842.]—STEEL WIRE.—I did not answer "J. R. T." (3842) for the worst of all possible reasons—*i. e.* because of mine incompetence to do so. I may as well remind him, if he has not yet become tired of his fad of model church erection (by the way he had much better go to one ready built), that small bells only cost a few pence each, and what he calls wire gongs have a very disagreeable tone.—THE HARMONIOUS BLACKSMITH.

[3844.]—ENTOMOLOGICAL QUERY.—Larva of *Cosmia trapesina* is of a dirty green colour, with its dorsal, subdorsal, and spiracular lines white and spotted with dark green. Let "E. N." beware of the larva of *Scopelosoma satellitia* also. It is dark black-brown, with three white lines on the second segment, and a white spot on the second, third, fourth, fifth, and twelfth segments, below the spiracular line.—AUTOMEDON.

[3844.]—ENTOMOLOGICAL QUERY.—I send for "E. N." the description of *C. Trapezina* (larva), as given in "Stainton's Manual," vol. 1, page 258, "Larva greenish with the dorsal, sub-dorsal, and spiracular lines white; the spots black or dark green. On oak, birch, &c., especially fond of other caterpillars," appears in May and June, abundant everywhere.—A. S. C.

[3849.]—STUFFED CANARY.—"Excelsior" can clean his canary by rubbing it with a piece of clean white wadding. Afterwards he may pound a small piece of chrome yellow and sprinkle upon it and then brush off off again with the wadding, tempering it to the shade with dry whiting.—IGNORANT.

[3858.]—HOLE IN EARTHENWARE.—I think if H. Joseph drills a circle of holes, 1in. diameter, with a small Archimedian drill, and knocks the centre out, he can file it down smooth with a medium file.—H. A. C.

[3858.]—HOLE IN EARTHENWARE JAR.—A hole may be bored by a common blacksmith's drill used lightly, and it had better be not more than ¼in., after which the hole can be enlarged to any size with a half round file; or a sharp point, with repeated blows of a light hammer, will quickly penetrate the jar, care being taken not to strike so hard as to cause a crack, and the point to be kept moving from place to place.—J. B.

[3859.]—FLORENTINE BRONZE.—In answer to H. Joseph, I beg to inform him that to bronze the articles he inquires about, he should boil them in strong soda water, scrub them with sand, and dip them in aqua fortis; then lay them in a weak solution of the same acid, about one part acid to eight of water, into which he must put some pieces of iron wire; he will find them turn a red colour. After leaving them about two hours, take them out, dry them, and lacquer them with red lacquer.—W. SEABROOK.

[3873.]—BOOKBINDERS' GLUE.—The best method of making the above is to break the glue into small pieces; then put it into a glue-pot; cover it with cold water, and put it on the fire; stir it up frequently, and, when melted sufficient, use it hot. It must not be too thin or too thick. A little practice will soon put you right.—J. PLASTANS, 55, Dale End, Birmingham.

[3875.]—BLEACHING POWDER.—Bleaching powder is made as follows:—It is a mixture of calcium hypochlorite, or chloride. It is produced by the action of chlorine gas upon moist slaked lime. The gas is passed in rooms, on the floor of which is laid the lime 2in. thick, which absorbs the chlorine, and the powder is formed. "When treated with a small quantity of a dilute acid, hypochlorous acid is liberated, and may be distilled over. Hereby an aqueous solution is obtained as a colourless liquid, having a peculiar smell and bleaching properties. If a larger quantity of acid be added, the hypochlorous acid itself is decomposed into hydrochloric acid and oxygen. Hence, in bleaching, the goods are first dipped into a solution of bleaching powder, and then passed through a dilute acid, whereby hypochlorous acid is formed and decomposed, liberating chlorine in the fibre of the cloth. The bleaching effect is therefore only visible after the goods have been 'soured,' or dipped in acid." (See Roscoe's "Chemistry.")—H. A. C.

[3877.]—RETINNING HOLLOW WARE.—Well clean the inside, and lay them in a bath of muriatic acid; then put some muriatic acid and sal ammoniac in and a piece of tin; hold them over a coke fire till the tin melts; then with a piece of tow wipe the tin round the inside; leave them till cold, and rince them in water.—W SEABROOK.

[3941.]—MARKING.—The best way to apply printers' ink is as follows:—Get a little cotton wool; tie it up in a little soft leather; put a little ink on it, and dab it on a flat surface, either iron or stone, till it is spread even. Then dab it on the type till it is inked all over; then press the type on the article you want to mark. Writing marking ink is far more durable.—J. PLASTANS.

[3985.]—FLEXIBLE PIPE.—India rubber canvas hose pipes (vulcanized) will stand hot water, and so will leather, but if only a small size is required vulcanized India rubber will be found cheapest.—H. U.

[3989.]—SCREW ENGINE FOR CANOE.—What does "A Young Subscriber" mean by wanting an engine for a "canoe." Either his boat is not a canoe or he wants to alter it into a steam "launch." What is really the shape of it, and what is the width? He says in his query about 2½ft.—H. U.

[3993.]—PASSAGE TO NATAL.—"A Cornishman" will find that the "best" way to get to Natal is to take a first-class berth on board the mail steamer; the "cheapest" is to *work* a passage out. Seriously, there is a regular line of traders to Natal leaving London, and he might find a captain willing to take him for his labour and a money consideration.—H.U.

[3996.]—BOOKBINDING.—Brass type would be best for "An Amateur;" it requires great care, and a deal of practice, to use single letters. Leather is all prices, from 2s. 6d. to 12s. per skin; calf and morocco are very dear; bookbinders' cloth, from 8d. or 9d. per yard.—J. PLASTANS.

[3999.]—CYLINDER.—If "Ixion" gave the size and weight of his steam carriage he might expect some one to give him the dimensions of cylinders for it. How it is possible to say what size they ought to be without knowing the work required of them I do not comprehend.—H. U.

[4007.]—CURING HERRINGS.—I do not imagine Mr. Baskerville is likely to find a book containing any authentic directions for the process he requires, so I will tell him what I know about the matter. The method of curing herrings varies with the place of curing, and the state of the herrings. At Yarmouth, off which port the shoal is in prime condition, two methods are pursued, and the fish are known by the names "bloaters" and "high-dried." The bulk of bloaters for the London market are simply taken from the boats and laid in barrels or troughs, with salt between each layer. After remaining in pickle 24 hours, they are hung up to dry in the smoking-houses, but they are not subjected to any large amount of smoke. They are ready for packing in three or four days, and are little more than fresh herrings dried, with just sufficient salt to keep them a week or so. The proper bloaters, although they are not kept in salt much longer, are really smoked over fires made of oak saw-dust (at least that is what should be used). They will keep some considerable time. The "high-dried," as their name implies, are kept in pickle till they are thoroughly impregnated with salt, and are then taken to the smoking-room, and allowed to hang there till they are, so to speak, "tanned," in which condition they will last a voyage round the world, and then be good. The Scotch herrings, and those caught in St. George's Channel, are made into "kippers" in large quantities, or else are treated to rather too much salt. The reason of this is, that the fish having spawned, the roe would only act as a predisposing cause of putrefaction, although, strictly speaking, this does not apply to Scotch herrings, which are turned into "kippers" for convenience in packing, especially as they are then worth as much commercially as the others, and farmers buy up the "offal" for manure.—SAUL RYMEA.

[4012.]—**WORM-EATEN ORGAN BARRELS.**—"Pupil" will find a solution of corrosive sublimate the best cure for worm-eaten wood. It is a violent poison, and great care should be exercised in using it. The ordinary price is 6d. the oz.—SAUL RYMEA.

[4054.]—**MICROSCOPIC INVESTIGATION WITH POLARIZED LIGHT.**—Micro-chemical testing differs from ordinary chemical analysis only in the use of the microscope to observe the effect of reagents, and I do not know that I can give "John Barleycorn" any hints which will be of any use to him, as he doubtless is already *au fait* at so much of chemical analysis as applies to testing for acetic acid. *Crystals* of acetic acid, like most, if not all crystals, will polarize, but only in the form of crystals. If "John Barleycorn" can persuade the acetic acid in his liquor to crystallize on his stage plate he may succeed in polarizing, but I suspect that it is usually found in so small a proportion that this will not be possible. For polariscopy objects must be mounted in balsam or in fluid (glycerine answers well for many objects), and the two glasses (that of the slide and cover), should be *thin*. The polarizer must be fixed in its place beneath the stage, the analyzer also being in its position, light should be thrown fairly into the polarizer by the *plane* mirror if possible, though the use of the plane mirror is not necessary, and the prism rotated to see if all light be cut off twice in each revolution. This is polariscopy in its simple form. Most of the objects commonly viewed by polarized light are seen by this arrangement in a ghostly kind of light on a dark ground, and if colour be wished the use of a thin film of selenite is needful. These are commonly used of such thickness as will give red and green, blue and orange, yellow and purple, the latter being by far the best. To secure the best effects it is necessary to "set" the analyzer relatively to the axis of the selenite used—this can be got by experiment, by slightly rotating the analyzer as well as the polarizer, till the best effect be obtained. Some objects require a special "setting" of the prisms, and it is usually advantageous to try all possible positions of both prisms, as much may in this way be learned, which otherwise would have remained unlearned. Of mere *beauty* I say nothing—polariscopists know what this is.—H. P.

[4127.]—**MOUNTING CHARTS.**—Any kind of cloth will do, but brown holland is, perhaps, the best. This should be *nailed* tightly and well strained on a drawing board and pasted. The map or print should be also pasted and damped till it lies *quite flat*, then place it on the cloth and press out air-bubbles with a cloth, lifting the paper at the edge to let the air escape when needed, and when completed, leave the whole to dry, and when quite dry, cut round the map with ruler and sharp knife, and the map will come off in a perfectly satisfactory state. If to be varnished, do so with mastic varnish, whilst on the board, sizing the paper first with weak isinglass size.—J. B.

[4128.]—**SETTING JEWELLED HOLES** is an easy matter, practised by many a workman who possesses self-reliance and a steady hand; it ought to be particularly useful to those who live in country towns. Finishers, and English workmen generally, being accustomed to cut hollows in wheels and pinions, and hold the graver in their own hands when using the mandrel, will find it comparatively easy, and certainly not so difficult as learning to cut a clean hollow in a "best" pinion. Of course, it requires a little practice, and more attention to one or two important details. The holes are bought by the gross and half-gross unset for English jewelling ready set in brass. I believe, by sending to the manufacturer's or tool-shop the size of any particular hole or holes, they can be obtained in smaller quantities, or of different sizes assorted. I should recommend the first attempts to be made in odd pieces of brass and steel, till the hand is fairly into it, before attempting to operate on a watch plate; these, if cleanly done, will serve some future time in English jewellings. The more precision and accuracy possessed, the better one is likely to suceed. Those who work in an anyhow sort of fashion should certainly leave it, and watchwork altogether, alone. The first and most important requisite is to centre the plate perfectly true to the hole to be jewelled; not that this is anything very difficult, but the accuracy of the work entirely depends upon it—the depth of the pitching is altered if not absolutely true. It must also run true in flat. The plate is chucked up on the platform P P of a tool (like Fig. 2) in wax or shellac, worked with a bow or treadle, or on a Swiss or English mandrel. When properly centred, the hole is opened to A A (Fig. 1), leaving enough substance to support the stone; the socket B B is next turned out to receive it. This is also essential to be fitted as closely as possible to keep the jewel properly centred; for if at all loosely fitted, besides being liable to get out of centre and upright, it will give great trouble to secure the stone by rubbing down the setting, and will never make a clean job. The stone is held while being fitted with shellac on the end of a piece of wire. The tool to measure the depth to sink the jewel is shown in Fig. 1. I do not know if this is exactly what professionals make use of, but am persuaded it is something of the sort, and know it will do perfectly well. E E are two legs, of a convenient length to rest on the plate or bottom of the sink cut out for the wheel, and F a screw or round rod, fitting so tightly in the bar as to allow of its being set as a gauge, and adjusted to the hole to be jewelled or replaced. The legs and bar can be filed out of one piece, or a simple bar, if both ends are supported on the surface of the plate, with F to adjust to the required depth. Sinking the jewel to the exact depth is the most difficult part of the whole operation, as it is easily sunk too deep, or the socket made wider, thus spoiling the fitting in the frequent retouches. When it is done, the plate is turned out a little way, flush, or nearly so, with the stone, to allow the groove C C forming the setting to be made. This rim or setting should be just thin enough to be easily rubbed down—if left too thick, the stone is apt to get broken in the effort to set it; on the other hand, it is liable to be cut too thin, or spoiled. The two or three tools required for rubbing down are easily made when their purpose is known, the shape M, edgeways N, will be found one of the most useful; no points or cutting edges are required, but rounded off, and burnished or polished at the acting parts. The gravers or cutters can also be made, just as finishers do, to cut any particular kind of hollow. To finish off the other side, the plate is turned to the other side, and the parts D D cut away to the stone without touching any part it rests on, either straight or curved, and polished. The above is for foreign work, where the jewels are set directly into the plates; the English jewels are in separate settings, which are fitted into the plate, and secured by two screws—G represents one. They are set in their settings exactly as above described, for which purpose the platform P P is taken off, and a piece of round brass fitted into the socket S S, the screw T will hold it firmly, the point is turned to a convenient shape, and the brass to form the setting waxed on. The continuation of the tool at R bears simply an English slide-rest; the platform is adjusted after it is brought either outside, as represented, or in the socket S. It will sometimes be found necessary, in foreign work, where the plate has been spoiled and a jewel cannot be found large enough, to set one in brass, and that as if it were a larger stone. The holes without end-stones are set from one side of the plate, and those with from the other, or that on which the end-stone is screwed on. H is the tool for sinking the screw-heads, I and L the end views, which, I think, can be made to cut sufficiently with a slitting-file; it can have a collet K fixed with a screw to sink any depth, or a shoulder turned on the drill itself. The magnetized balance is a sad job, and I can only confirm what H. Chapman has said, with the addition that it must not be placed in a drawer with any tools, or any other parts of watch work. It is much to be regretted that nothing has as yet been discovered that will demagnetize steel so completely as is required in horology. It would form a fair field of research for our electricians. I cannot understand why the watch should lose so much. If the hairspring were infected, two or more coils would adhere together, which would either make it gain or stop it altogether. It must be a horizontal watch, and both the wheel and the cylinder magnetized—if very strongly magnetized, would stop it. If such should be the case, there is no other resource but to replace the affected parts.—NOBODY.

FIG. 1

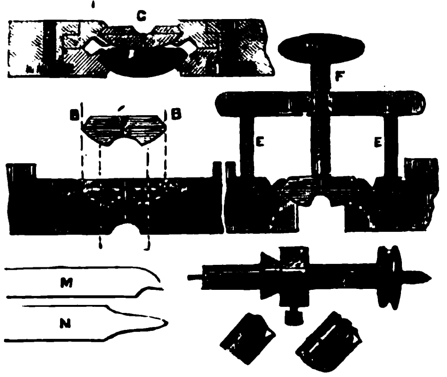
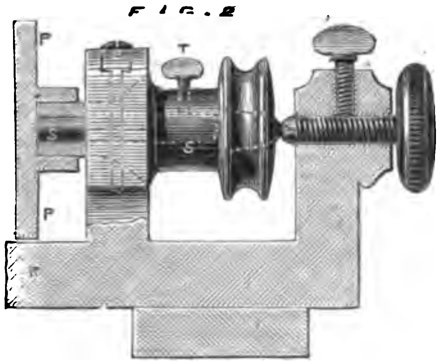


FIG. 2



[4156.]—**AQUARIUS.**—Try a work by Sir William Fairbairn on water-wheels. I believe he is the best authority. Messrs. Spon are the publishers, price 4s., sewed.—J. G.

[4156.]—**BOOK ON WATERWHEELS.**—Fairbairn's "Mills and Millwork" is perhaps the best.—AN ASSOCIATE OF THE ROYAL SCHOOL OF MINES.

[4159.]—**VINEGAR.**—I submit the following method for the preparation of vinegar to "E. H." (No. 4159, p. 358), known as the rapid process, now followed on the Continent to a large extent. A mixture is made consisting of 1 part of alcohol at 80 p. c., 4 to 6 parts of water, and 1-1000th part of a ferment, such as vinegar, honey, or the must of beer. A barrel with holes drilled in the middle and upper part, is then packed with twigs or shavings of beech, which have been soaked in strong vinegar. The mixture above mentioned is then warmed to 75° or 80°, and made to trickle slowly through the holes of the barrel upon the beech twigs or shavings, thus exposing an immense surface to the air. The temperature of the fluid rises rapidly to 95° or 105°, unless too small a quantity of air be admitted. When the mixture has been passed through the barrel three or four times it will be found sufficiently rectified to allow of decantation. "E. H." could favourably pursue the above process on a small scale, as from experience I find it yields a vinegar admirably suited for domestic and culinary purposes. Should the supply of oxygen—that is air—be deficient, much aldehyde is produced, which from its volatility is carried off as a vapour and lost. Any aromatic substance, essential oil, or even wood vinegar contaminated with kreosote, will arrest the progress of acetification.—WALTER J. NICHOLLS.

[4160.]—**KILLING MOTHS.**—If "J. C. S.," or your correspondent, p. 381, will try the following, I feel convinced they will at once abandon the chloroform, hot water, carbonic acid gas, and benzine methods of killing moths. Procure one ounce of cyanide of potassium, a little plaster of Paris, and a short, wide-mouthed, say 1½in. stoppered bottle, then mix the plaster of Paris with water to the consistence of thick cream, and pour it over the cyanide to the depth of ⅜in.; when set, cut out two or three discs of thin note paper, somewhat larger than the inside diameter of the bottle, and press them down on the surface of the plaster of Paris, and your apparatus is complete, compact, and in every respect convenient for killing moths and butterflies. It will also remain efficient for a couple of years or more, and the moths may, if required, be left in the bottle for weeks' when they will be found in a relaxed state for setting. I have just placed four large flesh flies, *Musca carnaria*, in my cyanide bottle, all of which were dead in twenty seconds, which is about the time required to kill a large moth. Two of the flies returned to life after remaining in the bottle ninety seconds. It is desirable, however, to leave moths in the bottle for a couple of hours before they are taken out and set. Entomologists, in their rambles, will find the cyanide bottle a most useful companion.—CYANIDE.

[4160.]—**KILLING MOTHS, ETC.**—I notice several brethren of the "net and pin persuasion" have given "J. C. S." information on this head, but neither seems to have used liquid ammonia. I find it has the great recommendation of leaving its victims beautifully relaxed for setting after death. My plan is first to stupefy specimens with chloroform and then transfer them for an hour or two into a jar (in separate chip boxes) into which has been previously dropped a piece of filter paper saturated with the liquid. For green insects it will not do, as it bleaches them. *Prussic acid* and chloroform make specimens too *rigid* for easy setting.—AUTOMEDON.

[4171.]—**BEES AND BEEKEEPING.**—"*Payne's Bee Book*" is published at 20, *Paternoster-row, price* 4d. I don't have any entrance in *the side of the cap of the hive*. Let the *hole in the top of the hive be about* 8in. square; place on this a piece of perforated zinc, *holes* 3-16ths of an inch; no other sized holes in the zinc should be used. I use old tea chests for caps 9in. square and 11in. deep; cut a hole in the top about 4in. square; on this place a piece of glass. No difficulty will be found in removing a cap or box of honey, as no brood will be there. Follow Payne's instructions, page 16.—J. LEE.

[4178.]—**MALLEABLE CAST IRON.**—Consult Percy's "Metallurgy," vol. ii., on iron and steel. Also the specifications of patents taken out under this head; these may be seen at the Patent Office. To render cast-iron malleable the articles are imbedded in powdered mine (*i.e.*, iron ore) or hammer scale, and heated for a certain time; a reaction between the oxygen of the ore and the carbon present in the cast iron is set up, carbonic anhydride is formed and escapes. The cast-iron is thus more or less decarburized, a more or less soft iron is produced; it is not truly malleable, it will not weld, but may be dented by a blow from a hammer. Inferior tools, &c., made in this way are termed "run steel" articles.—AN ASSOCIATE OF THE ROYAL SCHOOL OF MINES.

[4194.]—**PHOTOGRAPHY.—STAINS, &c.**—"W. G. C." can remove the stains produced by the silver solution by means of hyposulphite of soda or cyanide of potassium.—AN ASSOCIATE OF THE ROYAL SCHOOL OF MINES.

[4198.]—**GAS COOKING.**—There is a mistake in the statement of quantity of gas consumed. It should be, for a small fruit pie, from 2ft. to 2½ft. for a large pan of potatoes, or other vegetables, 2ft.—not 2ft. per lb. weight as stated.—THOS. FLETCHER.

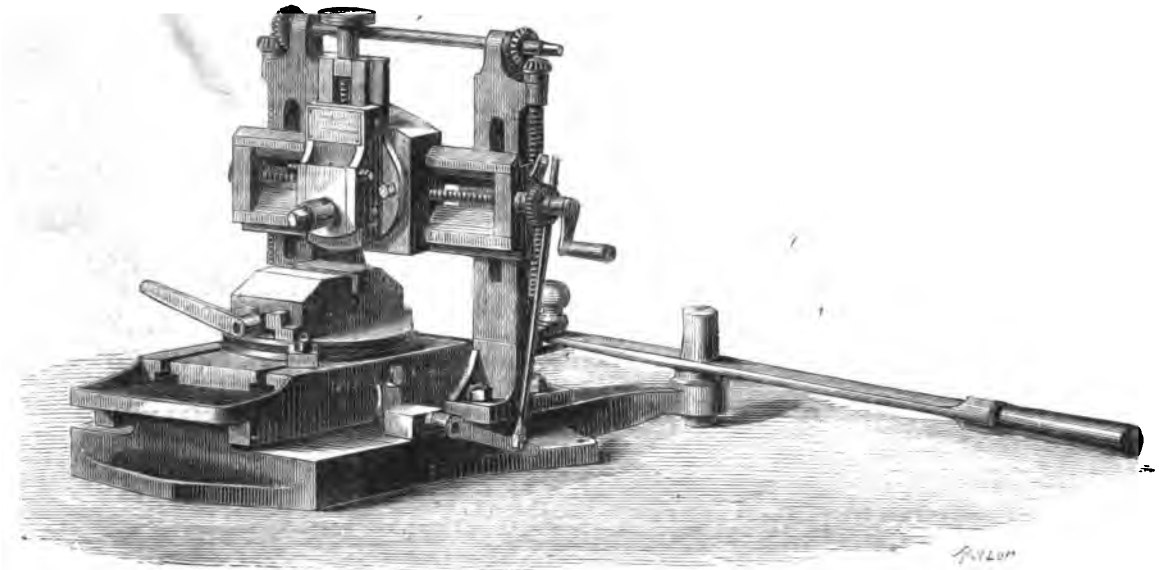
[4204.]—**DRAWING PENS.**—In reply to "T. M.," his failure in the use of his drawing pen may result from three causes—viz., first, from a bad pen; secondly, from the ink being too thin; and thirdly, by allowing too much space for the flow of the ink. As he is only a beginner, I would advise him to purchase a bottle of liquid drawing ink, which will cost only one shilling: this will save him much time and trouble, it being always ready for use when required. Now, as to the use of the pen. When you are going to work, see that the inside of the pen is clean and bright (remember, if it is dirty, the ink will never flow properly), then open the pen to a very slight extent, and with a pen, or still better, a camel-hair brush, put a small quantity of ink into the pen, then close it till the points just touch, when the pen is ready for use. After a little practice he will find no difficulty whatsoever in using it. When he commences to study the proportional compass, diagonal scale, universal scale, &c., let him, if he can, call on me, when I shall be most happy to give him all the instruction he may need.—THOMAS S. O'CONNOR, Wrexham.

[4204.]—**DRAWING PEN.**—As I understand "T. M." his fault lies in using too much liquid ink, instead of buying it in cakes and rubbing it for himself as required. The ink sold in bottles is gummy, and will not make fine lines. "T. M." must expect to have to replenish his pen continually (using a camel's hair brush for this purpose), as the great merit of Indian ink lies in its power of drying quickly.—R. P. T.

[4204.]—**DRAWING PEN.**—The difficulties of which "T. M." complains, and many others that he probably knows not of, will be removed by reading the second course of Binn's admirable work on "Orthographic Projection," and its application to mechanical and engineering drawings. See advertisement in the columns of our ENGLISH MECHANIC.—A DRAUGHTSMAN.

[4204.]—**DRAWING PEN.**—Take care to keep the pen clean, drawing a bit of paper between the points when the ink fails to flow; and never let the ink dry upon it; there will then be no difficulty.—J. B.

[4214.]—**SALMON TACKLE.**—"Doncastrian" will find a rod of 18ft. or 19ft. the most convenient, although for very broad streams 21ft. or 22ft. may be requisite; but



HAND PLANING MACHINE.

the smaller rod is enough for any average man to manage properly. A reel about 4in. in diameter, with about 80 or 100 yards of eight-plait dressed silk line; a gaff, with a handle 6ft. long, a few different kinds of flies, and a basket into which to put the fish, will complete his equipment. As to his own wearing apparel he should get a pair of waterproof boots with tops to come above the knee. I would not advise him to make his rod: he can buy one cheaper and better, because the wood will be more likely to have been properly seasoned; indeed, I doubt very much whether he can buy the wood in a fit condition. One bit of advice I will give him. When the fish has taken the fly, don't strike till he has really got it, or till he has turned to go off with it; then strike, and strike hard, so as to be sure to drive the hook in over the barb. 50 per cent. of fish are lost through neglect of this point.—J. McF., Stobo.

[4229.]—WASHING MACHINE.—I herewith send you a sketch of the most simple washing machine I have seen. I think perhaps it may be the kind of thing your correspondent "J. W." wants. I shall be happy to give any further information on the subject that may be required. The cost if made by a carpenter would be about £2 10s.

Description.—Fig. 1 is a section through the middle of machine. Fig. 2 is a side view. In each case the dotted lines represent the beater. Figs. 3 and 4 are front and side views of beater. The bearings are cast in gun metal, and the beater is made of ash.

FIG. 1

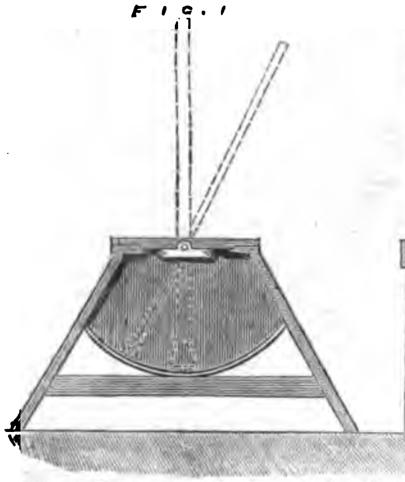


FIG. 2

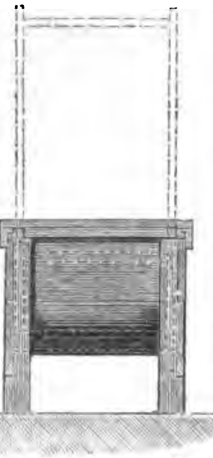


FIG. 3

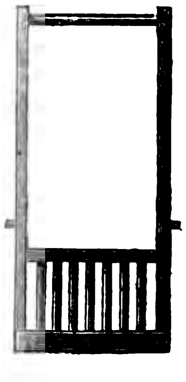
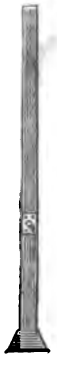


FIG. 4



Mode of Use.—Place the beater in its place and put the clothes in each side with enough soap-water to half fill the machine, then work the beater backwards and forwards.—F. M.

[4231.]—HAND PLANING MACHINE.—I send engraving cut out of Cook's catalogue. It is described thus:—"To plane 12in. long, 8in. wide, and 6in. deep, self-acting cross slide; screw clamps; screw keys; and six tools; mounted on a cast iron base for handwork, only £38 10s. Without self-acting cross slide, less £7 10s. Parallel vice with circular plate £7 10s. Ditto without circular plate, £5."—J. K. P.

[4233.]—BICYCLE BREAK.—The ordinary form of break is the proper one for rubber tires. It does not appear to wear or injure the rubber in the slightest degree.—Thos. Fletcher.

[4234.]—SEWING MACHINE IRONWORK.—Reduce with the file any very rough parts (such as what I would call the "seam" of the casting), and give it two or three coats of coach-painters' varnish. Price, 1s. 6d. per pint. Proved.—Aquillus.

[4237.]—VINEGAR.—Let "Grocer" do nothing so simple as to try to turn wine into malt vinegar: one advertisement in your columns would secure him sufficient orders to dispose of a large quantity of his genuine white wine vinegar.—W. H. C.

[4238.]—KANSAS.—The fare from London to Liverpool is 12s. 6d.; from Liverpool to New York, by steamer, £6 6s.—by sailing vessel, £4. Passengers can also be booked from London at the same rates. Railway fare from New York to Kansas City is £3 16s. 6d. While on this subject, I would say the society mentioned in my letter, the "Working Mens' Co-operative Emigration Company," whose office is at the Mission Hall, Darling-place, Mile End-gate, will be sending out a party about the middle of August.—J. D. Rogers, Hon. Sec.

[4241.]—OIL OF BRICK.—This is obtained by soaking common bricks in oil, and afterwards distilling the oil from them at a red heat in an iron alembic.—Harry G. Newton.

[4244.]—EQUISONANT FLUTE.—If "S." can call at 85, Percy-street, Tottenham Court-road, he will obtain the information he seeks; or he can write to Jno. Clinton, Esq., at the above address. If he is an advanced player, and aims at proficiency, no matter what flute he selects, I strongly recommend the daily practice of Boehm's "Twelve Grand Studies."—Sable.

[4248.]—SILKWORMS.—The length of filament usually produced by a cocoon is about 300 yards, although in somewhat rare cases this has been doubled. For one pound of silk eleven or twelve pounds of cocoons are required, about 250 of which go to a pound, therefore an ounce of silk would require about 180 cocoons. The other information may be obtained at Covent Garden Market.—Harry G. Newton.

[4248.]—SPARK FROM INDUCTION COIL.—The only way to find the length of spark it will give is by experiment.—Thos. Fletcher.

[4250.]—ALGEBRA.—I will endeavour to give A. Davies as little work as possible; but he must understand that he will now and then come across passages, which he must omit through not understanding the principles to which they refer. This will not often be the case however, and if I knew the edition of Todhunter's differential calculus which he intends to use, I could easily point out anything which would be better passed over on a first encounter. It is only necessary to know algebra as far as quadratic equations, with a fair knowledge of the theory of indices. The student must also be able to use the binomial theories, though he need not trouble himself with the proof of it. He must also read the chapter on exponential and logarithmic series In trigonometry, he may omit the chapter on the proportional parts, and chap. xvii., &c., to the end of the book. Conic sections he ought to be well acquainted with. I mean analytical conics of course: geometric conics will not help him at all. As almost all the applied examples of the calculus are taken from conic sections, he will find it almost impossible to proceed without a good knowledge of this branch of mathematics. I must warn him that he will find it exceedingly difficult to read such a subject as the calculus without assistance —R. P. T.

[4250.]—MUSHROOM CULTURE.—After the horse manure (or droppings) has been kept in a heap for about a week or ten days, and heated to a certain extent, have it spread out in the open air to sweeten and drive off the ammonia. If there is a hot sun and nice drying wind, three or four hours will be sufficient. You may then put it together to make your bed, treading the manure thoroughly all the time (you cannot make it too solid), until you get a depth of 18in. to 2ft.; upon this place your spawn. Cover this spawn with good damp mould to the extent of about 2in. Again tread this, and make it tolerably solid. By this simple method on a bed 7ft. by 8ft. in an ordinary stable or outhouse at a temperature of 55° to 60°, I can produce and cut mushrooms of the finest quality.—T. Pearson.

[4253.]—TODHUNTER.—Todhunter says (page 10) "If r denote the circular measure of four right angles, the circumference is $2\pi r$ ∴ the circular measure of four right angles is $\frac{2\pi r}{r}$ that is 2π." Hence we see that the circular measure of two right angles is π, that is 3·14159265 &c. &c. The symbol π is used to express the ratio of the circumference to the diameter, because the value of π cannot be stated exactly. It will now be seen that 3·14159 &c. (or π), is the circular measure of two right-angles, and that Todhunter is perfectly consistent. —J. R. Rendall.

[4253.]—TODHUNTER.—"The constant ratio of the circumference of a circle to its diameter is usually denoted by the symbol π; hence the ratio of the semi-circumference to the radius will also be denoted by π, and the ratio of the quadrantal arc to the radius by $\frac{\pi}{2}$." —Hymer's Trig., p. 4. Note: The semi-circumference is 180°, or the measure of two right angles.—Anon.

[4256.]—NEW VELOCIPEDE SADDLE SPRING.—"T. L." in your last issue speaks of a bicycle he has seen with the saddle spring carried beyond the guide socket, about 6in. over the front of the guiding wheel, the hind wheel being very small. I beg to inform him that it is not patented. The makers are Orme Brothers, Wolverhampton. The advantages are that the rider can sit directly over the crank, and so obtain very high speed with less exertion than when the saddle is further back, the small hind wheel dispensing with the drag which larger ones have for fast riding. I believe it to be the best principle of construction yet adopted. — Thos. Smith.

[4264.]—MATHEMATICAL.—Multiply together the height, the breadth, and the mean depth, which in this case is half the height. Multiply again by 62½ (the number of lbs. in 1 cubic foot) and divide by 2240 to reduce to tons, thus:—

$$\frac{18 \times 11 \times 9 \times 62\tfrac{1}{2}}{2240} = \frac{111078}{2240} = 49\tfrac{1}{2} \text{ tons.}$$

What is called the "centre of pressure" is at ⅓ the depth, or 6ft. from the bottom; and is where you should apply a beam across a sluice to support it in the purely theoretical case of having that beam and nothing else for a support, and it is actually the place where some sluice gates are hung on horizontal pivots, so as to turn over of their own accord when the depth increases beyond a certain point.—J. K. P.

[4271.]—TRIGONOMETRICAL DIFFICULTY.—

$$3\,(3 \log. 3 - 1) + \frac{4}{5}\,(4 \log. 3 - 2) - \frac{5}{4}\,(2 \log.) + 13$$

$$= 9 \log. 3 - 3 + \frac{16}{5} \log. 3 - \frac{8}{5} = \frac{5}{2} \log. 3 - \frac{5}{4}$$

$$= 9 \log. 3 + \frac{16}{5} \log. 3 - \frac{5}{2} \log. 3 - 3 - \frac{8}{5} - \frac{5}{4}$$

$$= \left(9 + \frac{16}{5} - \frac{5}{2}\right) \log. 3 - \frac{60 + 32 + 25}{20}$$

$$= \frac{90 + 32 - 25}{10} \log. 3 - \frac{117}{20}$$

$$= \frac{97}{10} \log. 3 - \frac{117}{20}$$

Now log. 8 = 0·4771213, which multiplied by $\frac{97}{10}$ or 9·7 = 4·6280766, and $\frac{117}{20}$ = 5·85, which subtracted leaves $\bar{2}$·7780766.—J. K. P.

[4271].—A TRIGONOMETRICAL DIFFICULTY.—I am afraid that "Poor Lad" has not sufficiently studied Mr. Todhunter's previous explanations, or rather has not brought any knowledge of algebraical bracketing to bear upon the subject. The given expression is—

$$3(3 \log. 3-1) + \frac{4}{5}(4 \log. 3 - 2) - \frac{5}{4}(2 \log. 3 + 1)$$

(take away brackets),

$$= 9 \log. 3 - 3 + \frac{16}{5} \log. 3 - \frac{8}{5} - \frac{5}{2} \log. 3 - \frac{5}{4}$$

Again using brackets for all expressions in which log. 3 occurs, we have

$$\left(9 + \frac{16}{5} - \frac{5}{2}\right) \log. 3 - 3 = \frac{8}{5} - \frac{5}{4}$$

$$= \frac{97}{10} \log. 3 - \frac{117}{20} = \bar{2}\cdot7780766 \text{ nearly.}$$

C. H. W. B.

[4276.]—GUTTA-PERCHA.—Gutta-percha may be dissolved by chloroform, and also, I believe, with bisulphide of carbon. The solution may be made any thickness, from a clear fluid to a thick paste, and the gutta-percha resumes its original state after the evaporation of the chloroform or other solvent.—THOS. FLETCHER.

[4282].—CONTINENTAL SCHOOLS.—I can recommend to "Anxiety" the college of Melle, near Ghent, and the commercial school of the Josephites at Grammont, also near Ghent, as the best he will be able to find. These two establishments are very highly esteemed, both in Belgium and in other countries. The Trinity College of Louvain is also a very good one. For prospectus and particulars, write to the director of St. George's College, Croydon, Surrey. E. V. D. S.

[4282.]—CONTINENTAL SCHOOLS.—I should recommend the Rev. J. G. Pfluderer's classical, mathematical, and commercial school for young gentlemen, in Kornthal, near Stuttgart, as one of the best and most economical schools on the continent. The institution is under the supervision of the Royal Council of Education of Wurtemberg, and comprises, besides the private apartments of the principal and his family, and the tutors' apartments, a dining hall, three large and airy dormitories, one large study, six school rooms, a large gymnastic hall, as well as a playground, 15 acres in extent, containing a large lake for boating in summer and skating in winter, a cricket ground, shrubberies and woods. The country round Kornthal is an intermixture of vineyards, fields, and woods, and is within an easy distance for excursions to the celebrated Black Forest, Solitude, and Hohenheim: is therefore situated in a healthy climate. The community of Kornthal forms a religious settlement, in some respects similar to those of the Moravians, and singularly free from all temptations to vice. A physician resides in the village. Should "Anxiety" require any further details, he may apply to A. TOLHAUSEN, 103, Dale-street, Hulme, Manchester.

[4285.]—GAS MUFFLE FURNACE.—I fear this is not practicable without an enormous consumption of gas, even for a very small muffle, and also that a strong blast will be necessary. I use a blast gas furnace for small crucible work, and I find in the most perfect form of furnace I can get it requires a consumption of 18ft. or 20ft. per hour, and a bellows blast of 6in. water pressure, to heat a 2½in. × 2in. crucible white hot. The burner I use is similar to Griffin's blast gas burner. I should also fear the continued breaking of the muffles, from the great difficulty in applying the heat gradually.—THOS. FLETCHER.

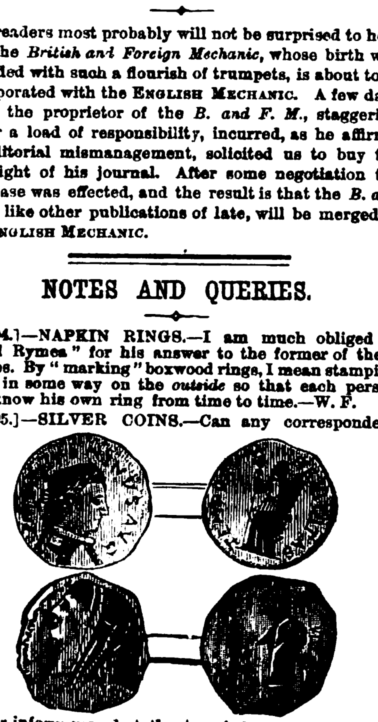
IMPORTANT ANNOUNCEMENT.

OUR readers most probably will not be surprised to hear that the *British and Foreign Mechanic*, whose birth was heralded with such a flourish of trumpets, is about to be incorporated with the ENGLISH MECHANIC. A few days since, the proprietor of the *B. and F. M.*, staggering under a load of responsibility, incurred, as he affirms, by editorial mismanagement, solicited us to buy the copyright of his journal. After some negotiation the purchase was effected, and the result is that the *B. and F. M.*, like other publications of late, will be merged in the ENGLISH MECHANIC.

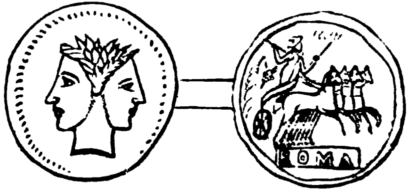
NOTES AND QUERIES.

[4304.]—NAPKIN RINGS.—I am much obliged to "Saul Rymea" for his answer to the former of these queries. By "marking" boxwood rings, I mean stamping them in some way on the *outside* so that each person may know his own ring from time to time.—W. F.

[4305.]—SILVER COINS.—Can any correspondent brother inform me what the two following coins are of which I enclose full-size sketches, and if they are of any value; they are rather thick, and of pure silver?—N.T.M.B.M.



[4306.]—SILVER COIN.—Will some correspondent kindly describe the silver coin figured above, and give approximate value? Actual size. Preservation good. —GILES.



[4307.]—HORIZONTAL *v.* VERTICAL ENGINES.—Why are horizontal engines preferred to verticals?—A YOUNG TYKE.

[4308.]—MODEL MILL.—Will some one favour me with directions for a clockwork arrangement to drive a model mill?—A YOUNG TYKE.

[4309.]—BARTON'S SELF-ACTING FEED-WATER HEATER.—Would S. Crompton say what kind of a float Barton applies to his heater (see p. [illegible])?—J. H.

[4310.]—DESTRUCTIVE SOAP POWDERS.—Can any practical chemist among your very numerous and able correspondents inform me whether a simple method exists of ascertaining whether any "soap powder" containing destructive acid has been applied to linen sent to the wash? Paper collars have superseded linen, but till paper shirts are adopted most of us have an interest in preventing processes which reduce in so few washings this very necessary garment to the consistency of tissue paper?—SANS CHEMISE.

[4311.]—EMIGRATION.—Would some one *who knows* be good enough to give us a little information about our East Indian possessions as a field for emigration. Is there not a good opening there for a few mechanics and an odd cotton clerk and railway clerk or so. An advertisement I saw lately offering £16, £18, £20 per month for spring makers and wheel tyrers leads me to ask this question.—AQUILLUS.

[4312.]—ROCKING CHAIR.—I have bought a rocking chair, and when rocking in it, it leans forward, consequently it is very uneasy sitting in it. Can any one suggest how I can alter it without taking off the rockers? —EASY BACK.

[4313.]—SILKWORMS' EGGS.—Ought the eggs of the common silkworm to turn a kind of brownish colour about a week after they are laid, or should they keep a bright yellow until a short time before they are hatched next year?—C. H. B.

[4314.]—RULE WANTED.—Will some brother reader give a rule for finding the contents of a weight of a known length and breadth? For instance, I want a weight 60lb., must be 9in. long, 14¼in. broad. What thickness will it be in the wood pattern? An answer in plain figures will suit best, as I do not understand algebra.—GOOD WORDS.

[4315.]—CLEVELAND IRONSTONE.—What is the cost of the Cleveland ironstone f. o. b. in the Tyne, and is it shipped to Newcastle in the raw or calcined state? —R. W. M.

[4316.]—A DIFFICULT QUESTION.—In the honours paper of the subject "Applied Mechanics," in the science examination just past, the following question is given. It is so ambiguous, that I spent one of the three precious hours of the examination in endeavouring to comprehend it, and for the life of me I could not determine whether there were two or three enclosing rings, so I gave it up. Since then, I showed it to a bachelor of science and he finds it as difficult as I did, and for the same reason. I propose to submit it to my fellow-readers, in the hope that some one of them will kindly explain it. At the same time I think a protest ought to be made against the practice adopted by some of the examiners of putting questions which are of the nature of a puzzle. Such a practice is likely to bring the papers into contempt, which is most undesirable. The question is as follows:—6. "Built-up guns are made of concentric rings, the outer hoops, or rings, being shrunk or forced upon inner tubes with a regulated tension. Supposing the external diameter of the inner tube to be 12in. and that the substance of its covering hoop is to have given to it an initial grip of 4 tons per square inch of its sectional area; the exterior diameter of this second hoop is 18in. and is to be covered with a third hoop, having an initial grip of 8 tons per square inch of its sectional area; will you work out in arithmetic the difference of dimensions which will afford the above conditions?"—STUDENT.

[4317.]—SIZING.—I mix 20 packs of flour at once for sizing, and when fomented it is very yellow, can any of your correspondents inform me how I can bleach the same, or how I can make it white?—JOHN BURY.

[4318.]—COMET.—Will "F.R.A.S." kindly give the situation of the "comet" which he says is in "Serpens," so that it may be found without an equatorial?—G. C.

[4319.]—SPECULUM POLISHING.—Will Mr. Purkiss be kind enough to describe his rule and method of finding the exact size of the small plane or flat for any aperture, and whether his polisher goes as regular at the end of the polishing, or whether it does not go in "fits"? How long does he take to polish the surface "till no trace of grain is left"? Will not rosin answer to harden the pitch with?—G. C.

[4320.]—BREAM FISHING.—Will any of your readers kindly inform me what will entice bream to the hook?—POMPEY.

[4321.]—WATERPROOF.—Will some reader inform me how to soften a waterproof coat? it has got quite hard.—J. C.

[4322.]—SEWING MACHINES.—Any one versed in the above would oblige by solving this difficulty. The material seems dragged into the teeth of feeder, and a number of threads are wound around the point of hook. Without the threads the feeder acts very well. The machine is a Wheeler & Wilson's.—H. W.

[4323.]—GLASS BURNING.—Thanks to our obliging friends Mr. D. F. Ashton, and Mr. Joseph Leicester, for their information on glass painting, &c. Will either oblige me with all particulars of flues, &c., to construct an oven or kiln as used by glass painters, &c., the distance of the fire from the grate to the bottom of the oven, and what supports are used to keep the oven in its place, and what is the best material for the oven, as I am about to replace my old one, which is of iron?—K

[4324.]—FAN BLAST.—I should be obliged if some would instruct me how to make a small fan blast to heat small pieces of iron about 1in. thick. I should like to see a rough sketch of one, and a simple plan, so that I could make it myself. What size would the fan have to be?—G. COOK.

[4325.]—PLANTING.—What is the proper time of year for slitting and planting house plants?—M. N.

[4326.]—POLARISCOPE FOR LANTERN.—Will some one amongst your numerous readers kindly give me a description of the above for a lantern 3½in. condenser, as I want to add one to mine? I want to use the ordinary front lenses, or microscope combined with it. A diagram would be useful?—E. H. J.

[4327.]—WANT OF PRESSURE.—Would any reader help me out of my difficulty? I am in charge of two egg-end boilers, they having been in for fourteen years. I get the steam up to [illegible] pressure, when it will fall to about [illegible]. I should like to know the cause. I believe it to be in the flues.—A STOKER.

[4328.]—MOUNTING MICROSCOPIC OBJECTS.—I am at a loss to know how to mount some objects. I can manage flat surfaces, such as wings of insects, which I steep in potass until transparent, then stick on with Canada balsam, finally putting on the thin glass cover. Should heat be applied to the glass to ensure a firmer adherence. If I want to mount an object which is any thickness—for instance, a cricket—I am at a loss, for if done as above, the top thin glass would be such a great distance from the slide. Another thing is the petals, &c., of flowers. Are they fit for mounting when first picked, or should they be put into potass? If so, how long to remain in, or is there a better way to prepare them? If "H. P." will kindly answer me these questions he will confer a great boon on others as well. —C. R. H.

[4329.]—THE MICROSCOPE.—I am glad to see from your "Answers to Correspondents," that Mr. C. C. Smith offers to supply information on the microscope. Now I should like to ask him what kind of instrument he would advise me to purchase. I want one that will show the various insects and animalcula to be found in a pond, the starch-cells of a *potato*, or the *markings* in the wings of the neuroptera, &c.—*in short an instrument* that will serve to while away a *leisure hour, without* being extraordinarily *perfect*, and *consequently* expensive.—SABBAS.

[4330.]—WALL DECORATION.—Can any one tell me how to prepare a wall for fresco painting?—FABER.

[4331.]—STONE FOR TRINKETS.—I have a quantity of stone to cut for trinkets. Can any brother reader inform me which is the best way to cut it?—F. H.

[4332.]—BLACK GLASS OF ANTIMONY.—I do not know the proportions of Antimonium and Silicium to flux for producing the glass of antimony (Black).—SABLE.

[4333.—LANCASHIRE BLACK.—Will any reader say what is the composition of "Lancashire black," how it is prepared, and used as on tools?—ANXIOUS.

[4334.]—ECLIPSE OF THE MOON.—Would any of your readers tell me why, when the moon was "eclipsed" on the night of the 12th, she was distinctly seen of a dark copper colour? I expected the moon's disc to disappear altogether. Is it the *refractive* qualities of our atmosphere which cause it?—LUNAR.

[4335.]—IRISH MOSS.—Will any reader inform me what Irish Carrigaune moss is used for, and where would be the best place that I can find a market for the same? —AN IRISHMAN.

[4336.]—TONGA BEAN WOOD.—A friend of mine gave me a small piece, coming from Australia; could "Bernardin," or another correspondent give me some particulars about that wood, he will oblige—T. B. W.

[4337.]—HOLLOW CANDLES.—Candles with three longitudinal holes are made in Paris. How are they made, and what advantages do they possess over other candles?—JOHN X.

[4338.]—DRAUGHT FURNACE FOR SMELTING LEAD ORE.—Could any of your readers inform me how to erect a draught furnace for smelting lead ore? I have a relative writing to me on the subject who is living in Hamilton White Pine, Nevada, U.S. He can procure plenty of charcoal and wood to heat it with, but the only material at hand to build it with would be stone, which he can get in blocks.—THOS. PEARSON.

[4339.]—LA CROSSE.—Can any brother reader inform me of a hand-book of the above game, which is said to be more exciting than cricket, both for spectators and players? I have for a long time wanted a book of the above description, but could never come across one. Perhaps some readers, if allowed, would give a description in our MECHANIC.—VELOCIPEDIST.

[4340.]—LAMBORNE'S VELOCIPEDE.—Will Mr. Lamborne kindly give a description, size, &c., of his four-wheeled velocipede on which he went 52 miles in 8 hours? It is the opinion of many that the bicycle will die out, as far as travelling goes, and the four-wheeler take its place.—VELOCIPEDIST.

[4341.]—KILMARNOCK OR BACK-WHEEL BICYCLE.—Will any reader who has ridden the common bicycle, likewise either of the above, state which is easiest to propel. Have any great distances been ridden on them? It seems to be the proper motion for the legs. What is the length of the cranks of the "Kilmarnock," which appeared in the MECHANIC, Nos. 216 and 220? Please give a description of the stampings or pedals for the feet, and their distance from the centre of the saddle at the commencement, and likewise the finish of the stroke. Will this bicycle ascend hills as well as the common bicycle? I am not the only one who would wish to have this query answered.—VELOCIPEDIST.

[4342.]—READINGS FROM THE GLOBES.—St. E—— would feel much obliged for the title of the best and most recent "Treatise on the Use of Globes." In Tate's Astronomy (Gleig's School Series), page 87, it is said: "In England, at the present time, the north pole of the needle points about 24° to the westward of the north." Is this correct? The date of publication is 1868.

[4343.]—WINDMILL FOR WORKING LATHE.—In your Mechanic of June 14, 1867, your correspondent "Liver" gives a drawing of windmill for working lathe. As I have the drawings, will "Liver" kindly give the dimensions of the mill as under, without trouble of sending another drawing. 1.—The thickness of shaft. 2.—Length of wands from centre of shaft. 3.—Size of slips of board for the wands. 4.—Size of wand frame in which the slips of board are to be fixed. 5.—Size of wood for wand frame. 6.—Diameter of driving wheel, and how to be fixed on the shaft for driving the lathe.—Subscriber.

[4344.]—WEIGHTS OF CHEMICAL SOLUTIONS.—Would Mr. "G. E. Davis," "Sigma," or any of your chemical subscribers kindly inform me how to calculate the weight of soda, hydrate of soda, and carbonate of soda in solution at different specific gravities. For instance, suppose I have a solution of soda ash, 10 tons at 50° Twaddel (or any other degree), how can I ascertain the weight of pure soda, hydrate of soda, or carbonate of soda (crystal), what I ought to obtain from it; also what weight, supposing the hydrate to be only 60 per cent., and the crystal soda to contain 10 equivalents of water. An answer with calculations worked out will oblige.—Alkali.

[4345.]—CRACKED BOILER PLATES.—Wanted a composition that will stand the fire between a cast-iron plate and a cast-iron boiler that is cracked, the plate being bolted on. Borings and red lead have been tried, but they are not permanent.—T. L.

[4346.]—CONCERTINA.—Can any of my fellow readers give me assistance in the following:—I am trying to make an English concertina (dimensions of bellows, 9in. by 6in., with six double ribs), and I wish to know of what compass it would be best made? Can the reeds be purchased ready finished? or would it be better to make them myself? If so, of what scale, and of what metal?—James Robson Rendell.

[4347.]—TUNING BY EQUAL TEMPERAMENT.—Will any practical musical reader explain concisely, but explicitly, the equal temperament method of tuning in your journal, as applied to pianoforte or organ?—A Would-be Tuner.

[4348.]—PROBLEM.—Will "C. H. W. B." or "Bernardin" be good enough to solve the following without trigonometry, using Euclid only (Book I.)?—Please draw a figure *(a)*, two forces of 100 pounds each, act upon a point at an angle of 150°. Find resultant. (Ans. = 51·7638lb.) *(b)*. Forces of 60 and 160lb. respectively act upon a point, at an angle of 120°. Find resultant. (Ans. = 140lb.)—Amicus.

[4349.]—HEATING HOUSE WITH HOT AIR.—Will any one who has tried the American system of heating houses with hot-air from cockle, &c., describe how the flues are arranged, as also the cockle or hot air stoves; what time it takes to heat an ordinary eight-roomed house; what effect this hot air has on the general health of the inhabitants—with any other remarks applicable.—Scot.

[4350.]—BAROMETER, Etc.—I have a desire to possess a barometer, &c., at a moderate cost, in order that I may be able to make observations, and have seen your descriptions of the Polytechnic barometer, and Solomon's new compound set (pages 8 and 128). Which would answer my purpose best? or would an aneroid barometer be better than either of the others? Is it of any consequence where a barometer is placed, say in a hot room or cool passage of a house?—K.

[4351.]—CASE FOR FERNS AND MOSS, described by "*A Dentist*," on page 259.—What depth should the soil box be made? Should any arrangement be made for draining the moisture away? Would not the box be improved if lined with lead, to prevent the wood box from rotting?—K.

[4351.]—CONIC SECTIONS.—Will "F.R.A.S." or Mr. Proctor, kindly decide whether in conic sections the "vertical plane" of the "parabola" must be exactly parallel to the slant side of the cone; or in other words, whether in a right cone the plane that cuts the cone so as to form a parabola, must run parallel to the one slant side of the cone. If so, must not the conic section that is not parallel to the slant side, and approaches it, be an ellipse, and the section that increases its distance from the slant side, be a hyperbola? Personally I am pretty certain as to which is correct, but should be obliged by an answer?—A Ursæ Minoris.

[4352.]—WEAVING.—Will some kind flax, woollen, or cotton spinner inform me if they have any scientific method of knowing what number of, or lease of samples of yarn, when they are very small and without number, grey and bleached? Also, I have small samples of cloth, linen, and cotton, grey, boiled, and bleached white, and woollens only woven and finished. If any manufacturer could tell me a correct method of ascertaining what number of yarns for warp and number for weft after the various processes named above, I should be obliged?—A Weaver.

[4353.] — ROAD MEASURING. — Can any fellow reader inform me if there is extant any machine used for measuring roads, &c., besides the pedometer?—J. T. S.

UNNOTICED QUERIES.

In future, if any query remain unanswered for four weeks, we shall insert the number and subject of the query in this list, where it will remain for two weeks, if not previously replied to. We trust our readers will look over the list, and send what information they can for the benefit of their fellow-contributors.

Harry G. Newton has answered 2643, 2652; "R. R.," 3726; "Ignorant," 3849; "H. A. C.," 3858, 3875; "The Harmonious Blacksmith," 3812; "J. K. P.," 3923; "J. B." 2637, 2643, 2677, 3738, 3766, 3858; W. Seabrook, 3716, 3832, 3859; R. Sedgfield, 2668, 3781; "Automedon," 3844; "A. S. C." 2684, 3907; Wm. Holmes, 3716.

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USEFUL AND SCIENTIFIC NOTES.

THE *ENGLISH MECHANIC'S* SCIENTIFIC SOCIETY, MANCHESTER.—Sir,—I beg to inform you that this society met, as already announced, on the 6th inst. The chair was taken by the President (Mr. J. M'Ewen), and the business of the evening commenced with a paper on "Light," by Mr. Baguley. The speaker, in a short but well-worked essay, explained the Huyghenian and Newtonian theories of light, as well as the analysation, dispersion, and recomposition of rays. A discussion on the subject read followed, in which many of the members present took an active part. Amongst the objects shown to the society was a splendid microscope and a newly-invented eyeleting machine. Persons not yet members may become such by applying to the Secretary, 103, Dale-street, Hulme.

VICTORIA LEGAL FRIENDLY SOCIETY.—The annual meeting of the members of the Liverpool Victoria Legal Friendly Society, for the purpose of passing the accounts and other annual business, was held at Liverpool recently, Mr. Timothy Crowley, president, in the chair. The financial statement showed that there had been collected from the 28th May, 1869, to 27th May last, £43,852 19s. 5d., and there had been paid on 4181 insurance claims and grants during the same period, £18,804 17s. 2d.; on collectors' commission, £10,962 0s. 4d.; managers, agents, and collectors' salaries, £3,258 13s. 6d.; officers, clerks' and auditors' salaries, £1,064; committee and collectors' fees for transferring names of members, £537 8s. 2½d; officers and others visiting country districts, and agency superintendents' salary and expenses, £446 4s. 10½d. The sum of £7,424 5s. 0½d. had been saved during the year, and the total worth of the society on the 27th of May last was £26,945 16s. 8d.

GRAPE-SUGAR MANUFACTURE.—The production of grape-sugar, or glucose, appears to be extending with considerable rapidity in America. Factories for the purpose have been established in New Orleans, Buffalo, and Brooklyn. When grain or potatoes, yielding starch as the material for the manufacture, are cheap, and sugar is high-priced, the business will prove profitable; but a reversed condition of things, very likely to occur, will make the results quite different; and it is doubtful if the manufacture can be made a permanent industry in view of the unlimited facilities for making sugar from beet-root and other saccharine plants as soon as our producers have acquired that practical knowledge of processes which has enabled European sugar-makers to build up a production of the staple as vast as it is permanent.

INDIA-RUBBER INEXHAUSTIBLE.—The belt of land around the globe, 500 miles north and 500 miles south of the equator, abounds in trees producing the gum of india-rubber. They can be sapped, it is stated, for twenty successive seasons without injury; and the trees stand so close that one man can gather the sap of eighty in a day, each tree yielding, on an average, three tablespoonfuls daily. Forty-three thousand of these trees have been counted in a tract of country 30 miles long by 8 wide. There are in America and Europe more than 150 manufactories of india-rubber articles, employing some 500 operatives each, and consuming more than 10,000,000 pounds of the gum per year, and the business is considered to be still in its infancy. But to whatever extent it may increase, there will still be plenty of rubber to supply the demand.

AUSTRALIAN LEECHES.—The *Melbourne Argus* states that a large consignment of leeches went to England in April by the steamship *Somersetshire*. It appears that some parts of Australia abound with leeches, and those which frequent the Murray River have a good repute for biting freely and leaving no inflammatory wound or mark behind; they are said to rival the speckled leech of Northern Europe. Measures were taken some time ago by a Melbourne firm for the conservation of the Murray leeches, and their contracts with the fishermen in the Murray district for the past season exceeded half a million. But the intercolonial demand is almost equal to the supply. The leeches sent to England were packed in boxes of soft clay, made to resemble as much as possible the muddy bottom of the river which is their ordinary resort. It is said that the prime cost of leeches sold in Europe must exceed two millions sterling per annum.

ARTIFICIAL ICE.—There comes from Germany a promise of relief from the extortionate demands of the ice companies. Mr. Franz Windhausen, of Brunswick, has invented a new machine for freezing water without the aid of chemicals. The process takes place in a cylinder, "where the air is first powerfully condensed, then cooled by the admission of water, and finally expanded till its pressure is about equal to that of the atmosphere." By this means, it is asserted, the very astonishing result is obtained of lowering the temperature of the air to 50° Celsius (4° Fahrenheit), so that when conducted in moderate quantities into a space through which water flows, "the water is almost immediately turned into ice, of which enormous blocks may be thus obtained if desired." The invention will also, it is said, be applicable to the cooling of large apartment, such as theatres, hospitals, and churches.

UNITING PARCHMENT TO PAPER, WOOD, Etc.—It is not an easy thing to join the stiff, smooth surfaces of parchment paper on to other paper, or on to wood, pasteboard, &c. The paste does not seem to hold, and on this account this paper has not been so generally used in bookbinding and for similar purposes. The difficulty can be overcome in a very simple way. The surface of the parchment must first be moistened with alcohol or brandy and then pressed while still moist upon the glue or paste. When two pieces of parchment are to be joined both must be moistened in this way. It is said that the paper will sooner tear than separate where it has been thus fastened together. Another way is to put a thin piece of paper between the surfaces of parchment and apply the paste. This forms a firm joint, and can with difficulty be separated. Glue and flour paste are best adapted for uniting surfaces of parchment. Gum arabic does not answer.

WASTE GAS IN BLAST FURNACES.—Dr. Percy writes to the *Times* as under:—"It is reported that four men have been killed at ironworks in North Staffordshire by what is termed 'waste gas from the blast furnaces.' The poisonous ingredient of that gas is carbonic oxide, and the inhalation of it in very small quantity, whether pure or mixed with common air, rapidly destroys life. I have collected and published several cases of fatal poisoning from that cause at ironworks, foreign as well as British. A few years ago the engineer of the Dowlais Ironworks was suffocated in his office by the escape of this gas from an adjoining culvert. It is important that the managers of such works should be acquainted with its highly poisonous nature, and take every precaution to prevent their workmen from being exposed to its influence. As the use of the waste gas from our blast furnaces for heating steam boilers, mine kilns, &c., is extending daily, it is to be feared that deaths from its inhalation may become more frequent than hitherto, unless those who deal with it are fully instructed concerning its action on man. With the hope of communicating such instructions as widely and as quickly as possible, I beg to submit this letter for your consideration."

RUSTING OF IRON.—Dr. Calvert communicated to the Chemical Society some very useful information on the rusting of iron. Rust is mainly sesquioxide of iron, and it has always been supposed that the active agents in producing it are moisture and oxygen. It seems, however, from Dr. Calvert's experiments, that carbonic acid must be associated with these to produce any considerable amount of oxidation. In dry oxygen iron does not rust at all, in moist oxygen but little and seldom, but in a mixture of moist carbonic acid and oxygen iron and steel rust very rapidly. In like manner a piece of bright iron placed in water saturated with oxygen rusts very little, but if carbon is present as well oxidation goes on so fast that a dark precipitate is produced in a very short time. Curiously enough, bright iron placed in a solution of caustic or carbonated alkali does not rust at all. These facts show that the points to be attended to in the preservation of iron from rust are the exclusion of carbonic acid and moisture, two indications which may be very easily fulfilled.

A HINT TO IRON SHIPBUILDERS.—In a paper read before the Polytechnic Club of the American Institute, by Mr. Norman Weard, entitled, "The Ship of the Future: Shall it be Wood or Iron," after enumerating all the bad qualities of iron ships, and all the good ones of wooden ones, he says:—"If it were the fact that the ship of the future is to be of iron, there would be left us but one course to pursue, in order to regain the ocean ship-building and steam-carrying trade of the great Atlantic, namely, war—a war with England. We can never hope to excel or even equal England in building large and swift ocean mail steamers of iron. I am not here, however, as the advocate of a war with England; for I do not believe that the ship of the future is to be made of iron. I prefer to take the weather-gauge of the English ship-builders, by assisting to discover how to make a better ship of the material we have in like excess to the English supply of iron—or take the wind out of their sails, as our yachtsmen did the other day. And this I propose to do by enquiring into the bad qualities of the ships they produce, and by investigation in advance to find out how to produce a better ship than they can make without coming to us, or applying to some foreign country for the material."

THE OBSERVING ASTRONOMICAL SOCIETY.—This society entered upon the second year of its existence on July 1st. The recent election of officers for the ensuing year has resulted in the re-election of the former President, treasurer, and secretary and committee. The Rev. R. E. Hoppell, M.A., LL.D., F.R.A.S., is the president; Mr. William F. Denning, the treasurer and secretary, and the following are members of the committee:—Messrs. T. P. Barkas, F.G.S., James Cook, A. W. Blacklock, M.B., H. Michell Whitley, and Albert P. Holden. The society numbers 43 members, and was formed for the purpose of aiding the spread of practical astronomy.

ANSWERS TO CORRESPONDENTS.

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*** All communications should be addressed to the EDITOR of the ENGLISH MECHANIC, 31, Tavistock-street, Covent Garden, W.C.

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The following are the initials, &c., of letters to hand up to Tuesday morning, July 19, and unacknowledged elsewhere:—

R. Burgess, Dr. Allnatt, Ashcroft & Co., Walter, J. C., junr., W. H. C., J. H. & Co., E. V. S., D. J. W., Bernardin, Saml. Wishart, C. C. Clifford, J. P. S., H. W. Henfrey, Jesse Lowe (with photo. of lathe work), J. M., Evan Hughes, Stucco Plasterer, E. M. T. Tydeman, C. Draper, J. R. D., L., Mark Steward, Music, D. T. Batty, Mac. D., S. Rogers, W. B. Stanley, Patience and Perseverance, W. B. Harvey, Sunbeam, Banting, G. G. Brassey, Jet, Harry G. Newton, Agent, W. M. M., Telescope, J. Miller, Amateur, Jobber, A. J. Adams, Country Brewer, W. Griffiths. Sheffield Flood, Exact Share, Geo. Higgs, Leather, K. T. Z., A Fireman, H. W. C., Somerset Amateur, S. Hewitt, W., T. Gatesby, W. T., R. A. B., Ignorant Irishman, Rev. E. Kernan, Peregrine Pickle, F. G., Edinburgh, H. M., Flautist, G. G. André, G. Firth, G. K., H. H, Halley, W. Jones, Ventas, E. D. Cope, Electra, Cuthbert, Virgil, A Mechanic, Would-be Entomologist, N. T., F. X. Wright, Good Words, Nemo, S. W., A. J. Jarman.

A. R. Your letter is too much a puff of the "Doctor Bedfordian system of astronomy." If Dr. Bedford is determined to associate his name with an historical astronomical system, he must begin *de novo*, take a wider survey of facts, and be less disposed to jump at conclusions. Besides, it would be more in harmony with the modesty and geniality that accompany man's greatness, for him to let others associate his name with a "system" and not do so himself. The insinuation that we are "staff-bound" is simply absurd. Neither Mr. Proctor nor any one else is in the slightest degree "a dictator in our columns," and we are sure that Mr. Proctor would be amongst the first to repudiate such a claim. Our space belongs to those who can fill it most worthily.

H. G. T.—Described several times.

R. E. W.—We cannot make engravings from sealing wax impressions of coins.

W. H. SAYER.—See answer to R. E. W.

E. H. JONES.—There is some truth in your remarks, and we have sometimes considered the advisability of taking the step you suggest.

J. EDGILL.—See recent back numbers for discussion as to whether the use of the velocipede is injurious to health.

A WORKING SMITH.—See last volume for instructions to make electric bells.

IGNORANT.—Longmans, Paternoster-row.

MILLER.—We cannot. An advertisement in the Sixpenny Sale Column would probably gain for you the information.

AQUILLUS.—Send us the information, but make it as brief as possible.

STUDENT.—Yes; order through any bookseller.

CYMRO.—"Gwilt's Encyclopædia," published by Longmans.

C. L.—Your views are correct. It is surprising how any sensible person can think differently.

AMATEUR PHILOSOPHER.—We ought not to be called on to make engravings for purely theoretical enquirers.

NIAGARA.—Your query involves perpetual motion—or an impossibility.

J. HARRIS.—Your question about the best watchmakers is a commercial one. We have before said that we desire to keep the educational and commercial departments of the paper distinct.

J. B. S., Macclesfield.—Fenchurch-street, London.

T. M.—We cannot encourage private correspondence, therefore your letter is not forwarded. You can now only recover your strength by temperate habits, early rising, cold water ablutions, and a virtuous life.

CHARLES RUSSELL, Birkenhead.—Thanks for the list of millers.

TRADE AND COMMERCE.—We have received letters during the past week from "Sigma," "Herbert," "F. W. M." "Political Economist," and a "Disciple of J. S. Mill."

J. WINTER.—In answer to your first question—yes, as you may see announced elsewhere. To your second question—no. Mr. Edward Henri Todé did not originate the ENGLISH MECHANIC. He was no more the creator of this publication than an empty coal barge in the Thames creates the tide on which it rides. The ENGLISH MECHANIC owes its popularity and circulation, as "Sigma" long since said, to its multitudinous correspondents, who rejoice in mutually giving and receiving useful and interesting information.

NORTHERN MECHANIC.—Carefully read Mr. Sprague's articles. They will give you much of the information you ask for.

A MODEL CORRESPONDENT. "Sable," who, we believe, is a clergyman, and whose article on the Flute is inserted, says,—"I wish only to be admitted amongst the least of those whom you are pleased to call your friends, although I give place to none as your sincere well-wisher. If you print this article, I shall be gratified, but if you consign it to the abysmal waste basket and the tender mercies of the redoubtable 'Betty,' I shall not be disappointed in any degree."

C. RICHARDSON.—The numbers can be had for 8s. 2d., exclusive of postage.

P. T. B.—We think no harm could result from the use of the Turkish bath, but in a case of disease medical advice should be taken.

X. O.—Write to the publisher of the *Journal of Horticulture*, 176, Fleet-street.

K. T. Z.—Write to J. R. Willis, 29, Minories.

H. HOLDERNESS.—If you refer again to our reply in No. 274, you will see we told you it was impossible for you to gain the information without fuller particulars.

The Sixpenny Sale Column is the only place in which can appear queries sent by J. W., Miller, C. H. B. (first part), Artemus Ward, Purpura, Busy Bee, Nemo, X. O.

A SUFFERER.—Consult a medical man; avoid quacks.

SOMERSET AMATEUR.—The numbers announced in print at the foot of the article *are* in print, and can be had direct on receipt of stamps.

H. H. C.—Yes, with a drawing, if possible.

W. T. P. L.—We do publish from time to time accounts of boiler explosions.

E. A. P. (Rochester)—The ENGLISH MECHANIC can only be forwarded by book-post to the Australian colonies.

H. P.—You will notice that the termination of your communication has been left over. It will appear with your next.

E. L.—Yes, the war, if it continues, will to some extent influence the timber trade. It is already doing so at Grimsby, where freights have advanced 10s. per ton, and timber has consequently risen in price. Many ships of the timber fleet now due are German ships, and have been ordered to run into Bremen.

B. G.—You may be sure all the good contributors will be welcome. Some of the others will undoubtedly be sent to the right-about.

SIMON LESLIE.—The status of Building Societies is a most important question. We fear, however, the Government will do nothing in the matter this year, notwithstanding the favourable reception given on Monday by the Home Secretary to the deputation you refer to.

A READER OF BOTH.—Yes; a visible alteration in the tone of the once hostile and now to be amalgamated journal is noticeable in the last few numbers. A friend observed to us that, like the swan, its dying utterances were the best.

H. A. L.—All the usual Continental trips will be interrupted, so such information would be useless for the present.

R. HITCHMAN.—Your plan is not novel, nor do we think its adoption would be desirable. What is the "nation" to do with the invention when it has bought it. The majority of inventions are only to be profitably worked by private enterprise.

BERNARDIN.—It was a mistake, and the others have been forwarded. To ensure insertion communications should reach us by Saturday. Anything of importance, however, would be in time on Monday.

JAS. HARRISON.—Your letter is not inserted, because of the contemptuous way you speak of another correspondent.

THE INVENTOR.

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IN obedience to the suggestions of a number of readers, we have decided on appropriating a portion of our space to a condensed list of Patents as nearly as possible up to the date of our issue.

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APPLICATIONS FOR LETTERS PATENT DURING THE WEEK ENDING JULY 11, 1870.

1895. T. Carr, Bristol, arrangements for cleaning and reducing wheat, maize, beans, peas, and other seeds into flour or semolina.

1896 E. Holden, Bradford, apparatus employed in preparing and combing wool and other fibres.

1897 J. Heaton, Eastwood, Improvements in obtaining motive power.

1898 E. L. Macdonell, Titchfield-street, improved means of facilitating and effecting the traction of wheel carriages drawn by horse power.

1899 R. A. Novare, King's-square, Goswell-road, improvements in the Morse telegraph printing apparatus.

1900 J. H. Johnson, 47, Lincoln's Inn-fields, improvements in evaporating and boiling or concentrating liquids, and in apparatus employed therein. A communication.

1901 T. Hydes and W. Wigfull, Sheffield, improved methods of connecting together the vertical and horizontal bars of iron fencing.

1902 J. W. Hoffman, and F. A. Harrison, Birmingham, improvements in the manufacture of certain ornamental and useful articles, such as buttons, knobs for doors and drawers, &c.

1903 E. T. Hughes, 123, Chancery-lane, improvements in the manufacture of caustic soda. A communication.

1904 W. R. Lake, Southampton-buildings, improvements in mechanical appliances and furnaces. A communication.

1905 G. Burn y and C. Ingall, Millwall, improvements in storing petroleum and other inflammable or explosive liquids.

1906 J. Young, Glasgow, improvements in lamps.

1907 J. Robertson, Nitshill, Renfrewshire, improvements in apparatus to be used in making tubes.

1908 A. Prince, improvements in soldiers' litters. A communication.

1909 J. Bourne, 66, Mark-lane, London, improvements in the means and apparatus employed in cutting various substances.

1910 L. Le Chevalier Cottam, Winsley-street, improvements in the construction of spiral staircases.

1911 F. R. Ensor, improvements in the manufacture of lace in twist lace machines.

1912 H. M. Ward, Loop Bridge Mills, Ballyinaconaghy, improvements in machinery for spinning and twisting fibrous substances.

1913 J. Ascough, Handsworth, improvements in Venetian blinds and shutters.

1914 W. R. Lake, Southampton-buildings, London, improvements in furnaces chiefly designed for heating metals and ores. A communication.

1915 F. Tommasi, Paris, an improved submarine hydro-electric telegraph cable.

1916 F. J. Liger, 23, Rue de Beaune, Paris, improvements in the building of ironwork walls.

1917 E. L. C. d'Ivernois, Paris, an improvement in the means for producing electric light.

1918 A. M. Clark, 53, Chancery-lane, improvements in smoothing irons. A communication.

1919 C. Falck, Fairfoot-road, Bow, an improved portable refrigerator.

1920 J. J. M'Grath, Cable-street, St. George's-in-the-East, improvements in the construction of wheels.

1921 I. Whitesmith, Glasgow, improvements in looms for weaving.

1922 B. Dobson, T. Thornley, and J. Settle, Bolton, improvements in apparatus for cleaning the fluted and top rollers of machines used in preparing and spinning cotton.

1923 W. R. Lake an improved device for fastening tickets upon woven goods and other articles. A communication.

1924 T. Read, Malton, improvements in the construction of reaping machines.

1925 D. Lord, Great Horton, improvements in shedding warps in the process of weaving.

1926 C. Holste, 14, Southampton-street, Covent-garden, improvements in the manufacture of pots or crucibles used in glass furnaces. A communication.

1927 H. H. Murdoch, 7, Staple-inn, improvements in combination locks and padlocks, and keys for the same. A communication.

1928 C. de Bergue, 10, Strand, improvements in machinery for punching metal.

1929 H. J. Crockett, 6, Canonbury-grove, Islington, improvements in window sash and casement fasteners.

1930 D. Gordon, Ayr, improvements in machinery or apparatus for churning.

1931 J. Hensman, Ampthill, and W. Armstrong, Haynes, improvements in agricultural drills.

1932 R. Edwards, Bow improvements in interlacing and interlaying of papers with thread, and their application to the manufacture of envelopes.

1933 G. G. Bussey, Rye-lane, Peckham, an improved apparatus to be used as a substitute for bird-trap shooting.

1934 F. W. Roberts, Blaby, an improved method or application for preserving the fronts or edges of stays and corsets.

1935 J. Buchanan, and S. Vickress, Liverpool, improvements in the manufacture and reburning of animal charcoal.

1936 P. Chaplin, Harlow, improvements in wheels to be used on railways. A communication.

1937 R. Hutchison, Glasgow, improvements in bleaching and improving vegetable and animal oils and fats.

1938 J. Kershaw, Bolton, improvements in looms for weaving.

1939 W. R. Harris, Manchester, improvements in the mode of connecting wheels and other articles to their shafts.

1940 Count Sparre, 18, Boulevart St. Martin, Paris, improvements in breech-loading fire-arms.

1941 A. Cochrane, 9, Wilton-place, St. John's Wood, improvements in giving motion to ships and other floating bodies.

1942 W. G. Jackson, Dockhead, improvements in the manufacture of cordials.

1943 W. R. Lake, improvements in buckles for fastening [illegible], belts, and other like articles. A communication.

1944 W. R. Lake, improved locking and releasing hooks. A communication.

1945 T. T. Chellingworth, 8, Great Queen-street, Westminster, an improved hot-air engine.

1946 H. E. Pavy, Rue du Bac, Paris, improvements in bins and granaries or holders for corn and grain. A communication.

1947 T. Bruce, Monkton, Ayrshire, improvements in pumping or forcing apparatus for hydraulic presses.

1948 E. Leahy, Cardington-street, Euston-square, improvements in portable or movable railways.

1949 P. Spence, Newton Heath, Manchester, improvements in the treatment of sewage.

1950 D. Nicoll, Fell-street, London, an improved waterproof fabric applicable for rugs, carpets, tents, and outer coverings or wrappers.

1951 Sir C. H. Pennell, Woodlands, Weybridge, improvements in skates.

1952 W. Marriott, Huddersfield, improvements in the manufacture of iron salts or compounds.

1953 J. P. Barford, Banbury, improvements in carriage jacks.

1954 M. H. Wiley, Massachusetts, certain new and useful improvements in oil cabinets.

1955 G. T. Bousfield, Loughborough-park, Brixton, improvements in warp tension and let-off mechanism for power looms. A communication.

1956 T. Holcroft, Bilston, improvements in the manufacture of nails and spikes.

1957 J. Crossley, Heywood, improvements in looms for weaving.

1958 P. D. Hedderwick, a new or improved apparatus for counting paper in sheets.

1959 E. Holborow, 18, Ledbury-street, Commercial-road, Peckham, improvements in window sash fasteners.

1960 J. T. Griffin, 77, Upper Thames-street, improvements in reaping and mowing machines. A communication.

PATENTS SEALED.

1368 W. Young, improvements in crates, packing cases, and travellers' and other boxes.

1370 T. Coles and W. Henderson, improvements in machinery for scutching flax and other fibres.

1371 J. Heddle, improvements in preparing, clarifying, and preserving vegetable juices and other liquids.

1437 G. T. Bousfield, improvements in looms for weaving. A communication.

1451 W. R. Lake, improvements in machines for lapping cotton and other fibrous materials. A communication.

1469 R. Harte, improvements in means and apparatus for effecting aerial locomotion.

78 W. G. Cunningham, a machine or apparatus for cleaning and polishing boots and shoes.

80 E. A. Chameroy, improvements in means and apparatus for gauging or regulating the flow of water.

93 L. Sterne and J. G. Warner, improvements in bolts for securing parts of the permanent way of railways.

96 W. Denison and H. Teall, improvements in steam engines.

97 W. H. Balmain and W. J. Menzies, improved means for conveying and storing vitriol.

102 A. Clark and A. Van Winkle, improvements in machines for bottling soda water.

116 T. Restell, improvements in breech-loading arms and cartridges.

117 W. Thornley, S. Spencer, and J. Wright, improvements in steam boiler and other furnaces.

122 H. A. Bonneville, improved means for warming and ventilating close carriages and boat saloons. A communication.

126 W. F. Reynolds, improvements in ships' logs and sounding machines, and in the rotators thereof.

138 G. Baker, improvements in machinery for cutting splints for matches.

243 G. Leach, apparatus for shipping and unshipping auxiliary screw propellers whilst in deep water.

1278 C. Exter, an improved brake applicable to the rolling stock of railways and other vehicles.

111 E. Leigh, improvements in the construction of the permanent way of railways.

123 T. R. H. Fisken, improvements in machinery for breaking and softening flax and other fibrous materials.

134 G. Lampen, improvements in the manufacture of shot.

145 H. B. Barlow, improvements in machines for sizing yarn. A communication.

160 D. Spill, improvements in the treatment of xyloidine.

198 A. M. Clark, improvements in the manufacture of chains and chain cables. A communication.

215 W. R. Lake, an improved method of and apparatus for operating railway switches. A communication.

228 C. F. Varley, and T. A. Rochussen, London, improvements in producing heat and light.

336 A. V. Newton, improvements in the construction of knitting machines. A communication.

489 J. L. Norton, improvements in embroidering machinery.

490 G. Jones, improvements in the construction of furnaces to effect consumption of smoke and saving of fuel.

500 A. Jeffers, a new and useful machine for moulding, rounding, channeling, and stamping the soles of boots and shoes.

679 G. W. Wigner, improvements in or applicable to centrifugal drying machines or hydro-extractors.

907 W. E. Newton, improvements in pumps or apparatus for raising water and sand and mud. A communication.

971 W. Smith, apparatus for working and locking railway switches and signals.

1094 J. Plaskitt, improvements in velocipedes. A communication.

1186 P. Spence, improvements in the productions of the prussiate of potash, prussiate of soda, and Prussian blue.

1478 B. Perowne, improvemtnts in machinery for cutting turnips and other roots.

1491 W. R. Lake, improvements in machinery for sewing boots and shoes. A communication.

1492 T. A. de Carvalho, improvements in ships and vessels.

THE *ENGLISH MECHANIC* LIFEBOAT FUND.

Subscriptions to be forwarded to the Editor, at the Office, 31 Tavistock-street, Covent-garden, W.C.

Amount previously acknowledged	£191	18	1
T. Halifax	0	2	6
W. T. P. L	0	1	6
Snatch Block	0	1	0
	£193	3	1

NOTICE.

THE BRITISH AND FOREIGN MECHANIC is now incorporated with this journal.

The English Mechanic
AND
MIRROR OF SCIENCE AND ART.
FRIDAY, JULY 29, 1870.

A PRACTICAL TREATISE ON THE HARMONIUM.*

By HERMANN SMITH.

THIRD DIVISION.—CHAPTER V.

OF THE INFLUENCE OF THE SHAPES OF THE CHANNELS UPON THE TONES GIVEN BY THE REEDS.

THE "Moabite Stone" has made us aware that the familiar household word "squeeze" has recently been raised to the dignity of technological usage. The "squeezes" of this valuable relic of antiquity have become famous. A pulpy plastic material pressed upon the face of the stone has given in fac-simile what the sculptor had written to the order of one of those rulers of Moab who ages ago had, in royal fashion, made history.

Very pleasant it is in this fair summer time to watch the waving cornfield and drink the freshening air. The broad elm plank, unsound and weather-riven, spanning the brook now dwindled to a rill, and the old iron-bound stile on which we rest awhile, mark even to us the passing away of more than one generation. An old stile—these country stiles, were they ever other than old?—and carved with quaint letters, records of the kingly idleness of village youths. Strange what a curious interest these initials excite; some seem to stare at us vacantly, as if they wanted to get away furtively out of sight; some are half obliterated, past recall, whilst others look as if they had a tale to tell if we could decipher it, and then there are those following each other so significantly in pairs that we can scarcely help questioning as we read them and wondering whether E. M. ever won M.P., whether they were united and faithful, and what history they made in the world about them, for all human life makes some sort of history, recorded or unrecorded.

Lessons in stiles, sermons in stones; these deeply-cut initials, speaking to us from the old stile, are a mould which the air fills as surely as the molten metal fills the moulds forming the solid type of which this page is composed. We wish to lead you to picture to yourself the air as possessing in some degree the characteristics of solidity, taking form and shape, capable of giving and of receiving impressions; we would have you think of sound as though you saw it, for thus only will you be able fully to apprehend the bearing your least influence will exercise upon the form and mode of the vibration determining the quality of the sounds issuing from our harmonium channels.

Lift your eyes again. The waving cornfield is taking "squeezes" of the air; now deeply furrowed with undulations, now shimmering in shallow ripples, chequered with currents that intermingle and cross each other, glinting in the brilliance of the sun's rays, or tinted with the shadows of the travelling clouds. The broad white path divides the standing corn, yet breaks not the long undulating roll; the wave passes onwards, but the ears of corn are rooted to their places—like anchored boats they rock to and fro obedient to the pulses of the wind. The great wave of air is shaping itself in the undulations and ripples that are made visible to us upon the yielding surface of the corn. The comparison of corn ears and particles of air is almost as that of stars and dust, so wide is the difference of magnitudes. We are to understand the vibrations of air as movements of minutest particles agitated with the pulsations recognised by us as sounds, and undulating in the same manner as these ears of corn under the rushing of the wind-wave. River or rivulet, the activity is the same; the stream wanders away whilst the ripples are constant, for they are localised.

Every organ pipe, tube, or channel giving voice to music is reproducing within itself the same kind of activity, the same evolution of waves and ripples, as is here under the free heaven empictured for our study. Let us select as a representative channel one that gives a tone corresponding to the 16ft. C C C, and is 4¾in. long, ¾in. wide, and 1⅜in. deep; a stream of wind passes through it—it is not the stream that is musical, but the ripples in it that are making the music. If, now, we imagine the sides of the interior of this channel to present surfaces of some fine plastic matter which shall be relatively as sensitive to the vibrations of the air particles as the ears of corn to the undulations of the wind-waves, and if we could look with eyes of light into this dark aerographic camera, we should see it on all sides taking squeezes of the air, thrilled through with music as the heart with life, as the brain with thought; we should see the wave of the fundamental tone, the light shimmering harmonics, and the sympathetic vibration of the main reservoir of the instrument surging in, and clouding it, as it were, with the ever-changing shadows of its resonance.

The fineness of the musical pulsations of air is very difficult to conceive of; it is by similitudes that we best realize it to the mind. Shakspeare likens the invisible presence of music to the wind laden with odour:—

> Like the sweet south
> That breathes upon a bank of violets,
> Stealing and giving odour.

And another of England's worthies in a converse aspect likens odour to music—

> The breath of flowers is farre sweeter in the aire (where it comes and goes like the warbling of musick) than in the hand.

The sensitive substantiality which we demand in imagination has been in some measure achieved in the remarkably beautiful device, the phonautograph of M. Leon Scott, which we hope before long to introduce to the readers of these papers with suitable illustrations. Our present brief reference only admits of saying that this little apparatus visibly deciphers the pulsations of the enclosed air when agitated by musical sounds, and with a stylex indelibly registers its waves, both great and small.

The channel gives a tone which is the united product of two agents; the reed defines a tone of certain pitch, the channel moulds that tone and impresses it with the forces of its own nature. The character and influence of the channel we have to investigate; the disposition of the reed belongs to a distant branch of enquiry. Let us carry our microscopic research a step further and see what is going on in the recesses of our sound-board. We are familiar with the term 16ft. organ pipe, or C C C pipe; the definite length named expresses a theoretical approximation to the mundane relation of air in respect of the velocity of sound as attained by an enclosed column of air vibrating in its least constrained condition, a condition nevertheless dependent on human rearing and fostering for that approximateness. The word "mundane" is introduced in order to draw your thoughts a little way out of the beaten track, and by it we mean that relatedness which exists in the constitution of things—the free nature in contradistinction to that relatedness which springs from human design, which is favoured by the forecaste of intellect and is thus an artistic relatedness. Therefore it is *not* only the 16ft. pipe that gives a C C C note. Art brought about the coincident relation of length of pipe and pitch of note, and can produce the same result with infinite variety of lengths and proportions. In the fluepipes of an organ air is setting air in vibration, an elastic force conspiring with an elastic medium, agent and recipient are of the same substance—air of air, fluid of fluid; the power to influence each the other is reciprocal; nature is least trammelled in this original state, yet none the less is the product due to the union of two distinct activities—one we may call the generating, the other the resonating. The soft sweet pure tone of the flute organ-pipe is produced with the nearest approach to the freedom of nature; it is so mellow and clear because the sound the mouthpiece can give with greatest ease is likewise the normal tone of the pipe itself.

The column of air contained in the pipe when it is excited to vibration, spontaneously divides into vibrating proportional parts, divides into nodes and segments, at the half of the length, at the third, at the fourth, at the eighth, and so on, and so absolute is the division that we can measure the distances with accuracy, and if at such points we sever the pipe and hold the one half above the other, leaving a little interval between, the undulations will still pass to and fro as little interfered with as the cornfield's rolling billows by the path that makes its emerald sea seem riven with whiteness as with a beam of light.

From the great to the small. The channel of the harmonium in comparison with the organ pipe is as the little meadow brook to the broad river; yet both are subject to the same laws. As we learn theoretically that the tone wave in the organ pipe subdivides itself into aliquot parts, and have the means of practically demonstrating that it does so as clearly as that a vibrating string divides into nodes and segments, so also we know that the channel behaves in like manner. The pulse generated by the reed's activity travels from end to end, and is thrown back in rhythmic recoil, meeting the next transmitted pulse at the half distance. The exactness accordant with the theory is not practically arrived at, because there are certain disturbing elements to be taken into calculation as affecting the results; yet for illustration we assume the theoretical distances as sufficiently accurate; therefore, in our representative channel the wave should divide or strike its nodal distance at the half—2⅜in.—just as in the 16ft. organ pipe it would at 8ft. The similarity of action in these small channels rests on the principle called "multiple resonance"—that is to say, that smaller pipes or channels, if of any length, of which the larger pipe is a multiple, will equally respond in resonance to the note of the same pitch; thus, to a reed giving the note the same in pitch as that given by a 16ft. flue-pipe, we should find a pipe of 2ft. length would yield a perfect consonance, so also 1ft. and 6in., 4, 3, 2, 1½, and many other proportions more or less agreeing.

Or, to put the statement in more exact reference to number of vibrations instead of length of pipe —a multiple being a number which exactly contains another several times—a column of air will not only enter into vibration when it is capable of producing the same sound—namely, that which is the unison of the sound of the vibrating body or agent, but also when the number of the vibrations which it is capable of making is any simple multiple of that which the original agent produces; therefore, the shorter the tube or channel, the less its power of resonance to reinforce the original tone, for the multiple is too compound to give much aid, whilst the more simple the multiple, the greater is the energy of the resonance. The simplest multiple of vibrations, 32 in number, is, of course, 64, namely, the relation of the vibrations of the 8ft. pipe to those of the 16ft., or twice contained; the vibrations of a channel of 6in. amount to 1,024, a multiple which contains the original number 32 times. Theory says that the resonance is only the tone naturally belonging to the channel superadded to the note of the reed, and actually nothing more than a high harmonic to the reed's note. Theory again says the simplest multiple gives the most energetic resonance, but practice gives very different results, and affirms many limitations unheeded by philosophers in their study. Bye and bye, we shall reach the point for further explanations on this subject; what is now said should be sufficient for the present understanding of what is meant by "multiple resonance."

To secure the working of this principle it is necessary that the exciting agent should rule the air, the generator be more powerful than the resonator,—thus metal against air dominates the pitch. If our 16ft. tone reed is mated to a channel that is in true sympathy with itself, the resultant tone will be clear, pure, and smooth in quality, but if the channel is not of the correct proportion it will have a tendency to divide the wave not into parts of which a 16ft. is the multiple, but into some other spaces; the wave in recoil would either fall short of the half distance or go beyond it and get broken or collided, and the smaller fragmentary waves so originated would aid and abet the predominance of the subsidiary tones or natural harmonics which the reed is always ready to set up when unrestrained by the sympathy that should develope only its better nature.

It is quite an accident of art that we obtain the C C C note from an organ pipe that is 16ft. in length. Very unorthodox is the doctrine we here teach and offer for your acceptance, but perhaps you will not mind if you find that the facts supporting the heresy give a clearer insight into musical realities. We arrive at accurate proportions of channels equally by accident. Finding a combined reed and channel to give an agreeable flute-like tone we take it as a standard whence we deduce the relative degrees of length of all other channels intended to occupy the same rank or make up one register. The spaces we have to deal with are too minute for measuring off by aliquot parts, and the multifarious influences associated with the action of the channel preclude any reliance on rule and compass by arbitrary calculation. All our channels are marked off to scales, which are the practical result of observation and long-tried experience. Having succeeded in pairing the reed and channel in faithful consonance, the amateur will naturally come to the conclusion that there is nothing more to be desired and we ought to be happy ever after. Yet such is the perversity of our inclinations, perfection does not altogether content us—we want variety, we notice peculiarities a little incorrect, and take a liking to them; thus bassoon, oboe, and clarion tone display marked dissonances, yet they please and are a grateful change to the ear. Scales of imperfect correspondence are therefore worked out and secured in permanence. The same method is adopted for these as for the consonant. A good specimen is noticed and taken for a standard for the series. It is easy to drive a number of horses abreast in a curve if skill has been acquired to apply the check on the reins in due proportion all along the line. The condition of all such channels is one of coercion, the reed has an overbearing influence more or less and the channel obeys its master, shaping the form of its waves on the easiest course the circumstances admit of.

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It should not be supposed from this statement that any haphazard conjunction of reeds and channels will work equally well, for without choice and selection we should find, in a large majority of instances, there would be incompatibilities of disposition so prominent, conditions so strained, that neither partner would support the other, the channel would be dull, taciturn, unsympathetic, and the reed either coarse and harsh, or sinking to the opposite extreme—sluggish in speech and uncertain in intonation.

In our next chapter we shall present a tabulated view of a series of five sets of scales of proven value.

(*To be continued.*)

COMETS AND METEORS.

By RICHARD A. PROCTOR, B.A., F.R.A.S.

Author of "Other Worlds than Ours," &c., &c.

(*Continued from page* 363).

I CONSIDER it a very fortunate circumstance that precisely when the question has been put to me *whence* I gather my conviction that countless millions of meteor-systems exist within the solar family, I should have been on the point of laying my evidence in the matter before the tens of thousands who read the ENGLISH MECHANIC. Before proceeding to unfold the absolutely convincing evidence which recent discoveries have in my opinion supplied in this matter, let me promise that at each step (as I promised when I began these papers), I will indicate whether the argument I am about to use is certain or simply founded on a greater or less degree of probability.

We have seen that two of the meteoric systems encountered by the earth have been proved to travel on orbits of great eccentricity, their most distant parts lying many times farther from the sun than the earth is. Now no other meteoric systems have yet been dealt with in the same way. But the evidence derived from these two is quite sufficient to force upon us the conviction that meteoric systems are in no way dependent upon the earth, as we might have imagined if the November and August meteors had been found to travel in a nearly circular orbit at about the earth's distance from the sun; and we feel strengthened in this assurance when we learn that probable evidence has been derived from the recurrence of certain meteoric displays in December and April, in favour of the view that two other systems have orbits about as eccentric as the path of the November meteors.* Further, good reasons have been given for believing that other meteoric systems besides the November and August systems, are associated, as those systems are, with comets travelling in paths of greater or less eccentricity.

It cannot but be accepted as certain, then, that the earth has had no part in bringing these meteor-systems into their present positions; for her influence on the meteors when traversing the more distant parts of their paths may be regarded as absolutely *nil*.

It is then a merely fortuitous circumstance that the meteoric systems traversed by the earth cross her orbit as they do. A meteor system having its path assigned to it as it were at random (so far as the earth is concerned), by the attractions of the giant outer planets, might happen to cross the earth's path,—precisely as a musket bullet fired at random might happen to strike a distant telegraph wire. But precisely as the chance against this latter event occurring would be indefinitely small, so would be that against the former also. Now if a great number of meteor-systems had paths assigned to them in this way, there would be nothing very wonderful in the fact that one amongst them had a path given to it which intersected the earth's orbit, precisely as there would be nothing wonderful in a telegraph-wire being struck by one among a flight of bullets.

Now it is a legitimate application of the laws of probability to accept a less wonderful interpretation of an observed fact in preference to an interpretation which is more wonderful. Suppose, for instance, that we know nothing of a certain coin except that it has been tossed ten or twelve times running and each time "head" has turned up, we should reason justly that in all probability both sides of the coin were alike, because, if not, the observed result is so very surprising. Or, again, if a teetotum has ten sides marked with numbers not known to us, and we observe after spinning it, say a hundred times, that a particular number has appeared ninety times or so, while only one other number has appeared, we should be justified in concluding that *certainly* that first number was marked on more than one face of the teetotum, and that probably it was marked on nine faces out of the ten. For it would be an altogether amazing accident if the same *face* appeared ninety times or so in a hundred trials, while there would be nothing surprising in the fact that a certain *number* appeared so often if that number were marked on several faces of the teetotum.* In all such cases, speaking generally, that state of things which renders the observed result least surprising is the most probable.

The existence of a few meteor-systems only would make the earth's encountering one meteor-system such a very surprising coincidence that we are justified in concluding that for each meteor-system the earth encounters there are many circuiting around the sun. The argument would be strong if the earth encountered but one system; it would be immensely strengthened if she encountered two; but it becomes overwhelmingly strong under the actual circumstance that she encounters more than half a hundred. We are in fact, free in the actual case to simply multiply the number of systems actually encountered by the number which should exist to make the chances *even* that the earth would encounter *one*. What this last number may be it would be somewhat difficult to determine; but no one who considers the multitude of positions in which an orbit of great extent and electricity *might* be placed without coming near the earth's orbit can doubt that it is very large indeed. Thus, then, merely from the fact that the earth encounters such and such a number of meteor-systems, we have been led to the conclusion that the actual number of such systems must be enormous.

But we have reason for believing that there exists an actual condensation of meteoric systems in the neighbourhood of the sun, and if this condensation can be established we shall have yet further to increase our estimate of the total number of meteors which exist at every instant of time in the sun's neighbourhood.

I cannot prove the existence of this condensation *directly*; but I can show it to be highly probable, by attending to what has been shown about the connection between meteoric systems and comets. What the nature of that connection may in reality be I do not pretend to know. Whether every meteoric system is associated with a comet and every comet with a meteoric system I do not pretend to assert. What has been actually shown is simply this, that the only two meteoric systems whose orbits have been determined have been found to travel on the same paths as two comets. No one can deny that, so far as the evidence at present goes, probabilities are in favour of the view that the tracks of most comets are followed by multitudes of minute bodies such as form our meteoric systems. There seems no reason to suppose the two comets above dealt with to be exceptional. Nay, further, it has been shown in the case of other comets which pass near th· earth's orbit, that when the earth comes past th point of nearest approach meteoric displ ordinarily take place. Without at all insis[illegible] then, that comets must necessarily have me[illegible] attendants travelling on their track, I y[illegible]ell on the fact that probabilities are in favour of this being the case with at least a large proportion of the comets which belong to the solar system.

Now these comets show a marked tendency to aggregation in the sun's neighbourhood. The following table, one of Mr. Dunkin's very valuable additions to Lardner's "Handbook of Astronomy," affords most instructive evidence in this respect. The first column indicates the limits of distance from the sun estimated in millions of miles, within which the cometic perihelia are counted. The second indicates the relative cubical content of space included within those limits. Of course the cubical content of spheres whose diameters increase as the numbers 1, 2, 3, 4, 5, &c., varies as the numbers 1, 8, 64, 125, &c., and so the innermost sphere and the successive shells have volumes relatively as 1 (8 – 1), (27 – 8), (64 – 27), (125 – 64), &c. The third column indicates the number out of every 100 discovered comets whose point of nearest approach to the sun lies within the limits of distance referred to in the first column. And, finally, we obtain the density with which such points of nearest approach are spread through these spaces by dividing the number of points in each space by the number expressing the extent of that space.

Mr. Dunkin's table runs thus:—

	Cubical space.	Number of Perihelia.	Density of Perihelia.
0 to 20	1	8·65	8·65
20 to 40	7	11·70	1·67
40 to 60	19	20·30	1·06
60 to 80	37	17·20	0·47
80 to 100	61	20·80	0·34
100 to 120	91	8·65	0·095

Nothing can be more convincing than *the last column of this table. It indicates not merely an increase of density in the sun's neighbourhood,* but a very rapid increase.

But applying this to the case of meteoric systems—assuming, that is to say, that what has thus been proved to be true respecting :omets is true also of meteoric systems—there re nains yet something more to be said. I can s iow that, *apart* from this form of increase of de isity sunwards, there must be an increase resu ting from the mere ellipticity of the meteoric orb :s.

Suppose the meteors of a system to ravel one after another along the same track ı recisely (I put this merely for convenience), and *n t at equal distances all round the orbit*, but (st l for convenience) in such a way that they pass the perihelion of their track (the point ı arest the sun) at equal intervals of time, su intervals being very minute. Then they will pass the aphelion of their track (the point fa *hest from* the sun) at these same equal and mi *ite inter*vals of time. But they travel faster i erihelion than in aphelion, and so traverse gre :r spaces in these equal intervals of time. bviously, therefore, they are farther apart whe learest to the sun. It might seem, accordin . that I have proved precisely the reverse of hat I promised in the preceding paragraph, a that the peculiarities of motion in elliptic c its would cause meteors to be more sparsely istributed near the sun than at a distance from im. And yet, paradoxical as it sounds, thou meteoric systems open out their ranks as th approach the sun, and close up their ranks as ey travel from him, the members of a set f elliptic meteoric systems will always be mor owded in the sun's neighbourhood than at a di nce from him. The reason simply is, that the rihelia of the systems are crowded in a smalle ace than the aphelia; and one can easily sho at this is more effective to increase crowding the sun's neighbourhood than the other rel n is to diminish such crowding.

Suppose, for instance, we tak 1,000,000 meteoric systems in every possible ition, but all alike in shape, and ten times fart from the sun in aphelion than in perihelion. T he members of such systems would move ten times faster in perihelion than in aphelion, and for ten meteors along a given small range close by perihelion there would be 100 along an equal range close by aphelion. For 10,000,000 meteors then close by perihelion there would be 100,000,000 equally close by aphelion. But the latter set would be spread uniformly over the surface of a sphere having a diameter ten times greater than that of the sphere over which the latter set would be spread. The surface of the larger sphere would, therefore, be 100 times greater than that of the smaller sphere, while the number of meteors spread over it would be only ten times as great. It follows that meteors would be spread only one-tenth as richly at the aphelion distance as at the perihelion.

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* Professor Kirkwood has shown this.

* Here I am seeking to exhibit in a popular form a law of probability which is in reality admitted. The reader is to understand the above reasoning as not meant to *establish* but to illustrate the law. The science of probabilities enables us to calculate the chance that the teetotum has that particular number which has appeared so often, on any given number of faces.

On the average, the meteors belonging to such a system as the November one are spread eighteen times as richly (cubical space for cubical space) near the point of their closest approach to the sun as near the orbit of Uranus, beyond which their aphelion lies. Giving to the August meteors a period of about 100 years (the real period is certainly greater), we get a mean distance of somewhat less than twenty-two (the earth's as one), or an aphelion distance more than forty-three times exceeding the perihelion distance; so that the density with which these meteors are distributed in cubical space is, on the average, more than forty-three times greater at the point of nearest approach to the sun than at aphelion. And the like is true, *mutatis mutandis*, of every eccentric meteoric system, whether traversed by the earth or not.

To sum up then, we have—

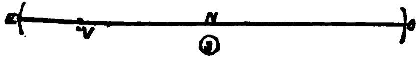
1. Absolute certainty that the number of meteoric systems is enormous.

2. Very good reason for believing that meteoric systems aggregate as systems towards the sun's neighbourhood; and

3. Absolute certainty that individual meteors in every elliptic system are, on the average, much more thickly spread (cubical space for cubical space) near the perihelia than near the aphelia of their orbits.

The last relation, only true *on the average* as expressed for any given meteoric system, must be absolutely true when all the meteoric systems are considered together. For example, when the *gem* of the November meteor-ring—as Mrs. Wood finely called its richer portion—is travelling out in space beyond the orbit of Uranus, this system is, for the moment, richer out there than near perihelion, where the poorer part is passing. But we cannot doubt that this temporary effect is much more than counterbalanced by the superior aggregation of the numbers of countless other meteoric systems near the sun—we cannot, I mean, imagine that any one system, or even several systems, can even temporarily disturb the preponderance of aggregation in the sun's neighbourhood.

Now, even giving up the second of the above conclusions as not absolutely demonstrated, the other two remain, and leave us no manner of doubt whatever that the neighbourhood of the sun must be more abundantly crowded with meteors than the track through which the earth pursues her course. But it has been proved that within every space along that track equal in size to the earth there must, on the average, be some 13,000 large meteors, and forty times as many small ones. If the whole space enclosed by the earth's orbit (to consider no farther) is at least as richly supplied with meteors as this (and I see no escape from the conclusion), some rather remarkable results follow, which we shall do well to consider somewhat attentively.



Here is one:—Let E *e* be a cylinder enclosing the earth at E, passing pretty close by the sun S at N, and extending to the earth's orbit again at *e*. The length of this cylinder would be about 180,000,000 miles, a length containing the earth's diameter some 22,800 times, and therefore the volume of the cylinder would exceed the earth's more than 34,000 times. The cylinder would therefore contain more than 442,000,000 meteors such as become visible to the naked eye when traversing our atmosphere, and 17,680,000,000 smaller ones, or more than 18,000,000,000 meteors of one sort or another. These would be illuminated by the sun with more or less brightness—those near N with an inconceivable glory of light (these, too, would be so heated as to be incandescent, if not vapourised), and they would turn more or less of their illuminated portions towards the earth.

Is it conceivable that so tremendous an array of illuminated bodies, let them be as minute as we can suppose them to be, would give no appreciable light when the sun is totally eclipsed? Is it an idea so utterly wild and fanciful that the light actually seen during eclipses—where this long array of illuminated bodies has been shown to be—the sun's corona, I mean,—does actually come from them? Or, if we were disposed still to be doubtful as to this interpretation, ought not all doubt to be removed when such a practised observer as Captain Noble tells us he has actually seen Venus (when placed somewhat as shown in the figure at V) projected as a black body on a relatively light background? When some one shall have shown me whence the light illuminating that background can have come, except from beyond Venus, or how, supposing it so to come, any doubt can exist that during total eclipse we ought to see some such light, I shall prepare to admit that there is no objection to Mr. Lockyer's theory that the corona is a phenomena of our own atmosphere, except "that it does not square with Mr. Proctor's opinions."

But there are other consequences to be considered. I reserve them for a future paper, in which I shall, in the first place, show how the results here deduced serve to explain the zodiacal light in a very satisfactory manner—even the phenomena hitherto considered most perplexing; how the zodiacal light is brought into direct association with the corona; and, further, how the peculiarities of comets, as distinguished from meteoric systems, find their counterpart in the peculiarities of the corona and zodiacal light. I would specially invite any readers of the English Mechanic who find my reasoning either obscure or unsound in any place, to kindly point out their difficulties or objections. I have no wish to make out a case, but to interpret, if I can, the phenomena I have referred to. Let me add that I can see no reason for waiting because we hope to gain new information during the eclipse of next December. The more earnestly we try to educe the meaning of what we have already learned, the more significant will new observations become. There is a good deal of affectation (to say nothing of downright laziness) in the continually repeated advice to wait for fresh observations. The warning addressed specially to me reminds me of Miss Lavinia Spenlow's remarks about "mature affection." "Mature science," Professor Pritchard seems to say, "does not easily express itself. Its voice is low. It is modest and retiring; it lies in ambush, *waits and waits*. Such is the mature fruit. *Sometimes a life glides away and finds it still ripening in the shade*." I confess I prefer a fruit of somewhat quicker growth.

(*To be continued.*)

THE WORLD: ITS FORMATION AND ANTIQUITY.

By Arthur Underhill.

(*Continued from page* 411.)

Chapter V.

HAVING investigated the nature of the igneous rocks, we now come to the consideration of those of an aqueous formation. The oldest, and in consequence the lowest, deposit of this species is that which is called the *metamorphic* (from two Greek words, signifying changed in form) or primary class. The rocks of this series are termed metamorphic because they appear to have undergone considerable alterations since their deposition, and under the influence of pressure, heat, and chemical forces, to have assumed a semi-crystalline character, which is not possessed by the ordinary aqueous strata. They are also called *non-fossiliferous*, *hypozoic*, (under life), or *azoic* (without life), because they contain no remains of plants or animals.

The primary, metamorphic, non-fossiliferous, hypozoic, or azoic class (for by all these names is it known) comprises three systems or groups—namely the gneiss, the mica schist, and the clay slate systems.

It will, perhaps, be noticed that in the list of rocks in order of superposition I have placed the clay state system in the class of secondary rocks. This was, however, a *lapsus calami*, which I must beg my readers to excuse. It should have stood at the head of the primary class, and the Cambrian system should have been inserted in its place at the bottom of the secondary class. The gneiss is the oldest and lowest of the three, and I shall therefore proceed to the consideration of it first, and shall then take the others in order. In a previous chapter, I said that, after the first convulsion had taken place, the sea deposited a system composed of the detached particles of granite. This deposition formed the gneiss system, and so well was the character of the original granite preserved that it is in many cases extremely difficult to tell the difference between the granite and gneiss rocks. The stratification of gneiss, however, is a sure test, and in most cases it is marked enough, although in others, on account of the very contorted and flexured stratification of the primary rocks, it is a work of difficulty to follow it. Gneiss is, however, of a neater appearance than granite, if I may be allowed to use such an expression.

The contorted appearance of the metamorphic strata is (when the flexures are large) generally accounted for by the supposition of an immense lateral and vertical pressure acting upon them while yet in a soft and yielding condition; and when the contortions are small, they are explained by the help of an analogous case, which presents itself to our notice at the present day—namely, the phenomenon of ripple marks, which is seen on the sandy beach of any of our many watering-places. The sea at the time of the deposit of the gneiss was in an excessively troubled condition, and in consequence the motion of the waves was communicated to the very bottom, instead of being confined, as now, to the shallow portions of the ocean. The first cause of contortion, namely, lateral and vertical pressure, has been experimentally demonstrated by Sir C. Lyell. He took some clay, and having made of it several slabs or cakes, he placed them one upon another on a table; he then placed two pieces of board, one at each end, and upon the top he laid another board very heavily weighted. He then, by means of a press, forcibly contracted the space between the *side* boards. The result was that the slabs were bent and contorted in a similar way to the strata of the primary rocks.

The strata of the gneiss system are *gneiss proper*, composed of quartz, felspar, and mica; *syenitic* and *porphyritic gneiss*, of the same minerals as syenite and porphyry respectively; and *quartz rock*.

The next system in order of superposition is the mica schist. This has by many geologists been classed with the gneiss, both on account of the similarity of the characteristics of both systems, and also because their order of superposition, unlike any other groups, is somewhat uncertain. However, as for purposes of description it is more convenient to keep them apart, I have adopted that method. Mica schist differs from gneiss in the entire absence of felspar, and has, therefore, an appearance of a white glistening stone, which is for the most part laminated like slate. It is, as a rule, softer than gneiss, more distinct in its lines of stratification, and less crystalline. Its chief strata are *mica schist* proper, composed of mica and quartz; *talc schist*, in which talc supplants the mica; *chlorite schist*, where chlorite takes the place of the mica and gives a greenish colour to the stone; *hornblend* and *actynolite schist*, of hornblend and actynolite respectively with quartz; and *primary limestone*, such as the highly crystalline Carrara, and other pure marbles. The meaning of the word *schist* is somewhat similar to that of *slate*, and is used to signify that such rocks are laminated. The gneiss and mica schist systems are very plentifully distributed over Scotland, but are extremely rare in England. I may mention, as examples, the passes of Glencoe and Killiecrankie, and the mountains around Loch Katrine.

We now come to the clay slate group, specimens of which are so continually seen in the roofing of our houses. It is of various colours, from light grey to black, and its texture is also subject to considerable modification; it is, however, much finer than that of gneiss or mica schist, and the minerals of which it is composed appear to be the finer and more impalpable particles of water than matter. The lamination of this group is particularly marked, and renders it of the greatest use in the arts, as it splits up into plates of the most perfect thickness throughout. The cause of this property is very obscurely understood, but is thought to proceed from chemical and magnetic action combined with heat, acting whilst the strata were under great pressure. The line of lamination, or cleavage, is not generally the same as that of the strata, but lies at all angles to it.

The scenery of the clay slate system is very wild and abrupt, the strata being tilted up into the most fantastic shapes and forming precipices of tremendous depth.

I have now reviewed the primary rocks, and in my next chapter shall commence the consideration of the secondary class, which is of far greater extent and of much more interest than the metamorphic or non-fossiliferous systems.

(*To be continued.*)

MICROSCOPICAL JOTTINGS IN TOWN AND COUNTRY.

No. IV.

THE name of micro-fungi is legion, there are at least 2,000 species for the study of which the microscope is essential, and, as I have before said, any person having good eyes and a fair amount of patience may collect a goodly number with little difficulty, from the beautiful "cluster cup" (*Æcidium*) to the humble smut (*Ustilago*). He will find ample scope for real earnest work which is not without its reward.

Whilst upon the subject of fungi, I may touch upon the yeast fungus, concerning which enquiries have lately been made by correspondents in the English Mechanic. In John Quekett's "Lectures on Histology," and in Dr. Carpenter's "Microscope and its Revelations," drawings are given of the various stages of the development of this plant, accompanied by a lucid description, which we cannot do better than abridge. The initiatory stage is that of a simple cell, which we may regard as the perfect plant. Place one of these in a saccharine fluid containing also albuminous matter, and each cell "rapidly puts out one or more projections which appear to be buds," that speedily become new and complete cells, themselves to increase in like manner, so that in a few hours a single cell will develop into several rows of cells, all remaining in continuity with the parent cell, but existing independently, and exercising all the functions of separate plants. If we check the process of fermentation these separate into single cells, and return to the isolated state we call yeast. Any of our readers can easily examine these for themselves if they be provided with a good ¼in. or ⅛in. objective, and, by a little ingenuity, can devise means by which the process of development may be watched for a considerable period.

Various "insect preparations" are generally to be found in our microscopical cabinets, and usually attract a considerable amount of attention from the outside public, so that I am not surprised that "C. R. H." (qy. 4328), requests me to give some information as to the best means of "putting them up." It will perhaps be more interesting to the readers of the English Mechanic generally if I give a few hints as I touch upon different kinds of insect preparations than if I give "C. R. H." a formal reply. Premising that he will require a few glass slips 3in. × 1in., a few thin covers, either square or round, about ¾in. across, a little balsam and gold size or asphalte varnish, I will for the present dismiss the subject. But if our readers wish a short paper on mounting I will try and meet their wishes as best I can.

The House Fly.—The proboscis is the favourite portion of this insect, and is really, when nicely prepared, a splendid object in the hands of a good manipulator, and furthermore affords a good test of the correctness of the lens used. We have to remove it from the head of the insect, soak it awhile in *pure* turpentine and mount it in balsam, paying great attention to its arrangement on the slide.

Balsam, when used in mounting, should be of medium thickness, and it is usually desirable to warm both slide and cover slightly, in order that the balsam may flow freely, and air bubbles be less likely to be included. When mounted, the slide must be placed awhile in a warm room, until the balsam becomes hardened, when the slide may be cleaned off. Under a good 1in. objective we can make out the anatomy of the proboscis very well. Briefly we may describe it as consisting of the two lobes of the lingula, or the expanded portion which is pressed upon our hands when the creature "bites" us, of the lancets formed by metamorphosis of the lesser pair of jaws (called the maxillæ), and of the maxillary palpi, small appendages attached to the latter. Certain ring-like markings on the lobes of the lingulæ are really metamorphoses trachea, as may be made out by a good lens and careful focussing. I have often watched, with much interest, through an ordinary inch pocket lens, the creature at work upon a lump of sugar, and have seen it pump up the dissolved sugar as though it were determined to lay in as much as possible in the least possible time.

The eye of the fly is perhaps not so easily prepared. We must carefully remove it by cutting round it with a fine pair of scissors, lay it on a slip of glass and wash it freely with clean water. A few minutes' soaking in potass solution will improve it, but I have rarely found this to be necessary. So soon as we have made the eye perfectly clean by washing away all its pigment, we may remove it to a clean slide and lay a piece of thin glass over it, add a *little* pressure to ensure its flatness (it is often needful to notch the eye all round), and allow it to dry at its leisure. When quite dry, we may moisten it in balsam. Under a good ⅛in. or ¼in. we find that the eye is composed of a great number of hexagonal facets, of which there are as many as 4,000 in the two eyes. Each facet is the "corneule" of a distinct "ocellus," and may be correctly regarded as a perfect eye. The question has often been asked whether a fly with its 4,000 eyes sees but one object or many at once. To this there can, I think, be but one answer—viz., that it receives but one image at once, and that one impression only is transmitted to its brain. The why and wherefore of this, our readers may profitably work out by the aid of their microscopes. To explain it here would require diagrams and more space than I can ask.

I must reserve further notes on the fly until my next, which I think ought now to be my last, as it is unfair for one contributor to monopolise space for too long a time together.

H. P., Hull.

TELESCOPIC WORK FOR MOONLIGHT EVENINGS.

By W. R. Birt, F.R.A.S.

IT is well known that the finest views of lunar scenery are obtained about the times of the first and last quarters of the moon, when the boundary of light and darkness, which is technically called the terminator, divides the visible disc into two portions; in the first case, before the full, the western or day side, and the eastern or night side, which in the second case, after the full, are reversed. With such telescopes as those mentioned by Webb in his interesting work, "Celestial Objects for Common Telescopes," the irregular and rugged line separating the two is well brought out. On the west of the first lunar meridian (the line on Webb's map joining the letters S and N) may be detected, about the time of first quarter, the formations numbered on the map 288 (*Hipparchus*), 289 (*Albategnius*), and 290 (*Parrot*), and as the terminator moves eastward one of the finest chains of walled plains to be found on the moon, just eastward of the first meridian, comes into view—viz., 208 (*Ptolemæus*), 207 (*Alphonsus*), 204 (*Arzachel*), 202 (*Purbach*), 201 (*Regiomontanus*), and 200 (*Walter.*) These formations are mentioned as being calculated, when beheld through a good glass, to arrest the attention of the observer by the magnificence of their appearance and the quantity of interesting detail to be found in their immediate neighbourhoods; it is, however, to a few of the characteristic features of *Hipparchus* that attention is solicited, as this formation exhibits in many respects, a marked difference from its neighbour *Ptolemæus*. Although the boundaries of each may be easily recognized when the sun has newly risen upon them, those of *Hipparchus* differ so greatly from the usual boundaries of walled plains, which are more or less visible under every angle of illumination, as to remove *Hipparchus* from this class of lunar objects, its general outline being lost to view in about forty-eight hours after sunrise upon it, it is rather, as Beer and Mädler describe it, "an assemblage of diverse lunar forms than a general whole." Under suitable illuminations these diverse forms possess considerable interest for the explorer of the moon's surface.

If the observer be fortunate enough to catch the terminator on the eastern part of *Hipparchus*, there is little doubt of his being greatly interested in contemplating the high chain of mountains which separates *Albategnius* from *Hipparchus*. The summit of this chain, which is *narrow*, appears at the time of sunrise upon it as a brilliant line of light, and he will soon detect upon its western portion three craterlets—the *northern half* of the middle one having been *elevated* apparently by the upheaval of the narrow strip of mountain, while the southern half has remained at a lower level. Schmidt first noticed this narrow mountain chain perforated in parts by craterlets, and which he calls a crater-rill, on February 3rd, 1865, although the eastern part of the same mountain wall he had known as early as August 17th, 1843.

The observer will not be long in ascertaining, under the oblique illumination at the time of first quarter, or a little later, that the mountain wall separating *Albategnius* from *Hipparchus* is but a small portion of a line of cliffs extending eastward to the junction of the borders of *Ptolemæus* and *Alphonsus*, a very rugged and rocky region, and westward as far as the two craters on Webb's map 64 (*Ritter*), and 65 (*Sabine*). The faces of these cliffs are very steep towards *Hipparchus*, the depressed level of which appears to have resulted from *subsidence*. At the time of full moon, a ray from *Tycho*, the metropolitan crater of the moon, as it is called by Webb, crosses *Hipparchus*. This ray, by comparing lunar photograms taken at the full, and shortly after the first quarter, is found to traverse very uneven ground, which is sufficiently connected and linear in its direction to warrant the supposition that it has been dislocated and shattered in the line of the ray, and therefore that the ray and fault are mutually connected. At the point where this fault or ray crosses the mountain wall common to *Albategnius* and *Hipparchus*, the wall has been greatly disturbed, and from the manner in which this has been effected it is probable that the ray from *Tycho* is the most recent of the two.

In Webb's map there are four small craters, three on the S.W. border of *Hipparchus*, and one within its enclosure north of them. The largest has been called *Halley*, and the one west of it *Hind*, the northern one within the enclosure of *Hipparchus* has been termed *Horrox*. The observer will find a small crater west of the three, on the S.W. border, forming a conspicuous row of four craters, which is well worth his study. From the three craterlets on the mountain wall between *Albategnius* and *Hipparchus*, the cliffs pass close to the N.E. border of *Halley*. An interesting feature connected with *Halley* is a peak common to its border and the cliff, which according to Beer and Mädler rises to the height of 3,543 English feet. The western foot of this peak is perceptible within the interior of *Halley*, and it sends out a spur towards the N.E. on to the floor of *Hipparchus*, which has a rapid declivity. As the sun rises upon the spur it appears as a fine line of light, and is a very interesting object,

There are similar peaks on many parts of the moon's surface well deserving attention. Of these mention may be made of *Pico* (Webb, 131) on the south border of the ancient plain called *Newton* by Schröter. The plain is visible for a short time only, but *Pico*, with an altitude of nearly 8,000ft., may always be seen. There is also a fine peak on the east border of *Plato* (Webb, 132) named by the late Dr. Lee "*Rupes Smythii*," which Schmidt finds to be 9,000ft. high. Peaks of this kind should be well examined under every phase of illumination.

Mention of a feature connected with the mountain wall to which the attention of the observer was first directed must not be omitted; it is that the western of the three craterlets is the *brightest*, and immediately below it, on the face of the cliff, is a shallow ravine, which appears on Rutherford's photogram, 1865, March 6th, as if it had been excavated by the flowing or descent of some material over it, and on the floor at the bottom of this ravine is a mound of apparently accumulated material. It is very desirable that further observations of craterlet, ravine, and mound, should be made, also that the rocky region in the intermediate neighbourhood should be well examined, for it is in such localities that discoveries are likely to be made. Schmidt says:—"As other objects of a rigorous and searching examination, I mention those little craters, crater rows, crater rills, that, situated in the interior of the ring mountains, form the limits of the plain and the beginning of the wall mountain. Here the eruptive forms have issued, as it were, out of cracks, and in parts of considerable and high mountains, where two mountain masses approaching each other form a narrow valley, or a sharp corner."—Report of the British Association for the Advancement of Science, 1865, p. 307. Craters are much more numerous on the rocky land filling the region between *Albategnius* and *Ptolemæus* than they are to the westward, but as yet no evidence of recent formations has been met with.

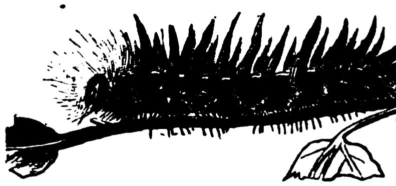
It is probable that on some future occasion the interesting features on the floor of *Hipparchus* may be described.

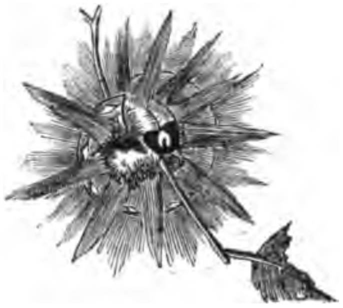
CHAPTERS ON CURIOUS CATERPILLARS.
AUGUST.

By J. R. S. Clifford.

AUGUST is very often a month of sunshine, and one also favoured with heavy showers of rain. The first is agreeable enough to many of the caterpillars now feeding, though there are some so squeamish as to resort to various concealments during the heat of the day, preferring to feed while the early dew studs the leaves, or at night, when they can come abroad with the additional advantage of not being in danger of their lives from some vigilant bird intent on filling its own crop, or intently engaged on the more benevolent business of providing for the wants of a helpless brood. There are some caterpillars, too, which seem indifferent to the rainfall—in fact, perhaps rather enjoy a shower bath than otherwise; while again, in many species, the dislike and avoidance of moisture is notable. After a summer's rain, we shall find numerous caterpillars, especially young and naked ones (for the hairy and spiny individuals have the best of it at those times), sadly bedrabbled, or even lying half dead, while a certain portion are actually killed; and there is no doubt the numbers of some destructive species are thus diminished by drenching showers or long rains, to the advantage of vegetation.

What are commonly called by collectors the Dagger moths (from peculiar markings found belonging to the very deficient family of the *Bombyces*. Some of them are amongst the earliest on the wings of some species) belonging to the genus *Acronycta*, and the family of the *Noctuæ*, in the caterpillar state remind one rather of those captures made by the young seeker of caterpillars, who is surprised at the emergence of a moth or moths not at all resembling his expectations. The most common of all is the Grey Dagger (*A. Psi*), which occurs all over the country, and even in the heart of towns. On the back of this caterpillar are two humps—the first being long and horn-like, on the fifth segment, and at the extremity of the body is another, shorter and broader; the former of these is deep-black, covered with hairs; a yellow stripe runs down the middle of the back from the third segment, ending at the anal lump, and on each side of this is a black stripe of the same breadth; enclosed in this stripe on every segment from the fifth there are two red spots and two white warts; beneath this black stripe again there is a grey one on each side, tinged with red, and hairy. The head is black and shiny, like that of the well-known Tiger caterpillars, often called "Woolly Bears." The caterpillar of this species is by no means particular as to its food, roving about in gardens from plant to plant, and from tree to tree, sometimes continuing to feed until late in autumn. Closely allied to the preceding is the so-called Dark Dagger (*A. tridens*), though not noticeably darker; indeed, in the perfect state the two species are so alike that our greatest entomologists find it no easy task to distinguish them. The caterpillars, however, are markedly distinct, and of the two, *tridens* is apparently the scarcer species, though widely dispersed. The body of the caterpillar is black, having numerous orange and white spots disposed in a regular manner; there is a narrowish orange-yellow stripe along the back from the sixth to the eleventh segment. There is a hump, as in *tridens* on the fifth segment, black on the top but grey behind; and on the twelfth segment there is a slight hump, with a snow-white mark on its top; behind this is a horn pointing backwards. There is a stripe along the sides containing the spiracles which is mottled with yellow, not grey, as in the preceding. This caterpillar is most partial to the blackthorn and whitethorn, and remains out, like its relative, for some time; the cocoon is generally spun in a crevice of the bark of some tree. The sycamore is not a tree favoured with many insect dwellers, but one of the devourers of its leaves is the caterpillar of the Sycamore Dagger (*A. aceris*), which generally prefers to feed on the higher branches, also eating occasionally the leaves of the horse chestnut. When alarmed it assumes one of the positions shown in the figure, and remains unmoved for a good while. The body is of a dull flesh colour, but this is scarcely noticed, owing to the long hairs which clothe it, and which, though varying in tint, are usually yellowish-red; some of these hairs form a series of "facicles," or brushes, each series having nine. Along the back we find a series of white spots bordered with deep black. The head is black with a white mark like the letter V, the spiracles and legs are black and the claspers brown. This is by no means an easy caterpillar to rear in confinement; though it may be found sometimes in good condition, on a trunk or paling, making its way to the earth, where it usually spins its cocoon in some dry nook, not appearing as a moth till the spring, which is the case with others of the genus. Another handsome caterpillar, not very frequent, is the Coronet (*A. ligustri*). This refuses to roll itself up when alarmed, but moves off with some speed. The head is of a very light green tint, and appears almost transparent; the general colour of the body is also green, while down the middle of the back is a narrow white stripe, and below this another broader stripe of yellowish-white, which does not however reach to the spiracles; on each segment there are a few silky bristles. Though called after the privet in its Latin designation the caterpillar before us seems to prefer to feed on the ash, near the roots of which the chrysalis may be found in some slit in the bark or hidden in moss. The cocoon turns black after a certain time, and is somewhat of a gummy texture. On the alder there is sometimes detected, though very rarely, the caterpillar of the Alder Dagger (*A. Alni*), and this is remarkable not only from its scarceness, but because it curiously differs from the other caterpillars of the genus. The head is very glossy, and as broad as the segment to which it is united, black in colour. The body is purplish-black, and along the back are situated a series of yellowish-white markings, which are sometimes absent, wholly or partially. The most singular circumstance connected with its appearance is that on each segment there is what has been called a "process" or "appendage," black and flattened, and unlike anything seen in other British caterpillars. In confinement this caterpillar has been found to eat other leaves besides those of the alder. The cocoon is compact, and usually concealed.





Our largest native caterpillar is to be found of its full dimensions at the end of July or during August, and he who has once seen it will not easily forget its appearance and proportions. Though most partial to the potato, it has sometimes been detected on the privet, the jessamine, and several other plants. Whatever its food it usually hides from view during the day, going to the surface of the earth, or to the thicker portions of some bush or shrub. When at its greatest size, the caterpillar of the Death's Head is nearly five inches in length. It has long been noticed that the moth had the power of producing a peculiar sound, so stridulous as to be sometimes called a squeak, and some of those who have reared the caterpillar assert that it has also a rather similar faculty, only the noise resembles more the snapping of electric sparks. Others have failed to perceive this, and have questioned the truth of the statement. This caterpillar, like so many others of the Sphinx family, has an anal horn, which is rather rough, and has a double bend downwards at its junction with the body and then upwards again close to the tip; in colour it is yellow and black. The head, which is occasionally almost withdrawn beneath the second segment, is orange-yellow, with a brown stripe on each cheek, commencing at the crown and running down to the mouth; the colour of the body is rather lighter, and the yellow passes into green on the under side; on the three segments immediately behind the head there are no spots; but the other segments are highly ornamented—first, with a number of oval deep purple spots, and secondly, with markings in the shape of the letter V, and these are of a dull violet hue. The quantity of leaves consumed by these caterpillars when in their last stage is extraordinary, and having arrived at maturity they enter the earth to a considerable depth and there construct a cell composed of a gummy substance mingled with earth. Not unfrequently, when potato-fields are dug over, the caterpillars and chrysalides are turned up, the former being called "locusts" in the midland and northern counties. The chrysalides thus got are sent sometimes to London or to other towns for sale, and some years they may be purchased at a moderate rate by those who may be curious to see this magnificent moth emerge. The getting the moth out is no easy matter, for very often the chrysalis has received some unnoticed injury when unearthed, and afterwards the temperature and the moisture or dryness of its condition must be nicely adjusted in order to secure its emergence.

Considerably less in size, though still to be reckoned a large caterpillar, is that producing the Privet Hawk-moth (*Sphinx ligustri*); this is so conspicuous on the privet hedges that those not insect-hunters sometimes see it, and pause to admire its beauty, as I have myself noticed in the vicinity of London. This has also a horn, pointing backwards, black and shining above, and yellowish beneath. The ground colour is a delicate green, and along the sides are seven stripes, which are purple and white. A few days before the caterpillar is adult, the colour of the stripes fades, and the green of the rest of the body turns to a brown. Entering the earth, the caterpillar finally scoops out a cell, in which it becomes a chrysalis, on the front of which there is a sort of beak, which contains the proboscis of the future moth, whose appearance on the wing is usually in June. Feeding on the lime or the elm, and in some places not rare, we may discover during August the caterpillar of the Line Hawk-moth (*Smerinthus Tiliæ*). It is rather partial to the higher branches of trees, whence a brisk wind occasionally dislodges it, and sends it to the ground, not advantaged by the fall. But, like others of the family to which it belongs, it grasps the branch or twig on which it rests with great tenacity, and may be injured if torn suddenly from its hold. This caterpillar is shagreened all over, and sprinkled with yellow dots, the ground colour being green; on the sides are disposed the seven stripes so frequent amongst the Hawk-moth caterpillars. The anal horn is blue on the upper surface and yellow underneath, while close to it there is a very singular plate or circlet, purple, edged with yellow. This is not found in the two other caterpillars belonging to the same genus (*Smerinthus*), and which are commonly known as the Eyed Hawk-moth, and the Poplar Hawk-moth, though in other points they are not dissimilar. The caterpillar of the Eyed Hawk is most partial to willow, occasionally visiting fruit trees, and in this the horn at the tail is blue, which at once distinguishes it. That of the Poplar Hawk is generally more of a yellowish cast, and along the sides close to the spiracles there runs a series of red spots.

Some curious caterpillars of butterflies are feeding in the month of August, and several belonging to the *Vanessa* genus are full grown at this time, or a little earlier. It is singular that several of these live exclusively on that apparently unpalatable and most abundant plant, the stinging nettle. Living in companionship almost throughout their caterpillar life (which only lasts from four to six weeks) we have the small tortoiseshell (*V. Urtica*), a beautiful insect as it sports from flower to flower. The caterpillars of this species vary much in colour, being all shades of grey, mingled with yellow, green, or black. The head is shiny and black, while the claspers are quite pale. The whole body is covered with what are called compound spines. That of the peacock (*V. Io*) is also social until the last change of skin. Here the ground colour is a rich black, not variable, and freckled all over with white dots, which seem to be arranged in rows. The spines are long and compound. Rather hermit-like in its habits is the caterpillar of the brilliant and fearless Red Admiral (*V. Atalanta*), and not only does it choose to live alone, but draws the leaves slightly together with silken threads as an additional security. This is very dark grey, or sometimes reddish-black, slightly marked on some parts of the body with white, and with a wavy yellow line along each side. The spines are of a reddish-brown. Sometimes on the nettle, but more frequently on the thistle or the burdock, protected by a slight silken web, dwells the Painted Lady caterpillar (*V. Cardui*), similar to the preceding, but darker, and having usually more stripes. Singular as this caterpillar is, like many others, it gives no indication of the splendidly adorned winged insect it is to produce. In some years the Painted Lady is scarce, and the cause is doubtless a mortality amongst the caterpillars, as they appear to be liable to severe attacks from insect enemies. The caterpillar of the large tortoiseshell is little known in this country. Unlike its brethren, it rejects low plants, and climbs tall trees, especially the elm and the sallow. This is also spiny, and of a dull yellow hue, with a black stripe on each side.

Some of the Geometric caterpillars to be seen this month are large and singular. That of the Peppered Moth *(Amphydasis betularia)*, when reposing, stretches out its head in a peculiar manner, having almost invariably a silken thread passing from the mouth to some part of the branch, and thus securing it against a sudden shock. This caterpillar has the head notched on the crown. The ground colour varies much, even in individuals from the same batch of eggs, some being clay-coloured, others greenish or brownish. There are two conspicuous red spots on the back of the ninth and twelfth segments, and six similar ones along each side. The food is a variety of trees; in the birch, whence it has its name, it is rarely found. The chrysalis is buried beneath the earth through the winter. The Great Oak Beauty *(Boarmia roboraria)* is developed from a rather handsome and stick-like caterpillar, having two humps on the sixth segment. The colour is a chequered tinge of black and white, and down the middle of the back there is a slender thread. Oak is the chief food of this choice caterpillar, which has been taken formerly in Richmond Park, and still occurs in the New Forest, and a few other places in the south of England.

PLATINISED MIRRORS.

THE cost of large mirrors, to whatever cause it may be due, is undoubtedly larger than what the nature and price of the materials of which they are composed would lead one to imagine. We are not now alluding to a framed mirror, but simply to a given area of glass and quicksilver. It has therefore been proposed, some years since, to dispense with the silvering and substitute a preparation of platinum. At Aisne, this system, which was introduced by M. Dodé, is in full operation, the basis of the process being the chloride of platinum. After being thoroughly well cleaned, the glass receives the liquid, it is then moved about in various directions, so as to ensure the layer or film being uniformly spread over its surface. The liquid has a slightly oily character, as it is mixed with a quantity of essence of lavender. It spreads gradually, and dries without leaving behind the faintest tint of any kind. The platiniferous compound is made as follows. About three and a half ounces, avoirdupois measure, of thin platinum ribbon are dissolved in aqua regia, dried in a sand-bath, care being taken to avoid the decomposition of the newly-dried chloride of the metal; spread out upon a glass surface, and the rectified essence of lavender added, little by little. So soon as nearly fifty ounces of the essence has been poured upon the chloride, the mixture is placed in a porcelain vessel, and left completely undisturbed for eight days. At the expiration of this time it is decanted and filtered, and after a further period of six days, it is again decanted. As a flux for this mixture, certain proportions of litharge, borate of lead, and essence of lavender are employed. These are all mixed up and thoroughly incorporated; and the liquid is then ready for application. Mirrors prepared in this manner are exceedingly brilliant, and the cost does not exceed one shilling per square yard of glass, a notable degree of cheapness compared with the price of the silver mirrors.

DOES ALCOHOL WARM THE BODY?—Professor Bing has come to the following conclusions on this subject:—1st. That alcohol lowers the heat of the body, and that it preserves life in febrile affections, where the temperature rises very high, by its antipyretic properties. 2nd. That extreme depression of the vital powers in febrile cases is most frequently dependent upon the temperature of the blood, and passes off when it falls. 3rd. That the number and strength of the contractions of the heart always rise under the use of alcohol. Whenever, therefore, such an effect would be injurious, alcohol would be an improper remedy. 4th. That in all probability alcohol lowers the temperature by the retarding influence it exerts over the oxidizing process.

REVIEWS.

Contributions to the Mineralogy of Victoria. By George H. F. Ulrich, F.G.S. Melbourne: John Ferres. 1870.

THIS little pamphlet contains a list of the minerals hitherto found in the "richest gold-bearing country in the world." Victoria possesses not only the very essence of mineral riches, but it is likewise the home of several minerals which are new to science; but taking into consideration the small number of different mineral species hitherto discovered in the many hundred of auriferous lodes opened up throughout the country, and comparing the result with the dozens of fine minerals occurring in the ore-lodes of Cornwall, Saxony, the Hartz, &c., the reward for mineralogical research appears rather a meagre one.

The list includes bismuth, stibnite, the valuable cassiterite, and magnetite; and among precious stones the sapphire and oriental ruby, topaz, garnet, and opals; while Selwynite, pyrophyllite, and talcosite are among the more recent minerals known to science. Speaking of the rubies hitherto discovered, the author says that several have been found of a size worth cutting, and one in particular, presented to the National Museum, a small, but nearly perfect crystal, would, from its fine violet colour, be called by jewellers the oriental amethyst. It resembles the quartz amethyst, but its distinction from the latter is easily proved by its more acute pyramid, far superior hardness (scratching topaz), and its action upon the dichroscope. It shows before the blowpipe, on and after strong heating, a behaviour generally recorded for the spinel ruby, but which is also characteristic of the oriental ruby; it turns quite a dark opaque, but on cooling becomes green, then colourless, and finally resumes its original red colour.

This book will doubtless be of use to crystallographers, as correct figures of the more interesting crystals are given, together with accurate measurements of angles for the determination of the indices of the planes of some of the new crystals. As a record of the more recent discoveries of the minerals hidden in one of our most distant colonies, this little *brochure* must be of interest, if not of value.

Pewtner's Comprehensive Specifier. A Guide to the Practical Specification of every kind of Building-Artificers' Work. Edited by William Young, Architect. London: Longmans.

THIS handy work of reference will doubtless save the architect and builder some trouble and time, containing, as it does, the various items necessary to form a specification, which are printed in distinct paragraphs, and marked by consecutive numbers for facility of reference. There is also an appendix, which contains a specification for repairs and alterations, together with a short form of building conditions and agreements. Those of our readers who are aware of the disputes which often arise between architect and builder, or between the former and his employer, through some item of a specification being insufficiently or wrongly described, will readily understand and fully appreciate the value of such a concise *vade-mecum* as this little volume.

The Manual of Colours and Dye-Wares; their Properties, Applications, Valuation, Impurities, and Sophistications. By J. W. Slater, Author of the "Handbook of Chemical Analysis for Practical Men." London: Lockwood & Co.

THE title of this book almost renders unnecessary any elaborate review of its contents; and all we need say is that Mr. Slater appears to have done his work well, and has really made his handbook what its title asserts it to be. The object of this manual is to furnish an account of the chemical products and natural wares used in dyeing, printing, and the accessory arts, their properties and applications, the means of ascertaining their respective values, and of detecting the impurities which may be present. Recent years have been so fruitful in novelties, and have witnessed so great an enlargement of the resources of tinctorial art, as to render older authorities defective and, in some measure, obsolete. Mr. Slater's work is a strictly scientific manual, as he relies on the chemical methods of determining the nature and value of the different dye-wares, rather than upon the judgments formed by brokers and consumers after a cursory examination of the article.

The Quarterly Journal of Education. London: T. J. Allman. July, 1870.

THE latest number of this unpretending quarterly is now before us, and we are astonished at the amount of interesting matter it contains. That a journal devoted to the interests of schoolmasters should be well written cannot occasion surprise; but that it should contain such papers as are printed in this magazine is really more than could be expected. Thus we have an article on "Political Economy as a Means of Education," by Professor Rogers; a paper by A. R. Hope, the well-known author of the "Book about Boys," "Stories of School Life," &c.; and a short description of the "State of Linguistic Studies in France," by J. R. Morell, LL.D. There are also some useful notes on "The Twelfth Night," which will interest all students of the language and afford some mental pabulum to lovers of Shakspeare. Several other interesting subjects are discussed, and the columns devoted to correspondence are, as might be expected, replete with matter for thought, although naturally enough connected principally with schools and schoolmasters. One letter in particular we would commend to the attention of those of our readers who have any notion of sending their children to boarding school. There is no doubt that Dotheboys Hall has been greatly changed for the better, but the facts related in this communication show very clearly that there is still ample room for improvement. At the present time, while the education question is so fiercely debated, there is matter in this *Journal of Education* to interest everybody, and we cordially commend to our readers a periodical so ably conducted.

ON ZYMOTICS.*

(*Concluded from page* 415.)

BOTH the local specific process and the fever have a tendency to terminate in the restoration of the sufferer to health, without any intervention of the medical art. But at the termination of these conditions a state of health, often wretchedly below par, is left behind. Scarlet fever frequently destroys the drum of the ear, by extension of the sore throat backwards into the Eustachian tube, and there sets up an ulceration by which the patient's life is in constant jeopardy; at any time, too, from the fading of the rash until a month afterwards, that fatal form of dropsy, called scarlatinal dropsy, may supervene on the slightest exposure to cold. Measles, chicken pox, and whooping-cough, very slight in themselves, leave behind a predisposition to a most fatal complaint, the deposit of tubercles in every part of the body. In grown-up people the brunt of the disease usually falls upon the lungs, and it is then called consumption; but in children the disease is spread more generally throughout the system, the brain and other organs suffering quite as much as the lungs. This disposition to tubercle arises after these three diseases without any previous hereditary taint or inclination whatever. The zymotic diseases, then, are not the harmless ailments which the public think them to be, but even the mildest may leave behind the seeds of a malady which, sooner or later, will destroy life.

The circumstances under which zymotic diseases are enabled to spread are the following. First of all, the zymotic principle itself must be present; next, a condition of the atmosphere or of the surroundings, favourable to the spread of disease; small-pox and scarlatina are always present in England, yet it is only occasionally that the sporadic cases multiply so greatly as to become epidemic. Thirdly, a medium for the conveyance of the contagious matter to the individual or some part of him, where it can easily enter his blood; it seems probable that most of the zymotic poisons enter by the mouth. Lastly, an individual in a state fit to receive the germ of the malady, and allow it to multiply.

Knowing that these four conditions are necessary for the spread of these contagious diseases, the means at our disposal for their prevention will be shortly alluded to. With regard to the zymotic substance, the agent which most effectively destroys it is heat. In Egypt, the spread of the plague is always arrested after St. John's day, from the intense heat which then arises. A temperature of 120° Fahr. will destroy the contagious material contained in clothes, papers, &c., thus most conveniently disinfected, the most delicate fabrics remaining uninjured after exposure to so low a temperature. Several chemical agents are said to have the power of altering or changing the composition of the contagious material so as to render it innocuous. Amongst these are especially to be mentioned carbolic acid, chlorine, and nitrous acid.

The state of the surroundings is very important, but unfortunately little is known of the meteorological changes which accompany an epidemic. A temperature of 32° Fahr. seems to check the spread of some contagious diseases, but the whole of our information on this point is most meagre. One of the surrounding conditions is known to be extremely important—the dilution of the contagious material with fresh air—this is without doubt, the most important agent that we possess in checking the progress of a contagious disease. Free, efficient ventilation of a house will often protect its inmates from infection from without. The media for the conveyance of disease have been spoken of previously. A predisposition on the part of the individual who is exposed to the contagion; for not every one exposed, is infected. Some persons seem quite incapable of receiving the zymotic diseases during the whole of their life; while, on the other hand, certain conditions of the system predispose to them; mental anxiety, worry, and trouble of any kind render a person peculiarly liable. So do fear of taking the complaint, a poor state of health at the time, great bodily fatigue and exhausting labour, above all, the fasting state. A person who has not eaten for hours will be far more likely, other conditions being equal, to be infected, on exposure to contagion, than one who has just taken a meal of meat and wine. We cannot always control our emotions or secure a tranquil and happy frame of mind; but at the worst, most of us can afford a dinner and a dose of stimulant. After exposure to infection, a glass of sherry, or brandy and water, is said to prevent the complaint from taking root; it would always be well to try this remedy when a person has been near a source of contagion.

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* Written by J. Wickham Legg, M.D., and extracted from *The Student*.

Amongst the poor, the want of good food and clothing, the indifferent light which does not allow them to see the dirt about them, and which they therefore do not remove, the overcrowding and bad ventilation, all render them exceedingly predisposed to the acute specific disease. Accordingly we find that an outbreak of zymotic disease always makes head among the poor first; amongst them it gathers its strength and multiplies its points of contagion before it attacks the rich man's family. Indeed, there is one disease—typhus fever—which is unknown except among the extremely destitute; clergymen and doctors occasionally die of it, their profession obliging them to visit the sick poor, but under no circumstances does it ever *spread* among people moderately well to do.

After a consideration of the preceding remarks, the question, "How may zymotic diseases be prevented?" may be more easily answered. Individual action can do little; it is to the State that we must look for efficient interference for the suppression of these complaints. With our English notions about the liberty of the subject it will take years of active teaching and reiteration before any government will be sufficiently interested to make laws which will perhaps seriously interfere with the present prerogative of every English subject to spread infection. It has taken seventy years for the English Government to realize the value of Jenner's great discovery, and to take steps to protect the community against periodical outbreaks of small-pox. It is to be hoped that another seventy years will not elapse before something is done to stop the spread of scarlatina, measles, or typhoid fever. Laws compelling the drainage and water supply to be at least effective, and forbidding the frightful overcrowding of dwellings which now prevails in every large town, ought to be made; every case of zymotic disease ought to be watched by officers of health, since that one case may become the centre of extension to the whole town, country, or even kingdom.

Individuals may, however, do a little in preventing these complaints, especially in their own households, but their exertions can scarcely reach beyond this. In the first place, let the water that is used for drinking be most carefully seen to *at all times.* No one should buy water of a company the purity of whose source of supply is at all questioned, for water that looks, smells, and tastes perfectly good may convey the deadly poison of cholera or typhoid fever. The same consequences ought to follow the sale of unwholesome water to the public as follow the sale of unwholesome meat or vegetables; or, rather, the punishment should be greater, because the effects are more widely spread.

One of the most important means of prevention is also within the reach of individuals; it is quite simple, needing no apparatus or chemicals, and is the free and complete ventilation of all rooms and passages by means of windows opening on the external air, assisted, where there are opportunities, by fires in open grates. This method yields to none in efficiency; it is of far more use than any chemical means of disinfection, useful though these may be; the only effectual plan is complete and thorough ventilation. When a member of a household has been seized with a zymotic disease it is most important that no communication should be held with the sick room other than is absolutely necessary; everything which comes from the sick bedside, or which has approached the sick man should be immediately destroyed with fire. When this is impossible from the nature of the article, as porcelain or glass, it should be placed in boiling water for several minutes, as soon as its contents have been got rid of. The disposal of water and other fluids which have been used by the sick is a matter of some difficulty. It is without doubt in the highest degree immoral to throw such refuse into a drain, whence it may easily pass on and infect others; the best plan seems to be to mix all these fluids with a solution of chloride of zinc, or carbolic acid, and then to have them deeply buried in the earth with a quantity of disinfectants, far away from any wells or sources of water supply to any human habitation. If the refuse materials are more solid than liquid, they should be completely destroyed by fire.

A low degree of civilization sets a low value upon individual human life. If we compare the thousands of pounds lavishly spent by Government, where cattle alone were concerned, with the small sums given grudgingly for the prevention and investigation—the first step in the prevention—of human disease, it will be seen how hollow our boasted advance really is. The lives of cattle must be protected because they are valuable property; the lives of men are apparently of little or no account. So long as the poor remain in their present wretched and unhealthy condition—a very poor population may yet be healthy—and so long as the death-rate exhibits little or no decline in each succeeding year, so long are we on the moral level of barbarians in disregard for human life. This deep stain on modern civilization, the entire neglect of the sanitary condition of the poor, can only be wiped away by a great effort on the part of society in general, by the framing of laws, which shall be no half measures—the curse of English sanitary legislation—but which shall effectually and at once remove this evil from amongst us.

THE APPLICATION OF PHOTOGRAPHY TO MILITARY PURPOSES.

MODERN warfare may in many respects be considered as so many applications of science. Not only is war *matériel* designed and manufactured nowadays upon the most approved data, and according to theories worked out with mathematical accuracy, but a large section of our soldiers are educated in such a manner as fully to appreciate the value of their resources, and so to overcome difficulties which years ago would have been regarded as impossibilities. No instance demonstrates this more satisfactorily than the recent Abyssinian expedition, which, whatever may be said of it as a campaign, cannot but be regarded as one of the most wonderful feats of engineering accomplished in modern times. The nearer warfare approaches perfection, the more decisive, and therefore less cruel it necessarily becomes, as witness the brief duration of the wars of late years on the Continent; and for this reason the improvements in warfare effected by science cannot by any means be regarded as a misapplication of knowledge.

Our present remarks bear reference to the applications made of a very modest branch of science, if science, indeed, it can be called, our object being to demonstrate the many uses made by the War Department of photography. In the special application of this art-science to military matters, our Government is certainly in advance of others, if we except, perhaps, that of France. No less than three establishments have been organized in connection with the army in which photography is extensively practised, the most important of them being the General Establishment at Woolwich; but, besides these, there are again many Royal Engineer stations, both at home and abroad, which are furnished with photographic requisites and employ the camera for divers purposes. At Chatham, the photographic establishment assumes the character of a school of instruction, at Southampton it forms an adjunct to the Ordnance Survey Office, while at Woolwich, of which department we desire more particularly to speak, the duties performed by aid of the camera are as various as they are numerous. For registering patterns, recording experimental results, imparting military instruction, and for other purposes too multifarious to enumerate, photography is extensively used, the faithful accuracy of sun pictures, as likewise the facility with which they are produced, causing the art to be eagerly employed in any way where it can be made available.

As an example of the value of photography in instruction, we would cite an interesting series of pictures taken to illustrate ordinance drill. This series comprises upwards of one hundred views, and demonstrates the practical working of the various kind of guns, mortars, rockets, &c., in the service. One picture, for instance, will illustrate the command "Prepare for action;" a gun will be shown surrounded by a group of artillerymen in the positions they have been instructed to occupy on the issue of that order, each man having his respective number attached to his cap as a distinguishing mark. The next illustration in the series is probably that of "Load," and the next again "Fire," both of which will represent the change in position of the men, as one operation succeeds another, and the various duties performed in turn by each gunner or number, for it must be remembered that in gun-drill every man is told off to a particular number and entrusted with a separate and distinct duty. Thus, on the promulgation of any new system of drill, or of any modification in the method of working, it is merely necessary for the military authorities to forward pictures of this kind to the different instructors, who cannot fail at once thoroughly to understand the new exercise; and even the rawest recruit who had assigned to him a certain number at a gun would see at a glance the exact position he is to occupy by a reference to the photographs.

Another not less striking instance of the importance of photography in this connection may be given. At the outset of the Abyssinian campaign it will be remembered that several thousands of packsaddles were required for transporting war *matériel* into the interior. These packsaddles were made in and sent direct from England to Annesley Bay, so that the troops coming from Bombay knew nothing of their construction, nor of the method in which they were to be packed. This ignorance in the hurry of affairs would have been of serious consequence (for a military packsaddle of the present pattern is a somewhat complicated contrivance) had not the authorities at home been fully alive to the subject and foreseen the threatening difficulty. A mule at Woolwich was harnessed and packed, after some experience had been acquired in the matter, in the most suitable and approved manner, and the animal then carefully depicted by the aid of the camera; the disposal of the harness and trappings and the correct way in which the packages were to be carried, were thus clearly shown in a photograph, numerous copies of which were immediately sent out to Annesley Bay and distributed among the officers of the Quarter-Master-General's department.

In recording experimental results photography again fulfils a duty which could not be discharged so rapidly and impartially by any other means. The stout iron-cased shields and armour targets built up of metal plates of different thicknesses, and then fired at by shot and shell of all descriptions, are carefully photographed after each decisive experiment, and a record of indisputable accuracy thus obtained. With a picture before us of a target, constructed to represent the side of an armour-plated vessel which has been experimented on, we can at once form an accurate estimate of the impression made upon the iron wall by shot of different calibres, while rear and side views of the structure will show plainly the amount of damage which the backing or skin of the shield has suffered. As may be imagined these prints form important illustrations to the written reports made from time to time to the War Office authorities.

The photographing of newly adopted government patterns, whether in the shape of guns, carriages, waggons, mantelets, tents, &c., is also an important section of the work undertaken at Woolwich, as likewise that of producing pictures relating to army equipment, such, for instance, as demonstrate the setting up of cooking apparatus, disposal of ambulances, refitting of ordnance in the field, &c. There is, moreover, the pursuit of photo-lithography to be mentioned, by means of which designs and sketches are copied and transferred to stone for printing off in the ordinary manner.

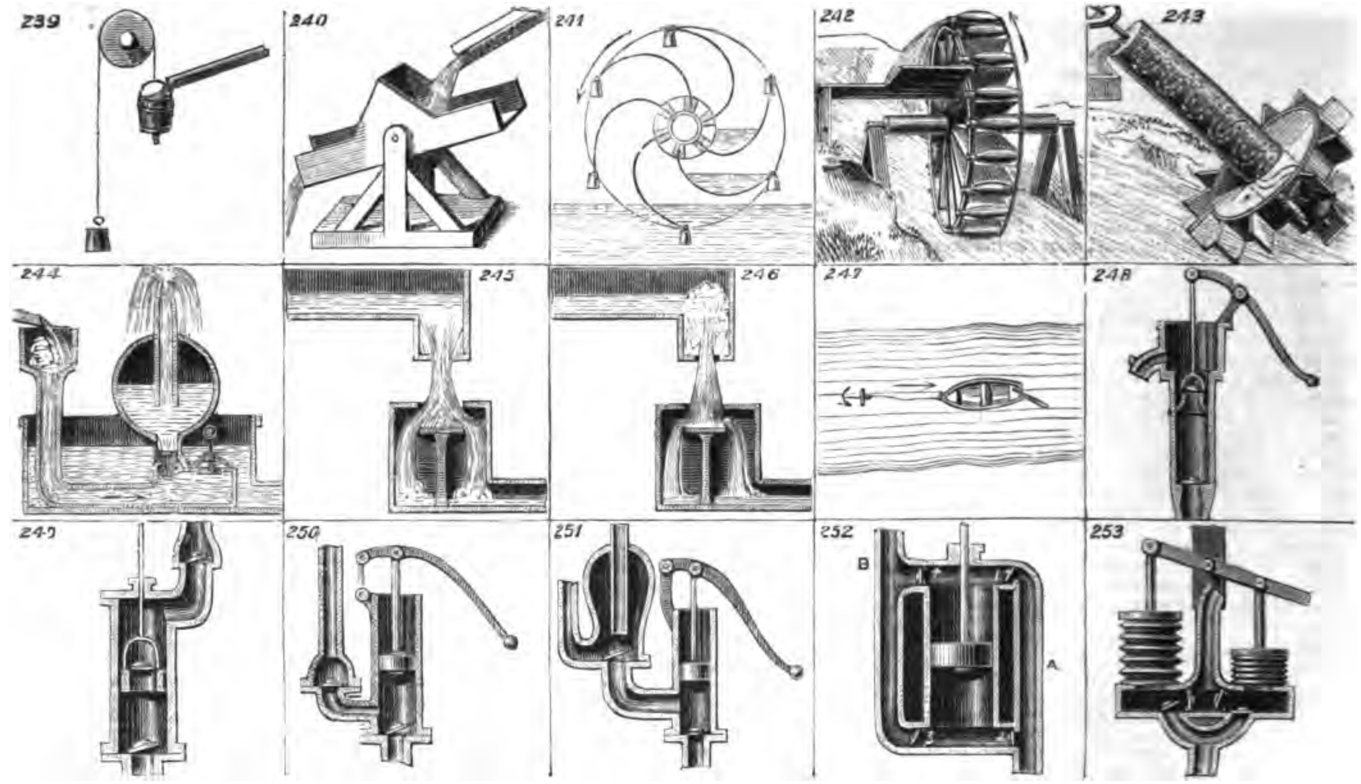
The subject of working photography in the field is a matter to which much attention has been given at the general establishment, for it will be readily conceived that the simplest and most effective methods of working, as likewise the different uses to which the camera may be put during warfare are questions of very serious study.

The photographic copies, many thousands of which are annually produced and distributed over all parts of Her Majesty's dominions, are not now printed upon silver paper in the ordinary way, but by the so-called carbon or autotype process, a method which produces prints of an absolutely permanent character. Ordinary silver prints are always liable to become faded and stained after the lapse of a few years, owing to the presence in the paper itself, or in the atmosphere with which it comes into contact, of sulphur compounds which attack the metallic silver composing the image. In the carbon pictures, however, no silver at all is present, the composition of the image being a mineral pigment in combination with an insoluble chromium.

Our description of the General Photographic Establishment at Woolwich has been very brief indeed, but enough has been said to show to what an important extent the art is employed in connection with the War Office; the department which we have described is a branch of the chemical establishment of the War Department, which was first organised in 1854, by Mr. Abel, and has gradually become intimately and indispensably connected with every branch of the military service.—*Nature.*

THE VARNISH TREE.

THE beautiful black varnish which is so much admired the world over is the production of a tree which grows wild in Japan—and China as well.



MECHANICAL MOVEMENTS.

It is cultivated in plantations, and is so much improved by the treatment it receives that a cultivated tree affords three times more of this valuable product than the wild one. The tree has some resemblance to the ash, with leaves shaped like those of the laurel, of a light green colour, and feels downy to the touch. It is of no great beauty, but is valuable as the source of a very lucrative manufacture.

These trees are capable of supplying the varnish when they have attained the age of seven or eight years. The varnish is gathered in the following manner:—About the middle of summer a number of labourers proceed to the plantations of these trees, each furnished with a crooked knife and a large number of hollow shells, larger than oyster shells. With their knives they make many incisions in the bark of the trees about two inches in length, and under each incision they force the edge of the shell, which easily penetrates the soft bark and remains in the tree. This operation is performed in the evening, as the varnish flows only in the night. The next morning the workmen proceed again to the plantation; each shell is either wholly or partially filled with the varnish; this they scrape out carefully with their knives, depositing it in a vessel which they carry with them, and throw the shells into a basket at the foot of the tree. In the evening the shells are replaced, and the varnish again collected in the morning. This process is repeated throughout the summer, or until the varnish ceases to flow. It is computed that the fifty trees, which can be attended by a single workman, will yield a pound of varnish every night. When the gathering is over, the varnish is strained through a thin cloth loosely suspended over an earthen vessel.

MECHANICAL MOVEMENTS.

(*Continued from page* 418.)

239. A method of obtaining a reciprocating motion from a continuous fall of water, by means of a valve in the bottom of the bucket, which opens by striking the ground and thereby emptying the bucket, which is caused to rise again by the action of a counter-weight on the other side of the pulley over which it is suspended.

240. Represents a trough divided transversely into equal parts and supported on an axis by a frame beneath. The fall of water filling one side of the division, the trough is vibrated on its axis, and at the same time that it delivers the water the opposite side is brought under the stream and filled, which in like manner produces the vibration of the trough back again. This has been used as a water meter.

241. Persian wheel, used in Eastern countries for irrigation. It has a hollow shaft and curved floats, at the extremities of which are suspended buckets or tubs. The wheel is partly immersed in a stream acting on the convex surface of its floats, and as it is thus caused to revolve, a quantity of water will be elevated by each float at each revolution, and conducted to the hollow shaft at the same time that one of the buckets carries its fill of water to a higher level, where it is emptied by coming in contact with a stationary pin placed in a convenient position for tilting it.

242. Machine of ancient origin, still employed on the river Eisach, in the Tyrol, for raising water. A current keeping the wheel in motion, the pots on its periphery are successively immersed, filled, and emptied into a trough above the stream.

243. Application of Archimedes' screw to raising water, the supply stream being the motive power. The oblique shaft of the wheel has extending through it a spiral passage, the lower end of which is immersed in water, and the stream acting upon the wheel at its lower end, produces its revolution, by which the water is conveyed upward continuously through the spiral passage and discharged at the top.

244. Montgolfier's hydraulic ram. Small fall of water made to throw a jet to a great height or furnish a supply at high level. The right-hand valve being kept open by a weight or spring, the current flowing through the pipe in the direction of the arrow escapes thereby till its pressure, overcoming the resistance of weight or spring, closes it. On the closing of this valve the momentum of the current overcomes the pressure on the other valve, opens it, and throws a quantity of water into the globular air-chamber by the expansive force of the air in which the upward stream from the nozzle is maintained. On equilibrium taking place, the right-hand valve opens and left-hand one shuts. Thus, by the alternate action of the valves, a quantity of water is raised into the air-chamber at every stroke, and the elasticity of the air gives uniformity to the efflux.

245 and 246. D'Ectol's oscillating column, for elevating a portion of a given fall of water above the level of the reservoir or head, by means of a machine all the parts of which are absolutely fixed. It consists of an upper and smaller tube, which is constantly supplied with water, and a lower and larger tube, provided with a circular plate below concentric with the orifice which receives the stream from the tube above. Upon allowing the water to descend as shown in 245, it forms itself gradually into a cone on the circular plate, as shown in 246, which cone protrudes into the smaller tube so as to check the flow of water downward; and the regular supply continuing from above, the column in the upper tube rises until the cone on the circular plate gives way. This action is renewed periodically and is regulated by the supply of water.

247. This method of passing a boat from one shore of a river to the other is common on the Rhine and elsewhere, and is effected by the action of the stream on the rudder, which carries the boat across the stream in the arc of a circle, the centre of which is the anchor which holds the boat from floating down the stream.

248. Common lift pump. In the upstroke of piston or bucket the lower valve opens and the valve in piston shuts; air is exhausted out of suction-pipe, and water rushes up to fill the vacuum. In downstroke, lower valve is shut and valve in piston opens, and the water simply passes through the piston. The water above piston is lifted up, and runs over out of spout at each upstroke. This pump cannot raise water over thirty feet high.

249. Modern lifting pump. This pump operates in same manner as one in previous figure, except that piston-rod passes through stuffing-box, and outlet is closed by a flap-valve opening upward. Water can be lifted to any height above this pump.

250. Ordinary force pump, with two valves. The cylinder is above water, and is fitted with solid piston; one valve closes outlet-pipe, and other closes suction-pipe. When piston is rising suction-valve is open, and water rushes into cylinder, outlet-valve being closed. On descent of piston suction-valve closes, and water is forced up through outlet-valve to any distance or elevation.

251. Force pump, same as above, with addition of air-chamber to the outlet, to produce a constant flow. The outlet from air-chamber is shown at two places, from either of which water may be taken. The air is compressed by the water during the downstroke of the piston, and expands and presses out the water from the chamber during the up-stroke.

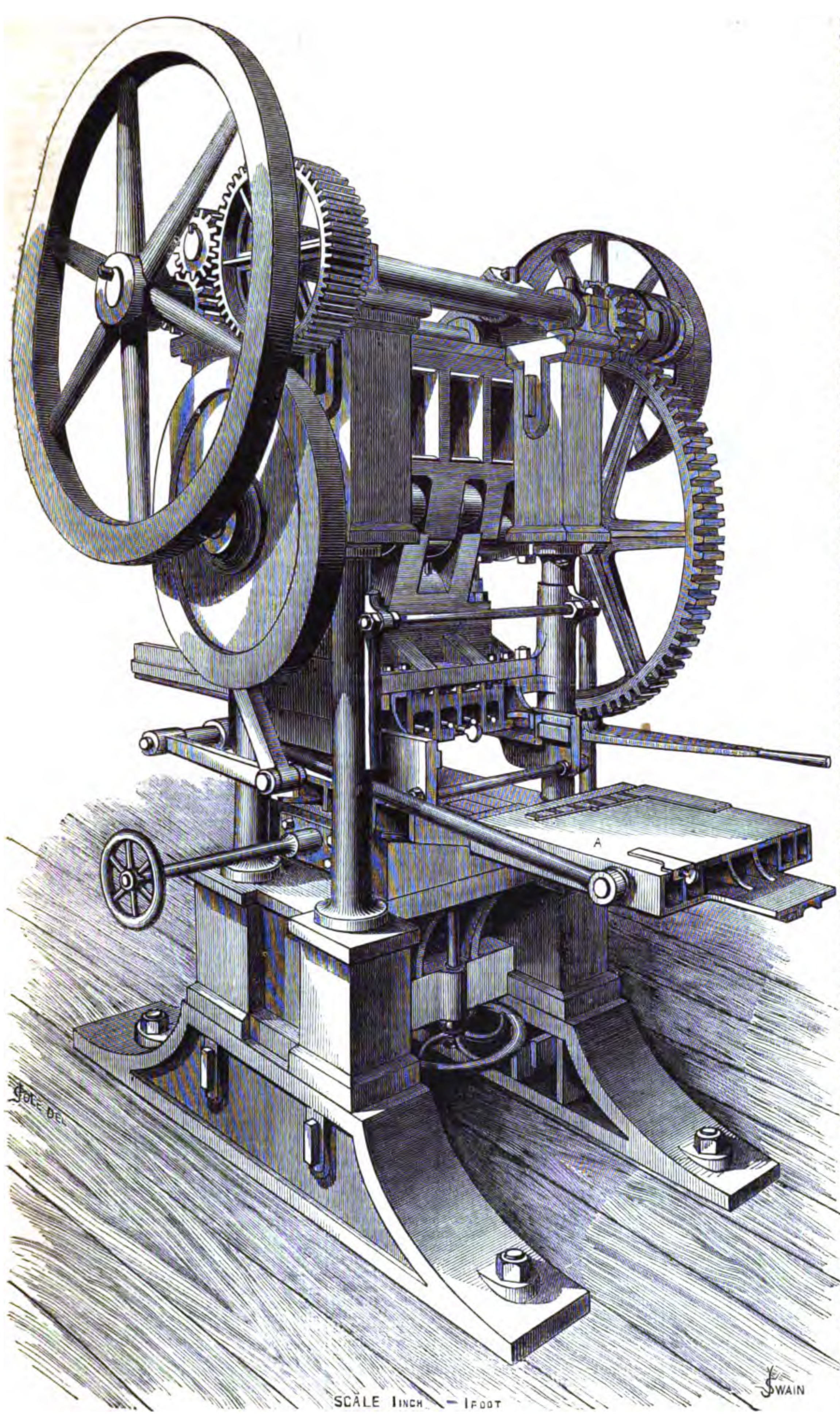
252. Double-acting pump. Cylinder closed at each end, and piston-rod passes through stuffing-box on one end, and the cylinder has four openings covered by valves, two for admitting water and like number for discharge. A is suction-pipe, and B discharge-pipe. When piston moves on, water rushes in at suction-valve 1 on upper end of cylinder, and that below piston is forced through valve 3 and discharge-pipe B; on the piston ascending again, water is forced through discharge-valve 4, on upper end of cylinder, and water enters lower suction-valve 2.

253. Double lantern-bellows pump. As one bellows is distended by lever, air is rarefied within it, and water passes up suction-pipe to fill space; at same time other bellows is compressed, and expels its contents through discharge-pipe; valves working the same as in the ordinary force pump.

(*To be continued.*)

WEIGHTS AND MEASURES.

THE following is an abstract from the report of a joint-committee of the International Decimal Association, and one of the Central Chamber of Agriculture has been issued, signed by Lord Fortescue, chairman:—"From evidence brought before your committee, it appears that the extreme difference of practice in the weights and measures used in different markets of the United Kingdom, for the sale of grain and other agricultural products and manures, is the cause of considerable inconvenience and loss. The Banbury, Devonshire, Essex, Howdenshire, Kincardineshire, Leicestershire, Malton, Monmouthshire, Norfolk, North of England, North Riding of Yorkshire, Scottish, Warwickshire, and Worcestershire Chambers of



GOUGH'S PRINTING AND ARMING PRESS.

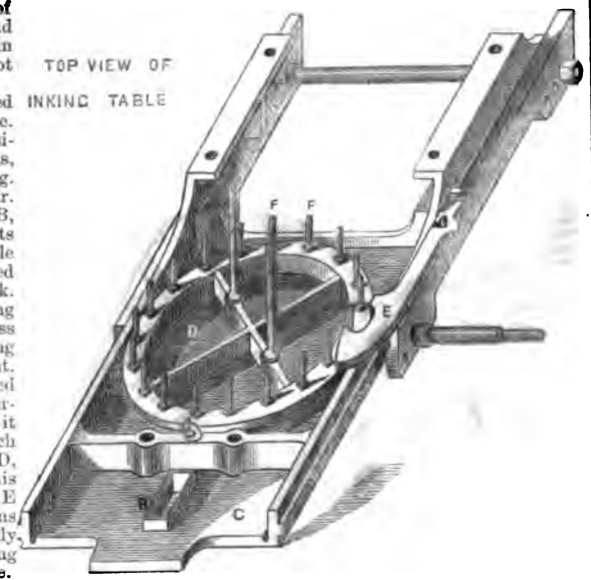
Agriculture are unanimous in their opinion that steps should be taken for obtaining a uniform system as speedily as possible; and, from long experience, your committee are convinced that no voluntary or permissive legislation, and that no local arrangement or understanding, will enable us to realize the object in view. In the language used by more than one of such Chambers, 'Whatever standard be decided upon, the same should be made compulsory throughout the country.' Besides, however, a general testimony in favour of uniformity of weights and measures in the United Kingdom, your committee find that a movement has been gaining ground for extending such uniformity among all countries. And your committee are strongly impressed with the conviction that, dependent as we are upon foreign countries for the supply of grain, other agricultural products, and manures, great advantage would be derived if, in making the necessary change, we could contribute to the realisation of this larger object. It would save time, it would prevent errors, it would greatly facilitate commercial transactions, if grain were quoted in the same manner in every market of the world, and if our merchants and corn-growers could understand the ordinary quotations from Stettin and Odessa as readily as those from their own home markets. Nor is the object far from practical attainment. Your committee have learned that considerable progress has already been made in the great work; that a large number of countries, having an aggregate population of more than two hundred millions, both on the Baltic and the Mediterranean seas, and on the Atlantic and Pacific oceans, have agreed in adopting, and are already using, the metric system; that this system has just been established throughout our Indian Empire; and that, in this kingdom, and in the United States of America, the use of the same weights and measures has been made legal and permissive. Under such circumstances—and believing that, if a change is to be made, it is best to endeavour to secure a system as perfect as possible, one not likely to be again altered, and one equally suitable to the general wants of all classes of the community—your committee have come to the conclusion that the best mode of obtaining a real and permanent uniformity in weights and measures applicable to the sale of grain and other agricultural products and manures, is by adapting our present practice to the metric system.

GOUGH'S PRINTING AND ARMING PRESS.

THE arming press illustrated in the annexed engraving, and which supersedes hand labour by the use of steam, is the invention of Mr. Gough, of Kirby-street, Hatton Garden. It is of the rotary class, and as far as we can hear is already working satisfactorily in many places in London and elsewhere.

This press is fitted in such a manner that it can be used for blind blocking, gold blocking, or for printing in ink and colours. The method of feeding is a very great advance upon the old system. The table A, following the action of a cam, is caused to work to and fro, the case to be blocked or printed is placed upon the table to gauges while it is in its outward position, the motion of the press then draws the table inwards, which at the end of the stroke, is caused to stop while the case is blocked; it then returns the case to the attendant, the table being ready for successive feeding. This round of mechanical movements takes place at the rate of 600 per hour, and in a vast number of instances the entire case—sides and back—can be worked at once, which, in the ordinary arming presses, could not by any possibility be accomplished.

The inking arrangements employed in this press are also exceedingly simple. Ink used in cloth binding has necessitated somewhat special provisions, owing to its want of ease in working. For its thorough distribution, Mr. Gough places it in a flat metal box B, with a perforated bottom, which fits in an aperture in the inverted ink table C, part of which is circular, and caused to rise and fall with the engraved block. The plane of the block and table being the same, the rollers are free to pass from the table over the block, during its upward and downward movement. There are three rollers: one, the feed roller, is caused to pass over the perforated bottom of the ink box; it then becomes speckled with ink, which it distributes over the circular table D, and the movement imparted to this portion by means of the spring catch E becoming locked in the vertical pins F F causes it to be most effectually distributed, the circular portion moving the distance of one pin at each stroke.



TOP VIEW OF INKING TABLE

SPONTANEOUS GENERATION OF LIVING THINGS.

IN relation to the controversy on this interesting question, Dr. Gull, in his Harveian oration at the Royal College of Physicians, on June 24 last, said:—"The dogma 'omne vivum ex ovo,' for the truth of which Harvey so justly contended against the fanciful notions of his age, cannot perhaps be now maintained in its integrity. Whether, to use an expression of that day, living things are ever produced automatically—that is *de novo*—through putrefaction or otherwise, is, like the question of the limitation or universality of the germ power, still a matter upon which opinion is divided; and as it is my duty on this occasion to exhort you to investigate nature by way of experiment, I must ask you not readily to accept negative conclusions which impose limits where none may really exist. . . . . The time is passing in which the human mind can remain satisfied to rest under the fetters it has imposed upon itself, or to cherish its own phantasms, as if its very existence depended upon them. 'Man knows only what he has observed of the course of nature' is the notorious dictum of science, showing the limit and the mode of the acquirement of our knowledge; the limit as wide as nature itself: and the mode is but readiness to be taught. Notwithstanding, therefore, the adverse decision of schools and dogmas, science still occupies itself with the possibilities of occasional automatic generation. And that it should be so, let it not raise antagonism in the minds of those whose pursuits (inquiries) lie in another direction, since the infinity of nature may well include facts which at first seem to be antagonistic. . . . We have lately been rather blamed for not gratefully accepting the germ theory of disease; but to this college the theory is not new, and, I think I may add, has not been proved to be true. It will be in the remembrance of many present that in the year 1849 a theory was put forth that epidemic cholera was due to fungi and their germs. Peculiar bodies, it was said, had been found in the rice-water evacuations, and also in the air and drinking waters of the infected localities. It was confidently asserted that we had substantial facts in support of the theory, and that it fulfilled the conditions required of being both true and sufficient. This college thought the subject of such moment that a sub-committee was formed from the Cholera Committee of that day for its investigation. The drinking water of infected places was examined, the air of rooms in which cholera patients were dying was condensed, that it might afford whatever floated in it for examination; dust was collected from cobwebs, window frames, books, surfaces of exposed food, and every imaginable place, to try it for cholera germs. . . . The supposed germs, when really germs (for many shapes had been included in the supposed direful growth), were found to be spores of known harmless fungi and confervæ, of which, if even the startling number of thirty-seven and a half millions should be contained in about two drachms of water, as quoted by Tyndall, from Mr. Dancer's examination, it is probable that the whole or repeated units of such millions might be harmlessly swallowed. But for the most part the supposed germs were not germs of any kind, but broken scraps of vegetable and animal tissues, spiral vessels from dried horse-dung, hairs, wings, and legs of insects, detrita of dress, and the like. The results were, in fact, entirely negative of any peculiar bodies to which the epidemic disease could be referred. One general result arrived at at that time, however, agrees with the observation of Tyndall in his recent investigation of dust by a beam of light—viz., that the floating particles in the air are chiefly of an organic nature. This we might have been prepared for, from the specific weight of dried organic material, enabling such dust to float, when the heavier inorganic substances would be deposited. That the infectious diseases spread by emanations from the sick, must have been long known, and that such emanations are of a solid nature, we may infer from the fact that they may be dried and conveyed from place to place; but in what state, whether as amorphous material or as germs, we know no more to-day than was known a thousand years past. No new fact bearing upon the propagation of contagious disease has been reached by the recent investigations on dust; nor can we infer the nature of summer catarrh because the nasal mucus under such circumstances, and at no other time, was found peopled by vibriones, since decomposing mucus is always populous with this common race of infusoria. The phenomena of fermentation and putrefaction in dead and decomposing substances afford no explanation of the changes observed in a living body in a fever process. The purulent matter produced in small-pox is not, as we know, in any way comparable to the yeast formed in fermenting fluids. On the contrary, the microscope demonstrates that the forms, as for instance in various pus, are not different from those contained in other purulent and innocuous exudations. Nor have we any reason to conclude that any forms which are observed are germs which convey the disease. It is to be regretted that a confusion in terms has been made. Instead of dust and disease it ought rather to have been dust and putrefaction, or dust and fermentation, since the relation of dust to disease has not been revealed anywhere in the inquiry. That the air conveys the material causes of the infectious diseases from the sick to the healthy, is a notorious fact, which had equal force before these enquiries were instituted, though, owing to the exigencies of social intercourse, a fact more neglected than in times of comparative ignorance. It is difficult to vindicate exactness in progress without seeming to be at the same time a hinderer of it. The onward and the regulating forces of a machine, though not incompatible, but necessary, require the nicest balance. This reflection suggests itself by the way the spread of infectious diseases has been handled. The theories it has given rise to have been so easily put forward as to thereby create distrust. But the spirit of science is no favourer of negations. 'Der Geist der stets verneint' finds no greater friend in medicine than in theology. Still, it will be admitted that no progress can be made by the ready acceptance of every proposition, however distinguished the source from which it emanates. The parasitic origin and nature of epidemics *may* be true, but it has yet to be proved. As an hypothesis, it admits of proof or disproof, and so has further claim upon the industry of those who have put it forward as a suggestion. Without going to the length which this hypothesis demands, we must admit, however, that we know enough to guide us much further than we have yet gone in the practice of prevention."

Graham ascertained that the rate of diffusion of gases is inversely as the square root of their densities.

STEAM ON COMMON ROADS.

WHAT is the true reason that we nowhere s the steam engine used to any great exte for common road traffic? There is probably problem, says the *Engineer*, in the whole range practical mechanics, and there is certainly no oth problem in steam engineering, which has taxed i genuity so long, so much, and yet with such co paratively slight results. Almost innumerable i ventors, dating from Cugnot, have been trying their hands at it for more than a century. It true that their work has not been without so fruition. Steam traction engines now carry themselves and their ploughing tackle in farm operations; they are used for drawing heavy loads fo short distances on special bits of road; but th is nearly all. Road engines have never yet foun general application in England; and, after man different trials at various times, they have almos completely failed in France, in Germany, an America. The multiplicity of the proposals and attempts in this direction is remarkable. We have Savery, and later Dr. Robinson, ten years before Cugnot's trial, proposing the thing. Then Oliver Evans; in 1784 Watt patented the application of his engine to the purpose; William Symington tried it; and afterwards Murdoch. Oliver Evans actually propelled an engine of some size. The most ingenious attempts were made by Trevithick; and, after him, by Gurney, Gordon, Ogle, Dr. Church, and Dietz in France. The curious, and perhaps significant, point about the history of these attempts is that the principal ones were renewed with an interval of a generation between each. Thus, after the first schemes in 1759-69, we find Trevithick working in 1802-4; Gordon, Church, and many more in 1832-6; and, lastly, Boydell, Aveling, and others, from 1855-65. We now have another ingenious plan, but, in spite of all that we have lately heard from Edinburgh about Mr. Thompson's road steamers, we are *not inclined*—while we wish him *every success—yet to make an* exception in his favour. *In the first place, they* have not worked long *enough; and, in the second,* we do not know the proportion *that the excellent* roads in and about Edinburgh have *contributed to* his success. In fact, isolated cases of the *partial* success of steam power on common roads can generally be traced to the good state of the roads in the given locality.

Trevithick, the greatest genius amongst traction engine inventors, seems at first to have even believed that "railroads are useful for speed and for the sake of safety, but not otherwise; every purpose would be answered by steam on common roads which can be applied to every purpose a horse can effect." In this there is, of course, an evident fallacy. The only reason that greater speed is obtainable on a pair of rails, with a locomotive and its train, than if the locomotive and train were p on a road without rails, is that the rail offers a hard, smooth, unyielding surface, and that the ordinary road offers a soft, rough, and yielding surface. If we took an ordinary train of a locomotive and carriages, turned the flanges off the tyres, and placed them on an iron road, made with one smooth bed surface—one long metallic table, in fact—we could evidently get the same speed on such a road—which we may suppose perfectly straight and sufficiently wide to get over the difficulty of our want of flanges—as on an ordinary line of railway. As soon, therefore, as a locomotive and train were put to run on rails, it might have been seen clearly that the locomotive steam-engine did not want improving, but that, in order to put steam power on roads, it was the roads that wanted improving. In fact, only a year or so after his patent for [illegible] Trevithick came to the conclusion that steam carriages could not be placed on common roads before common roads were radically improved and rendered able to bear heavy loads without giving way and increasing the draught to an impracticable amount. Some of the more able later inventors of traction engines saw this, more or less clearly, and attempted to make the engine carry its own railway, though we are not aware that even Boydell's traction engine and endless railway are now anywhere in practical use. After making the most successful road traction engine of any, we now see Messrs. Aveling and Porter taking the lead in the production of steam road rollers.

Briefly, the whole future of the application of steam to common roads clearly lies in the improvement, not of the engine, but of the road. In the same way as rails must be laid down before running the locomotive, so must common roads be rendered able to bear heavy weights, and have given them a hard, level surface, one approaching as nearly as possible that of the rail table. The nearer this condition of hardness is approached, the more extended will be the use of steam on common roads.

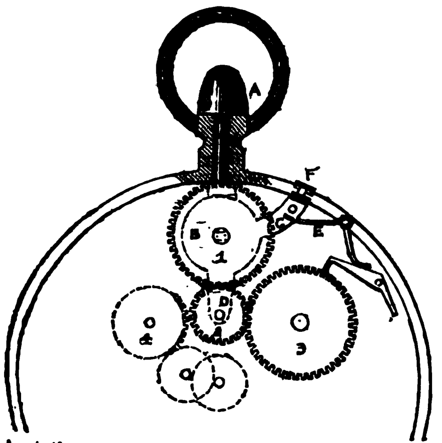
These premisses being granted, the solution of the old problem of applying steam to common roads is simply to be found in the general use of the steam road roller. The steam roller must precede the steam traction engine. Experience shows that this process of road-making and maintenance gives us a hard level surface, not liable to sink and take ruts under the wheels, and affording more than sufficient adhesion for propulsion with smooth wheels. The possibility of applying steam in this way would give us what might be termed a universal tramroad, rendering available for steam power our 200,000 miles of macadamised roads. Much in this sense was a passage in a late public speech of such an experienced engineer as Sir Joseph Whitworth, in which he pointed to the improvement of common roads rather than an extension of tramways. The roads are there, and their improvement by the process, instead of involving an outlay of capital, actually greatly reduces the cost of their maintenance. In our especial case the employment of an engine on common roads, able to move about with facility, also means the application of steam to the conveyance of stone from the various deposits along the road; to breaking it up and taking it to the required spots before rolling it down. Of extraordinary value would these applications of steam be in countries with such dear labour as that of America.

WINDING WATCHES AND CLOCKS.

THE object of the invention of Mr. Christian Lange, of 99, Strand, is to arrange the winding mechanism of watches and clocks in such a manner that it may be effected by the knob at the pendant—as applied to a watch—as well as by a key, by which arrangement the advantages are obtained that both the key and the knob may be turned the wrong way without detriment to the watch, while at the same time the hands may be set by means of the knob as well as the common key.

For the sake of illustration the improvement is explained as applied to a watch. The wheel, which is geared into and worked by the pinion on which the knob at the pendant is fixed, and which is called the first wheel, is fixed on to one end of an axle while the other end of the axle is formed square to take a key. This first wheel gears into a second wheel, and the two are kept in constant connection and gear by means of a piece of steel or other metal fitted over or under them, and on which the centre or stud carrying the second wheel is fixed. This piece of steel has its turning centre in common with the first wheel, and has an arm to be acted upon for the purpose of setting the hands. On the barrel arbor is fitted a third wheel, and the second wheel is kept in gear with it by the pressure of a spring. By turning the knob at the pendant, or a key fitted on the square one way, the watch is wound up, but by turning it the reverse way, the piece of steel on which the stud of the second wheel is fixed moves concentrically with the first wheel, and the second wheel is lifted out of gear with the third wheel. The setting of the hands is effected by pushing the piece of steel the reverse way to that caused by the above-named spring, by which means the second wheel is thrown out of gear with the third wheel and into gear with a wheel acting into the motion work.

The engraving shows those parts of a watch which form the subject of the invention. The knob A at the pendant has on the end of its spindle a pinion which gears into a wheel on the spindle B, which passes through the steel plate C. The latter has two arms, one of which carries the stud D, on which works a pinion 2, gearing into a wheel 1 on the spindle B, and the other arm has a pin or projection, against which presses a spring E, with the view of keeping the wheel 2 in gear with the wheel 3 on the barrel arbor. A small knob F, by being pressed against the arm with the projection on the plate C, throws the pinion 2 out of gear with wheel 3 and into gear with the wheel 4 acting into the motion work.



WROUGHT-IRON CRANES.

WHEN it is considered to what very violent jerks and sudden strains a crane is continually subject it is a matter of some surprise that cast iron should have been so much used in its construction. This can only be accounted for by the fact that a very large margin of superfluous strength is always allowed for in cranes, derricks, and all machines which have to do with the hoisting and transport of heavy materials. Timber is a good and reliable material for the construction of cranes, but unfortunately its powers of resistance are soon exhausted, and are totally inadequate to perform the onerous duties which are now demanded of it. A cast-iron post and jib, and a wrought-iron tie or arm, constitute the principal features of an ordinary crane. With respect to what has been already stated regarding the employment of cast iron in cranes, it should be borne in mind that the first shock or impetus of a sudden load is borne by the hoisting chain, and transmitted by it to the arm and jib. There is no doubt but that a portion of the wrench or strain affects these parts of the crane, but still the chain manifestly breaks the violence of the jerk. Similarly to its ancient predecessor, timber, the capabilities of cast iron are limited, although they surpass those of the former material. This is not so much owing to the absolute want of strength, as the crushing force of cast iron is very large, as to the somewhat treacherous nature of that substance, which is liable to fracture without evincing the slightest incipient weakness or deflection. This liability increases with the weight of the load and nature of the strain to which it is subjected, and it is therefore no wonder that engineers are cautious not to overtask a material that has frequently failed under very disastrous circumstances.

The usual form of a crane is well known, and consists of an upright post and sloping jib, and an arm which is sometimes horizontal but more often inclined. This latter position increases the strain upon both itself and the jib, but possesses some advantages in diminishing the length of the upright pillar, and thus requiring less headway. But when cranes are required to lift twenty, and even thirty tons, it is imperative to employ wrought iron, for two principal reasons: In the first place because a more reliable material is necessary to resist strains of so great a severity, and in the second because the peculiar form required cannot be obtained by the use of cast iron. In Fig. 1 is represented an elevation of a wrought-iron bent crane, and an inspection of it will at once point out the superior advantages possessed by that particular form. With the straight sloping jib it is impossible to hoist a load, especially if it be of a bulky shape, even nearly up to the top of the crane, but when it is arched, as shown in Fig. 1, it may be raised close up to the under surface of the machine—in fact, as high as the shackle will permit. The utility of this arrangement in loading and unloading the cargoes of ships cannot be over-estimated. Wrought-iron cranes may be constructed either on the solid or open principle. In other words, they may have the sides built up of solid plates, or made similar to those of a warren or lattice girder. The latter are rather the cheaper, as there is a saving effected in the workmanship, a great quantity of cutting and fitting in the plates being avoided. It is a very simple matter to cut the end of a small bar to any required angle, compared with cutting the edge of a large plate to a curved shape. Confining ourselves for the present to the solid-sided or plate crane, the section of one intended for moderate duty is represented in Fig. 2. We shall in another article, refer to the subject of the strains upon these structures, which require very accurate and careful calculation. The section is composed of one or more flange plates, which vary in scantling with the strains upon them, and as a rule increase from the summit to the end, where obviously the leverage tending to break the crane across is a maximum. The web or side consists of a series of plates riveted together at the joints by wrappers of T iron, which thus fulfil the double purpose of acting as covering plates for the joints, and as stiffeners for the side or web of the crane. This is one of the disadvantages attending all iron constructions which are based upon the plate or solid-sided system. Whatever may be the strength of the web, so far as its sectional area of metal is concerned, it must be supplemented by stiffening pieces of some other form. In every description of girder the joints invariably constitute the weak points. In the plate form the joints in the web are very numerous, while in the open or lattice principle there are virtually no joints at all in the web, the bars of which, by virtue of their shape, carry their own stiffening within themselves. A glance at Fig. 2 will at once indicate that a large amount of extra rivetting is incurred in the solid side. This pinching or drilling, as the case may be, of so many holes in close proximity to one another, must tend to produce a local weakness in the plates, in spite of the best manner in which the riveting may be performed.

FIG. 1

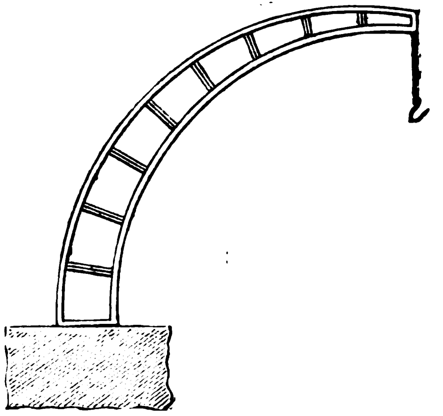


FIG. 2

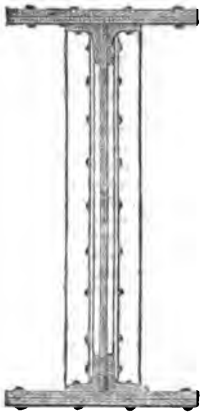
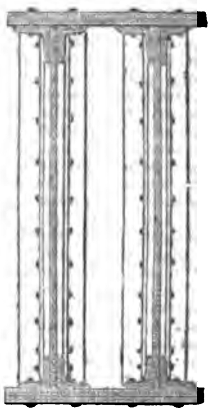


FIG. 3



The section represented in Fig. 2 would answer only for cranes designed to lift a moderate weight. When the maximum load to be hoisted reaches to twenty tons and upwards, the section alluded to would be too weak for the purpose. It would not fail for want of absolute strength, but from want of the requisite rigidity. This is the fault of all single web plate girders, and the same remark applies to lattice girders, in which but a single row of diagonal bars is employed, either in the plane of the elevation of the girder or in that of its transverse section. Whenever the load exceeds about twelve tons, the crane should be made tubular, with a box-shaped section, represented in Fig. 3. The additional stiffness imparted by thus doubling the sides is at once apparent from a mere inspection of the drawing. There is an objection to this tubular form of crane which applies to all box girders of small dimensions. It is the difficulty, in many instances the absolute impossibility, of examining the interior after the separate parts have been put together. It may in some cases be just possible to give the inside a fresh coating of paint, but anything like a proper examination is out of the question. Rust and corrosion have full license to develop themselves unknown and unchecked. This objection is even urged with some degree of truth against tubular girders similar to those spanning the Straits of Menai, for although there is no difficulty in getting at the various interior parts of the bridge, yet the task of examination can never be so thoughly and satisfactorily accomplished as in examples which are open to the light. We must reserve for another article the description and investigation of the manner in which cranes are affected by the strains they undergo, and the method of calculating them.

SCIENTIFIC SOCIETIES.

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AMERICAN PHILOSOPHICAL SOCIETY.

AT the meeting of this society, held on June 17th, a paper was read entitled, "On the Reactions occurring during the Process of Smelting Ores at Freiburg, Germany," by Persifor Fraser, jun. A paper was read by E. D. Cope, being "A Partial Synopsis of the Ichthyology of North Carolina."

Dr. S. A. Genth exhibited photographs of a meteorite from North Carolina. Also a specimen of a meteorite from Rockingham County, in the same State, which displayed several peculiarities. It appeared to be composed of several kinds of iron. In a portion of it minute crystals of a hard mineral were visible, which he suspected would prove to be iron pyrites. He also exhibited a small quantity of native lead, which he believed to be genuine. It was sent with particles of gold, quartz, &c., which constituted the tailings of the pan of some gold miners in Montana Territory. It was furnished by some miners, whose washings were made at 8ft. below the surface of the ground.

Prof. Cope exhibited a series of Reptilian remains from the Triassic sandstone of Pennsylvania, from the collection of Chas. M. Wheatley, and reviewed the species described from the American Trias indicating their ordinal relations. He explained that he had discovered the ischium of Clepsysaurus, Lea, and that indicated that that genus was a Dinosaur, near Megadactylus. He referred several supposed genera to *Belodon*, including *Palæosaurus*, of Emmons (not Riley and Stuckbury), *Compsosaurus*, &c., and indicated the existence of four well-defined species in the United States. These were:—*B. carolinensis*, *B. priscus*, *B. leaii*, from North Carolina, and *B. lepturus*, new species from Pennsylvania. The last was represented by many parts of the skeleton, including limbs, pelvis, ribs, vertebræ, &c. The vertebræ indicated that costal articulations were continued to the sacrum. He exhibited three vertebræ of a large cretaceous Dinosaurian, which presented immense pneumatic foramina, like those seen in *Megadactylus*.

He stated that he had already indicated that the bone regarded by Mantell as the os quadratum of *Iguanodon* was evidently a vertebra, and that Seeley had since made it the type of a new genus of Dinosauria, under the name of *Ornithopsis Hulkei*, supposing it to be Plesiosaurian in affinities, and indicating the most gigantic member of the class. Prof. Cope showed, however, that the characters were in many important respects similar to those of vertebræ of Laelaps, and probably Dinosaurian. Megadactylus and the specimens exhibited confirmed this position. The latter resembled it in the great pneumatic foramina, but differed in the much denser structure of the spongy tissue of the cerebra. It was named *Pneumatosaurus pelorens*; size that of *Lælaps aquilunguis*.

ASTRONOMICAL NOTES FOR AUGUST.

The right ascension of the sun at Greenwich, mean noon on the 1st of August, is 8h. 45m. 38·49s., and his declination north, 18° 1m. 31·9s. He is, therefore, situated a little to the east of the star δ Cancer (*vide* map, p. 494, vol. x.). The approach of Arcturus and other well-known stars in this part of the sky towards the west in the evening twilight now will indicate to the student the progress of the sun in the ecliptic. The equation of time is additive during the whole of August, becoming subtractive on the 1st of September. On August 1st, 6m. 4·33s. must be added to the time indicated by a sun-dial to obtain mean time; and this quantity diminishes to 0m. 12·49s. on the last day, prior (as we have just said) to becoming subtractive on the first day of the succeeding month.

The moon enters her first quarter at 51½m. past 8 a.m. on the 4th, is full at 9h. 13m. a.m. on the 11th, enters her last quarter at 50m. past 7 in the morning of the 19th, and is new at 9h. 26m. on the night of the 26th. She will be four days old at noon on the 1st; five days old at the same time on the 2nd, and so on. Libration will bring some of the south-west portion of her disc into view at 7 a.m. on the 11th, but daylight will of course be too strong to render this of much practical benefit to the ordinary observer. The maximum appearance of the south-east point of her apparent disc will occur at 2 o'clock on the morning of the 24th. There will be three occultations of fixed stars by the moon this month. At 18m. after midnight on the 9th, 4 Capricorni will disappear at the moon's dark limb, and reappear at her bright limb 35m. afterwards. On the 17th, the moon's bright limb will occult μ Ceti at 10h. 29m.; the star will emerge from behind the dark limb at 11h. 23m. On the 19th, the moon having passed quite close to δ^1 Tauri an hour after midnight will at 13h. 14m. occult δ^2 Tauri with her bright limb. The reappearance at the dark limb will take place at 13h. 58m. The moon is in conjunction with Saturn at 5h. 39m. a.m. on the 7th; with Jupiter 48m. before noon on the 21st; with Mars at 4h. 35m. on the afternoon of the 23rd; with Uranus at 18m. past 1 a.m. on the 24th; with Venus at 7.10 in the evening of the same day; and finally with Mercury at 1h. 15m. on the afternoon of the 28th. Mercury is too close to the sun at the beginning of August to be visible, but owing to his rapid motion to the east he becomes an evening star soon after the middle of the month. He sets, however, at his latest only some three-quarters of an hour after the sun. He is on the meridian at 1h. 33m. on the 31st. He travels from the confines of Cancer through Leo into Virgo during the month. He is near Regulus at 7.17 in the evening of the 9th, and β Virginis at 7h. 56m. in the evening of the 23rd. Venus is a morning star throughout the month. She rises a little after 1.30 a.m. at the beginning of the month, and about a quarter to 3 a.m. at the end of it, setting about 6 in the afternoon, or a few minutes afterwards, throughout the whole of August. She souths at 9h. 50m. in the morning on the 1st, and at 10h. 24m. on the 31st. She travels from Gemini right through Cancer. She is in conjunction with Uranus at 24m. past 3 a.m. on the 16th, and, as we have said before, with the moon on the 24th. Mars is a morning star too, southing at 9h. 44m. a.m. on the 1st, and at 9h. 9m. a.m. on the last day of the month. He rises about half-past 1 a.m. on the 1st, and about 1 on the 31st, setting about 6 and 5.15 in the evening of those days respectively. He is in Gemini during the entire month. He is in conjunction with Uranus at 6·23 on the afternoon of the 31st, and with the moon, as has been mentioned, on the 23rd. Jupiter, after the first week in August, will rise before midnight, and be an interesting object until sunrise. He souths at 8·32 a.m. on the 1st, and at 6.54 a.m. on the 31st. He continues in Gemini during the whole of August.

The phenomena of Jupiter's satellites once more present an agreeable spectacle for the contemplation of the student. At 2h. 1m. in the early morning of the 2nd, the first satellite will enter on to Jupiter's disc, and will be followed by its shadow at 3h. 12m. At 1h. 31m. a.m. on the 3rd the first and second satellites will, almost simultaneously, reappear from occultation. On the 8th, at 3h. 28m. a.m., the ingress of the shadow of the third satellite will take place, and the shadow of the first will come on at 2h. 52m. a.m. on the 9th. At half-past three on the next morning satellite 1 will reappear from occultation. In the early morning of the 17th the first satellite will disappear in an eclipse at 2h. 8m., and the second at 2h. 4m. At 1.29 a.m. on the 18th, the shadow of the first satellite will pass off Jupiter's limb, and will be followed by the satellite itself at 2h. 42m. The egress of the second satellite from the planet's face will take place at 1h. 44m. a.m. on the 19th, and the third will be occulted at 2h. 19m. The first satellite will be eclipsed at 3h. 56m. a.m. on the 24th, and during the early morning of the 25th the shadow of the same satellite will enter on to Jupiter's disc at 1h. 9m., the moon itself following its shadow at 2h. 25m.; while at 3h. 23m. the shadow will pass off again. After midnight on the 25th, the third satellite will be eclipsed at 1h. 29m. The egress of the shadow of the second will take place at 1h. 46m., and the ingress of the satellite *three minutes after its shadow has gone off*. The first will be occulted at 1h. 53m., and the third reappear from eclipse at 3h. 37m. Finally, on the 31st, or rather during the early morning of September 1st, the ingress of the shadow of the first will take place at 3h. 8m., and that of the satellite itself at 4h. 22m.

Saturn, up to the middle of August, is tolerably favourably situated for observation. During the latter half of the month, however, he sets before midnight, and must be looked for early. He is on the meridian at 8h. 46m. on the 1st, and at 6h. 46m. on the 31st days of the month respectively. He continues in the south-east part of Ophiuchus during the entire month. Uranus is a morning star, but so close to the sun as to be invisible. He remains in Gemini. Uranus and Mars will be less than half a degree apart at 6.23 on the afternoon of the 31st. Neptune is a morning star, something between 4 and 5 a.m. at the beginning of the month, and between 2 and 3 at the end of it. He is situated a little to the north of μ Piscium.

From the 10th to the 12th of August, and notably on the former night, watch should be kept for shooting stars, as the earth then at this period encounters that meteoric stream which Schiaparelli has shown to belong to Comet 2 of 1862.

LETTERS TO THE EDITOR.

[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]

*** All communications should be addressed to the Editor of the English Mechanic, 31, Tavistock-street, Covent Garden, W.C.

All Cheques and Post Office Orders to be made payable to J. Passmore Edwards.

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> "I would have every one write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks: a vice from whence great inconveniences derive their original."—*Montaigne's Essays.*

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CHIEFLY ASTRONOMICAL.

[118] Sir,—I may answer "H. A. C." (4259, p. 406) by saying that it is simply impossible to determine longitude by the aid of an equatorial *alone*, a sidereal clock or chronometer being absolutely indispensable. Moreover, with these two instruments, in the absence of transit, he can only do his work in an exceedingly imperfect manner. However, assuming him to possess a clock and an equatorial, he must first obtain his local time as accurately as he can, by inserting a transit eyepiece into his telescope, levelling his declination axis with all possible care, and then taking the transit of some star as near as possible to his zenith, inasmuch as (all vertical circles intersecting in the zenith) his central wire will be in the meridian there, however much it may deviate from it in the horizon. If now he can get Greenwich time flashed to the nearest post-office or railway station for him, and compare it with his local time, the difference is his longitude. If not, by observing a sufficient number of occultations of stars by the moon, and reducing his observations in the manner described in "Loomis's Practical Astronomy" (pp. 317 *et seq.*), he will get an approximation which may possibly serve his purpose. Using an equatorial to obtain longitude with though, is a little like painting a watercolour drawing with a birch-broom, or shaving with a hatchet.

The best answer I can give to the question of "G. C." (4318, p. 430) is to tell him that on the 31st of this month D'Arrest's comet will be a little to the W.N.W. of ϵ Serpentis, where he can fish for it. It will be rather more than a degree from that star. If "Lunar" (4,334), same page, will consider that a certain small portion of sunlight must be refracted by the earth's atmosphere within the cone of her shadow, and will further call to mind the property possessed by that atmosphere of reflecting the blue rays of the spectrum, and *transmitting* the red ones, as evidenced by the colour of the disc of the setting sun, he will not have much difficulty in understanding the glowing tint presented the other night by our satellite during the lunar eclipse.

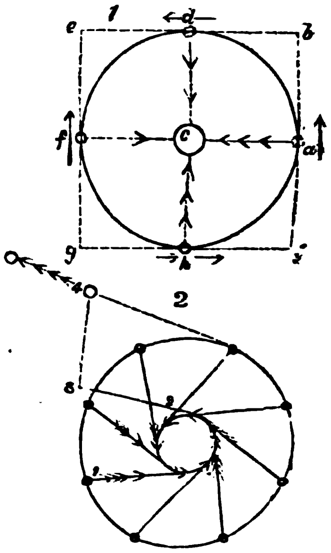
After a little puzzling over the expression "*vertical* plane," employed by "α Ursæ Minoris" in his query (4351) p. 431, I see that he only uses this form of words to signify what is commonly called the plane of a parabola (or other conic section). I may tell him, then, that in a right cone, the plane that cuts it to form a parabola "must be parallel to the slant side of the cone." If the plane cuts both sides of the cone the section is an ellipse; and this even if it be parallel to the base, as the circle is only a kind of ellipse with its foci coincident. Finally, if the cutting plane take such a direction that, being produced, it would meet the opposite cone (or one with its apex in contact with that of the one cut) the resulting section will be a hyperbola. I am sensible that these are not very rigidly scientific definitions; but I hope that they will supply your correspondent with the rudimentary information he requires.

A Fellow of the Royal Astronomical Society.

ON MOMENTUM AND ATTRACTION.

[119] Sir,—Attraction is universal through all creation, always acting with no intermission, all matter attracting all matter. There is therefore no room for repulsion; the antagonist is motion. And the motions of the heavenly bodies at right angles to the line of attraction is given and continued by attraction alone.

Let the division of forces explain Fig. 1.



The moon during the half journey from *f* through *h* to *a* was receiving different degrees of attraction in the direction *h c*, so it has acquired force enough to go on to *b*; but the attraction *a c* is now in full force, drawing it aside, so it arrives at *d* with the 2nd force, that *a c* had given it, but in passing through *d* towards *e* the new 3rd force *d c* has come into action and is drawing it aside, so it arrives at *f*, where the 4th force *f c* will draw it aside to go on to *h*, and again round to *a*, and so keep on for ever.

When the moon is coming down from apogee the attraction is not quite at right angles, but a little in advance, so it accelerates the moon's motion till it passes perigee, and then the attraction slightly retards till it again arrives at apogee. Thus the average of action is quite at right angles to the motion, which it is continually imparting to the moon in perfect equilibrium. So there is no visible cause for alteration.

But the motion of a stone in a sling, Fig. 2, is to be accelerated, so it is forcibly pulled in always in advance or as a tangent to the small circle in which the hand moves, and this pulling in increases the urgency to fly out till its speed in the large circle fully equals the speed of hand in the smaller circle, then adding his own motion from 2 to 3 he lets go.

Cornelius Varley.

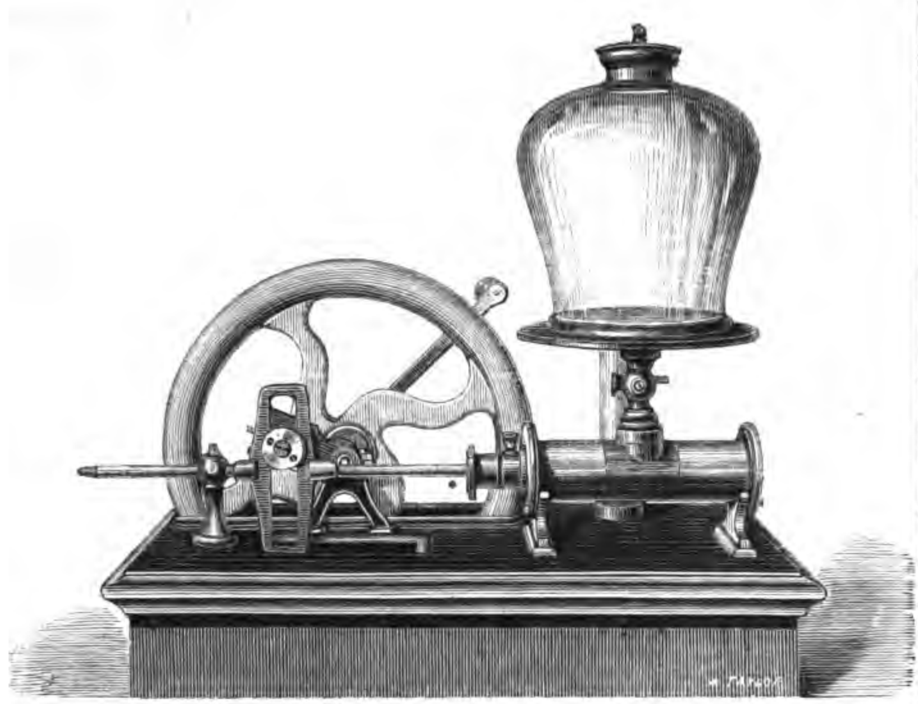
VARIATIONS IN BAROMETRIC PRESSURE.

[120] Sir,—Will some one kindly inform me as to where some information can be obtained concerning the influence on the health of animals and plants occasioned by variations in the barometric pressure of the air? We are many of us aware by our sensations of the changes in the weight of the atmosphere. Some observations must surely have been made and conclusions arrived at regarding this important subject.

F. B. C.

EMIGRATION.

[121] Sir,—I am glad to see the emigration question taken up with so much spirit in your columns, and trust we may glean some good and useful knowledge thereby. Emigration has become one of the leading features of the day, having been forced on all



IMPROVED AIR PUMP.

classes alike from the necessity to provide some out-let for the thousands of unemployed who are unable to obtain work at home. Now, if emigration is so necessary, I think the intending emigrant ought to be furnished with correct information in regard to the best places for settlement, and not forced into any colony merely because some particular class or interest may be benefited thereby. It is a fact patent to all that skilled labour and production is concentrated in the United States, and from her position, immense natural resources, and intelligence she must soon become the commercial mistress of the world. I do not at all agree with "Masquelongue," relating to the portion of North America, Canada. I believe that the British philanthropists and statesmen may think they are doing their country good service by turning the tide of emigration to Canada, but those, as a rule, who escape from Canada become violent enemies of Great Britain.

The Canadian papers estimate the number of native Canadians who went last year south of the lakes and the St. Lawrence, and exchanged the Union Jack for the Stars and Stripes, at 80,000. 13,000 emigrants landed to stay, and 80,000 who had been living there abandoned it. You may judge from this, that Canada has at present nothing to set over against the superior advantages of her great competitor. I should be glad if the following information should be interesting to "Kansas Emigrant":—

Kansas is one of the youngest and largest States of the Union, containing 52,000,000 acres; area, 81,318 square miles; 48,000,000 acres are yet unsold. In 1850 it was a wilderness, in 1860 it contained 107,000 inhabitants, in 1867 they had increased to 400,000. The soil is very rich, from 2ft. to 6ft. deep, will no doubt produce heavy crops of all kinds of grain without any manure. Vineyards and orchards have been a great success wherever they have been planted. The whole State is a rolling prairie with rich grasses from 2ft. to 4ft. high. The climate is temperate and healthful (consumption being nearly unknown) and is very favourable for stock raising. The following statistics show the immense increase in stock:—

In 1860	there were	18,000 horses..	1867 ..	150,000
,,	,,	1,400 mules ..	,, ..	10,000
,,	,,	87,000 cattle ..	,, ..	1,000,000
,,	,,	15,000 sheep ..	,, ..	100,000

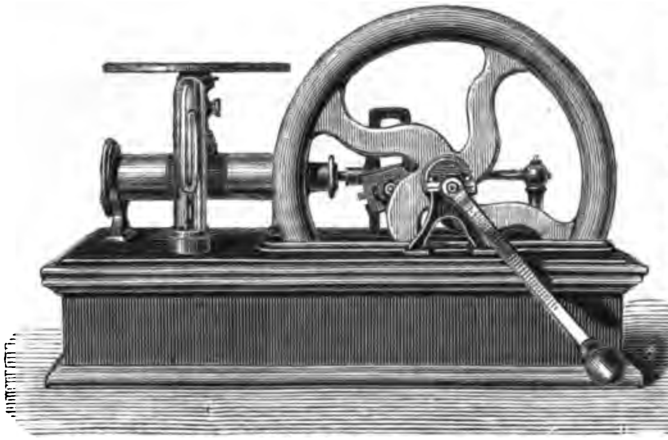
Kansas has many advantages over other States, for west of her lie the iron-producing mining region and large Government posts, which will afford her excellent markets for her produce for years to come. There is a line of railroad—now cutting her in two from east to west—which will soon be completed to the Gulf of Mexico. Kansas is the land of cattle and game—the land of corn, the peach, the apple, and the pear. The land is everything necessary for the sustenance of man, and a land rich in the elements of wealth and opulent commerce, and the land I should most strongly recommend to the notice of intending emigrants. The scheme of forming a body of emigrants to establish an English township, or as it has been called an "English Mechanic" colony is, I think, a good one; as the advantages offered by combination of labour and capital over individual enterprise are obvious to anyone. I shall, therefore, watch for a further development of the scheme, and would most willingly support it, providing that Kansas be determined on as the new home. I ought to add, that emigrants settling there under the Homestead Act are entitled to 160 acres of Government land, or 60 acres of railroad land.

W. M.

IMPROVED AIR PUMP.

[122] Sir,—Having seen letters in the Mechanic from "Inductorium" and others, I enclose you two photographs of my improved air pump now at the Workmen's Exhibition, Islington. It is in every way perfect in construction, being very easy to turn, and as you will see from the photos, brings the mercury in gauge down to the 30th part of an inch. It exhausts my aurora tube, "5ft. in length," to such an extent that I am obliged to admit a small quantity of air to ensure brilliancy. I have had one in action six years, and can wish for nothing better. It consists of a brass barrel 10in. in length and 2in. bore, with a metallic plunger mechanically fitted. The stuffing-box is composed of twelve collars of leather and a chamber of oil, which you will observe in your photo has a cup attached for supply, and a piece of hollow brass to divide the other pieces of leathor at the end of the gland. I have known this pump remain perfectly air-tight for a fortnight. The valves are made of oil silk, which I have practically proved to be the best material for the purpose. The piston has a slot motion and regulated crank, which adjusts it so as to strike the top and bottom of the barrel, which is a most essential point in gaining a good vacuum. The bottom of piston has a piece of wire in its centre to fit the valve hole so as to exclude all air.

J. A. Rudge.



MUSICAL.

[123] Sir,—I cannot resist the impression that the whole of Mr. Frayler's arguments apply with at least equal force to the established as to the tonic sol-fa notation. 1st. That a sol-faist can sing as well in a flat key as in the natural key. Why should not this also be done in the old notation? The change of key or pitch is much more forcibly impressed on the mind by the signature and the change of position on the stave. And why should signatures of three or four flats or sharps be perplexing? they simply indicating transposition of a third major or minor, the scale containing three major and four minor thirds. It ought to be glaringly apparent that the scale thus transposed can only contain three and four natural notes; what remains of the seven being flats or sharps? Again, I cannot conceive of music being taught without teaching key-relationship. The reference to the monotony of going over the intervals of the scale I presume alludes to a system in vogue some years ago, but which was a great mistake; no grounds for it exist in the old notation. Neither is the modulator or musical ladder the exclusive property of the new notation, but I often wish that in elementary works it were more used; and with regard to time, in addition to the bars, there is in instrumental music the very effective mode of marking expression by joining the stems of the notes, and even the old notation is within the reach of any desiring to attain it; but I would not represent a knowledge of its principles or beauties as of mushroom growth, nor exclude such requisites as industry, perseverance, &c., that are good friends to success in other matters besides music; but I would demur to the conclusion that there is, even in the keys (which I have always understood was the point aimed at by the promoters of new systems), anything to detract from its claim to be the "established system of musical notation."

P. S.—Will any of your readers favour us with the origin of the stave? I presume there is no doubt that it represents the strings of an instrument, and the notes the finger touches. Could any notation be more musical?

Music.

THE MICROSCOPE.

[124] Sir,—I am very much interested in the article written by your correspondent Mr. Pocklington on "The Microscope, or, Jottings in Town and Country." As our Mechanic gives a large share to the telescope, may he not hope to give the microscope a little more elucidation. Its construction, how to make it, how to detect or test good object glasses, and, last of all, how to work it with all its accessories, would, I am sure, be very interesting to many of your numerous subscribers besides myself. Mr. P. speaks fluently of mounting chalk fossils in Canada balsam. I find it a difficult matter to do so without having small air bubbles, but I have no means of having the advice or practical experience of some expert hand in mounting, hence my failure may arise from that cause. Perhaps your kind correspondent would not object to give us the advantage of his experience on mounting objects. I have read several small works, but cannot succeed to my satisfaction.

An "Axmouth" Resident.

PRINTING MACHINES.—A HINT TO "OUR" INVENTORS.

[125] Sir,—In the last number of the happily absorbed *British and Foreign Mechanic*, there appears a paragraph containing some rather wonderful information. A Mr. Hector Orr, writing in the *Journal of the Franklin Institute*, states that "we now have machines which print 25,000 impressions per hour." I do not doubt but that it is possible to make a machine which shall be *calculated* to run at the rate of 25,000 *impressions* per hour; but in actual working it has nevor been done. Hoe's 10-feeder, and Whitworth's improvement of Hoe, are the machines which approach nearest to this fabulous number. I believe they have really accomplished 15,000 within the hour; but any attempt to drive them beyond that number has failed, in consequence of the terrific speed splitting and tearing the rollers. In these machines the type is carried on a large central cylinder around which revolve ten smaller "impression cylinders." Each impression cylinder has a set of inking rollers, and the ink is distributed upon that portion of the large cylinder which is not occupied by the formes. It will thus be seen that to make 20,000 impressions the type cylinder must make 2,000 revolutions per hour, and each feeder must supply 2,000 sheets per hour—all accurately laid, for a deviation of a ¼ of an inch spoils the appearance of the paper, and as the type surface would travel at the rate of over 80in. a second, if a sheet is sent to its impression cylinder only the 1-80th part of a second too soon or too late, it will make a difference of 1in. in the position of the page upon the paper. I have already said that the rollers will not stand a speed of 20,000 an hour; but even if they can be made to do this I do not beleive it possible to lay 2,000 sheets properly in an hour, *i.e.*, barely two seconds for each sheet. Now for the "hint to inventors." I have shown there are two difficulties to overcome—rollers and "laying on." The former should be soft, yet tough, elastic without being liable to split. They are at present made of glue and treacle, glue and molasses, or glue and honey, in the proportions of 8lb. of glue to 1 gallon of sugar-house molasses for summer use, and 4lb. of glue to 1 gallon of molasses for winter use. These are thoroughly melted together and poured into moulds. Corrosive sublimate is sometimes added to give greater toughness, at least so it is said. Now with regard to "laying on" the way to improve it is to do without it altogether, and supply the paper in a continuous roll, as is done in the Walter *Times* machine, illustrated and described on p. 523 of "our" last volume, and in the Bullock machine, p. 609 same volume. In both these machines the paper is in a

continuous roll, but while the *Times* machine takes up a great deal of room, the Bullock is very compact. The former divides the sheets after the impression, as it is only by the hold the cylinders have on the paper that it is drawn through the machine. The latter cuts its paper just as the grippers seize the sheet to take it under the first impression cylinder. Both machines damp their own paper. A speed of 11,000 an hour is computed for the Walter machine; but in the description of the Bullock, p. 609, vol. x., no speed is mentioned. Now in any machine there are three absolute requisites:—The cylinders must be so arranged that the plates can be readily laid on, *i.e.*, "made ready;" there must be no danger of any of the parts *continually* "breaking down;" and the whole must be so arranged that "register" can be easily made and maintained. With these hints I leave the matter in the hands of "our" inventors, assuring them there is a fortune for the man who succeeds. A simple machine is more likely to achieve the desired result than a complicated one; but nevertheless, *cæteris paribus*, a machine that saves five minutes in each hour has very great attractions for the managers of morning newspapers. Readers should carefully examine the drawings I have mentioned above; and if anyone sees his way to make an improvement, I shall be always happy to help him.

Saul Rymea.

SQUARING THE CIRCLE.—CONIC SECTIONS.

[126] Sir,—My approximate rectification of the circle must yield the palm to the one given by "A Member of the English Mechanic Scientific Society." His plan and Mr. Penrose's approximate trisection of an angle must be regarded by all mathematicians as very valuable contributions to the English Mechanic.

The remarks made by "α Ursæ Minoris" (4851) accurately describe the distinction between the ellipse, parabola, and hyperbola. It is well to notice that the name hyperbola is not limited to sections made parallel to the axis of the cone, as is sometimes stated.

Richd. A. Proctor.

CONSTELLATION NAMES.

[127] Sir,—I think the criticism on this subject in the very kind review of my atlas is just; and very much fear my new constellation names will have eventually to be abandoned. Felis was a name given by Bode to a constellation he invented. I thought of Ursula for Ursa Minor; but as Ursula is a lady's name I trembled at the thought that I should seem to suggest that all Ursulas are *little bears*. It would be worth while to make an effort to retain the new and much shorter names, using both for a time, as in my introduction. They are few, and I think they are manifest improvements. Some of them were suggested to me by Sir John Herschel.

Richd. A. Proctor.

MR. PROCTOR AND PROFESSOR PRITCHARD.

[128] Sir,—Mr. Brandon is very personal while objecting to personality in me. And further, whereas I wrote only what I knew, he rashly writes without knowledge. It sounds very fair to say that if Professor Pritchard's review on my book is unjust, "the merits of the book will answer the criticism." A review, however, is not written for those who *have* read, but for those who have *not* read a book. How the merits of a book can convince those who may be deterred from reading it by an unjust criticism, I leave Mr. Brandon to show. But as a matter of fact every one acquainted with publishing knows that an unfair review, if unanswered, invariably does mischief. As in this case the whole loss would have fallen on Messrs. Longmans & Co., I had a duty to fulfil in the matter.

I have said that Mr. Brandon writes without knowledge. He throws out the suspicion that I have tried to steal a march upon the Savilian Professor by sending a letter to the English Mechanic, having reference to a review which appeared elsewhere. This personal insult finely illustrates Mr. Brandon's objection to personality. Let him now learn that, first, I addressed a letter to the same effect to the paper in which the unfair review appeared; secondly, I wrote to Professor Pritchard telling him what I felt it my duty to do; thirdly, I offered to send him copies of all such comments as I might make, in order that if he thought fit he might reply to them; fourthly, he *has* sent me privately a reply to the three chief points of my counter charge. I do not feel at liberty to mention the terms of this reply, and only remark respecting it that it does not meet my statements.

For the rest, Professor Pritchard's quotations from my book, and the book itself, are before the public. If anyone is anxious to take up the cudgels in defence of Professor Pritchard, let him show that the quotations are fairly made,—that I have really said (*in effect*—not in words pieced together unfairly) what Professor Pritchard has asserted. To such evidence I shall gladly listen; but I can allow no question of my right (with your permission) to correct in your columns what I take to be erroneous and unfair criticisms. I have made it a duty to correct errors respecting scientific matters, errors affecting the repute of others, all errors, in fact, which touch on the subjects I take interest in; I also carefully admit errors I make myself; surely I may be allowed to correct errors by which, if I permitted them to remain uncorrected, the publishers of my work would suffer.

Lastly, I object as much as Mr. Brandon can to personality, but personality in attack is one thing, personality in self defence is a very different one.

Richard A. Proctor, B.A.

ROMAN NUMERALS.

[129] Sir,—"J. R. W.," p. 311 (No. 4048), asks "How did the Romans perform arithmetical operations with their Z's, Y's, and X's?" The Romans never employed the letters Y Z in their notation; but I will endeavour to explain their use of the characters of the alphabet for the purposes of counting and numbering. Some very ingenious suggestions have been made as to the origin of the use of letters to represent numbers, and one of these certainly has some pretensions to be the true explanation. It will be allowed, I suppose, that the most likely way anyone ignorant of figures would count would be by the use of his fingers. Thus, then, we have from 1 to 10 enumerated on the fingers, and written with ten strokes; but it is quite feasible to suppose that when ten strokes had been written down the numerator would make some mark to show that his hand was full. We will suppose that he drew a line in a diagonal direction through these ten strokes, and it is easy to believe that in endeavouring to shorten this he would make a character somewhat resembling the letter X. Then to make 100, as one mark across the unit stood for 10, he would very likely put two ligatures to the unit for 100, forming a character resembling ⊏, which in writing would soon be turned into C. As regards the 1,000, the unit mark would require three ligatures, which might be made somewhat like M, and in course of time would probably assume the form of ∞, which actually appears in print and in inscriptions as CIↃ. Having arrived at these it is easy to see that V is but the half of X, L the half of ⊏, and D the half of CIↃ. We then have the fact that in Roman numerals wherever the lesser symbol precedes the greater, under 100 it is *subtracted*, but afterwards it is *added*. Thus the unit mark I, the X, and the V are used as far as 40 (XL, 10 from 50), after which the L is used up to XC (10 from 100), C is used as far as 400, after which it is reversed and the unit mark prefixed (IↃ); hence D 500), and so on up to 1,000, when the mark above-noticed is used (CIↃ), or M, or the unit mark with a line over the top (Ī); 5,000 is written IↃↃ or V̄, the reversed Ↄ thus acting as our 0, and multiplying by 10; so 50,000 was written IↃↃↃ, and by putting the same number of C's before the unit as reversed ones occurred after it, the number was doubled, so CCCIↃↃↃ = 100,000, and IↃↃↃI (500,000) is thus turned into a million CCCCIↃↃↃↃ. One peculiarity of Roman numerals is worth mentioning, viz., that the various letters used are alternately quintuples and doubles of the preceding one: *e.g.* I × 5 = V; V × 2 = X; X × 5 = L; L × 2 = C; C × 5 = D; D × 2 = M. Whether the Roman arithmeticians (if there ever were any) had arbitrary signs to denote the different values is not known,—certainly none have been discovered. My own opinion is that they knew nothing of the science of arithmetic, and what calculations they made had to be worked out with the cumbrous numerals I have endeavoured to explain.

Saul Rymea.

FRICTION WHEELS.

[130] Sir.—I see from the fourth page of the advertising sheet of our present number (277) that Messrs. Forder & Co. have, either consciously or unconsciously, adopted an old idea of mine which I suggested as far back as January 16, 1869, namely, the application of friction wheels to velocipedes; and, strange to say, about the same time I made a model exactly similar to Fig. 2 in their advertisement, which is now in the possession of Messrs. Wilson and Longbottom, of Barnsley, who joined with me in taking out a provisional patent for the application of friction wheels to all kinds of velocipedes. We did not proceed with the patent because we decided, after various trials with ordinary bicycles side by side with one fitted up with friction wheels, that the advantage gained was hardly worth mentioning.

On smooth boards the difference was perceptible, but the friction wheels by no means compensated for the roughness of the ordinary road. I feel certain that improvements are not so much needed in the velocipede itself as on the road on which it runs. The extreme ease with which a well-made velocipede moves on smooth boards or flags, and the greatly increased exertion which is required when riding on the high-road, show that the impediment to progress is not to be looked for in the friction of the bearings, but in the roughness of the road. Wheels with india-rubber tyres seem to me to be a step in the right direction, as a velocipede fitted up with them may be said to lay down its own road as it goes along.

W.

HAND-PLANING MACHINE.

[131] Sir,—A good drawing of a hand-planing machine (p. 429) is given in your current number. But the price quoted is very heavy, and might discourage your readers from attempting to obtain this useful tool. I may, therefore, state that I have made one for myself at a price of about £10. It admits work 18in. by 14in. by 6in. The castings were made and planed for me by Pearce, of Union-street, Borough. They can also be had ready planed of Thomas Taylor, 7, Chester-street, Hulme, Manchester, for £7, taking in work 24in. by 13½in. by 11in. Mine works with a rack and pinion of 7in. pitch, and a double handle, which gives a longer stroke than the lever. One of the small American parallel vices fixed to the table serves to hold small work, and costs only £1, instead of £7 10s. A few carriage bolts, costing about a penny each, and some iron dogs complete the machine. The work is set true by a good T-square, and can be removed and replaced under the tool with very little more trouble than in an ordinary vice.

W. H. Stone.

BRINSMEAD'S HISTORY OF THE PIANOFORTE, AND A "LEETLE" MORE.—Letter I.

[132] Sir,—Having in No. 227, of the English Mechanic analyzed to the best of my very small ability Messrs. Brinsmead's so-called improvements in pianoforte actions, I now, as seemeth in duty bound, proceed to analyze a new book of the pianoforte, which is the production of a member of that firm, to the general goodness of whose productions (other than literary) I can with much pleasure bear testimony.

In justification of my doing this I will, with your permission, Mr. Editor, relate a short passage in my own personal history which, for the important moral truth and lesson of charity it contains, may, perhaps, not be unacceptable to my fellow-readers.

Many years ago, a friend of mine, who did the duty to which it pleased Providence to call him, by selling tea and coffee in the city for six days per week, but who, instead of resting on the seventh, or rather the first day, used to preach what he *believed* to be the "word in season" every Sunday morning in his own chapel, he being a "master of words" *i.e.*, eloquence, which I am not, I once strongly urged him as a matter of moral duty to preach against certain and sundry vices of great cities—I may sorrowfully add of rural districts also—which I had been writing in condemnation of as strongly as my very small command of language (combined with an amount of earnestness which those who only know me in the disguise of chaff would not give me credit for) enabled me to do. After some time worthily spent in thought, my old *friend* said to me, "S. cannot *make* duty for B. any more than B. can make duty for S. Each servant of the Most High must find his own duty, and do it, with Heaven's help, to the best of his ability." After such a moral lesson as this, which I trust by the force of its inherent truth sunk deeply into my mind, and assisted me in after life to judge charitably of what often seemed to me the misdirected efforts of many whose gifts far exceeded mine, I felt that it was not my mission to call my fellow-labourers in the Lord's vineyard of knowledge to account, but to bear my testimony to what *seemeth good*, and point out apparent evil. My friend, *whose loss I deplore*, further said, "no doubt *you* think I ought to bear testimony against these things, and could I but see that my doing so would induce more good than evil, it would indeed become my duty to do so; but you have *fallen* into the very common error of supposing one man can make duty for another, which error is the root of all persecution." Since that time, I have endeavoured to find my own duty, instead of presumptuously finding other *men's* duties for them. One of those found, or perhaps, self-imposed duties, is to examine, judge of, and comment on so-called improvements in pianofortes, and what matter is published concerning their history. In the execution of that duty I proceed to treat of Edgar Brinsmead's "History of the Piano," for which I felt in duty bound to pay 3s., or rather 2s. 6d. N.B.—Don't forget the customary allowance of 2d. in the shilling on all new works which competition saves us who are rather copious, if not *liberal*, buyers of new books.

In a former paper on the pianoforte and its congeners I have said that its true history—certainly the true history of its early manufacture in England—has yet to be written. Brinsmead's book has not induced me to alter that expression of opinion, but as the writer or compiler has collected into a small space a good many facts and sayings of the order of "things not generally known" about music and musical instruments, which will probably much interest the majority of readers, who desire rather a brief *precis* on those subjects than to wade through the ponderous tomes of Hawkins, Burney, and a whole host of by no means lively English and foreign writers, who, like the blacksmith, are not remarkable for the terseness of their style. I can honestly recommend my fellow readers to follow my example, and invest half-a-crown in its purchase, and when they have "gone and done likewise" I venture to prophesy they will not regret its cost. I also trust that some of them at least may be sufficiently interested in this subject to expend one shilling and sixpence more for an illustrated catalogue thereof, and visit the very remarkable collection of ancient instruments of music deposited in South Kensington Museum for our "heddification." They are extremely well worth seeing.

The greater part of the matter contained in the earlier chapters of the work is so good that Dr. Rimbault thought it worth printing A.D. 1860, and he, at least, ought to be able to select and compile suitable matter relating to the history of music and early musical instruments, especially those having strings, with or without manual keys; but as Rimbault's matter is to a large extent copied from Hawkins, Burney, and other older and more modern writers—almost verbatim—so in Brinsmead there is little that is new, and much which, if true, is at least unproved.

One assertion, in page 38, is certainly new to me. The author says that Plenius, the talented inventor, or improver of the lyrachord, employed a *circular* bow—*a la* hurdy-gurdy—to vibrate its strings, which he says were moved *to* the wheel or bow. What kind of wheel or circular bow could be made to act on the strings of more than two notes in an instrument whose strings were all in the same horizontal plane he leaves, as he found it, a mystery. It is just possible to make one wheel sound the strings of two notes if the said wheel be placed between them, and each pair of strings moved to it, but this is not using *one* circular bow, but *many*; indeed, half as many, less one, as there are notes in the compass of the instrument—(say) 29 bows or wheels for 60 notes.

This assemblage of wheels, yet further extended to more than double that number, was used by Schmidt, of Paris, 1806, for continuing the vibration of the strings of a pianoforte, the tone of which was said to resemble that of the cymbal. Why, it would puzzle Apollo and the muses nine to say, but this was only one of many attempts in the hurdy-gurdy line "with variations." I may enumerate—first, John Heyden's clavecin viole, A.D. 1600, succeeded by Marius, A.D. 1717, whose model of a mechanical fiddle, with keys like a harpsichord, is said yet to be preserved in Paris. There was also Holfield in 1754, and many others, not to mention "ye harpsichordis wyth gut strynges"—*i.e.*, lyrachord, which Evelyn records that he went to hear. "This," he says, "was made 'vocal' by 'a zone of parchment,' and that it sounded like a 'consort' of viols." In fact, it was a viol, it being a bow instrument with *fixed* intervals—*i.e.*, our chromatic scale. This is just the distinction between viols and fiddles, and its action was rather more practical than using half as many revolving wheels as there are notes in the instrument, for it is obvious that—especially in instruments like the harpsichord, which has metal strings—moving the strings to the bow (instead of the preferable plan of moving the bow to the strings) would have the effect of unsettling the tuning of them. At a later time it was done (under circumstances in which it did not have that effect) in that powerful keyed bow instrument, the claviol of J. J. Hawkins, for in this the hook which *pulled* the string to the very ingeniously constructed horsehair rotating bow—it was not strictly a wheel, but an assemblage of horsehair bows inside a wheel, for its strings were attached to very long *heliacal* tempered steel springs—which resolved almost exactly the same amount of tensile force of its waterproof gut strings, whether they were quite straight, or slightly deflected to make them touch the bow. Under these circumstances their pitch was not sensibly altered; besides they were tuned when deflected, so as to be in contact with the bow, which it is obvious the steel strings of a harpsichord, having plectra also, could not be without great inconvenience.

Plenius would have had little inducement to torment himself by making and keeping in order, duly resined, half as many wheels as there were notes in his lyrachord, for the endless band had been used nearly a century before his time. This is shown by my quotation from "Evelyn's Diary." Plenius, who was a very clever fellow, would, we think, have been about the last man to repeat such a mistake. The lyrachord existed until 1772 at least, for one was sold that year by the elder Christie. I trust it is yet in existence, and may adorn South Kensington Museum. To it my fine celestina harpsichord — its celestina stops were added by Walker, its inventor—would be a worthy companion, and I fully intend it to go there when completely restored.

In Brinsmead the old story that Plenius attempted to make a copy of the hammer harpsichord, known as Fulke Greville's piano, makes its customary appearance, but, as usual, no date is given when he made this alleged unsuccessful attempt. To this is added that the only pianofortes manufactured in England were those made by him. If I could suppose this true, small indeed must I assume their number to be. Trying, with small success, to make a copy of an existing piano, and making pianos for sale is something rather dissimilar, and the two statements are hardly reconcileable. That Plenius both tried and succeeded in making a mere copy is very probable, for no one who has read his patents can much doubt he was quite capable of doing something rather more than this. In fact, that he was a person very likely to succeed in anything he attempted. The man who copied the old German and English harpsichord with gut strings, and improved on it to the extent he claims having done in his patents (which contain abundant internal evidence that the man who drafted their specifications knew very well what he was writing about, even if, as was the practice of his time, they are remarkable for the absence of specific instructions)—who anticipated refined modern practice by clothing the mortices in his keys—who double pinned his long bridges (an improvement not universally adopted by square pianoforte makers until about 1820), and effected other improvements which modern pianoforte makers use daily, little knowing to whom they are indebted for their introduction, was not likely to fail, even in his first attempt, to perform so simple and merely mechanical an operation as the making a mere copy of a hammer harpsichord is. No inventive power is needed for this, but I should be glad to be referred to the authority on which the writer states that he afterwards not only made pianos for sale, which is quite possible, but that he was the only man in England who then did so. On the contrary, the great probability is that this copy, when made, was like the original, so weak in tone that a Plenius, accustomed to what were then considered tolerably powerful harpsichords, would have regarded it as the elder Kirkman did the piano of that date generally, "a very poor, weak affair indeed."

Besides being very weak in tone, this copy was probably also very imperfect in its mechanism. Some of the earliest pianos did not even have their hammers supported on centres or hinges, but merely had strikers fixed in the key—in fact the old tangent of the clavichord with some clothing on the top of it. With this kind of action it was absolutely needful that the finger should be lifted instantly after the string was struck, or its vibrations would have been stopped or damped by the clothed tangent or strikers acting on it as a damper. I suspect this is at the bottom of what we read about performances by "a maestro accustomed to the touch," &c., indeed, he must have been exceedingly well accustomed to such a touch to produce much effect. It was not until long after this time that English pianoforte makers—and in this respect they take the lead of their Continental brethren—appreciated and carried out the instruction of their father in the art, Christofali, who expressly says "that this kind of (hammer) harpsichord should have *much thicker strings* than the common sort, for then the objection that its tones are weak *doth not so much apply*." Since his time we have greatly improved his instruction. Messrs. Broadwood, and other first-rate makers, now use No. 17 or No. 18 wire on middle C; and I, being a dissatisfied person, constantly engaged in trying to improve and make well better than well, have gone far beyond this, I having employed No. 26 wire with great advantage for that note, by altering the length, the place at which the hammer strikes it, and increasing the weight of the latter. This is what our American cousins would term a "pretty considerable" advance on No. 7 or 8, probably the largest wire the father of the art ever used for that note; for I doubt not he soon experienced the difficulty of making the frame strong enough, as then constructed.

The author goes on to repeat the old story that the piano did not "at once" supersede the harpsichord. It would have been a very unusual, not to say unprecedented, circumstance if it had. Not to mention the very grave defects in tone and touch of all the early pianofortes known to have existed in England, of whose mechanism I have representations—for Christofali's, which is far in advance of them all, does not seem to have been known in this country until a few years ago—I may just remark that it is not very common for new things, however good, to supersede old things "at once." We old fogies know very well in our hearts (at least we should be afraid to deny) that young ladies and gentlemen are, like all other new (Qy. green) things, far superior to ourselves, their progenitors. Of course the improvement in each succeeding generation is quite manifest, at least to the angels which are in Heaven, who view the human race from a *high* standpoint, if not to our own imperfect perceptions; but somehow, these clever young people don't push us from our stools and *supersede* us "at once." We elders have a prescriptive right to be allowed a reasonable time to "die out."

Brinsmead leaves the early history of the manufacture of the piano in England just where he found it—*i.e.*, in outer darkness; he throws no light on it whatever. More than thirty-five years ago, my old friend Joseph Kirkman, Esq., said that not only had it not then been written, but that he much doubted if any one survived, even at that long past time, excepting himself, who combined a memory extending back into the last century, with access to authorities in the archives of so old a firm as his own. He then promised to write his history, but has not yet done so, and I fear never will. Rimbault collected a great deal of information concerning keyed instruments in use anterior to the piano, but no very great amount of undisputed facts concerning its early manufacture in England, and this subject continues in "outer darkness." Of course, as usual, we are told all the early specimens of English manufacture were grands. It may well be so, for Fulke Greville's pianos were all most certainly of this form, just as the earliest of continental manufacture of which we have any record, viz., Christofali's, is a hammer harpsichord, *i.e.*, an imperfect grand! piano. Strange to say we have squares considerably older than any grand known to exist of English make, for the earliest—or rather its name board, the instrument itself is lost—bears the name of Americus Backers, fecit A.D. 1776. Messrs. Tschudi, Broadwood, & Co. did not commence to make grands until 1781, but they sold squares ten years before that time. I strongly suspect they or Robert Stodart, perhaps in conjunction with Backers, made the first grand piano, properly so called, produced in England; I mean an instrument with hammers *only*, not hammers added to jacks, for although the addition of hammers really converted the harpsichord into an instrument capable of expression, which were commonly termed *harpsichords* on which you can play piano and forte, harpsichord being yet the principal or leading name of the instrument; and it seems probable the Americus Backers (of which we only have the name board) may have been one of this kind.

The Harmonious Blacksmith.

PHRENOLOGY.

[133] Sir,—For so "'umble" a correspondent, as lowly as a mere blacksmith, to give utterance to opinions differing from those of so august, sublime, and sage a personage as an editor seems almost *lèse majesty*; but, just as the "slaves" of old Rome had their Saturnalia, so your humblest of slaves would, although in abject fear of your whip, exercise a similar license by asking if you were not lately just a leetle hard on the poor phrenologists, when you triumphantly enquired if they were able to distinguish astronomers from gastronomers, poets from parsons, engineers from engine-drivers, or solicitors from surgeons—in a word, the profession of the "party" whose pericranium they manipulate blindfolded; and whether this is not rather too much to ask?

Without committing myself to the acknowledgment of belief in all so-called phrenologists have put forth, I may just say that I believe the foundations of this so-called science—which, after all, is only one division of human physiology—are well-ascertained physiological facts; for what scientific physiologist can dispute that fundamental one that, *cæteris paribus*, *size* is the almost universal external indication of power both of nervous and muscular tissue.

When we see a man's arm of great girth, and we find its muscles hard and healthy, we feel perfectly justified in inferring that it is capable of exerting great force; just so the true phrenologist infers from a large brain-case or cranium a large brain within it, and from that *fact*, in accordance with the observations of all comparative anatomists on the cerebral hemispheres of man, and what we with great self-complacence term the lower animals—he also infers, *cæteris paribus*, greater mental power, for it is no less true of nervous than it is of muscular tissue, that quantity is the external sign of power. That the phrenologist also assumes that he can, from differences in the local growth of brain, infer greater aptitude for certain kinds of mental activity is quite true, and it is only when he draws these inferences that he steps beyond the path of the mere physiologist; but these special inferences do not affect the main principle one jot, that size of brain is, *cæteris paribus*, an indication of mental power. It only enables him to indicate the kind of mental activity a given brain is likely to be capable of.

The physiologist who infers from the muscular development of Mr. Strong-in-the-arm that he can exert great force does not presume to say on what kind of labour that force is habitually exerted; he never says of one, this is an oarsman—of another, this man is accustomed to use the plane and the saw, or to wield the axe or blacksmith's sledge hammer, or that he is a miner or artilleryman, but simply that his arms fit him for the various labours of persons engaged in such labours as I have enumerated; and he can do this as well blindfolded as with his eyes open. So likewise can the phrenologist manipulate and judge the heads of the people as well with his eyes shut as with them open; but there is all the difference between judging the kind of work a given head is likely to be capable of doing, and determining the specific work it habitually does. This is as far beyond the province of phrenology as it is beyond the ability of a stranger to the individual whose pericranium is undergoing manipulation, and to expect it of the former is about as reasonable as to expect it of the latter, for he obviously cannot determine by the mere external form of a brain-case whether it belonged to a poet or a philosopher—an author or an editor—although, if his eyes are "thoroughly open," and artistically educated, it might not, from his peculiar physiognomy, be quite impossible to distinguish the latter from the former, for Minerva herself—although feminine and strong-minded, even if she wore ringlets or a chignon (which is not on record in Rollin)—could hardly have had the assurance to ape the ambrosial curls of Olympian Jove.

The Harmonious Blacksmith.

IRON IN BATTERIES.

[134] Sir,—Your correspondent, Thomas C. Haines, says he is inclined to think that iron has not received much attention as a positive element in a battery. I beg to inform him that it is well known that iron stands next to zinc in the list of electro-positive metals, zinc being the highest of the two. Many use zinc and iron for a galvanic battery. When such is used cast iron is the best, because out of every 100 parts of common cast iron sixty-five parts are carbon and thirty-five parts iron. This explains how cast iron stands so electro-negative to zinc. The reason, I believe, why iron is not so much used in the galvanic battery, though being highly electro-positive to copper, carbon, &c., is because it is acted upon so furiously by acids, and not an easy metal to amalgamate; though cheap in the first place, it is dear in the end.

A. J. Jarman.

MODUS OPERANDI.

[135] Sir,—Does "Xenophon" (4270) wish for the simplest mode of obtaining the metal from a mixture of the oxides, &c., he names? If so, the best and simplest mode would be to distil with an excess of potassium. The sodium will distil over pure, and fused magnesium remain behind with the unaltered potassic hydrate.

The simplest mode of obtaining magnesium from its hydrate is to fuse it with sodium. The best way, though, is to first convert it into the double chloride of ammonium and magnesium and then fuse with sodium.

Sodium is obtained from its carbonate—most simply by distilling with potassium, most economically by converting it into the tartrate, mixing with charcoal and distilling. Four ounces of sodic carbonate by this means will yield one and a half ounce of sodium.

Potassium is obtained most simply by distilling at a white heat the oxide, or hydrate rather, with carbon, or else by decomposing by a powerful battery. It is most easily prepared by igniting the tartrate with charcoal and distilling at a bright red heat. Six ounces of potassic hydrate will yield little more than one of potassium.

A porcelain incased graphite crucible will prove most durable for such work, and will, I think, best suit "A Student" (4272).

If "J." (4285) will apply to Griffin's they will doubtlessly furnish him with a detailed description with illustrations of their gas furnace, which by a little manipulation is readily converted into muffle furnace of a very superior description. It uses from 20 to 200 cubic feet per hour, as may be needed.

E. H. (4298.) Chloride of silver turns blue from decomposition.

Urban.

P. S.—One of your correspondents wishes to know the date of the Metrical Act. From a copy of the standard measures of this commission, printed for private use of the members, I find it to be known as 1864, the year of the commission.

THE SAFETY-VALVE LEVER.

[136] Sir,—I send you, for the benefit of my brother readers, the following experiment, conducted by me within the last month, on the safety-valve lever, showing that the effective pressure of a tapered lever may be calculated with as much facility and with sufficient accuracy for all practical purposes as a parallel one.

The first was a parallel lever of the following dimensions—viz., length, 22·75in.; distance from the fulcrum to the centre of the valve, 3in.; and weight 2·875lb.

22·75in. ÷ 2 = 11·375in. = half the length of lever.

11·375in. ÷ 3in. = 3·7916′ = the ratio of the distance from the fulcrum to the end of the lever, to the distance from the fulcrum to the centre of the valve.

3·7916
2·875

189580
265412
303328
75832

10·9008500

Effective pressure by calculation .. 10lb. 14oz.
" " dynamometer 10lb. 8oz.

The second was a tapered lever of the following dimensions—viz., length, 22in.; distance from the fulcrum to the centre of the valve, 2·75in.; breadth of the lever of the fulcrum, 1·5in.; breadth at the end ⅞in.; and weight, 4lb. 2oz.

The only thing to be observed in calculating the effective pressure of a tapered lever is, to diminish the half of the lever by the difference of the taper.

1½in. − ⅞in. = ⅝in. ∴ 11in. − ⅝in. = 10⅜in. or 10·375in.

2·750) 10·375 (3·772 = ratio of the two arms
8250

21250
19250

20000
19250

7500
5500

3·772 = ratio of the two arms.
4·125 = weight of lever.

18860
7544
3772

15088

15·559500

Effective pressure by calculation .. 15lb. 8oz.
" " dynamometer 15lb. 4oz.

Thomas J. O'Connor.

MUTUAL IMPROVEMENT SOCIETIES.

[137]—In your valuable paper, No. 264, page 89, I see a letter on "Mutual Improvement Societies, English Mechanic." Ever since I first read that letter I have had a desire that one should be formed in the town where I reside (Dewsbury, Yorkshire), as I think it would be both instructive and interesting to be able to discuss with some of my fellow-townsmen the many topics which are weekly under review in the Mechanic.

I do not wish to take it upon myself to call a meeting, as I had rather hear the ideas of some of my fellow-subscribers. I would suggest that if a meeting is called, it may be away from a public-house or tavern. I hope some one besides myself may think it worthy of notice.

F. H. S.

LATHE CONSTRUCTION.—TO "J. K. P."

[138] Sir,—I hail the arrival of your most comprehensive journal as one of the greatest pleasures of the week, and must add my testimony to the zeal and ability with which it is now conducted. I did oncegive it up, when I found proposals for emptying leaking ships by a *syphon* seriously entertained, and other childish matters filling up valuable space, *Mais nous avous changé cela*. I have derived great benefit from the various papers on lathe construction, and I would endorse your correspondent's request that some such proficient as "J. K. P." should give a complete description, illustrated with working drawings, of a lathe which combines all the latest improvements.

I am very anxious to obtain information as to the construction of Lo 'e's medallion cutter, as I would wish to construct one, and I cannot find that it has ever been described in your pages. I have never either seen Messrs. Kennan's, of Dublin, very ingenious geometric cutter, mentioned in our journal. It is a beautiful tool, and ornaments, flat-sided pedestal, &c., as no other tool can.

H. D. C., Capt. R. E.

Gibraltar.

ARTILLERY DISCHARGES AND RAIN.

[139] Sir,—A continued drought in this country is so uncommon that the attention of our scientific men has not been drawn to the question whether such a calamity may not be mitigated if not averted. The want of rain has already cost us millions, and it is time we raised this important question. It is a known fact that a continuous discharge of artillery will draw rain in cloudy weather. Many military men have noticed this, and it is well known that many of our modern battles have terminated in a deluge of rain, as Waterloo. Long practice of artillery has been known, even in India, frequently to draw rain; and it has been remarked that the practice of our Volunteer Artillery is often followed by a rainy evening.

My attention was particularly called to this fact upon the occasion of the Sultan's visit to this country. Wherever he went he was followed by rain. It was so when he went to the City—to the review at Spithead—and especially to that at Wimbledon, where he sat on horseback in drenching rain—although not a drop had fallen until the rounds of artillery, which announced his arrival, had been discharged. I wrote a letter for insertion in the *Times*, with a view to draw attention to this matter, being confident that if our men of science, who have accomplished such wonders in other directions, could be induced to take it up, something would be done for our relief. My letter was dated Wednesday, the 15th ult., and in it I asked whether an explosion of gunpowder would produce the same effect as the firing of artillery. The editor did not think my letter worth publishing, but the question I asked was answered the following day by the explosion of the Government Powder Mills, at Waltham Abbey, which was followed, as is well known, by some hours of rain, extending into the surrounding counties. Such an explosion would certainly cause a concussion of the atmosphere, which—drawing the clouds together—would produce thunder and lightning, and rain; and did so on this occasion, reaching in a circle as far as 150 miles from the scene of the disaster. We all know what a ripple or wave will reach the shore when even a small stone is thrown into a pond. And if, as I have heard, the firing of a gun will cause a dead body, hid at the bottom of a pool, to rise to the surface, I can well believe that the explosion of gunpowder may cause rain to fall from clouds passing over us, which otherwise would empty themselves into the German Ocean.

If the insertion of this letter in your valuable paper will draw the attention of the right men to this subject, I believe agriculturists, all over England, will be greatly your debtors.

R. P.

ELLIPSOGRAPH.

[140] Sir,—Since last I wrote on this subject I have roughly tried each of the plans shown above, and with a 30in. connecting rod to a 6in. ellipse I can scarcely perceive any error in the curve. In each figure C is centre of expanding crank C D, and D E the connecting rod with the pencil P, the distance P D in each case being ·422 of D E or $1 - \frac{1}{\sqrt{3}}$ which in this case, with the connecting rod 6in. long, is equal to 6 × ·422 or 2·53in., which will be right for projecting circles in isometrical drawing. I think the easiest guide to make for the end E would be as I have drawn it, with a small roller kept in contact with a short straight-edge by means of an elastic band. I have shown the base-piece as made, of sheet iron about 1-12in. thick, with a gap in the middle and feather edges to place on one axis of ellipse, and a broad arrow to be brought into contact with the other.

FIG. 1

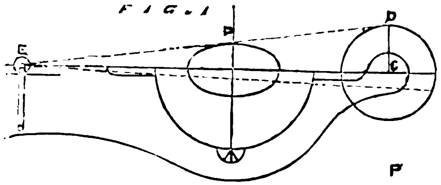
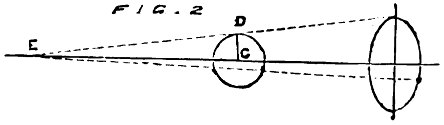


FIG. 2



The lower, Fig. 2, would probably be the best for showing the ellipses for this purpose, as the half exhibited is generally all on one side of the major axis, and in this plan the two halves of that half match each other, or are symmetrical, while in Fig. 1, the oval is symmetrical about the major, and not the minor axis. In case of the whole ellipse being required it might be drawn half at a time, first on one side of axis, and then reversing the instrument, for the other half, or better still the whole struck in from both sides, and the mean of the two taken with a French curve. This would scarcely be necessary, however, except with a short connecting rod, or with the largest ovals that the instrument will take in. I have drawn the connecting rod only four times the length of the ellipse shown, and Fig. 1 is quite equal to drawing one of 2¼in. long. The gap is much deeper than necessary, as I have made it semicircular, which it has to be in any other instrument. These things could be turned out very cheap, and I should think would pay an instrument maker to bring out. The base of Fig. 2 would have to be something like a capital Y, and would be made of wood.

J. K. P.

CHEAP GAS.

[141] Sir,—In my letter (p. 354) on the subject of "Cheap Gas" I made some remarks upon the present state of gas manufacture, the relative interest of the gas companies and their customers, as bearing upon the question under consideration, but I *also* stated that I only referred to it in order that we might get at the real state of the case, and did not wish to follow that part of the subject, observing that in doing this we must expect objections from parties that were interested in the existing gas companies.

I am glad to see that I have helped to ventilate this important subject, but I certainly felt *not a little* surprised to find (p. 370 of your number for the 8th inst.) our well-known and valued contributor "Sigma," indulging in rather discourteous language in his critique on my letter.

I little thought that we should have to class *him* amongst the interested parties from whom we must be prepared for objections in our attempts to reduce our gas bills, and had he advanced any scientific facts or arguments against my statements I am sure that all your readers, including myself, would have felt much obliged to him for such, as we already are for his valuable articles upon "Electricity," &c., &c., which I am sure are read with deep interest and attention by thousands of my fellow subscribers to the English Mechanic.

But I fear our talented electrician has rather lost his temper upon my having unknowingly trod on his "tender corn," and that he has written rather hastily about "gas."

I do not think your readers will care much to know what he or I think of each other's knowledge about gas, nor do I wish to fill your valuable space with personal dispute, but as "Sigma" distinctly charges me with making "misleading statements," he is bound to prove such a sweeping and dogmatic assertion; but he does not do this, for the rest of his letter goes, in fact, to confirm what I stated regarding the extraction of the hydrocarbon vapours from the gas in the course of manufacture; but he does *not* tell us what is most undoubtedly a fact—viz., that the illuminating power of the gas is lowered thereby.

I could add much on this point, and show that "Sigma" has kept back part of the truth in his desire to "burk" the subject, by talking about "false statements" and gas quacks, &c., which is rather strong language; but as the whole subject of "gas-making" is to be found fully explained in any of the good works upon practical chemistry, and all the tricks and dodges have been often exposed, it is no use "Sigma," or "any other man," trying to throw dust in our eyes. And if he classes such writers as Letheby, Frankland, Defries, Renton, and others as gas quacks, because they have proved the doings of the gas companies to be open to remark, I shall be proud to be called a gas quack too.

It is very well known that a ton of coal will yield gas, differing in *quality* and in *quantity*, according to the manner in which it is treated in the retorts—in the one case giving off a fine and brilliant gas of less quantity; and in the other case producing a *larger quantity*, but of very inferior gas, of which the consumers are obliged to use more to obtain requisite light, and thus our gas bills are found to get heavier, and the public suffer.

The concluding part of "Sigma's" letter is really very rich indeed, for while he tells us it is our own fault that the price of gas is so high, he takes care *not* to admit the fact of the handsome dividends that have been paid to the shareholders, and of the *bonus* in addition, to avoid the letter of the law, which restricts their dividing a higher dividend.

I do not think that I need take any notice of the offhand way in which the question of carburetting gas is also disposed of. Let your readers *try*, and they will soon find "facts are stubborn things," and worth a host of such sneers, which are so evidently prejudiced that they will go for nothing with all reflecting minds.

In reply to the questions of "Cheap Gas" (p. 383), regarding the size of his burner, he had better try a smaller size than that he has been using, or he will find no saving in the quantity of gas. The best burners are the new brass patent ones, sold for 2d. by Hulett, 56, High Holborn. The No. 2 gives a light equal to nine candles, which is a better result than I have found with the old burners.

In reply to the second question, I have always obtained the best carboline or carburine from Messrs. Woodward & Co., 2, Mint-street, Borough, S.E. It is simply light naphtha with unextracted benzole, obtained from coal tar, or shale. Messrs. Carless and Blagden, of Hope Chemical Works, Hackney Wick, also sell the "carburine" at 3s. 6d. a gallon, obtained from petroleum, but it does not give so fine results or prove cheaper in the end, as it consumes quicker and gives less light.

C. D. C.

SHORTHAND.

[142] Sir,—Will you kindly allow me space for a few lines by way of a reply to Mr. Grierson's remarks respecting the comparative merits of Lewis's and Pitman's systems? I am a writer of Pitman's phonography, and, notwithstanding all the "complications" of which Mr. Grierson speaks, I completely mastered the system in about nine months, without more than three hours practice per week during the whole time.

I think it is unfair for Mr. Grierson to quote from the 11th edition of Phonography, in his endeavours to prove its inferiority to Lewis's system, for if his only object be to direct "Hermit" to the best system of shorthand he should make a comparison between Lewis's system and phonography *as it is* rather than *as it was*; though I by no means admit that the 11th edition of Phonography was in any respect inferior to Lewis's system.

As I do not desire to trespass largely on your space, I will at once proceed to review Mr. Grierson's remarks on the vowel scale of the system. He objects to the number of vowels in Mr. Pitman's system without showing anything in Lewis's which will in any way compensate for the *correctness* obtainable by using the extended vowel scale of Pitman. According to his own admission, Mr. Grierson has no means of ascertaining whether a vowel in Lewis's system should be read before or after a consonant, for he says, "in the former Lewis's) system it is not of the least consequence on which side of the consonant a vowel is placed. It is inserted as near its proper situation as convenient, otherwise its position is immaterial." The consequence of this is, that the writer of Lewis's system has to *guess* where the vowels should be placed when he comes to read what he has written, even if they are inserted in the manuscript. How much more difficult, then, must it be for a second person to read this system with any degree of fluency. This, then, is a very prominent defect. Mr. Grierson proceeds to state that Mr. Pitman has *six* different positions for the vowel; but, on the contrary, he has *only three*—viz., at the beginning, middle, and end of the consonant; but, in order to insure accuracy and to avoid the possibility of mistaking a *third* position vowel for a *first* position vowel, the third place vowel is written *before the second consonant* instead of *after the first*, and the second place *short* vowel is written before the second consonant to distinguish it from a second place *long* vowel. Then bearing in mind that the vowels—with few exceptions—are only inserted in shorthand correspondence and magazines, is there not an obvious advantage in the arrangement adopted by Mr. Pitman? In Pitman's system the reporter may with perfect safety omit all vowels, with the exception of about fifty *scattered over the whole of the English language*. So far as the consonants are concerned, enough has been said in other letters, but I may be permitted to say a word or two upon the prefixes and affixes. Mr. Pitman uses *five* signs representing *eight* prefixes, and *twelve* signs representing as many affixes. Of these the majority are disjoined from the body of the word, thus rendering their character clear to the reader, and it must be patent to the most casual observer that the nearer the number of signs employed for the representation of prefixes and affixes approaches the number of prefixes and affixes so represented, the less difficulty will be experienced in deciphering what has been written. Mr. Grierson also takes exception to the number of signs employed for the aspirate, and tells us that *Lewis* represents it with a character *written in much less time than a dot*. Perhaps Mr. Grierson will inform us what this character is. For my own part I cannot conceive any character which, by itself, will occupy less time in writing than a dot. Immediately after this, Mr. Grierson, in a very triumphant manner, proceeds to ridicule Mr. Pitman's method of doubling consonants by the addition of initial and final hooks. "Why all this complication," says Mr. Grierson, "Lewis has nothing of the sort." Is its absurdity or uselessness proved because Mr. Lewis has nothing of the sort? Certainly not. Mr. Grierson goes on to state that Mr. Pitman has nothing corresponding to Lewis's "key symbols," and only twenty-four "grammalogues," as compared with Lewis's 108 "definite contractions for small words." Now this is not quite correct, for Mr. Pitman *has* marks corresponding to Mr. Lewis's "key symbols," and upwards of *four-hundred* "grammalogues" instead of twenty-four as represented by Mr. Grierson. Not only so, but there are only about fifty of these which require committing to memory, for the remainder are remembered almost without effort.

In conclusion, allow me to remark that any careful observer of Pitman's system will fail to find any "perfectly unnecessary rules and regulations," and that if Mr. Grierson will give himself the little trouble necessary to *learn* Pitman's system before he passes an authoritative opinion on it, he will probably avoid making a number of other errors similar to those he has already made. HERBERT CLARKE.

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[143] SIR,—As Mr. Grierson (page 400) invites corrections and criticisms, will you allow me to state that he ought not to have quoted from the "Phonographic Teacher," which is only for learners, but from he "Manual," where he would have found seventy-five "grammalogues, or letter-words," for ordinary use, nd about 300 for reporting. This, I think, puts Lewis's 108 contractions into the shade. Mr. G. brings up all his old arguments against Pitman's system—such as the number of different positions for he vowels, &c. It is quite a sufficient answer to all his to say that the alleged difficulties exist only in your correspondent's imagination.

Phonographers themselves do not complain. I am sure that amongst the "cloud of witnesses" who have written to our Editor in defence of Pitman, there will not be found one complaint on any of the points stated by Mr. G. We are also told that Lewis's system is as phonetic as Pitman's. This is not the case. Pitman's is the only system which is phonetic in the true sense of the word. Lewis's, in company with all other stenographic methods, is just as much phonetic as our A B C alphabet, and no more. Mr. G. ridicules Pitman for giving a character to the sound ZH. It is sufficient to say that the sound exists in the English language, and therefore no phonetic alphabet would be complete without a corresponding sign. If Lewis's alphabet is phonetic, where is his sign for ZH?

In comparing different systems of shorthand, three and features ought not to be overlooked—brevity, speed, and legibility. And I contend that on all these three points phonography carries off the palm. As regards brevity, it has been found that the average number of strokes required to write a word in phonography is one and a quarter. As regards speed, it is now generally admitted that the resources of phonography are superior to those of any other system; and its superiority in the matter of legibility has been so fully proved by previous correspondents, that I should almost imagine Mr. Grierson himself has conceded the point. Mr. G. challenges any one to show any complexity in Lewis's system. This, I contend, is not a fair test. The absence of what, to an outsider, might seem as apparent complexities, simply proves that the system is, in its earlier stages, a little easier for the beginner, but it is almost sure to result in what has been found to be the weak point of all stenographic systems—viz., an inferiority in brevity, speed, and legibility. To say that the decline of stenography and the spread of phonography is owing to the dearness of the former and the cheapness of the latter system is not correct. A man who is going to adopt reporting as a profession would scarcely stick at giving half a guinea for a book if it was superior to all others. The very fact of sixteen out of the nineteen reporters on the *Times* parliamentary staff using phonography speaks volumes; for the post is one which, above all others, will put to the severest test the capabilities of any system of shorthand.

I will, in conclusion, beg those of your readers who are contemplating learning shorthand to remember that the "*proof of the pudding is in the eating;*" and when those who are eating the pudding are loud in its praises, the grumblings of an outsider go for very little. It is absurd to suppose that phonography could have supplanted, as it certainly has done, all other systems of shorthand, both amongst parliamentary reporters, and throughout England and America, if it had not been found sufficiently easy to learn, and if its resources as to brevity, speed, and legibility had not been found superior to those of any other system. W.

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[144] SIR,—When in No. 271, your "Hermit" quietly asked you to stir up your "small army of shorthand writers" in his favour, he must not have expected that nearly your whole force took it for granted that he wished to join the "battalion of reporters." I have known very many of both sexes who became proficient writers of shorthand, and used it continually for their own purposes, who never had a notion of doing reporter's duty. A very small percentage of all who now practise shorthand use it for reporting purposes; whilst those who use it for "taking notes," even if they do not print them, and whose note-books remain "sealed" to the uninitiated, count, in the United Kingdom alone, as your "small army." Considering the "Hermit" as but one of the many who would wish to acquire an easy and accurate system, and one that would not involve much time in its mastery, I took it on me to point out (in No. 274), a mode of trying the merits of different systems now much appreciated; for I do believe that at the very beginning of our science, a student of it can judge clearly enough between the rivals. In that belief I again recommend a comparison of alphabets, and, as a matter of course, a comparison of their junction tables. As to vowels, they may be afterwards selected. As an interesting part of education, I wish to see the advance of shorthand; but I assure you that I care little what system triumphs, provided it be good and sound, and judged of by its own merits, apart from its many admirers. MAC D——.

MR. LOCKYER, MR. PROCTOR, AND SATURN'S RINGS.

[145] SIR,—I do not like to see men of science pitching into one another; but if they will do it let us have fair play. In your last number Mr. Proctor says, "I once, evolved from the depths of my moral consciousness, the fact that in certain parts of Saturn the sun is concealed by the rings of the planet for such and such intervals. This remark struck Mr. Lockyer as worth appropriating, and accordingly it appears in his 'Elementary Lessons of Astronomy, &c.'" I do not wish to be hard upon Mr. Proctor, but I might ask whose "remark he thought it worth while to appropriate"? I assure him that Dr. Dick, in more than one of his very popular works on astronomy, pointed out the same fact before Mr. Proctor was born. The idea evolved by Mr. Proctor is one which almost everybody acquainted with Saturn is struck with.

LUKE THE LABOURER.

THE FLUTE.

[146] SIR,—I am sorry that I have been unable to respond before this to your courteous invitation to follow out the subject of the Boehm flute, but must apologize if I have unintentionally misled your readers in leading them to suppose I could give much more information on the subject. I regret that such is not the case, but perhaps a few remarks that I intended to have sent in my first note to you may be of some interest to them.

There are two descriptions of bore in common use; one is called the conical bore, that is, the interior of the instrument gradually increases in diameter from the smallest end to the top of the middle joint, the head being cylindrical. The other is termed the cylindrical bore (the same as the clarionet). On this system the instrument is of the same diameter from the lowest part to the top of the middle joint, and the head conical, decreasing upwards. The bore of the Equisonant flute differs from both of the above for the following reasons:—Taking the human voice for a model, it will be found that every different sound has a different size or diameter of the larynx. Musical instruments are based upon the same principle—for instance, the pipes of an organ are gradually shortened in the ascending scale, but the mere act of shortening is not sufficient, they must also *vary in diameter*. A similar change of diameter is observable in the strings of a pianoforte, harp, &c.

If a flute be made with a cylindrical bore, it follows that every sound must have the same diameter of tube, and consequently be in direct opposition to nature. The Equisonant flute is based on the principal that each note should have its true and natural diameter of tube, hence the notes are equal throughout (a point of great importance, as on the old flute it was often impossible to give the desired expression to a musical phrase, because the accented and emphatic notes of the passage were obliged to berendered by some of its weakest tones).

"Another Flautist" (3974) may obtain the Equisonant flute at 35, Percy-street, Tottenham Court-road, and the prices vary from eight to thirty-five guineas. J. T. O'Brien (4082) may make his flute sharper by cutting the head-joint shorter. H. T. LEFTWICH.

P.S.—Just before sending this off I received your impression of July 15, containing a note from Mr. Chapman (73), who eulogizes the old flute so much in five paragraphs that I was quite astounded to find that in the sixth he had himself abandoned it. H. T. L.

COMPOSITION OF THE HUMAN BODY.

[147] SIR,—In the Food Department, South Kensington Museum, there is a case (No. 1) that attracts much attention, since it is intended to illustrate the nature of the materials of which the human body is constructed. As the subject is one of interest, and perhaps not generally known, I will, with your permission, offer a few remarks upon it. Chemistry teaches us that all substances are either simple or compound. To the former the term "element" is applied. When two or more elements combine together, a compound is formed. The human body, like all other substances, can be analyzed or separated into its component parts; and assuming the average weight of a man to be 11 stone, or 154lb., the following may be considered as the quantities of compounds or "proximate principles" that build up the human fabric:—

		lb.	oz.	gr.
1 WATER, a compound of oxygen and hydrogen gases		111	0	0
2 GELATINE, entering into the composition of bone, skin, and other tissues		15	0	0
3 FAT, forming the so-called "adipose tissue"		12	0	0
4 PHOSPHATE OF LIME. This is the chief mineral constituent of the bones ..		5	13	0
5 FIBRIN, found in the muscles, also in the clot and globules of the blood..		4	4	0
6 ALBUMEN, a constituent of the blood and nervous tissue		4	3	0
7 CARBONATE OF LIME, found in the bones		1	0	0
8 CHLORIDE OF SODIUM, or common salt. It exists in the blood or other secretions		0	3	376
9 FLUORIDE OF CALCIUM, or fluor-spar. It is a constituent of the bones, and the enamel of the teeth		0	3	0
10 SULPHATE OF SODA	Occurring in the blood and tissues	0	1	170
11 CARBONATE OF SODA		0	1	72
12 PHOSPHATE OF SODA		0	0	400
13 PHOSPHATE OF POTASH		0	0	400
14 PEROXIDE OF IRON, constituting the colouring matter of the blood ..		0	0	150
15 PHOSPHATE OF POTASH, found in the blood and tissues		0	0	100
16 PHOSPHATE OF MAGNESIA, found in the bones		0	0	75
17 CHLORIDE OF POTASSIUM, met with in the blood and tissues		0	0	10
18 SILICA, occurring in the hair and teeth		0	0	3
		154	0	0

These compound substances or "proximate principles," when resolved into their simplest forms, furnish us with the following list of elements and their quantities:—

	lb.	oz.	gr.
1 OXYGEN, a gas. The quantity contained in the body would fill a space equal to 1,300 cubic feet ..	111	0	0
2 CARBON, a solid, familiar in the form of charcoal	21	0	0
3 HYDROGEN, a gas. The lightest body in nature. It would occupy nearly 3,000 cubic feet..	14	0	0
4 NITROGEN, a gas. It fills a space of more than 40 cubic feet	3	9	0
5 CALCIUM, a metal. It is the base of lime	2	0	0
6 PHOSPHORUS, a solid of a very inflammable character	1	12	190
7 CHLORINE, a gas of a yellowish-green colour. With sodium it forms common salt	0	2	382
8 SULPHUR, a solid, commonly called brimstone	0	2	219
9 SODIUM, a metal. It inflames in contact with water	0	2	116
10 FLUORINE, a gas. With calcium it forms fluor-spar	0	2	0
11 POTASSIUM, a metal. It readily oxidizes and inflames in contact with water	0	2	290
12 IRON, a well-known metal	0	0	100
13 MAGNESIUM, a metal. It burns with a brilliant light, forming magnesia	0	0	12
14 SILICON, a non-metallic body. It is the base of flint and sand	0	0	2
	154	0	0

l *not* at 3h. 52m. in the afternoon of the 24th. Mercury ot in superior conjunction with the sun on the 28th, is in conjunction with that luminary on the 27th at 20m. a.m.

Vhy has "F.R.A.S." discontinued to give us the io of rising or setting of some of the planets?

t must be acknowledged by all, that it is far more sonant with reason to give us the right ascension l declination of the sun, or the longitude in the iptic, than to state that his right ascension is (on the July, 1870) 6h. 40m. 50·48s., and his declination 23° 22·7′ N., and that he is "*consequently*" in Gemini, . The inference or deduction is illogical.

Why do the compilers of the "Nautical Almanac" ckon from that important point called the first point of ? You have his right ascension computed from this oint, as well as his longitude, &c.

The "Firth point of view" is therefore, as you are leased jocosely to term it, of far greater importance an the outlines of a fabulous animal. In short, we efer to say that the sun is in (the sign) ♋, and not the constellation) ♊.

G. Firth.

GEOMETRICAL APPROXIMATIONS.

[154] Sir,—I herein enclose some of my geometri-l approximations inserted in the *Philosophical Maga-ne*, stimulated by Mr. Proctor's in your number the 8th inst., page 376, his L G being simply one-fth of $\sqrt{2}\cdot$ O B or O G, producing 3·141421.* The te Mr. Willich gave, in his "Popular Tables," a nearer pproach, and were my numerical triangulet convert-ble to a geometrical appendage it would be very close. ou perceive I found, from considering 3150000 − 4000 = 735 that (3000000 − 8007 = A) $\frac{21}{20}$ gives 314159215 nd affixing (1200 − 2) A, or 35897932014, we have π rue to 16 decimals. The first portion is representable y tracing a semicircle, diameter 1000, applying $\sqrt{50^2 + 13^2} = \frac{1}{8}\cdot 3007$ as a chord, and reducing the supplementary chord in the ratio of the ordinates to the abscissæ of $\frac{5}{6}$ and $\frac{7}{8}$ of the diameter, producing a chord exactly equal to $\sqrt{314159265}$.

Page 374.—Although as an old Fellow of the Royal Astronomical Society, I rejoice at the further extension of the "family likeness" between the constituents of other planets with our own, yet is it not premature to suppose their chemical elements are exactly alike, and so as to produce the same sorts of plants and sentient beings, knowing as we do the immense terrestrial variety God has formed out of the few chemical elements, oxygen, hydrogen, azote, and carbon?

Page 380.—Metrical Act: Referring to the "Companion of the Almanac" for 1827, page 100, I lately deduced that (883 − ·000536) pendulum lengths = 960 yards per Act of 1824.

In the *Philosophical Magazine* for January, 1841, I attempted to show that the equatorial circle plane of a rotating orb whose radius from orb's centre is the cube root of ratio, equator gravity to centrifugal force at orb's surface (*i.e.* $\sqrt[3]{289}$ for the earth), is a *limit* where these forces balance each other, and a molecule there will be undecided to revolve round or fall upon the orb. It is curious that Kepley's law applied to Mercury and the solar limits, to our moon, and $\sqrt[3]{289}$ to Jupiter's moon and his limit, give from the secondaries' period the rotation times of the orbs $\left\{ \text{Virg. } 60^3 : 289\tfrac{2}{3} :: (27 \text{ days } 7 \text{ hours}) \therefore (24 \text{ hours})^2 \right\}$ as we might see them, thus combining the sun's twenty-five days with Mercury's 88 days, earth's 24 hours with the moon's 27 days, Jove's 10 hours with his moon's 42 hours, and perhaps thus indicating the limit sphere separating the primary *local influence* from its action as a *cosmic* body on the others.

S. M. Drach.

THE MONSTER HARMONIUM OF THE FUTURE.

[156] Sir,—The Tantalus cup held to my lips by your correspondent "W. T.," No. 257, page 580 (whose initials you printed "R. T.," which will account to "Harmonious Blacksmith" for my addressing him under those initials), has never been removed. I suspected he was quizzing in proposing the scheme of an harmonium with 19 rows of reeds distributed between two manuals, and 3 rows extra allotted to the pedals: and I prayed him in my letter (No. 260, page 657), as an earnest enquirer after the most perfect harmonium that can be suggested, to afford me, if he was not quizzing, certain information, which, although then it was March, and now it is July, and our journal has been deluged with the ideas of "W. T." and his old collaborateur, "Harmonious Blacksmith," on various topics, harmoniums not excepted, my thirstings after a few drops *apropos* to my requirements, are still unappeased. Despairing of a satisfactory reply, I have been compelled to treat the whole description as a joke; otherwise, I should have been very glad to have given an order. These sort of *jeux d'esprit* may serve as a little amusement amongst weightier matters, for seekers after lighter literature than the staple of our journal, but answer no practical object for earnest enquirers.

Another thing, waiting these four months has left me to look around and examine various models and suggestions for models of harmoniums. I have some of these latter in my possession which I will place at the disposal of any of your readers who have similar wants to those which I have already experienced.

I had nearly exhausted the list of names of makers supplied in your last issue (p. 399) to "J. C. P.," and as the result of my experience I said that there are no makers of large harmoniums amongst them; no one who attempts to introduce a novelty either in tone or in expression; every one working on the same model, and one, indeed, I met who would rather not hear of anything new or different, and certainly would not work to originate anything. Nearly dispirited, I took heart from reading the advertised testimonial of Dr. Leslie in favour of the Professional and Connoisseur's Harmonium to see the harmonium he praises. In addition to seeing it I had the good fortune to see an extraordinary harmonium the same maker is exhibiting which surpasses anything I have seen in Paris, or in London, or in Leeds, or wherever I have been. I have given an order for one exactly similar, the maker intending to keep the present one some time longer for exhibition, and ultimately for his private use. Now I can realize everything I wanted in soft and gentle tones, that is to say by the row of keys at top. There are two rows of keys, but the top row gives delicious notes, so soft it is an echo, not by a breath resembling reeds. I cannot understand it, but I am charmed to find that anything can give sounds so gentle without any difference in blowing. By one stop there is a very pretty beat in the note, quite a pulse, making a wave of sound dreamy and delicious in its ebb and flow. I cannot take the bass part for reeds; it is deceptive enough to pass for wood pipes, though in the bottom row of keys there is something quite different, and more like an harmonium. I should be glad to describe to your readers its effects. I have nearly got what I desired as to loudness and boldness. My old words "rank and strident," though not strictly applicable here, picture a want felt by all musical natures. Light and shade are required in musical scene painting as well as in nature. I much want a trumpet stop in an harmonium, but I am informed I cannot get it. Next best to it, I find in the lower row of keys stops of great brilliancy and power. These taken in comparison with those at the top show a great contrast. I find a beauty there. They are not wrongly labelled. I do not know the Cor Anglais, but the violincello is perfect. Also the flute and clarionette. The contra bassa is a power by itself unique. They are not unaptly described by Dr. Leslie, whose words give a good guide to what you actually find in the instrument. A little pressure by the knee keeps the full power on; it is magnificent. Press the other knee swell, and it produces an effect of piano, either on one stop or on full power. I may say I have found in reality twenty-seven stops and nine sets of reeds, whilst your correspondent has been playfully poking his fun at me respecting his harmonium of the future. Thanks, however, to him for his kindly notice of me as regards the sketch of the piano.

Alexandra.

P.S.—I see that some other correspondent has the *nom de plume* under which I address you. Would you kindly desire him to adopt some distinguishing addition, or to substitute a name not already appropriated. This I ask in order to prevent confusion.

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* For 12in. diam., error = ·00205554 = $\frac{1}{500} + \frac{1}{18000}$ inch ery nearly.

EXTRACTS FROM CORRESPONDENCE.

◆

TRACTION.—"J. B." says:—"In reply to Mr. Thomas, page 394, the action of a tramway in reducing the draught is, that the equality of its surface does away with the obstruction caused on all ordinary roads by rough ridges and projections which do, in fact, cause the load to be *lifted over them* at a useless expenditure of power. The saving of *this*, which is effected by the tramway, is, of course, therefore, as beneficial on a gradient as a level, and "bite of the wheels does not in any respect affect the question when horse-power is employed, and is only needed when traction is obtained by power which rests *on* and draws wholly *by* its *adhesion to the rails*. It, therefore, is far easier for horses to draw a load on a tramway than on a road under all circumstances; only if the gradient be steep and the load heavy the wheels should be chocked if the horses are stopped, as the tendency to run backwards is as much increased by the tram as the upward draught is lessened by it."

REPLIES TO QUERIES.

◆

[2666.]—COPPER DEPOSIT ON CAST IRON.—Watts's "Electro Metallurgy," gives the following solution for coating iron with copper:—Carbonate of potassa, 4oz.; sulphate of copper, 2oz.; liquid ammonia, about 2oz.; cyanide of potassium, 6oz.; water, about 1 gallon. Dissolve the sulphate of copper in boiling, distilled, or rain water, and when cold, add the carbonate of potassa and ammonia; the precipitate, when formed, is re-dissolved. Now add the cyanide of potassium until all the blue colour disappears. A precipitate will be found at the bottom of the vessel, from which the clear solution may be decanted. Two cells of a battery will be necessary to deposit from this solution. Articles of iron which are to receive this deposit should be previously soaked in a strong solution of caustic alkali, either soda or potassa, made by adding to either of these salts some recently slaked lime; the clear liquor proceeding from which is to be used for the purpose of removing any grease which may attach to the article, which is to be then well washed and immersed in a pickle consisting of sulphuric acid, 1lb.; hydrochloric acid, 2oz.; water, 1½ gallons. After the iron has remained in this pickle for a short time it may be removed, and well washed and scoured with sand and water applied with a very hard brush.—Patience and Perseverance.

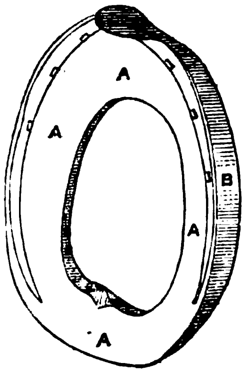
[2678.]—CASTING SILVER BALLS.—A mould made of iron and resembling a bullet mould in shape should be used for this purpose. The handles should be long and the inside of the mould should be well blacked over the gas. Before casting, the mould should be made so hot that it will not admit of being touched by the hand. —Walter J. Nicholls.

[2677.]—HYDROGEN GAS FOR BALLOON.—Taking the weight of air at 1¼oz. for each cubic foot, it would require about 1,970 cubic feet to be displaced to raise 11 stone weight (*i.e.*, 154lb.). Pure hydrogen gas is 14¼ times lighter than air. You would require about 140 cubic feet of this gas, but common carburetted or coal gas is generally employed, whose density is rather more than half that of air. Using this would require about 1,000ft. To this must be added the weight of balloon, car, and cords.—Patience and Perseverance.

[2677.]—HYDROGEN GAS FOR BALLOON.—"Henry Nutt" does not state which carburetted hydrogen gas he intends to use, whether CH_4 or $_2H_4$; nor does he say how high he wishes his balloon to rise, nor what is its weight.—R. T.

[2694.]—GREATER PTHAH.—César Cantu "Hist. Univ." t. i. p. 194, says, speaking of Egypt, "the dogmas particular to the priests acknowledge a unique Supreme Being, who could not be represented by corporal images. Plutarch says their highest science consisted in regarding *Phta* as the great architect of the universe; they worshipped specially his wisdom at Sais under the name of *Neit*, his goodness at Elephantine, under that of *Cnef*, the symbol of which was a serpent rolled upon itself."—Bernardin.

[2756.]—LAMENESS IN HORSES.—In the first place, I must apologize for not having answered "J. O. Duffryn's" query sooner, but through pressure of business, and having had to leave home for a time, I have been unable to do so. As regards the above disease, the querist omits to state what stage of the disease he wished to treat. If in the first, or active stage, I should advise him to adopt depletive measures, viz.:—Physic ball, composed of Aloes Barb. 6oz.; bleeding at the jugular vein; bran or cow-dung poultices to the feet; cooling diet, rest, &c. On the other hand, if the disease has assumed a chronic form, which it generally does, I know of no better treatment than the adoption of Mr. Broad's heavy shoe, invented especially for laminitis, or fever in the feet (of which I forward a sketch), which has lately made its appearance before the public, and has elicited such a lengthy discussion in the pages of the *Veterinarian*, *Field*, &c. From my own observations, and that of others, I have come to the conclusion that it is the best shoe extant. Should the querist require any more information, I shall be most happy to render it.—Country Vet.



[3708.]—PASTEBOARD.—Thomas Grist should put his pasteboards into an hydraulic press. They will be quite straight when dry.—Saul Rymea.

[3716.]—RELACQUERING BRASS WORK.—"Pro Bono" should scour his old brass with very fine pumice, thoroughly rinse and polish. The acid will no be required.—Walter J. Nicholls.

[3726.]—CHROME BLACK.—I beg to send the following instructions from Thos. Love's "Dyer and Scourer," which I have found a first-class book. He says the best way is to clean them well in soap and water, and boil them well for half an hour in clean water and argol, take them up and hang them up to cool, throw away the contents of the copper, fill it up with clean water, make it boil, and put 4oz. of chrome and 4oz. crude tartar in the copper. Put in the goods and boil well for 40 minutes, take it up, cool it, throw away the contents of the copper, and fill it up with clean water, make it boil; put in as much logwood chips by weight as the goods weighed when dry, and a quarter as much fustic chips, boil well for 10 minutes; while this last copper is getting on the boil you must rinse the goods in two clean waters, drain them, put them in the copper and boil well for an hour, handling well all the time; then take them up, cool, rinse, dry, and they are done. He says some dyers clean with chamber-lye, and dispense with the argol copper, making two coppers do the work. The quantity above is for 10 yards of French merino, which takes about 8 gallons to dye in. I have dyed many things by his direction and have found them first-rate. —T. K.

[3752.]—DEPOSIT FROM SODA CRYSTALS.—In reply to the query of "Natrum" on this subject, the deposit that he complains about is soda. It is caused by the solution being too concentrated to retain it in solution, and by the heat. To prevent it getting into cakes it must be stirred continually, and especially at that part of the pan which is exposed to the greatest heat. Does "Natrum" want to keep the soda in solution? If so, then water must be added, so as to have a weaker solution. Or does he want to get the soda in powder, as I presume he does? Then during the evaporation the solution must be kept constantly stirred as before mentioned. P.S.—If "Soda Crystal," who some time ago enquired of "G. E. Davis" respecting the manufacturing of this article on a small scale, is still in want of the same information, I shall be happy to furnish him with the same through the medium of the ENGLISH MECHANIC.—JOSEPH ROSKELL.

[3738.]—BAROMETER TUBES.—A little strong acid will remove every film and make them fit for use.—WALTER J. NICHOLLS.

[3766.] — CLEANING AND REFILLING BAROMETER.—Lardner's "Museum of Science," No. 44, says: —When the mercury has been purified it is next necessary to render the tube perfectly clean on its inner surface. It generally happens that tubes exposed to the air, always more or less damp, have a film of moisture upon them. It is necessary therefore to expel this. After cleaning the tube by internal friction it is warmed over the flame of a spirit lamp from end to end, so as to evaporate any moisture which may remain upon it and render it perfectly dry. Mercury is then poured in by means of a small funnel until a column of about 10in. has entered. To dismiss the air that has entered with the mercury it is heated over a spirit lamp until it is raised to a temperature higher than that of boiling water. The air being expanded by the heat escapes from the tube. Mercury is again introduced, and again treated in the same manner, until the tube is filled. In this process it is usual to heat the mercury to nearly the same as that of the tube before pouring it in, otherwise the difference of temperature might crack the tube. When the tube is completely filled the open end is finally stopped with the finger, and being inverted, is plunged into the small cistern of mercury at bottom of barometer. —PATIENCE AND PERSEVERANCE.

[3781.]—PHOTOGRAPHY.—I once used the wax paper process, and to change the paper made a bag of three folds of black calico one side, and three folds of yellow the other. There were two short sleeves about one-third from the bottom of the bag with elastic wristbands, and the top had a hem with running tape. I put "back" and portfolio into the bag, also my head and pulled the tape; then put my hands into the sleeves, made the change and then reversed the process. The only objection to this is a frolicsome companion'—M. W. G.

[3787.] — TEMPERING BUFFER SPRINGS. — The way I generally temper them is to heat them in a slow fire with wood chips, little more than blood red, then plunge them in water; then take and heat them over a clear fire, and rub them over with grease, and when you see the grease begin to show a blue flame roll them in water, and your springs are tempered.—DEESIDE.

[3789.]—AVIARY.—Having just completed one for some young canaries, I did thus:—I made the wooden part of the cage of ⅜in. mahogany, with four upright posts and cross bars at top of same. Bought 3lb. of 16 tinned wire, 2lb. of 12 ditto, and ½lb. of binding wire; bored the holes ⅜in. apart for the small wire, and 3in. apart for the cross wires, using a bell-hanger's small pliers to cut the wire into lengths. Some difficulty will be experienced in straightening the wire, but that can be overcome with the pliers and passing it between the fingers and thumb; set up on one side and bind as you go; the cost will be about 8s. for materials. Look at a ready-made birdcage and take a lesson and have—PATIENCE AND PERSEVERANCE.

[3815.]—FASTENING EMERY TO LEATHER.—The following will suffice:—Take and boil glue very thin, add a little milk, raise the pile of your leather and put on your glue with a brush, afterwards sprinkle on your emery and let it cool.—DEESIDE.

[3828.]—KID BOOTS.—Some time ago I discovered that my tin of harness compo emptied rather too fast. On inquiry I found that "Mary" had used it for months to missus's boots, so I began to investigate and found the boots (2 years old) to be in a beautiful condition. I also found that "Mary" had applied a little regularly, taking care to polish with a soft cloth, and that it was very successful. I make my own blacking and for the benefit of "Old Scrub," or any other man, I give the recipe. 2oz. best white wax, ½oz. prussian blue, 1½oz. ivory black, ¼ pint of spirits of turpentine, 1 table-spoonful spirits of wine. Melt the wax, over a slow fire, in an earthenware vessel, then add the blue and black, taking care to put in the black by littles at first, or it will boil over; when cool add the spirits. Stir it well from first to last. —BANTING.

[3828.]—TO SOFTEN KID BOOTS.—Let "Old Scrub" melt ¼lb. tallow, then pour it in a jar and add to it the same weight of cod or olive oil, stir and let it stand till cold—apply a small quantity occasionally with a piece of flannel. Should the boots be very dirty, cleanse with warm water. Will soften any kind of leather.—LEATHER.

[3831.] — STARCH MANUFACTURE. — Particulars are to be found in the "Chemical Technology of Dr. Bolley," printed in German, perhaps translated into English; volumes sold separately. Information at Messrs. Trübner & Co.'s, German booksellers, London. —BERNARDIN.

[3841.]—GRINDING DRUG SEEDS.—I have always found a common coffee-mill answer admirably for this purpose.—WALTER J. NICHOLLS.

[3844.]—ENTOMOLOGICAL QUERY.—The larva of *Cosmia trapezina* is greenish, with the dorsal, subdorsal, and spiracular lines white; the spots are black or dark green. It is full fed at the end of May or beginning of June. It is a noted cannibal. It feeds on oak and birch, between a packet of leaves united with silk.—R. T.

[3851.]—TO CLEAN SADDLES.—I think "Saddler" is a little too severe on my advice to "Equestrian" concerning his saddles. He ("Equestrian") did not ask for something to impart a high polish to a saddle that had been in regular use, but for a recipe to render "supple" the leather parts of a saddle that had lain aside for some time. Far be it from me to sound my own trumpet; but I must condemn the use of turpentine and bees-wax on brown leather. And I also know that there are parts of a saddle that do "not" come in contact with the rider's clothes, *i.e.*, "where there is no wear" (the sentence that "Saddler" comes down so heavily upon), viz., inside of skirts, inside of flaps, point pockets, sweat flaps, girth straps, &c., and that after a saddle has been out of use for some time, nothing could be better than to apply a little neatsfoot oil to the parts above named to bring them back to a proper pliant condition. And I also know that a saddle is not all made of hogskin—instance the parts above named, and I have seen saddles look a better colour and keep in better condition with the application of milk than with soft soap. I find no fault with "Saddler's" method of treating harness; but think the oil would be better applied before it was quite dry. Couriers lay on the oil when the leather is wet.—BANTING.

[3875.]—BLEACHING POWDER.—In reply to "Gratus" the following is the method of manufacturing bleaching powder:—The lime used for the preparation of this article must be of the first quality, for unless this is attended to the salt prepared from it will be very inferior in colour. To prepare the lime for the absorption of the chlorine gas it is brought to the screening department and slaked with just sufficient water as will cause the lime to crumble into a very fine powder; some care must be taken that not too much water is used, or it will be difficult to screen it. The powdered lime is then screened or sifted through fine wire gauze sieves, having about 400 apertures per square inch. The next step to be considered is the preparation of the chlorine gas. This is obtained by acting upon peroxide of manganese with hydrochloric or muriatic acid. The stills used for generating this gas are formed of large stone slabs, grooved and well cemented together, and in the form of a cistern; this is again surrounded by a casing of fire-bricks, iron, or stone slabs similar to the others. A cavity of about 6in. must be left all round between the two; this serves as a steam chamber, and is used to heat the contents of the still. The size of the still outside, including the steam chamber, may be about 9ft. square and about 4ft. deep. Inside of the still, and supported on pillars about 1ft. above the bottom, is another stone slab called a table; on this table is placed the manganese which is to furnish the chlorine gas. From the stills the gas is conveyed to the chamber through earthenware pipes; the joints of these pipes are connected together by water lutes, so that no gas can escape. Various apertures are required in the top of the stills, a large one in the centre for charging the still; other small ones for running in the acid, and another at one of the sides and at the bottom for running off the waste acid before recharging. This last is a round hole, and is stopped with a wooden plug. The chamber is formed of lead, supported by a framework of wood, similar to a vitriol chamber. The chamber has two doors, which are luted close during the time the charge is in. The bottom of the chambers are formed of fire-bricks. The size of the chamber and number of stills must be according to the quantity of bleaching powder to be made; the height of the chamber must be about 6ft. Having now briefly described the apparatus and the use of them, I will proceed with the manufacturing process. The first step consists in charging the chamber with the powdered lime to a uniform depth of from 4in. to 6in.; after this is done the doors are closed and luted, and it is then ready for receiving the gas. The stills are now to be charged by placing the manganese on the table in the interior; the muriatic acid is run in until it reaches about 3in. or so above the manganese. The covers must now be placed over the openings and securely luted with clay; steam is then turned into the intermediate space so as to heat the contents. In a short time the gas begins to evolve, and passes through the pipes into the chamber. The charges are usually worked off in a period of twenty-four hours, after which the stills are emptied of their contents, and another charge of manganese placed in. During the time that elapses in emptying and recharging the stills the lime in the chamber is stirred about, so as to expose a fresh surface to the influence of the gas. It is usually performed by the men, who go inside and stir the contents with short rakes, until it is completely mixed together. The surface of the lime is left in furrows caused by the teeth of the rake. When this is done the doors are closed and made secure from the escape of gas, acid is again run on to the manganese as before, and steam turned in as previously mentioned. The lime is left in the chamber until it is sufficiently impregnated with the chlorine gas, that is, until it contains from 36 to 37 per cent. of chlorine. The time occupied in doing this depends on, first, the quantity of lime placed in the chamber, because the thinner the layer of lime is the sooner it will be complete; and, secondly, the quantity of gas passed into the chamber, but perhaps four days may be the average time in preparing it. When thoroughly impregnated, and if the still is not worked off, the gas from it is turned into another chamber, the chamber doors are then opened, and, as soon as it is convenient to enter, the lime is packed in casks. I hope this information will be of use to "Gratus."—JOSEPH ROSKELL.

[3888.]—ALARUM FOR DUTCH CLOCK.—If "Amateur Horologist" will pay a visit to any country clockmaker, and examine a Dutch alarum clock, he will learn more in ten minutes than he would from any description, which would be practically useless without figures. —R. T.

[3893.]—PRECIPITATING GOLD.—Chloride of tin will precipitate the chloride of gold, and ammonia the oxide.—WALTER J. NICHOLLS.

[3919.] —GALVANIC BAND.—Surely "W. A." has neglected an essential element in the success of his band by omitting to enclose between the strips of metal a strip of cloth, which might be charged with some deliquesent salt, such as Epsom salts, or chloride of calcium. —MATRIX.

[3926.]—FORCING WATER.—"B. S. M. G. H." would not gain anything by trying to persuade his water upstairs, let the gradations be ever so gentle. It requires a certain force to raise a body through a given height, and as far as economy of force is concerned, the shorter the route the better. In his own case the lengthening of the pipe would be an actual disadvantage, as the friction of the water-flow in the pipe would be multiplied six-fold.—MATRIX.

[3934.]—ORGAN ACCORDION STAND.—If "Sigmatau" will look in No. 158, page 516, he will find a drawing and description of stand by "B. F., jun.," which I think will suit him, as it is very simple and easy of construction.—K. T. Z.

[3947.]—HARD WHITE PAINT.—"T. S. U."—The only conceivable way of reconverting scales of old white paint would be to grind it with oil between the stones of a regular paint mill, or by hand between two flat stones, the under one large. To apply an alkali, in order to dissolve out the highly oxidized oil, would inevitably destroy the article as a paint.—MATRIX.

[3962.]—WHITE LEAD.—It is exceedingly doubtful whether "H.'s" white lead contains any white lead at all. The pure article is the carbonate of the me its commercial value in the dry state averages f to 36s. per cwt. The adulteration of white l account of its high specific gravity, would have rather difficult were it not for the existence of a cer mineral nearly corresponding with it in this r and of very little use in the arts otherwise. sulphate of barytes, a ponderous, massive, mineral, occurring in extensive veins, permeating volcanic rocks. Two important veins of this de tion occur in Scotland—one in the island of Arran, of Clyde, the other at Muirshields, in Ayrshire—bo which are worked mainly for the purpose of adulter ing white lead. A few years ago, I carefully examined the workings of the vein, and also the process of manufacture of the adulterant at Muirshields, which have been in progress for many years. The vein is almost vertical, having an inclination of probably 5° or 7°, the upper edge cropping out on the surface in a perfectly moorland and mossy district. The gradual progress of the removal of the barytes has left a considerable gully behind the actual operations, from which I ascertained, as nearly as I can recollect, that the vein varies in thickness from 1ft. to 5ft. The direction of the vein, or dyke, as it may be called, extends nearly east and west, crossing the Frith in the direction of Arran; and there can scarcely be a doubt that in the dim vistas of the past, long ere Time's erosive tooth had gnawed out the deep and tortuous channels, the far-reaching rocks, the craggy, savage glens, the endless succession of heather-clad mountains, and the lovely isles which make up the matchless scenery of our lovely Clyde, those fragmentary seams of barytic rock formed one grand dyke, on the extent of which it would be useless to speculate. Barytes thus found is generally less or more discoloured by streaks or blotches, owing mainly to the presence of oxide of iron. The mineral, after being deposited at the works, is crushed to a fine powder by means of ponderous iron rollers, revolving with their edge resting in a large circular iron pan, similar to the arrangement employed for the grinding of loam in a foundry. After having been thoroughly ground, the mineral is digested in very dilute sulphuric acid, or rather in water strongly acidulated by that acid in tanks or vats, which should be lined with sheet lead. The digestion can be repeated with frequent stirrings until the bleaching is completed, and all trace of the acid can be removed by repeated washings and decantation after settlement. The pure barytes thus obtained is now thoroughly dried in any convenient manner, and in this condition is ready for market. It now only remains to be told that the manufacturers' white *lead* of commerce is made up by *mixing the two ingredients* in very various proportions to suit the pocket *of the* buyer, or the conscience of the dealer, those proportions varying from probably 75 per cent. to almost zero of the genuine article to the corresponding complement of the other. I need not explain that all this is performed in the ordinary paint mill with a sufficient admixture of oil. Taking the value of pure white lead at 35s. per cwt. and that of barytes at £3 per ton, the margin for profit will be at once recognized. Now, although barytes resembles, in a remarkable degree, white lead, yet, being essentially crystalline in character, and hence translucent to a certain degree, it does not, as a paint, *cover* so well, nor yet does it mix or combine in so kindly a manner with the oil as the more flocculent lead. So that "H." should not be surprised if *his* lead has split partnership with the oil and become a solid mass. I have already said that this barytes has few applications except as an adulterant; *its high specific gravity alone being often taken advantage of under circumstances which would scarcely be anticipated.* I will just refer to one instance for the benefit of our "Harmonious Cotton Spinner" (I think we have one) and his congeners. The little paper tubes used for placing on the spindles of spinning mules, and which receive the first windings of the yarn, forming in effect the *bottom* of the cop, are made by rolling upon a wire sheets of paper pasted on one side, drawn off the wire, dried and cut into suitable lengths. Now the paste used in this little process is amply charged with barytes. The spinner, although in the first instance defrauded by the tube maker, has good reason to wink at the deception, as he, in turn, disposing of the tubes along with the yarns, at maybe some shillings per pound, benefits to the extent of the difference. The mineral barytes is a compound of the metal barium, oxygen, and sulphuric acid. By mixing it in powder with charcoal, and subjecting it for a time (in a crucible) to the heat of a furnace, it becomes reduced to the sulphuret of barium, having lost its oxygen. In this condition it is easily acted on by nitric acid, for the formation of nitrate of barytes, a salt used by the pyrotechnist in the production of green fires. This fact will point out to "H.," if he possesses one, a ready means of testing the presence of barytes in his white lead by means of the blow-pipe, as a small piece exposed to the flame would give the characteristic green flame similar to that of copper, or still nearer to that of iron, but not so deep.—ALEXANDRA.

[3990.]—YELLOW DYE.—"A Countryman" should try Manchester yellow, otherwise known as Naphthylamine yellow, to be obtained of most chemists and drysalters.—SAUL RYMEA.

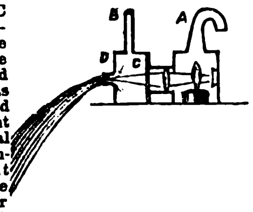
[4010.]—MELTING AND CASTING METAL.—"A Bristol Amateur" should get some metal from a stereotyper's. As a rule, it is slightly harder than type metal, which is made of three-parts of lead and one of antimony. Failing to obtain this he must add bismuth to the ordinary type-metal, till he gets the cast as hard as he wants it. The metal must be perfectly fluid, so as to run easily into all the crevices of the designs; but to obtain a thoroughly sharp cast a proper casting-box must be made. This may be either made to dip into the molten fluid or be so constructed that the fluid can be poured in. It consists of an iron tray made with a closely-fitting lid kept in position by a screw, and having the corners cut off to act as inlet holes. Into this tray the design should be placed "face" downwards; the lid screwed down so as to leave the required space for thickness of casting; and the casting-box inserted into the molten metal, which should be done in a diagonal direction to allow the air to escape at the upper corners. The other method consists in having a thick iron box, with one end open, made to unclose longitudinally, and leaving space according to the thickness of the cast for which it is designed. The mould is then fastened on one side of this, the box firmly closed, and placed in a tical position, and the metal poured in between the o slabs forming the box.—SAUL RYMEA.

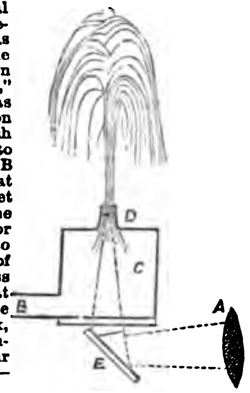
[4143.]—POTTERY.—In baking china and other pottery rials" (made of clay specially prepared for this pur- se), are placed in different parts of the "kiln," these rials" change in *colour* according to the heat of the ln, the "trials" are drawn out with a long iron rod ring the baking, and when one of the desired colour is rawn, the "kiln" has the required heat and the goods re properly baked, the fires are drawn at once, and it is llowed to cool.—ESAITCHARE.

[4144.]—FIRE CLAY.—Fire clay cannot be *made*, but is got out of the earth the same as coal and other minerals. "Amicus" can buy it. He will find it best to buy his pipes from some dealer in building materials in his own neighbourhood.—ESAITCHARE.

[4202.]—BALANCING LOCOMOTIVES.—By this I suppose "Staem" means putting weights in the wheels to balance the moving parts of the machinery. For that purpose the simplest way for an inside cylinder engine with *no* coupled wheels is to put in the driving wheel, a weight equivalent to three-quarters of the total weight of the moving parts inside the frames. When there are coupled wheels, they are so keyed on to the axles as to be in opposition to the inside crank, and, consequently, the weight of the outside rods must be deducted from the weight as found before; and when six wheels are coupled, the outside weight so nearly balances the inside weight that usually no balance weights are required. In the case of *outside* cylinder engines, the whole of the weight of the piston, rod, cross-head, connecting and coupling rods, and cranks, has to be balanced as far as is convenient, and usually equally in all the wheels. I have given but a mere skim of the subject, but if the Editor thinks the subject of sufficient interest, I shall be glad, as soon as I can find time, to contribute a paper on the subject of balancing moving machinery.—Q. Q. R.

[4206.]—CHROMATIC FAIRY FOUNTAIN.—Professor Tyndall, in one of his late lectures at the Royal Institution, showed that if a ray of light was directed and concentrated by a lens upon the point of issue of a horizontal jet, somewhat in the manner shown, the ray of light would not be able to leave the falling stream of water notwithstanding that it was curved, so that the stream was illuminated throughout its whole length. The same principle can be applied to illuminate a vertical fountain by a slight alteration in the apparatus and arrangement. In the sketches annexed, A is an ordinary "magic lantern," with the lens placed so as to concentrate the light on the jet D; to accomplish which the box C, into which the supply pipe B enters, must have that side opposite the jet formed of glass. For the vertical jet a plane mirror E will be convenient to change the direction of the ray. Coloured glass slides can be inserted at pleasure between the flame and the water box, and with a little scheming I think that it mighr *be made very effective.*—Q. Q. R.





[4211.]—SILICA, OR WHITE FLINT, can be had from T. G. Green, Gresley Pottery, near Burton-on-Trent, or from any of the potters in the Staffordshire potteries.—ESAITCHARE.

[4215.]—COLOURING TILES.—I do not think the tiles can be permanently altered in colour (after they are burnt) except by re-burning them, and colouring them in the ordinary way before re-burning them.—ESAITCHARE.

[4218.]—FIXING TUBE OF LEVEL.—"Apprentice" should hollow out two pieces of cork the same shape as the ends of his tube, and also to fit tight into the hole in the wood; then apply a little thin glue and press the whole in the wood until it comes perfectly true. If done in this way, it will not break although it get a fall.—BANCHORY.

[4218.]—TUBE IN SPIRIT LEVEL.—Take off the brass plate; clear out the recess in the wood; see your tube fits in very easy. Take a little white lead or putty, place it on the bottom of the recess; cover with a small strip of white paper; put the tube in; press it down until your brass plate will go on; try your level both ways on a surface plate. When you have got it right, be careful to put the brass plate on the same way you took it off, and the job is finished. All good tubes are marked either at the end or in the middle. Care should be taken to keep the mark at the top.—GOOD WORDS.

[4225.]—ICE.—Has a "Warm Countryman," or any one else tried Toselli's ice machine—a very simple way of making ice, ice creams, &c. If so, perhaps he will let your readers know the results, and whether the cost is too much.—ANON.

[4226.]—DOUBLE STOCKS.—The reason why double-flowered stocks never produce seed is, because in a real good full flower the stamens and pistils are transformed into petals; hence it is minus seed-producing organs. In saving single plants for seed, it is a good plan to thin the blooms, so as to leave (say) half a dozen on each plant, and to give plenty of manure, but guard against an excess of moisture to the roots. They should be planted so as to receive all the rays of the sun possible. If "Saul Rymea" carries out the above, he may get 75 per cent. double flowered.—S. ROGERS.

[4234.]—THE SMOOTH BLACK SURFACE ON SEWING MACHINES is given by japanning, and is a trade by itself, and if "J. W." has a machine he had better give it to a japanner, as it would be a deal of trouble and expense to him to do it himself, and would cost comparatively little.—J. R. D.

[4253.]—TODHUNTER.—I think the meaning of the quotation is that the symbol π, and *never another symbol* is used to denote the ratio of the circumference to its diameter. Circumference = diameter × π, or circ. $R = 2R \times \pi$, hence the half of the circumference = $R \times \pi$, and if the radius = 1, the half circumference = π, but the half circumference = 180° = 2 right angles. hence we may represent two right angles by π, but this is not *invariable*, as others represent it by 180° or by H (hemicycle).—BERNARDIN.

FIG. 1

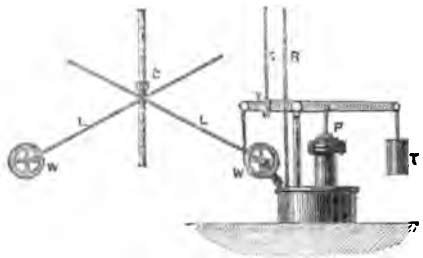


FIG. 3

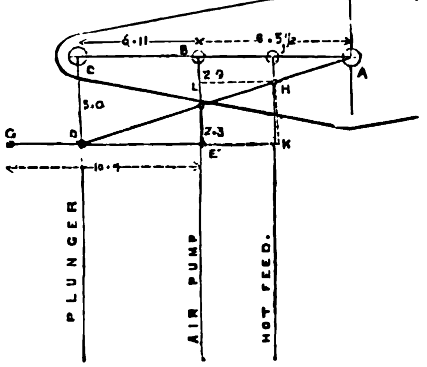
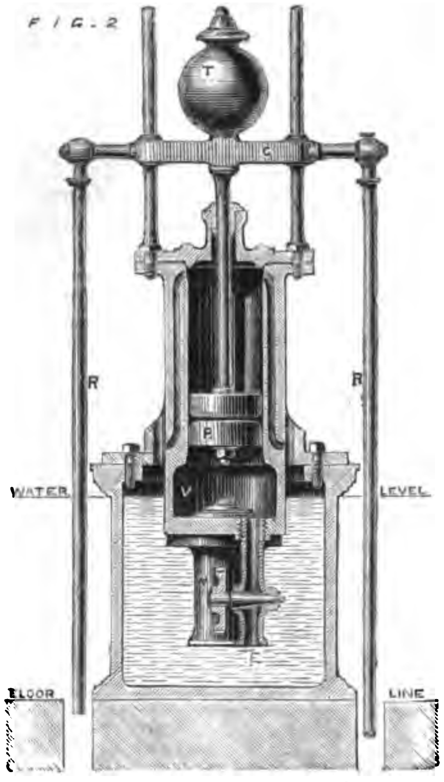


FIG. 2



[4262.]—CORNISH ENGINE.—Additional to "F. P." I send tracing of cataracts of Wicksteed engine at East London Water Works, Old Ford, which stand on a floor far below the cylinder, one on each side, and are both worked together by the plug-rod, which comes straight down from the beam; the action being as follows: As the plug rod comes down, the chock C catches both the cataract lever LL, and turning the wheels W W, which by chain and lever raise the plunger P and the counterbalance weight T. As soon as the engine begins to "go out of doors," the plunger P descends under the action of the weight T, and this descent is made more or less rapid, as desired, by opening or closing a cock under the plunger by means of the rod R. The other rod S has a loop at the lower end, and when the stud V reaches the top of the loop, the rod S rises and opens the valve to which it is appropriated. One of the cataracts opens the equilibrium valve, and the other opens first the exhaust, and, after a short interval the steam-valve. These are all closed again at the proper times by chocks on the plug rod catching hold of horns on the different valve levers as the engine comes "indoors." When the cataracts are placed on the engine floor they are made ornamental (see fig. 2), which is a cross section to show action), and are worked from below by side rods R R to a cross head C, with a turned bright weight T on top. As the piston P rises the water comes up through the valve V, and the air from above the piston escapes downwards through the side passages shown. As soon as the piston is allowed to descend by the commencement of the "outdoor" stroke the valve V closes, and the water escapes by the cock E faster or slower, according as the cock is more or less open, which is regulated by an endless screw (not shown) working in the worm-wheel W attached to the plug or "key" of the cock E. As to parallel motions, "F. P." will find them fully treated of in "Hann on the Steam Engine," Part I; price 3s. 6d.; Weale. But I send him a tracing of half of the beam of the Wicksteed engine to explain a little of the matter. A C is half the beam; C D is the main link, 5ft. long; B E another link, also 5ft. long, to which the air pump-rod is attached at F. J H is another link for feed-pump, and corresponds to the link for plug-rod in "F. P.'s" question. Now, the first rule to remember is that D F H A must all be in a straight line, or, which is the same thing, C D, B F, J H must decrease as they get nearer A, and you may have a dozen of them, if necessary. The next thing is to make F move vertically, and then, because A G is a straight line, and all the links C D, B F, and J H are kept parallel to each other by the parallel bars D E and L H, or, if you like it better, E R, therefore D E K will likewise move vertically. Now, to make F move vertically, you have only to make

$$GE \times EF = BF \times BA.$$

Now, in this case $AB = 8'' \; 5\tfrac{1}{2} = 101\tfrac{1}{2}''$

$BC = 6'' \; 11 = 83,$

and C D = 5ft. = 60in. Now, by rule of three, as

$$AC : CD :: AB : BF$$

$$184\tfrac{1}{2} : 60 :: 101\tfrac{1}{2} : 33,$$

and F E is $60 - 33 = 27$in. So, to find G E, which $= \dfrac{BF \times BA}{EF}$ we have $\dfrac{33 \times 101\tfrac{1}{2}}{27} = 124$in. for the length of C E the radius rod. Another way to get the same result without calculating B F first is to say $GE = \dfrac{\overline{AB}|^2}{BC}$ or $GE = \dfrac{\overline{101}|^2}{83} = 124$in., as before. The radius rod in the drawing from which I take the tracing is 129in. or 5in. too much, which accounts for what I think I remember used to occur at the end of the indoor stroke of that engine—viz., the plunger used to vibrate sideways. The piston rod is not fixed vertically under the end of the beam, either at half stroke, or when the beam is up or down, but midway, and the way to find the fixed centre of the radius rod is to place the beam half way up above the horizontal, and strike a circle with the length of radius rod previously calculated, taking the centre of piston crosshead as the centre of circle, and then putting the beam-end as much below the horizontal, strike another circle with the same centre and radius, and where the two circles intersect will be the radius rod centre.—J. K. P.

[4264.]—MATHEMATICAL.—Let "Schoolboy" read Tate's "Exercises in Mechanics," or Newth's "Mechanics" for information similar to that required to solve his question.

Let h = height of water = 18ft.
b = breadth of gate = 11ft.
c = centre of gravity $= \dfrac{18}{2} = 9$ft.

then area of gate = 18×11ft.
and pressure $= 18 \times 11 \times 9 \times 62{\cdot}5 = 111{,}375$lb.

C. H. W. B.

[4264.]—MATHEMATICAL.—The pressure of a fluid upon any plane in contact with it is equal to the weight of a column of the fluid whose base is the area of the given plane, and whose height is the depth of the centre of gravity of the plane below the surface of the fluid. The pressure on the gate (supposing it a plane) will therefore be equal to the weight of a column of water 18ft. by 11ft. area and 9ft. high—$18 \times 11 \times 9 = 1{,}782$ cubic feet. The weight of a cubic foot of pure water is 1,000oz. avoirdupois; so that 178,200oz. or 4 tons 19cwt. 1qr. 21lb. 2oz., is total pressure required.—IGNORANT IRISHMAN.

[4272.]—CRUCIBLES.—"Student" will find the best way to anneal crucibles by making up a coke fire, and before the fire is lighted place the crucible on the cold fuel, light the fire, and let the crucible remain until all is quite cold. I think "Student" will find the Hessian and plumbago crucibles are the best for most ordinary purposes.—A. J. JARMAN.

[4276.]—GUTTA-PERCHA may be rendered sufficiently soft and plastic by immersing in boiling water to be moulded to any desired shape, which it permanently retains upon hardening.—HARRY G. NEWTON.

[4278.]—FRENCH METHOD OF DETECTING ADULTERATION OF OILS.—Mr. Heidenreich, a chemist, of Strasbourg, proposed in 1841 to distinguish fat oils from each other—*a*, by their odour when warmed, *b*, by their colour by contact with sulphuric acid at 66° B., *c*, by their specific gravity. By the first process, the oil being heated in a porcelain capsule over a spirit lamp, the peculiar volatile odour of fish, linseed, or other oils may be detected, especially if compared in the same way with unadulterated oils. For the acid test, from ten to fifteen drops of the oil are dropped upon a piece of glass, underlaid by white paper, and a drop of sulphuric acid is brought in contact with it by a glass rod, two different reactions are observed—viz., when the acid is reacting with or without stirring up the mixture. The following reactions are indicated by Mr. Heidenreich—first, without agitation of the mixture, second, with ditto. *Rape or Colza oil*—first, greenish blue aureola, with light yellowish-brown lines; second, greenish-blue. If five drops of the acid are added the whole becomes almost brown. *Olive oil*—first, pale yellow passing into greenish-yellow; second, yellow, more or less gray. *Linseed oil*—first, dark reddish-brown, afterwards brownish-black; second, brown-black. *Whale oil*—first, red, passing to violet; second, brownish-red, passing to violet. *Sesamum oil*—first, red. *Poppy oil*—first, yellow, or greenish-yellow; second, yellow on white or grey ground, &c., &c. An unadulterated oil of the same kind should always be examined with the suspected one. The characteristic reactions vary also somewhat according to the age of the oil. Other particulars, see "Dictionnaire des Altérations and Falsifications," by M. A. Chevallier, Paris, 1870 (op. 417) vol. i.

Klemche. Leipzig, 18[illegible], p. 881. Characteristic reactions of some Indian oils, see "Technologist," t. iii., p. 348. I think particulars are also to be found in the works of Dr. A. Hill Hassall.—Bernardin.

[4279.]—GAS METER.—The dry gas meter is to be preferred to the wet gas meter, for many reasons. In a wet meter the water is liable to be affected by frost, which prevents the passage of the gas. If the water level be too low more gas will pass than can be registered, or if the meter be tilted forward the gas will pass without being registered at all, which, as may be supposed, causes much annoyance to the company. Why this form of meter should be used on the Continent in preference to the other I cannot say.—Harry G. Newton.

[4289.]—DANIELL'S BATTERY.—The fault "H. C. K." complains of is always experienced, and incapable of remedy without altering the battery altogether. I have been experimenting on this very subject for some time, and may soon have something to say on it. Probably "H. C. K.'s" battery has larger porous surface than is required for his work, and this may be corrected. Let him try with a galvanometer how much current passes through the whole circuit and is just enough to do the work, and also when the battery alone is in circuit; if the latter is more than double the former, he may diminish the porous surface by soaking and drying the cells, and greasing or saturating with melted paraffin all but a portion facing the middle of the zinc plate. The point to be aimed at is to reduce endosmose to the utmost, and limit the action of the porous partition to the exact quantity required for the current.—Sigma.

[4291.]—MAGNETIC BATTERY.—A number of bar or horse-shoe permanent magnets bound up in a bundle with their like poles together, so as to form a powerful compound magnet, is called a "magnetic battery" or "magnetic magazine." Has "Beriro" been misled by the name? A "magneto-electric machine," which is an apparatus for obtaining a current by means of permanent magnets, is a totally different thing, and depends upon the fact that when a magnet approaches or recedes from a wire, a momentary current is induced in the wire. —Ignorant Irishman.

[4296.]—GALVANIC BATTERY.—"J. S.'s" question is inconsistent with electrical laws, and can only be answered if further particulars are given as to the conditions. If there is little external resistance or work to be done, the proportions of work can be seen at once by the figures given in my papers on each cell, as they were obtained by strictly comparable cells. If there is any considerable external resistance or work a Smee made of plates a yard square, would give less current than a Grove's 1in. square. All depends on the relation between the electro-motive force and the resistances, and therefore each case must be considered on its own conditions. These points are little understood by amateur electricians, many of whom seem to think a galvanic battery has some magical properties, and therefore I will in an early paper lay out the whole system of the laws which control the actions of galvanic currents. —Sigma.

[4297.]—GALVANOMETERS.—I replied not long ago to this question. No galvanometer will give any very correct information on the subject, because the induced current is not a homogeneous stream, but a succession of independent pulsations in reverse directions. To use a galvanometer, it is necessary, therefore, to provide a commutator, which can separate the action at making contact from that which occurs at breaking contact, which, equal as to quantity, neutralize each other, though they are unequal as to tension. If the two ends of the secondary wire are led to the connections of a delicate galvanometer, and the primary connection with the battery made by hand, at each *make* the needle will swing to one side, returning to zero, although the contact is sustained; on *breaking* circuit the *needle* will swing to the other side and return to zero, and some estimate may be formed from the extent of these swings, but to test the actual quantity some chemical reaction must be effected by aid of a commutator separating the two currents.—Sigma.

[4298.]—CHLORIDE OF SILVER.—Does "E. H." evaporate his chloride of silver in daylight? if so, this is the reason why it turns blue.—A. J. Jarman.

[4320.]—BREAM FISHING.—If "Pompey" wants to know the *best baits* for bream, I think I can help him. The tail of a lobworm used with the Nottingham tackle, is capital bait for a river; but for a pond or stagnant water, gentles, with rather finer tackle and smaller hook will be found best. For ground-bait use worms encased in clay balls, or greaves previously boiled, either separate or mixed with bran or bread.—A. T., Staines.

[4328.]—MOUNTING MICROSCOPIC OBJECTS.—The method of mounting microscopic objects in Canada Balsam is to soak the object in liquor potassa for some time (varying with the opacity of the object), then to dry it between two slips of glass, soak it for a short time in spirits of turpentine, and place it in the balsam on the slide, apply a gentle heat, press the cover firmly on, put the slide in the oven after raking out the fire, and let it remain until the morning, when the hard Balsam can be scraped off, and the slide is ready for the cabinet. If "C. R. H." wishes to mount a cricket whole, he will require to soak it, for a considerable time, in potass, until it is soft enough to allow it to be squeezed flat between two pieces of glass. It should then be soaked in turpentine, and mounted in balsam in the usual way. Petals of flowers will not require any soaking, and the fresher they are, the better. They are best mounted in glycerine, but if they are to be viewed as opaque objects, with the condenser, they had better be mounted dry. Mounting in glycerine is done the same way as balsam, except that no heat is required, and that the cover will want a ring of gold size painted round it, to hold it on. Dry mounting is the easiest of all. Merely place the object on the slide, put the cover on dry, and paint a ring of gold size round it, and the thing is done. I hope "C. R. H." will have better success next time.—Henry Sutton.

[4351.]—CONIC SECTIONS.—See Mr. Proctor's letter.

[4380.]—AQUARIUM.—The greenness of the water in an aquarium depends upon the amount of light admitted to it. The greenness consists of an immense number of microscopic plants produced from germs contained in the water, or supplied to it from the atmosphere. Strong bright light tends to develop these, hence the thing complained of. The cure consists in removing or

shadier place, or during the hours when the light is most intense cover it with a sheet of light blue tissue paper, or the side next the light might have a sheet of the paper attached to it. At any rate the light must be lessened, then the greenness will gradually disappear. The best vegetation for an aquarium is the green film which covers the stones or rockwork of either salt or fresh water aquariums. After they have been some time in operation, these can be made to grow freely or otherwise, by the means indicated above. Pond, river, or marine plants of the higher order seldom do any good. Exception must be taken, however, to *Valisneria spiralis*, a grass-like plant, which grows freely in a fresh-water aquarium, is very ornamental, and gives out a good supply of oxygen, which it is the office of these plants to produce. Further information if desired.—T. G.

[4380.]—AQUARIUM.—Scrub the sides with a toothbrush tied to a stick, and when the scum has settled put in a bent tube nearly touching the bottom (as a syphon), suck out the air, and all the impurities will follow. Also keep up a supply of trumpet snails (*Planorbis corneus* and *carinatus*), which feed on the confervoid growths. The fresh-water periwinkle, though ornamental, does not live long, and fouls the water fearfully when dead. Fresh-water mussels will also help to purify the bottom. For plants, the soldier plant (*Stratiodes aloides*), with starwort floating on the top of the water.—Amateur.

NOTES AND QUERIES.

[4354.]—COPPER MEDAL.—Will any obliging correspondent translate the inscription on this copper medal, the head of which is very beautifully engraved, and tell me its probable value? Obv. Bust to right "CAROLVS XI. D.G., REX. SVECIAE." Under the bust "I.C.H." Rev. In ten lines, "52 F. Nat. 1655, C. 1675. Reovperatis Provinciis Germ. et Danis Extorta Pace Absolvtvm Imperivm in Regni Emolvm. Exergvit M. 1697." Size rather larger than a penny.—Tatius.

[4355.]—"ART DEGREES" AND "MATRICULATION EXAMINATION."—It was with much disappointment that I read J. Harrison's answer (p. 357) to my query on "A. A. Degrees," as I am eighteen months in advance of the age he quoted, consequently I cannot compete. But if he will be kind enough to give me any information as to the necessary requirements for the matriculation examination, or how to obtain such, I shall be extremely obliged to him; and whether there is any other degree that can be competed for, without matriculating; also the age. Or perhaps some other gentleman of the noble English Mechanic staff could give me the required information.—Beriro.

[4356.]—SOFTENING SKINS.—Can any of your numerous readers inform me how to soften skins that have been cured with alum, arsenic, corrosive sublimate, &c.? I want to make them pliable, so that they can be stitched together, in order to convert them into a hearthrug?—Country Vet.

[4357.]—COIL.—Can any one inform me how to make a good coil not longer than 1ft. 8in., to give spark in air 1ft. long, and whether I could use the same with a weak cell for small experiments? and how many of the best and what kind of cell it would require, how much wire, size of tinfoil, &c., for the Rhumkorff style, and what would the wire cost?—A Youth.

[4358.]—COPAL VARNISH.—I have about one gallon of good copal varnish. It has been kept in a common can with wood plug for a year, and does not set under 2½ days. Can any one tell me how to make it set in about three-fourths of a day? An answer would much oblige.—A Youth.

[4359.]—AMBER BEADS.—How can amber beads be repolished, and what means are there to distinguish real amber from imitation?—L.

[4360.]—GALVANIZING NAILS, Etc.—Will some brother reader please tell me how to galvanize nails, &c., and whether there is not some other and better way to coat wrought-iron articles with tin, zinc, or copper without dipping them in molten spelter?—Mark Stewart.

[4361.]—METHYLATED SPIRIT.—Will any brother reader inform me what methylated spirit is made from, and why it is not allowed to be used in preparing tinctures?—Shellac.

[4362.]—CONDENSING WATER.—Will any reader give me a description of the machinery used, and the process of condensing water for domestic purposes on board large passenger-carrying sailing ships? If it is not asking too much, a drawing of the apparatus would much oblige.—Banchory.

[4363.]—LIMEWASH ON MASONRY.—Can anyone tell me what will remove old limewash from masonry? I have a lot to remove, and don't know of any substance that will do it. Perhaps you or some of your readers do. —Agent.

[4364.]—DRYING SMALL WHEELS.—I am desirous of obtaining a quick and economical method for drying velocipede and other small wheels, not having the space or time to keep them as long as I should like before using them. Will some kind brother reader assist?—S. W.

[4365.]—INDICATOR DIAGRAMS.—Will any engineering reader oblige by giving the best rule for calculating indicator diagrams to find the horse-power of the steam engine? Also the rule for finding the lap and lead of the slide-valve to cut the steam off at any part of the stroke that may be desired? Perhaps T. J. O'Connor or J. Baskerville can assist me.—A Fireman.

[4366.]—INSECTS IN WATER.—I have a large iron tank (open to the air, painted inside), which is supplied with water from two sources—rain-water, and water pumped direct from a well through a refrigerator for cooling worts, the pipes being iron (whilst refrigerating, the water comes into the tank slightly heated). The uses I make of this water are to feed a boiling back, in which is placed a steam coil, with water to wash casks, &c. The other I use to feed my engine boiler. I find that a great number of little insects infest the water, which I cannot get rid of. Would any of your numerous readers inform me of any substance which I could throw into

out success. I also find that since I have fe[illegible] engine boiler with water from this tank, I am obli[illegible] clean the boiler every fortnight, instead of ever[illegible] months, when fed by the same water from another [illegible] Could any of your readers inform me of any subs[illegible] which would readily precipitate the muddiness in [illegible] tank without injuring the boiler or rendering the w[illegible] unfit for cask-washing purposes?—Countr[illegible] Brew[illegible]

[4367.]—RE-ENAMELLING [illegible] How can I re-varnish an old zinc clock [illegible] Sheffield Flood.

[4368.]—LINING-OUT SHAFTING.—Will [illegible] your kind correspondents explain the usual m[illegible] lining-out shafting, say about 80 yards long, and [illegible] the pedestals for same?—W. M. M.

[4369.]—EMIGRATION.—Will some of those who have been discussing the emigration question kindly state whether it would be advisable for a watch-jobber to emigrate to Australia?—Jobber.

[4370.]—PROBLEM.—Suppose a pole to be 10[illegible] height; and standing perpendicularly, what part of the pole will have to be cut off for it to touch the end [illegible] base line 80ft. from the bottom of the pole, which is perpendicular to the base?—Sun Beam.

[4371.]—CHANGE WHEELS.—Could our friend, [illegible] Slater, or any of our cotton-spinning friends, give a rule to find the change wheels for jack-lifter, cone, and ratchet wheels for roving frames?—Good Words.

[4372.]—THE HAUTBOY.—Wanted, a few hints as to how to blow the hautboy, and the kind of reed to select; and what should be the cost of a good reed.—Anon.

[4373.]—TO "SIGMA."—Can "Sigma" explain the following?—The other day, as I was experimenting with the electroscope that he recommends on p. 273, No. 2[illegible], Vol. X., I noticed a very curious thing. Having first arranged the electroscope so that the pith ball hung nearest to the stem, I hung a pith ball on by a linen thread, and took off the gutta-percha ball on the other end of the wire. I then excited a plate of gutta-percha with a dry silk handkerchief, and applied a proof plane I touched the plane and then withdrew it from the plate and approached it to the other end of the wire, on which the pith ball hung, in fact to the place where the india-rubber ball was; as soon as it came near the ball receded from the stem, and receded as the proof plane approached the wire, until it came near enough to spark. If this is repeated *once or twice the ball goes* further away than it did the *first time, but after that it* will go no further. *I also noticed that while the ball* under the influence *of the electricity is repelled from* the stem, if the *proof plane be approached to it* it is repelled until it gets close to it, when it is attracted. Such was the result of my observations, which I was at a loss to understand, but I have no doubt that you can explain them satisfactorily. Also can you tell me where to get the green carboys in London that I have often seen recommended in these pages for making the cylinder electrical machines, and also the cost of them?—Electron.

[4374.]—PRINTING.—Would some one inform me of a way to transfer ready printed matter to zinc plates, so as to be able to take impressions from them?—Cuthbert.

[4375.]—RED BRONZING.—I should feel obliged if any subscriber would tell me how the red bronzing on chandeliers, gas brackets, &c., is done. I understand the green bronzing and lacquering, but not the red.—Virgil.

[4376.]—COD LIVER OIL.—Can you or any brother reader tell me of a substitute for cod liver oil? I have been frequently advised to take it (being of a weak constitution), but I cannot master it; the sight of it being often too much for me. I would be glad if any one could tell me of anything more palatable, and as good.—A Mechanic.

[4377.] — TEMPERING BRACE-BITS.—Will any reader of the English Mechanic inform me how I can harden a set of polished brace-bits, mine being all too soft? They ought to have been good, as they cost £1 [illegible] —A Mechanic.

[4378.]—HOW LL.D.'s ARE MADE.—I see you allude in a somewhat satirical way in your last number to "Doctor" Bedford. I don't know whether he is a D.C.L., LL.D., or M.D., or what besides. I see two London gentlemen have recently been putting LL.D. after their names, or others have been doing it for them. I allude to J. Baxter Langley, LL.D., and W. C. Bennett, LL.D. Now Mr. or rather Dr. Langley as the President of the Sunday League I know, and I have heard of W. Bennett, but not as a Doctor. For what I know to the contrary, these gentlemen may have honorably [illegible] their degrees. But I should like to know a little [illegible] the *modus operandi*. I know a smattering of Latin, [illegible] read French, am pretty well up in mathematics, [illegible]graphy, and music; and I should like to be an [illegible]. Will some one enlighten me as to the how and the expense?—An Ambitious One.

[4379.]—BORING CYLINDERS FOR MODEL ENGINES.—Will any kind correspondent tell me how to bore the steam ports and channels in a model engine? I have a solid casting, and, although I can manage to bore the cylinder itself, I want to know how I am to set about making the channels which admit the steam to the top and bottom of the piston? I have not any tools, and I know nothing about the work.—Sabbas.

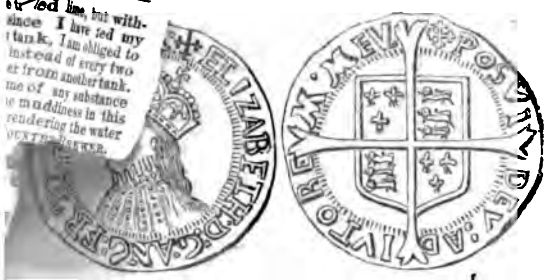
[4380.]—COLZA OIL.—What is the oil known by the name of colza made from? Is there anything peculiar in the process?—Sabbas.

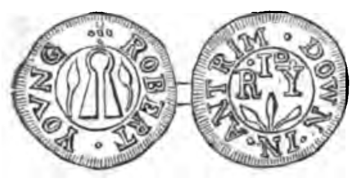
[4381.]—COURT PLASTER.—How is this made; and why is it called "court"?—Sabbas.

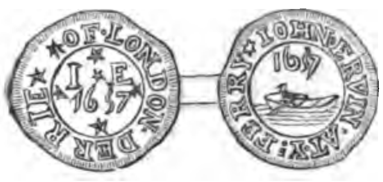
[4382.]—COPPER COINS.—Can any brother reader of our valuable paper inform me what the following coins are? 1. Obverse: Bust to right, "Diva Faustinæ." Reverse: Female standing beside an altar on a tripod, "Augusta S. C."—2. Obverse: Bust to right; "Imp. Caes . . . . an Aug. . . M E O XI." Reverse: A temple between "S. C.," "Aug." below. They are copper, and very thick, about the size of a penny.—Hastings.

[4383.]—THREE COINS.—I should feel obliged if you could spare me a corner in the English Mechanic for the three coins enclosed, and perhaps Mr. Henfrey, or

...ted line, but with-
since I have fed my
tank, I am obliged to
instead of every two
er from another tank.
me of any substance
muddiness in this
rendering the water
UNTER-BREWER.

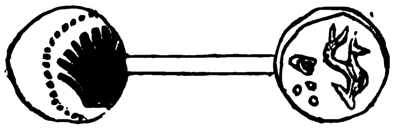






some other correspondent, would be kind enough to give a description of them. I have them from a young friend in America, to whom I send the MECHANIC after I have perused it. The large coin is silver, the other two are brass.—J. S. WRIGHT.

[4384].—COPPER COIN.—I shall be much obliged by



any of your readers informing me what the above copper coin is.—W. B.

[4385.]—BRAZING OR SOLDERING.—Can any of your readers kindly inform me what is the best method of brazing brass work, and how applied, and what kind of solder should be used for light work?—EDINBURGH.

[4386.]—OPTICAL ARRANGEMENT.—I wish to make or obtain some simple means of throwing on a screen an image of a small opaque object, such as (say) a watch, a large insect, or a mineralogical specimen, so as to be visible (say) to fifty persons at once in a moderate-sized room. I also wish to show transparent objects. I am aware that for an unknown number of guineas an optician would supply me with a phantasmagoria lantern, oxyhydrogen apparatus, microscope, &c., but I fancy some simpler and less expensive arrangement would answer my purpose, did I but know how to go about it. If anyone will kindly give me practical advice or instructions I shall be grateful.—IGNORANT IRISHMAN.

[4387.]—SULPHATE OF COPPER BATTERY.—Will our kind friend "Sigma" inform me how to construct a sulphate of copper battery in wooden trough? I intend to have three pairs of plates. What acid shall I require, &c.? An early reply will oblige.—W. G.

[4388.]—WEAK EYES.—I am afflicted with weakness in the eyes, which makes the lids red and swollen, and causes an abnormal secretion of matter, &c., in the corners; if anyone could give me a recipe for a wash to effectually cure the evil, I should be most thankful?—PEREGRINE PICKLE.

[4389.]—LATHE QUERY.—Can anyone favour me with instructions for chucking such articles as require a facing on both sides alike, and how to quickly produce a number of the said articles both of exact size and shape? The men of a draughtboard take as an example. Some objects I require grooved out like a pulley, also faced on both sides alike.—A YOUNG AMATEUR.

[4390.]—FIRE-CLAY BAKING.—I wish to know the method employed in the pottery district of drying and baking Stourbridge or fire-clay without cracking, the time occupied in the process, or any other useful information will be gladly received.—F. G.

[4391.]—SCREW TAPS AND DIES.—I want to make some taps and dies for screwing gas barrels, and I have no master taps or dies, so I want to harden different size nipples and sockets from ⅜in. up to 2in., sufficiently to cut steel for taps and dies. I have tried leather shavings, salt, and urine packing, and then making red-hot, but it will not harden sufficiently. If any brother reader could describe the *modus operandi* for hardening the iron to making the taps and dies he would greatly oblige.—W. REED.

[4392.]—CALLIPERS.—Can any reader inform me how to make two pair of callipers, inside and outside ones?—W. REED.

[4393.]—STEAM-TIGHT JOINT.—I have a boiler, and it being very difficult to make a steam-tight joint for the manhole door, and having heard that litharge is a good thing to do it with, can anyone tell me the price of enough for the job, and how to mix and use it?—W. REED.

[4394.]—IRISH MOSS.—Can any reader give me any information concerning this substance, such as its healthful properties, how it acts upon the system, and at what price it is to be procured in large quantities, and oblige?—HUNTER.

[4395.]—THE MITRAILLEUR.—Will any reader be kind enough to tell me what sort of engine is the "mitrailleur," which has just been purchased by the Government?—CURIOSITY.

[4396.]—ELECTROS.—I am much obliged to "J.K.P." for his answer to me recommending wax mixed with rotten stone for electros, but, having made about a dozen trials, I find it no good, as the wax sticks to the metal in places. I have made several good casts from it in plaster of Paris, but do not know how to make them conduct, as blacklead will not take. Is there not some solution of phosphorus, &c., in which I could dip them? Perhaps "Sigma" could help me?—FABER.

[4397.]—SCREW TOOLS FOR SCREW PLATES.—I should be glad if "J. K. P." could tell me how to make (if possible) inside screw tools from a screw plate, the holes in which are ¼in., and in top.—FABER.

[4398.]—MELTING SPELTER FOR BRAZING.—Would any brother reader kindly inform me if there is any acid I could mix with spelter when brazing so as to render it more easy to melt? I find the brass tubes often melt before the solder. Or how is the spelter made for brazing such tubes? I have no difficulty in brazing copper.—DEESIDE.

[4399.] — INTERNALLY-GEARED LATHE. — To "G. W. A."—In page 849 of the ENGLISH MECHANIC "G. W. A." gives a drawing of an internally-geared lathe; the gun-metal wheel (of which figure 2 is a front view) has on it five circles of holes, the other side having the internally cut teeth. I would ask "G. W. A." what are the use of these holes? does he use it as a chuck-plate, or do they play an important part in the gearing of this lathe? I have a 4in. centre lathe, and I wish to introduce this style of gearing here. Can the internal wheel be cut with the ordinary wheel-cutting machine, or shall I have to make a pattern and get it cast? I trust that "G. W. A." will supply the information.—DEESIDE.

[4400.]—MICROSCOPIC OBJECTS, DIATOMS, ETC.—Would any of our microscopic friends, Mr. Anderson, or the author of the jottings now appearing in our MECHANIC kindly answer the following? My holidays commence in a few days, and I am desirous of going to the sea-side, but wish to steer my course to where I could find a good variety of *marine* objects for the microscope, especially diatoms—if in the neighbourhood of chalk hills where foraminifera can be found so much the better. I know there are plenty of objects to be found anywhere on the sea-side, but I specially want to procure diatoms, and if chalk cliffs are near so much the better.—HUNTER.

[4401.]—CHEMICAL.—Will "Urban," or "Mr. G. E. Davis," kindly give me precise instructions how to convert 2oz. or 3oz. of ferro-cyanide of potassium into the red ferric salt? I have tried, by means of a current of chlorine, but find myself embarrassed by the K Cl and a green substance in attempting to crystallise the ferric salt out.—PRUSSIAN BLUE.

[4402.]—TELESCOPE.—I have a portable telescope, the tubes or draws of which are worn so that they slide too easily, making it difficult to keep the proper focus. Will some one kindly tell me what to do with the instrument to make it work properly?—G. F.

[4403.]—MECHANICS.—Can any of our subscribers assist me in this? I want, by pressing a certain weight down 1in., to raise another 100 times as heavy, up 12in.—ALYSSUM.

[4404.]—BLAST GAS FURNACE.—Will Mr. T. Fletcher oblige by giving me further details of his blast gas furnace? What is the arrangement of the Griffith's gas burner, and how is the blast arranged? A sketch would oblige.—J. M.

[4405.]—SHELL GOLD.—Can any correspondent inform me how to prepare shell gold?—J. M.

[4406.]—SUPPOSED ANCIENT PAINTING.—A painting has been in my family over a century, we have always considered it to be a Kneller, but have no proof of it. The subject is the Apotheosis of Queen Anne, represented as an engraving fastened to oak pannelling, the print torn, and the lower corner standing forward in a scroll. The queen is the centre figure, surrounded by angels. A smaller print is fastened to the pannelling, partly where it is opened by the scroll of the other, and represents Britannia weeping; the size inside the frame 37in. by 52in. I am unable to find any initial or other mark, but perhaps that arises from my ignorance of works of art. I shall be very thankful to any of your correspondents who will assist me in fixing the name of the artist.—H. H.

[4407.]—MAMMOTH.—In what museums are existing skeletons of the mammoth, or *elephus primigenius*?—NATURALIST.

[4408.]—INDIARUBBER.—Could some of my brother readers favour me with the names of the principal India-rubber trees?—K. L. M.

[4409.]—SECURING IRON CRAMPS TO STONE.—Can any brother reader inform me of anything as a substitute for lead in securing iron cramps to stone; something to flow with heat as lead, and set hard?—J. W.

[4410.]—TURNING SPHERES.—Would some adept at turning billiard balls give me some information as to that difficult branch of the art? I want to fit up a simple form of spherical rest for turning spheres about the size of billiard balls. I should be much obliged for any information as to the description of chucks used for holding the ivory. How is ivory polished after being turned?—J. D. L.

[4411.]—ISOMETRICAL DRAWING.—Will Mr. C. J. H. Cotthesson, who asked for a method of drawing the ellipses that represents circles, kindly let me know if he has got his required information from the elaborate papers written by our correspondent Mr. J. W. Bedford? But let me inform C. J. H. C. that Mr. J. W. B. is describing perspective drawing, which is quite a different thing altogether from isometrical drawing. In perspective drawing, we can represent a circle at any angle we please; but in isometrical drawing, circles are always drawn at a given angle. If Mr. C. J. H. C. wishes for any information on the above method of representing circles, I shall be most happy to give him any information that is in my power on the subject.—THOMAS J. O'CONNOR.

UNNOTICED QUERIES.

IN future, if any query remain unanswered for four weeks, we shall insert the number and subject of the query in this list, where it will remain for two weeks, if not previously replied to. We trust our readers will look over the list, and send what information they can for the benefit of their fellow-contributors.

Since our last Walter J. Nicholls has answered 2678 3716, 3738, 3841, 3898; "Saul Rymea," 3703, 3990, 4010, 4048; Joseph Roskell, 3752, 3875; "Alexandra," 3962; "Matrix," 3919, 3926, 3947; "K. T. Z.," 3934; "Leather," 3898; "Patience and Perseverance," 2666, 2677, 3766, 3789; "Deeside," 3787, 3815; "Bernardin," 2694, 3831; "Banting," 3828; "T. K." 3726.

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USEFUL AND SCIENTIFIC NOTES.

A SELF-FEEDING TURNING LATHE.—A remarkable lathe for turning banister or wainscot rails, whip handles, chair rounds, or any article of a round shape on which undulations of an ornamental character are required, is noticed by the *Mechanics' Magazine*. The blanks of a square sectional form are put in at one end of the apparatus, and they pass out at the other end in a finished state, taking as they go the shape of a pattern plate fixed to a slow revolving wheel at the side. The machine works very fast, the cutters running at an amazing velocity to act upon the blanks. There is no limit to the number of articles it can turn out. Anything of a plain, tapered, or of irregular shape can be made by it. All that is necessary is to adjust a pattern of the work wanted, which guides the chisels; then put in the length of square timber at one end, and it will speedily appear at the other smoothly finished. The finished work is turned out about ten times faster than can be produced by hand. The invention has been brought to this country by Mr. G. Sconcia, of New Coventry-street, Leicester-square.

THE HEART'S LABOUR.—The total daily work of the human heart is equal to 124,208 tons of 2,240 pounds each, lifted 1ft. Professor Haughton, of Dublin, states that if the heart should expend its entire force in lifting its own weight vertically, it could raise that weight 19,754ft. in an hour.

"SEELY'S PIGS."—An object of interest at the Workmen's Exhibition is a display of iron, obtained by a process invented by Sir Antonio Brady, from some of that dockyard refuse irreverently described as "Seely's pigs," and which has been the subject of discussion both in Parliament and by the Press. These pigs were of different qualities, but were all largely contaminated with phosphorus and sulphur, and were supposed to be of little or no value. The presence of phosphorus renders iron brittle when it is hot, the presence of sulphur renders it brittle when it is cold. The pigs containing both were worth in the market about £2 5s. per ton. By Sir Antonio's process the sulphur and the phosphorus can be extracted at a cost of about 35s. per ton, and the residual iron is superb. It bears any and every test. One of the pieces exhibited had been beaten cold to the thinness of writing paper at one end, drawn to a point at the other, and then twisted by hand eight turns in an inch at a single heating. Massive bars had been beaten cold until the surfaces on each side of the bend came into perfect contact, and a plate 6in. wide and ½in. thick had been beaten till its edges were in contact, the flat surface remaining horizontal. In neither case were there any traces of a flaw either at the convexity of the curve, where the metal was stretched, or at the concavity, where it was compressed. Holes in a thick plate had been enlarged by driving cones into them, and, in a word, the iron had been knocked about in every possible way. At a very low estimate it is worth £14 per ton, and as there is plenty of the raw material to be had, the profit of the invention seems likely to be great.—*Nature.*

ANOTHER ADVERTISER'S TESTIMONY.

SIR,—Please quote price for enclosed advertisement * * * I should have advertised again before now, but through an accident that went nigh to cripple me, have been laid up nearly 10 weeks, and had so many orders on hand through my last advertisement that I dared not advertise again till I got a little clear.—E. M. T. Tydenham, 10, High-street, Brighton, July 21st. 1870.

ANSWERS TO CORRESPONDENTS.

*** All communications should be addressed to the EDITOR of the ENGLISH MECHANIC, 31, Tavistock-street, Covent Garden, W.C.

The following are the initials, &c., of letters to hand up to Tuesday morning, July 26, and unacknowledged elsewhere:—

H. W. Henfrey, W. A. D., Ephemeris, Rev. E. S., C. C., Jas. Turner, C. and B., J. H., J. P. J., C. and H., G. G. André, Booth Bros., J. C. Mellinton, Flautist, Rev. H. H. H., J. T. jun., Veritas, Rev. D. C., J. Sinkwell, J. E. H., C. H. W. B., W. S. A., M. L., F. C. S., R. P. S., Hermann Smith, J. A. Maclean, W. Melroy, W. A. S., W. T., Propeller, H. H., A. S. C., Amateur, Cabinet Maker, J. G. M., E. Gibbs, Z, Burnard, Alzol, A Young Beginner, J. K. P., J. Sargent, Jun., Doelalus, Vigie, Bernardin, F. S. E., Capt. O. H. Stokes, J. N., Jas. Hamson, J. E. W., S. Crompton, John Fleet, F. J. M. Butt, Inventor, J. Starley, H. W. Henfrey, J. D. L., Enquirer, H. Jack, John Meek, J. H., T. S. H. M. D. Hy. Clapman; Q. Q. R., J. M., T. J. O'Connor, John.

R. O. F. S.—We have already given Mr. Perry's address, Saalemus, J. Powell, 8, Bouverie-street, E.C. Other queries next week.

H. H RICHARDSON.—Several descriptions of tourist's trips could not be inserted for want of room.

W. H, B. and others say that they have paid in advance for the *British and Foreign Mechanic*, and want to know how they can get their copies in future. As we did not get the money, it cannot reasonably be expected that we can send the numbers. We are in no way responsible for the short-comings and blunderings which characterized the defunct journal. From beginning to end it was a pitiful enterprize, and the sooner it is forgotten the better.

G. FIRTH thanks "Omicron" for working out the required formula.

LAVERICK.—Scarcely suitable for our columns.

"An Exhibitor" sends us a long letter complaining that he has not a ticket of admission to the Workmen's Industrial Exhibition, Islington. He should have written to the Committee. We really cannot afford space for these outside questions.

E. M. T. TYDEMAN sends us a long letter in reference to the Pritchard and Proctor controversy. After Mr. Proctor's letter in our last number but one, it is, we think, best to let the matter rest with the two disputants.

INDEX.—Thanks for your able letter in answer to "F.W.M.," but so many letters were received on the trade and commerce controversy that we were obliged to drop it.

S. HEWETT.—We have followed your instructions.

J. M. SMITH.—It is useless to be off[illegible] because your letter was not inserted. We cannot insert all, and must therefore make a selection. We have received sufficient correspondence recently on what we may term outside questions—such as shorthand, emigration, trade and commerce, and tourist maps—to fill the journal.

A WOULD-BE ENTOMOLOGIST, who writes to the *British and Foreign Mechanic*, should buy the back numbers of the present volume of the ENGLISH MECHANIC.

J. MILLER and W. S. H.—Such a communication can only be made as an advertisement.

CHAS. H. LYCESTER.—We do not know. Advertise in *The Sixpenny Sale Column*.

SPECS.—Any respectable optician will give you the information.

J. HARRIS.—Our correspondents can hardly be expected to recommend manufacturers or tradesmen.

A SUFFERER.—Consult a medical man at once. The symptoms you describe, and probably exaggerate, may be those of a tumour, and any ignorant meddling therewith would be highly dangerous.

F. S. BOISSIER.—It should have been 1·16in. not 1-16th of an inch.

A MANX SUBSCRIBER.—Each maker has his own partisans. If we "named the best" we should possibly be mistaken, and should certainly give them all reason to complain.

W. B.—We give an engraving of No. 1 coin; No. 2 is a coin of Emanuel di Rohan, M.M. of the Knights of Malta—see reply to Saml. Smith a few weeks ago; No. 3 is a Moorish coin; No. 4, legend on obverse too indistinct for illustration.

THE SIXPENNY SALE COLUMN is the only place in which can appear queries sent by Charles Wrigley.

MATRIX.—A letter from "Robert" is waiting here for you.

T. KING.—Write to Messrs. Doulton Bros., Lambeth.

OLD SALT.—The use of electricity as a motor for sewing machines is not a new idea.

B. E. ZODDY.—Put your query in a separate distinct form.

E. PERRY.—Stamp and letter were received, but too late. To last, no.

R. DAVIS.—"Inductorium" has been asked to send us his address for publication—several have asked for it.

REV. DR. GIBBES, Plymouth, complains that he cannot get the ENGLISH MECHANIC regularly through his agent. We beg to inform them and others who have cause of complaint that it is not our fault. The E. M. is regularly supplied to the trade at the same time; the irregular delivery of the weekly numbers is attributable to the agents. The Rev. Dr. had better change his bookseller.

W. M.—Messrs. Leroy's address is 12, Gray-street, Philpot-street, Commercial-road, E.

VELOCE.—We cannot recommend any particular maker.

JOHN CHAPMAN.—We don't answer through the post.

W. H. L.—Though we have bought the copyright of the *British and Foreign Mechanic* we have not taken over its liabilities. Had we done so it would have been a bad job for us.

C. H. W. BIGGS says:—"The absorption of the *British and Foreign Mechanic* is no more than I expected. I hope the idea of your buying will not induce speculators to start another journal." As the proprietor of the late *B. and F. M.* was commercially ruined on account of his connection with the *B. and F. M.*, it is not likely any one else will be in a hurry to make another such an attempt.

THE BRITISH AND FOREIGN PRIZE SCHEME.—To J. Gillard, Jas. Parker, S. Elliott, A. S., B. E. Soddy, R. H. Nicholson and others. The prizes we believed were offered when the *B. and F. M.* was in a hopeless condition. In fact, we regarded the advertisement as a flag of distress. The proprietor having since become insolvent, and his affairs being now in liquidation it is not likely the prizes will ever be distributed. At all events we can only refer you to the trustee appointed by the Bankruptcy Court, and to request you to be more cautious in future.

THE INVENTOR.

APPLICATIONS FOR LETTERS PATENT DURING THE WEEK ENDING JULY 18, 1870.

1961. A. Gilbey, Oxford-street, construction of glass orchards.

1962. W. R. Lake, Southampton-buildings, London, improvements in machines for moulding bricks. A communication.

1963. W. Goreham, Swanscombe, improvements in Portland cement.

1964. J. Butcher, Southport, improvements in fountain pens.

1965. G. F. Griffin, 19, Great George-street, Westminster, improvements in the permanent way of railways and tramways.

1966. R. J. Scott, Brixton, new apparatus for preventing priming in steam boilers.

1967. B. Hunt, 1, Serle-street, Lincoln's-inn, improvements in the process of and apparatus for carburetting gases or atmospheric air. A communication.

1968. J. W. M'Carter, Foyle-street, Londonderry, improvements in condensers for steam engines.

1969. N. C. Maximos, Liverpool, drying malt, grain, and other substances, and in the apparatus therefor. A communication.

1970. R. Long, Liverpool, a continuous self-wedging fencing.

1971. J. Frearson, Birmingham, improvements in screws and screw-drivers, and in machinery for the manufacture of screws.

1972. S. Putney, Gray's Inn-road, an improved apparatus to be worn by railway travellers for lessening the effects of vibration on the spine or nervous system.

1973. J. A. Coffey, 9, Lincoln's Inn-fields, improvements in the process and apparatus employed for drying and roasting coffee, chicory, malt, and other substances.

1974. D. A. Fyfe, Manchester, improvements in the treatment and preparation of materials to be employed in the manufacture of paper.

1975. C. Moseley, Manchester, improvements in the manufacture and construction of india-rubber cushions for billiard tables.

1976. W. Cowley, Liverpool, improvements in the apparatus for pumping and forcing air and other fluids.

1977. W. J. Schlesinger, Union-court, Old Broad-street, improvements in machinery or apparatus for washing plates, dishes, crockery, and glass ware. A communication.

1978. W. H. Horsfield, 86, Rockingham-street, Newington Causeway, a new description of knife steel for instantly imparting an uniform keen edge on knives.

1979. W. Newell, Philadelphia, U.S., improvements in cleaning and polishing coffee and in apparatus employed therein.

1980. H. Kesterton, 9, Stratford-road, Birmingham, improvements in the manufacture of iron tubes, and in machinery employed therein.

1981. J. H. Johnson, 47, Lincoln's Inn-fields, improvements in carpets, and in machinery or apparatus for manufacturing the same. A communication.

1982. W. A. Whitty and H. Chattoris, 335, Strand, improvements in the means or apparatus for indicating or recording and registering the times of arrival or leaving of workmen and others.

1983. W. Spence, 8, Quality-court, Chancery-lane, improvements in steam generators. A communication.

1984. J. Redford, Radcliffe, improvements in looms for weaving.

1985. J. Abercrombie, Kirkliston, N. B., an improved lubricator.

1986. J. W. Ayres, Ramsgate, improving latches, locks, bolts, fastenings in general.

1987. G. Sconcia, New Coventry-street, Leicester-square, improvements in machinery or apparatus for reducing wood, metal, or other hard material to fixed patterns. A communication.

1988. W. E. Newton, 66, Chancery-lane, improvements in counting registers.

1989. J. Humphrys, Hull, improvements in steam engines.

1990. W. R. Lake, an improved machine for manufacturing spools. A communication.

1991. W. Brown, St. Mary-street, Portsmouth, improvements in the construction of screw propellers.

1992. C. J. Curtis and A. Fiddes, Bristol, an improved fireproof composition for safes.

1993. H. M. Nicholls, 148, Great Portland-street, improvements in printing machines.

1994. H. Wilson, Stockton-on-Tees, improved mechanical arrangements for cooling and heating liquids.

1995. A. Wenner, Manchester, improvements in fire-bars and grates. A communication.

1996. T. Halliday, Haddington, N.B., improvements in extracting water or other liquids from clothes or other fabrics or fibres.

1997. J. H. Johnson, improvements in packings and in bearing surfaces. A communication.

1998. C. M. Barker, 12, Kennington-park-road, improvements in steam generators.

1999. W. E. Gedge, 11, Wellington-street, Strand, an improved method of incorporating metal and cement in the construction of tanks, boxes, vases, or pots for horticultural and other purposes. A communication.

2000. H. W. Hammond, improvements in machinery for moulding clay and other plastic materials into drain pipes and other articles. A communication.

2001. G. Ashworth and E. Ashworth, Manchester, improvements in cards employed in the carding of cotton and other fibrous materials.

2002. B. Scholefield, Leeds, improvements in brick-making machinery.

2003. T. R. Fox, Wavertree, Liverpool, improvements in rigging steam and sailing ships.

2004. J. Russell, Forest Vale Iron Works, Cinderford, improvements in or additions to furnaces used in the manufacture of iron and steel.

2005. A. Maw, Broseley, Salop, improvements in apparatus to be employed in the preparation of pulverized clay used in the manufacture of tiles, bricks, pottery, and other articles of earthenware or china.

2006. H. Muir and J. Caldwell, Glasgow, improvements in purchase capstans.

2007. M. Johnson, Churwell, improvements in ploughs.

2008. J. Wakefield, Dublin, and D. M'Dowell, Waterf[illegible] provements in rails for railways and tramways, and [illegible] tyres for railways and tramways.

2009. H. Baines, Normanton, improvements in repair[illegible] or damaged rails of permanent way.

2010. R. Dudgeon, New York, U.S., improvements [illegible] engines.

2011. W. Husband, Hayle, improvements in pneumat[illegible] and hammers, also applicable to machinery for driving [illegible] ting, splitting, or dressing stone, and for boring rocks.

2012. N. J. Amies, Manchester, improvements in [illegible] machines.

2013. J. Spiller, Salcombe Lodge, Salcombe Regis, impro[illegible] on and application of certain machinery to the process of [illegible] facturing flour from wheat.

2014. A. Jackson, Loman-street, Southwark, improved [illegible] of supplying boilers with water.

2015. P. A. Blondel, 23, Boulevard de Strasbourg, an [illegible] lamp for burning mineral oils and essences.

2016. S. Tuddenham, Lower Marsh, Lambeth, improve[illegible] the manufacture of twisted metal work.

2017. G. Hartley, Aldermanbury, improvements in secu[illegible] of boots.

2018. H. G. Avery, Hackney, an improvement in [illegible]

2019. A. Jack, Maybole, Ayrshire, a new or im[illegible] tural implement adapted for digging potatoes.

2020. H. Ramsten, Carlskrona, improvements in ships' [illegible]

2021. S. G. A. Terry, Burnham, Bucks, improvements in [illegible] ratus for preparing finings for fining beer and other liqu[illegible] communication.

2022. W. Roberts, Inverness, and W. Stroudly, Brigh[illegible] provements in weighing machines.

2023. J. Walker, Wolverhampton, improvements in [illegible] for making railway and other spikes or bolts.

2024. W. S. Bentley and W. Isham, mechanic, Boston, Linc[illegible] shire, improvements in apparatus for economising and purify[illegible]

2025. C. Samuel, Ludgate-hill, improvements in articles [illegible] cable for advertising purposes.

PATENTS SEALED.

139. A. B. Rocke, improvements in knobs and spindles for [illegible] locks and similar fastenings.

149. H. W. Hammond, a new lever for changing altern[illegible] rotary motion into continuous rotary motion, and vice versa. [illegible] communication.

156. W. F. Padwick, an improvement in ordinary fire grates.

157. E. T. Hughes, improved apparatus for diminishing the effects of the oscillation of vessels and for preventing sea [illegible] ness. A communication.

158. B. Clarkson, and S. Charlton, Manchester, improvements in scale beams.

159. E. T. Hughes, improvements in looms for weaving. A communication.

160. C. Gordon, improvements in the construction of breech-loading firearms.

164. J. A. D. Cox, an improved vehicle or composition [illegible] mixed with white lead and other pigments.

170. D. Servante, improvements in printing machinery.

171. J. J. Richardson, improvements in machinery or appara[illegible] for pointing or grinding hackle gill, card, or other pins and tee[illegible] used in machinery for preparing fibrous substances.

181. W. Simmons and A. Brown, *improvements in plant or apparatus used for dredging purposes.*

184. W. E. Gedge, *the construction of pickers for an improved process for preserving bread in a reduced bulk. A communication.*

188. T. J. Smith, *a new or improved process for cleansing, drawing, and tinning wire. A communication.*

195. J. Macqueen, improvements in self-acting mules.

197. R. Fielden, jun., and T. Fielden, improvements in looms.

224. W. Hunter, improvements in looms for weaving textile fabrics.

232. F. J. Barnby, improvements in floor cramps.

239. M. Anketell, and O. F. Anketell, improvements in the production of manure and fuel from sewage.

336. J. Knowles, improvements in the mode of working self-acting mules for spinning and doubling.

581. D. Cameron, improvements in metallic pens.

772. R. Tonge, improvements in looms for weaving.

1555. G. Stevens and J. Hendy, an electro-magnetic motor for sewing and other machines.

1561. S. H. Stephens, machines for grinding, concentrating, and refining tin and other ores, in order to extract the metals in a pure state.

183. F. Rötig, improvements in the construction of watches.

186. J. Reichel, improvements on buttons and clasps for [illegible] and other garments.

189. F. C. Southwell, improvements in chaff cutters.

199. J. Dawson and T. C. Fawcett, improvements in raising gigs used in the process of raising the nap of woollen cloth or other fabrics.

203. W. T. Waite, improvements in the preparation of [illegible] charcoal for use in treating saccharine solutions.

204. W. T. Waite, improvements in filtering saccharine [illegible] tions and other liquids.

205. W. Garton, preparation of fermentable saccharine [illegible]

209. A. S. Campbell, an improved appliance for facilitating the working of bicycles and tricycles.

210. J. W. Eyres and J. Longbottom, improvements in cementing woven and felted fabrics.

211. W. Warren, improvements in ships' anchors.

212. J. Holdsworth, improvements in apparatus and mechanical means for excavating, filling-in, transporting, and discharging grain, seeds, and other materials.

262. R. H. Durie, improvements in braking or retarding railway trains.

257. H. J. West, improvements in refrigerating.

285. A. Werkmeister, an improved liquid meter.

300. F. R. W. Hedges, improvements in mortising machines.

316. J. Davenport, a new or improved riddle, specially [illegible] for cleansing and assorting potatoes.

324. J. Thomas, improvements in breech-loading fire-arms.

328. A. Le Brun-Virloy, improvements in treating iron [illegible]

330. T. J. Smith, improvements in the manufacture of [illegible] and other seats. A communication.

361. S. W. Thomas, improvements in bicycles.

376. C. Bardy, improvements in preparing and [illegible] colouring matters.

427. J. Flear, an improved machine or apparatus for [illegible] horses or other animals.

455. T. Whitehead and H. W. Whitehead, impro[illegible] in apparatus for preparing and spinning flax, tow, and [illegible]

533. A. M. Clark, improvements in machinery for [illegible] shoe nails. A communication.

605. A. M. Clark, improvements in railway carriage [illegible] A communication.

633. F. Walton, improvements in the construction of [illegible]

634. W. H. Bailey, improvements in boiler fittings.

951. F. Field and G. Siemssen, the application of a new material to the production of illuminating oils and solid hydrocarbons suitable for the manufacture of candles.

970. I. Summersfield and J. G. Sanderson, an improved [illegible] ing machine for the use of tailors and others.

1374. J. A. Gardner, improvements in apparatus for signalling between passengers, guards, and drivers of trains.

1515. J. W. Horsfall, improvements in ventilating mines.

THE *ENGLISH MECHANIC* LIFEBOAT FUND.

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NOTICE.

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HE BRITISH AND FOREIGN ECHANIC is now incorporated with this urnal.

The English Mechanic

AND

MIRROR OF SCIENCE AND ART.

FRIDAY, AUGUST 5, 1870.

THE EXHIBITION AT ISLINGTON.

WE have noticed, upon a broad ground, and in detail, the plan of this and similar exhibitions. It is with a sincere desire of recommending them that we now venture to point out a mistake or two, which, it may be, cannot be easily avoided, but which are certainly detrimental. One is the converting of an exhibition into a bazaar. This is an error, and might become an abuse, to tolerate so much of the bazaar principle, by which the attention is distracted from inventions and works of merit to meretricious stalls piled with Parisian trinkets, the fascinating trash of toy-shops, gew-gaws, and other trifles made only to be sold. Another is the arrangement of the collections. They are so composed as to be perfectly incomprehensible. We might multiply our protests; but the idea and the development of the exhibition are so generally excellent that we prefer to refrain from the fulfilment of an ungracious duty. The only one upon which we would emphatically insist is that against the puffery and shoppiness so manifestly encouraged, of course for financial reasons. Too much ostentation is permitted to wedding-cake, to patent mustards and starches, to dealers in largely-advertised sauces, to instantaneous toothache cures, to fancy labels, and to hair-dyes. Too much space is afforded for articles brought here less for show than for sale, which encumber the exhibition, vitiate the perception of the bewildered multitude, damage the interests of the conscientious manufacturer, and have no more relation to the genuine objects for which the Agricultural Hall has been opened in this broiling month than the American compounds which are consumed, or the bootjacks of the Reformation period. We pass on gladly, among the improvements: those in photography, now the livelihood of thousands and the enjoyment of millions; the substitution of electricity for the casting of statues, and for the costly old methods of gilding and silvering; the new dyeing processes; the elaboration and simplification, at the same time, of machinery; the comparison of raw material and simple industry with the results when the one has been transformed into a mechanism, and the other elevated into an art. We traverse the various regions and discover little to regret in the difference between ourselves and other nations. However exquisitely they work the Italian beauty is not worth the English strength. Certain ancient Oriental people, appreciating colour by instinct, knowing no fatigue in the perfection of detail, holding the goldsmith and the jeweller in especial honour, feminine in the softness and gaiety of their fabrics, jubilant in their employment of the imagination, eclipse us, no doubt, in their own sky. We invariably fail when we endeavour to imitate the rich stuffs of Kashmir or the celebrated Bombay work; but when your Hindu or your Chinaman comes to attempt a pianoforte or a sofa he is once more a barbarian and a bungler, and nothing else. Again, we do not follow Russia with her silver and enamelled bookbindings, and ecclesiastical plate—illustrating a fashion which combines modern feeling with the reminiscence and admiration of Byzantine, of Renaissance, and even of the Flamboyant era, which was imported, with some elegant ideas of Circassian origin, from Poland. Those blazing pictures, on resplendent gold grounds, and those stately malachite doors, prominent in all international exhibitions, do not represent the English genius; nor the imperial splendour of the Sèvres porcelain, nor the floral incrustations, in *pietra dura*, by the Florentine artists, who, with their painted stone strawberries and raspberries, are not ashamed to invoke applause by presenting in a semi-transparent stone the pips of a sham currant and the filament of an apocryphal gooseberry. We do not envy the progress of some continental countries in the art of veneer, the revival, by Spain, of her old damascening dexterity, the restoration, for Venice, of her historical superiority in glass—witness the copies from the Murano works and the early mosaics, and the gold-enclosing mould that produce so sumptuous an effect. We look, for only a moment, at the German stamped and coloured leathered wall hangings; at the stiff, stately, and academic decorative art patronized by Prussia; at the capricious crowd of Dresden nymphs in fantastic dresses and nymphs in none, plagiarising a phase of art which lost all value and meaning when it ceased to represent the frivolous age in which it originated; at the German Gothicism; the Teniers tapestry; the Belgian lace; and, indeed, not a few visitors will be puzzled to see them at all, or to find a record of them anywhere, for this, though an International, is yet a comparatively humble Exhibition. It has no streets of stalls bright with gold, jewels, and art, and exulting in all the luxury of a Western Lower Empire; but it contains, nevertheless, examples of which we may well feel proud; in furniture, costly and cheap; the utilizing of common woods for ornamental purposes; tasteful carpet patterns; the fancy majolica, Palissy, and neo-classical wares for which Worcestershire and Staffordshire stand unrivalled; tiles for mural decoration, as different from Dresden as fire is from frost; wrought-iron, cast, and bronzed work; incised stones for pavement, and so forth. Industry, in this, as in other countries, is now fighting a fair battle with the imperfections, prejudices, and forgetfulness of the past. It has taken into partnership art on the one hand and science on the other, and we already witness many triumphs of the combination. We have no longer reason to confess, for example, any inferiority in gem work, although we may not, in Lord Macaulay's language, conceive like Titans and execute like jewellers. It is for us a matter of more interest to consider the gradations by which in useful elaboration, our workmen and those of other countries are competing: and we indicate this all the more distinctly, because of an immense amount of useless work exhibited. The man who makes two blades of grass grow where one grew before, is, according to ancient wisdom, a human benefactor, but he who writes the Lord's Prayer on a threepenny piece, or includes the uniforms of all the British army in a blanket, or builds a cathedral out of champagne corks, or levies a tax upon every forest of America to make a table top, may be very ingenious, and persevering, and patient, yet there is invariably in such labour something suggestive of the cripple. There is no objection, if there be not much use, in men diverting themselves from their habitual employments in order to engage in totally opposite pursuits. Still, we will frankly say that in the industrial race, the principle *ne sutor ultra crepidam* holds good, if it be intended that the workman shall rise higher in his vocation. We have every respect for the ingenuity which prompted a coffee refiner to contrive a dish preventing those proverbial rogues—the bakers—from purloining Sunday mutton; for the compositor who has fulfilled his dream of a perfect fire-escape; for the violinist who has exhausted his genius upon a rat-trap, and especially for the self-sacrificing member of the Fire Brigade for proposing a method by which he and the body to which he belongs will be altogether superfluous. Still, while thoroughly admitting that men are entitled to exhibit their versatile capacities, and enjoy the value of their patents, we do think seriously that in many cases, although they may expect to reap benefits, they will be disappointed. Thus, what can a time-keeper on an omnibus station hope from his model of a ballot box; and what can a Government clerk anticipate from the adoption, if ever, of his peculiar street-sweeping machine? Let us allow that men do often hit, to the right or the left of their own marked paths, upon ideas which have fertilized into both applause and profit; but the ground safe for working men's exhibitions is, upon the whole, best chosen when it brings the working man as a working man, and in his own selected walk, into competition with his fellows. It was, we imagine, with this view the workshop rivalry was proposed at Islington. The international scheme is not in this respect represented; for it is a remarkable circumstance that on the part of foreigners, very few illustrations are given of eccentricities—using the term eccentricity in its proper sense—of industry. Thus the Italian, who exhibits a railway model, is generally a railway engineer; we do indeed find one of this capricious nation, who, being a music-master, aims at elevating himself from that desolate position by taking out a patent for cleaning rice; we also discover a genius which can fire guns without powder; but from the plains of Lombardy come ploughs, drilling and thrashing machines, and mill hoppers; from Genoa models of ships; from Florence specimens in marble; and from Rome revivals of that antique art which, although a thousand armies may march among her ruins, she can never forget. The Germans, too, while ambitious in their intellect, and self-exalting enough for the satisfaction of any human pride, are present with a very humble class of inventions and handicraft. The Austrians, who do not understand their own capacities, are here with suggestions, which it might take ten battles to make them work out, so fond are they of slumbering upon their fame and of reposing on their sense of dignity. Even the Bavarian beats them. The Bavarian workman is not the type of any peculiar genius, but he certainly represents a taste and a spirit which we must emphatically commend. If, in this notice, returning to the British departments, we have not signalized in many cases the works of our own countrymen, it is really because they are so numerous and so good, and the names deserving recognition are so many, that we fear to make an invidious choice. There can be no doubt in saying, as the *Standard* said, recently, that this is the very best workman's exhibition, answering to its declared purpose, taken for all in all, in an honest and comprehensive manner, that ever was held in England. It is full of suggestion, of ingenuity, and of proofs that the working class mind has been very beneficially turned within the last twenty years towards artistic studies. We would warn both the exhibitors and the visitors, however, at the Agricultural Hall against the danger of one false impression. They may be perfectly certain as to the authorship of a particular subsoil madder plough, a pair of galvanic skates, the matrice of a silk-weaving apparatus, or a stopchamfer, or a singular alpenstock, which we observed, and which, as it appeared to us, differed in no respect from other alpenstocks except in so far as it was more likely to cast you off your feet, or bring down an avalanche upon your head. We believe these advantages are much appreciated by Alpine tourists, but we refrain from mentioning the inventor on account of the statute against complicity in manslaughter. We do, however, conjure the public, regarding this as an Industrial International Exhibition, to put no faith in the Fine Arts as represented there. We say no faith, but we should say little. Many earnest and assiduous art-students have sent their works, and we should be sorry to detract from the merit of their efforts—flowers in water-colours, pen-and-ink drawings, stencil designs, crayon portraits, pretty pictures on fans, free-hand outlines and amateur engravings; but if the friends of the working men who exhibit at Islington, genuinely wish to obtain a knowledge of art historically they must not accept as original a single picture on the walls purporting to be from the hand of an old master. They ought not to be thus deceived. Why, to judge from this display, you might imagine Da Vincis, Michael Angelos, Giorgiones, Titians, Tintorettos, Corraces, and Vandykes were as common in Dalston and other suburbs of London as cucumbers are in Saxony! There is an impudent attempt to palm off the head of a girl as a Greuze. Our National Gallery is bad enough, but it is not so poor that these Dalston and other suburban collections, including one from the misty remoteness of Epping, can be acknowledged as eclipsing it. There are some pictures worth the covering ten times over of their surfaces with gold, and worth also that worship at the most sacred altar of the human mind, speaking in a human sense, which beauty is entitled to, and which if not conceded will be demanded; but it is an insult to working men to bring together such a congerie of replicas and copies when we know that the originals, which we ourselves have seen, are scattered through the great galleries of Europe. And, upon this consideration, we beg to tell our artisan friends that whatever else they admire at the Agricultural Hall, they will do wisely in our humble opinion, to regard the pictures as being generally the works of dishonest copyists, worth less respect than their frames, which are the work of honest workmen.

A PRACTICAL TREATISE ON THE HARMONIUM.*

By Hermann Smith.

THIRD DIVISION.—CHAPTER V. (*continued.*)

OF THE INFLUENCE OF THE SHAPES OF THE CHANNELS UPON THE TONES GIVEN BY THE REEDS.

> The difficulty of understanding vibratory action consists in this, that the movement of the parts of air, in which sound consists, travels along, but that the parts of air themselves do not travel, but are anchored like standing corn.—Dr. Whewell.

THE scales or dimensions of the channels of each register will be but one part of the calcuation; the style or shape to be adopted is another; and these styles or shapes are interchangeable with the several scales; hence it will readily be understood that out of the combinations many varieties of character may be obtained, even if no other influences are taken into consideration.

There are five orders of channels. 1. The channel having the reed-veneer and the pallet-veneer parallel to each other. 2. Having them convergent. 3. Divergent. 4. Curved reed-veneer expanded toward pallet aperture. 5. Curved reed-veneer, with depth under reed aperture and contracted under pallet aperture.

FIG.1

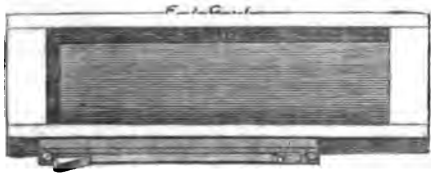


FIG.2

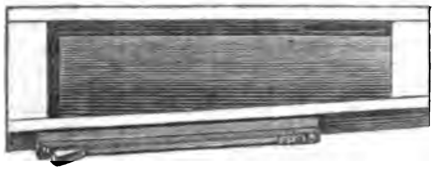


FIG.3

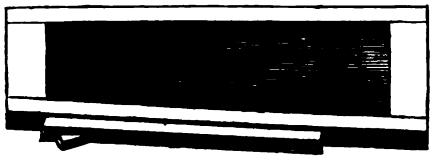


FIG.4

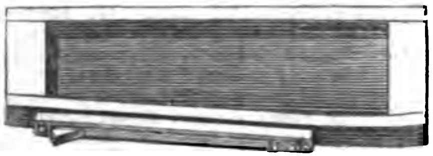
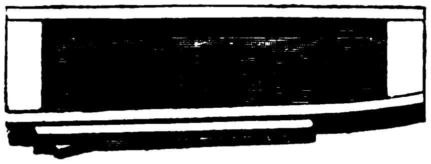


FIG.5



Each shape of channel having a different power over the reed, and on the composition of the waves surging to and fro in the interior, we should endeavour to estimate in our minds what would be the physical effects of whatever variations we arbitrarily determine. The visible aspect of nature will be our best guide; of the weight and impact of air we are fully conscious, and between air and water a very close analogy of movement exists. You who have wandered by the wondrous ocean, who have watched the advancing undulations, have heard them breaking on long lengths of sandy shore, rolling up steep pebbly beaches, or dashing with wild recoil on cliffs precipitous; or, in nature's calmer mood, seen the bright waves careering in graceful forms, prancing among boulders, and curvetting as if for their own delight in quiet coombes; you will have noted and remembered the ever-varied form and the ever-varied music. Wind and wave are the same, but every locality has its special features of elevation, depression, and environment, which shape the course of wind and wave, compel them to assume distinctive character, force, and form, and determine the quality of the sounds they give life to; each woodland and each shore is musical with harmonies which are its own and none others.

If we should place the same reed on each of these differently-shaped channels, and in imagination view the interiors, we should unquestionably find that in the "squeezes" not one would mould the same record as another, each would give a different history of the forms impressed by the tonal forces active within its bounds.

Professor Tyndall in his last lecture on electricity showed how hard it was to cut through the magneto-electric current, how the pure space seemed to be occupied by a solid viscous substance resisting passage through it; the impalpable put on solidity and demonstrated an existence which was invisible. Although air is shapeless and intangible, yet whenever the particles of air are excited to vibration there is a residential force within capable of taking form and of impressing whatever opposes the free involution of its waves. It seems to possess more substance. Opposition changes the contour of the äerial undulations, and if your active interposition is sufficiently near the source of sound it will in some degree transform the quality of the sound; and even as you may change the colour of a beam of light by refracting or reflecting media interposed in its path, so the quality of musical tones already defined may be changed by the media through which the sounds are transmitted before they affect the ear. Some modern lamps have large opal glass shades which, like bells, produce musical tones. A series of these milk-white gongs, chosen according to the pitch of the notes they give, would ring a fine elfin peal, for they throw off tones of lovely quality; if you strike one of these and whilst it is sounding place your hand within the bell, waving your hand to and fro you will sensibly alter the tone then resounding, both in pitch and quality, and will feel as it were the tingling shock of modulated form and rebounded undulations; your fingers are as breakers amid the mimic ocean, raising the foam of the white sea-horses, breaking the waves into new forms crested with harmonics. In association with this experiment we remember that Professor Airy considers that the hissing scream sometimes heard when the long Atlantic wave rolls up to the shore is due to the harmonics arising from the breaking of the wave into surf. Ole Bull possesses a famous old violin, one that has a history and is worth more than its weight in gold, and it is said to have been for so many generations in the companionship of gifted artists that its interior has become marked—

Ribbed as the brown sea sand,

by the incessant surging of its musical waves. The human larynx is formed of a number of cartilaginous rings connected by membranous bands. In reference to our subject it may be worth the thought whether these be not aids to the nodal division of the vibrating column of air; the purpose usually recognized in these elastic intersecting bands is for the elongation of the pipe. We seem to perceive another value in them, our experience in harmoniums favouring the hint. Frequently we find that the true vibration of certain reeds is blurred, the intonation imperfect, and by no manipulation of the reed or channel can we overcome the defect; yet if we insert a flexible band of leather at the side or bottom of the register chamber, the correct articulation is gained in a moment—a simple remedy for a serious fault and discovered by accident. How are we to understand the cause and cure? When the body of air under the reeds confined by the rigid walls of the chamber is set in strong vibration by one of the bass reeds, there appears to be so great a contention of opposing motions at one particular place that the free disposition of the waves into their natural division is prevented,—the crowd and the returning crowd meet in a walled-in passage, and neither will give way; under some reed or other they come to a deadlock, and the reed is unable to force its way out of channel or get room to strike. By allowing some degree of expansion at this tight place we ease the crowd, help the waves over their difficulty, and let them pass again freely. The speech of all the series of reeds is benefited by it, and it is noticeable also that one opening out to the leather band is not satisfactory, whether it is large or small; two apertures are requisite for obt the full advantage, a fact which suggests th bifurcation of the windpipe into the two bro tubes may play a not unimportant part in acoustical relations of the vocal organs; an further, we incline to believe that these secting bands, elastic themselves, and allo a yielding movement in the rings may tend to the places at which the nodal divisions strike, indifferent to theoretical precision securing a perfect sympathy between the each note in the varied scale of the voi the vibrations of the windpipe, which, h supple, never changes to any corresponding indeed, for all theoretical calculation, it said to remain practically at one length. we consider the human organ of voice and in the light of our experience with free re in the constant study of the peculiariti manifest, the whole conformation of th and, indeed, every detail of the structu vocal organs, seem to acquire new mea design, and we perceive more and wondrous beauty and perfection as a strument. All the allusions we have intended to render you conscious th invisible world of sound which we seek form is potent.

(*To be continued.*)

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THE FLUTE AND ITS VICISSITUD

By Sable.

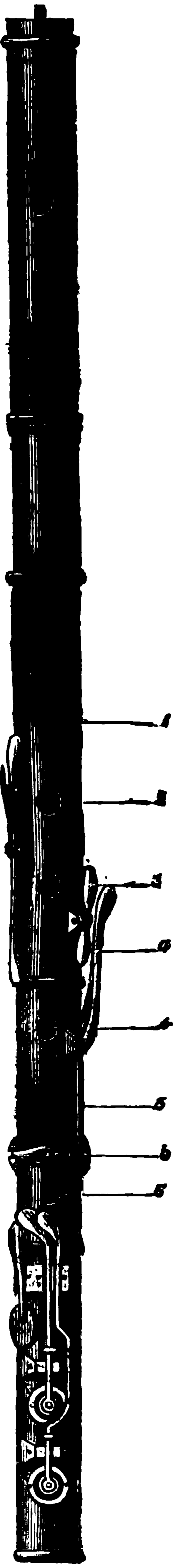
(*Continued from page 411.*)

The Nicholson Era.

FEW there are who have not scraped an acquaint ance with the flute, usually in *younger* and happier days, when the *heart* was *fresh, trusting,* buoyant with hope; when *life's sun shone cheerily,* casting no shadow *on the path, and the* wide world seemed one vast pleasure-*ground. But* as Old Time aroused us from youthful dreams, *pressing* upon us the stern realities and cares of *sober* manhood, and as the broad surging stream of *life* swept us onward, its ever varying currents have separated us widely from the friends and pursuits of earlier years: not that we forget them, although with some of us the sun is now behind, and a long evening shadow is thrown before us as we journey on; yet bygones are still dear to us, and we warm towards everything that recalls them, as we welcome the simple wild flowers because they remin us of joyous childhood's days, the green fields which we rambled "fancy free," and the spreading trees under which we sat while weaving our floral treasures into bright garlands. In the bustle of after-life all such things have drifted fa into the past, but it is good to be reminded of them now and then, for it keeps the heart youn Such a remembrancer is the flute to many. A we look at our old friends snugly reposing in the faded velvet of their old-fashioned cases, or lyi on the side-tables of our sitting-rooms, ear associations crowd into our minds—once again live in the past and forget for a brief period the corroding anxieties of the present.

The flute has ever been a favourite, and reason is obvious; no other instrument, with exception of the violin, so nearly resembl human voice in quality or can render a na melody with such sweetness and pathos. T the flute sufficiently well to please requires more than a moderate ear and a little appli and yet the flute was born amidst ignoranc reared in barbarism. The Hon. and Rev. I Skeffington thus describes its aboriginal st "it had six finger-holes, one mouthpiece, and unconquerable objection to being played in tun As it grew to maturity it gave painful evidence a sadly neglected education; it was rude, rough and retained most of its disagreeable propensiti The old German flute is too well known to ne much description. It is a portentous affair, with a pursed up embouchure, small finger holes so wide apart that the bare sight of them is enough to provoke the cramp in all one's knuckles. It boasts of a D sharp key, which is all the more imposing from its loneliness. Its voice is rich and mellow, with the *slight* drawbacks of a feeble and *awfully flat* third octave, elicited with much difficulty and uncertainty; a wretched *back-fingered* C natural, improved, by the substitution of an awkward *cross-fingering;* the absence of any means of producing a passable F natural; and lastly, an unequal and imperfect diatonic scale. There were no "sliding heads" in those days; perhaps some heels were all the steadier in consequence.

the time of the great masters the flute was nply an orchestral appendage: they availed emselves of its beauties and eschewed its decte. Even as late as 1823 Kuhlau was almost known, and the productions of other writers ere insufficient to give the instrument any assical status. As I write, the notes of just ch a flute steal plaintively through the still ening air; I know the utist, and can guess his hereabouts: he is playing Charming Nelly Gray," ot without taste, and is eated on a felled tree on he green near the village orge. His rude melody as charmed into a temorary lull the noisy mirth f his companions, who, ke himself, are out for a unge before retiring to est after the day's labour.



Such was the flute that ttracted the attention of he illustrious Charles icholson; he perceived hat locked up in this meodious piece of imperfecion lay the powers and capabilities of a valuable solo and concert instrument: to draw forth and develop them was his study and his eventual success. Perchance these lines may be read by some who can remember the enchanting and novel effects he produced upon his improved eight-keyed flute—effects even now unrivalled and perhaps unattainable. He made his *debut* in London about 1820, with that form of flute usually called "the concert-flute," to distinguish it from the old German flute. It was bored on a new and better principle, and its holes were much enlarged, and graduated with greater exactness, though still on an unequal scale. With this flute, so greatly improved in tone and tune, and extended in compass, Charles Nicholson presented himself before the public, now fifty years ago. It is true he only introduced a very old friend, but so changed in voice and appearance, and handled with such consummate skill, that it was *practically* new, and this was one cause of his immense popularity. The flute was Nicholson's *adopted child*, and he taught it to use its fine voice. He charmed and delighted his audiences with his instrument—exquisite playing astonishing them with its brilliant and dashing effects and marvellous power of execution; the flute, in fact, became the rage in society, and his well-earned reputation was only to be equalled by the extent of his teaching. His flute had a place in every well-bred family—much the same as that occupied by the modern pianoforte—and the pleasure of no drawing-room party was complete without its sweet vocality. As the flute was discovered to be capable of new and increased effects, music came into existence to embody them; thus it grew to be the charm, the never-failing source of enjoyment in the domestic circle, and the ornament of the concert-room. I give a drawing of a very beautiful "Nicholson," by Messrs. Rudall & Rose; it is not a recent one, as it bears the old address (Piazza, Covent Garden), but for tune, tone, and finish, it is not to be surpassed by any flute of its kind. The sketch has been made with careful reference to proportion, as I shall have to revert to its structure hereafter. "Then if this flute was all you affirm it to be," growls some sage, "why not let well alone?" What a mercy if we could but do *that!* He is surely the best of all artists who knows *when* and *where* to leave his work alone. In the matter of the eight-keyed flute all was not right, hence arose the revolution of Boehm.

And now to those who feel the need of, and will kindly accept them, the promised hints are offered. Early morning is the best time for study; the head is then clear, and the body refreshed: before breakfast, if possible—flute practice is not pleasant or profitable after meals. One hour at *least* should be devoted to it at a time. Standing is the best attitude; the music being placed high enough to be seen well without bending the neck or stooping the *shoulders*. The flute *speaks* at the embouchure; and if it be borne in mind that the functions of the chest and windpipe are the same in singing and flute-playing the importance of attitudes in connection with tone, tune, and expression, will be self-evident, to say nothing of the charm of an easy graceful carriage. The flute should be held at nearly a right angle with the body, in such a manner that the *thumb* and *fingers* of the left hand and the *fingers* of the right may be *perfectly free*. An unsightly contrivance, called a "crutch," is provided to help those who will not help themselves. It may be accomplished as follows:—Place the flute just above the knuckle-joint of the first finger of the left hand, about 1in. from the first or B hole, and press the instrument gently against the under lip with that part of the left hand and the *thumb* of the right hand, which latter must be placed against the *side* of the flute, about an inch from the F natural key. On no account ought the thumb to be placed *under* the flute. Inattention to this most important point has, as Rockstro remarks, been the bane of many who might otherwise have become creditable executants. The upper lip should be projected a little over the under lip, which latter should about half cover the embouchure; but this differs in flutes, as the "stop," *long or short*, does in various violins: a little experience will soon determine the exact orifice to be left uncovered. The breath should next be gently forced downwards in a smooth and even stream. All hard blowing must be carefully shunned, as any excess of wind above that which actually produces the *voice* of the flute occasions that insufferable hissing noise which has disfigured sometimes the performances of fine players. Rockstro says "in the production of a good embouchure the form of the aperture between the lips should resemble a barley-corn in size and shape," and he recommends those who would cultivate a full rich tone to practise before a looking-glass—and the advice is excellent. All undue pressure upon the holes or keys must be avoided; it gives rise to stiff crampy fingers; imparts an unsightly appearance to the hand, and is quite ruinous to execution. It should be the constant endeavour of the student to cultivate an easy unconstrained action of the fingers.

The next article will embrace the period of the great flute reformation.

HIGH PRESSURE BOILERS.

I.—STATIONARY.

THE first steam boiler of which any reliable account exists, was patented by Captain Thomas Savery in 1698, and it was unquestionably a high pressure one. This is abundantly proved by the fact that Savery raised water 80ft. high by the direct pressure of steam; for which purpose a pressure of 35lb. per square inch would be required. He also speaks of raising water in the same way "500ft. or 1000ft. high" could he find boilers strong enough to withstand so great a pressure. Although this statement, on his part, cannot be taken as evidence of his contemplation of an increase of pressure up to the precise point indicated—430lb., yet it shows that he was well aware that very much higher pressures than he was using could be attained. The Marquis of Worcester, in a manuscript written in 1655—which is now in the British Museum—speaks of having forced water to a height of 40ft. "like a constant fountain-stream." If his meaning is, that he raised water to that height in a pipe, we must conclude that he used steam approaching 20lb.; but if his words be taken to express forcing water in a jet, and the phrase "like a constant fountain-stream" seems to bear such a meaning, a pressure considerably higher would be indicated. His acquaintance with very high pressure steam is further shown by his experiments with cannon, which he closed up with a certain quantity of water inside, and then burst by the action of fire. Following the Marquis of Worcester and Captain Savery, we find Newcomen and Cawley, of Dartmouth, labouring at the production of the arrangement commonly known as Newcomen's engine. This was emphatically a low pressure engine; in fact, rather an atmospheric than a steam engine. The steam used in such an engine did not exceed 16lb. above a vacuum, the temperature being 216° Fahr.

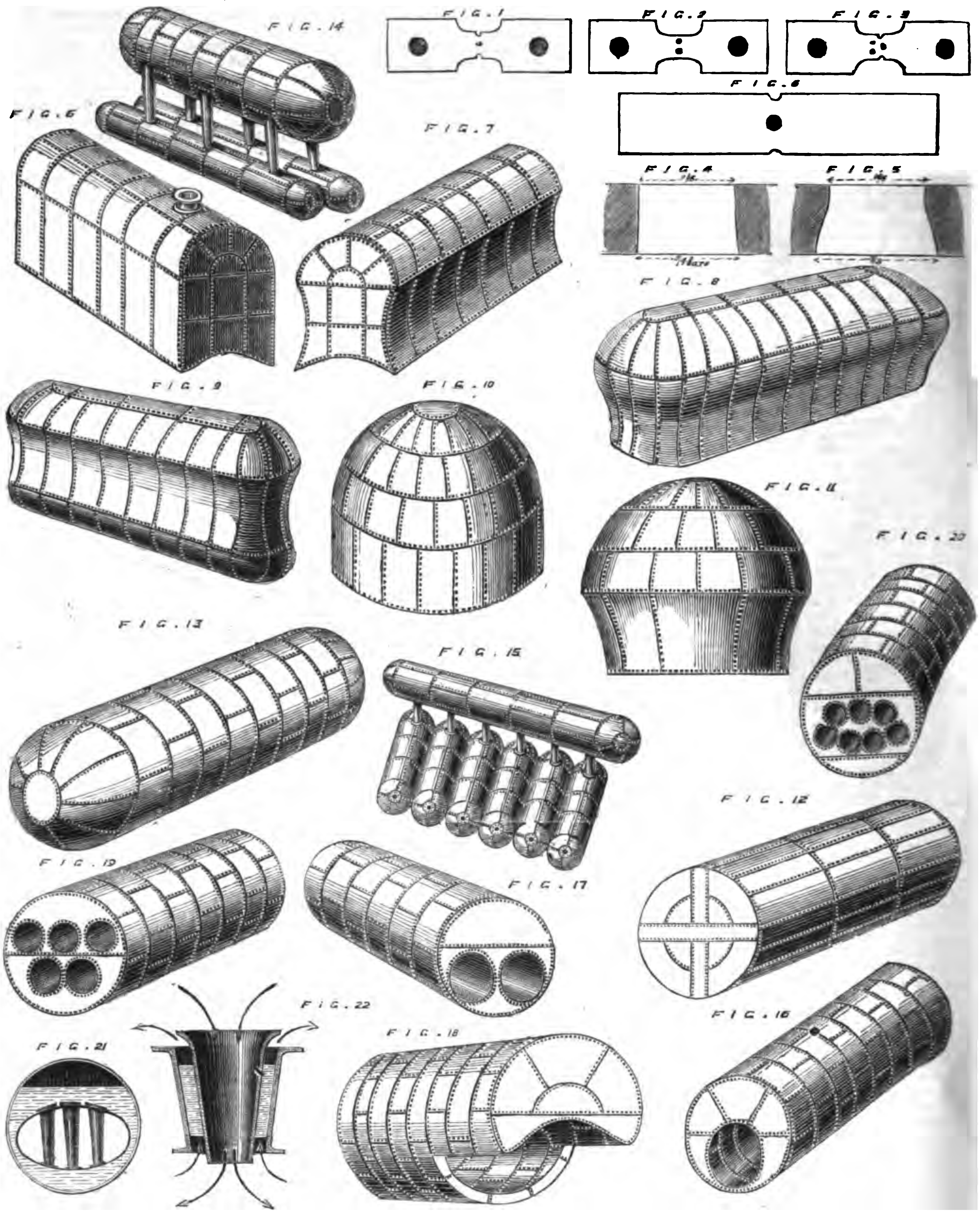
The power was, therefore, really obtained from the atmospheric pressure, and the vacuum produced by condensing the steam. Although the credit of the construction of this kind of engine belongs to Newcomen chiefly, and in some degree to Cawley, yet the honour of the great discovery of producing power by the condensation of steam undoubtedly belongs to Savery. In fact, his claim to this great invention was acknowledged by both Newcomen and Cawley. Smeaton and Brindley were also among the pioneers of low pressure. At length the illustrious Watt did all that could be done in this direction, and attention began to be turned to the advantages of high pressure steam; though not till low pressure had been carried to such preposterous lengths, that boilers made partly of wood and lead were used; nay, even boilers built of masonry were proposed if not actually made. Many profound mathematicians investigated the theory of heat and expansions; and, as the advantages of using steam at high pressures became more and more manifest, many able practical men took the matter in hand. Amongst these may be mentioned Woolf, Trevithick, and Perkins, in England, and Oliver Evans in America.

At the outset, the advocates of high pressure had many disadvantages to contend against in the prejudices and ignorance of the time, and still more in the danger arising from the use of so untrustworthy a material as cast iron in the construction of their boilers. Many of these boilers burst; and, from their extreme brittleness, they very much resembled "infernal machines," scattering death and destruction all round. Very many boilers were made of copper, but finally copper boilers were mostly displaced by wrought iron ones: though even now, we believe, many copper, and even some cast-iron boilers, are at work. The first wrought iron boilers which were made were the Waggon boilers with plain sides and arched top, Fig. 6. These boilers were neither suited to generate steam economically nor to withstand much pressure. The next step was to curve the sides inwards (see Fig. 7), thus improving the economy of the boiler to some extent. We find this form of boiler speedily further improved by rounding the ends (see Fig. 8), and finally the bottom (see Fig. 9). So many accidents occurred with these boilers that it was evident further safety must be sought.

As the Waggon boilers required many stays to keep them from "going out of shape," some boilers were made completely spherical. These spherical boilers gave the full tensile strength of the metal, except inasmuch as they were out of a true sphere by reason of the lap-joints. They were, however, deficient in heating surface, and very subject to burning through at the bottom by the collection of mud and scurf. Improvement was therefore sought by making the bottom considerably flatter than the spherical form.

The desire for heating surface caused the alteration into the well-known Haystack or Balloon boiler (see Figs. 10 and 11). Very great numbers of these boilers were used, particularly in Staffordshire and the district, many being as much as 20ft. in diameter. From their inherent weakness and great size they were terrible "magazines of death." Such great numbers having been used, explosions amongst this class have been very numerous. Owing to this cause, and also to their containing so large a volume of steam and water, a greater amount of destruction of life and property is chargeable to them than to any other form of boiler. A very considerable advance was made by the construction of the Cylindrical boiler (see Fig. 12). These were first made with straight seams and flat ends, but were soon improved by making the seams of rivets break joint, and by the addition of hemispherical ends, as in Fig. 18.

These boilers, however, are very objectionable. They suffer a great strain through the unequal expansion of the top and bottom. They have been made even as long as 100ft. At such an extreme length this inequality of expansion would

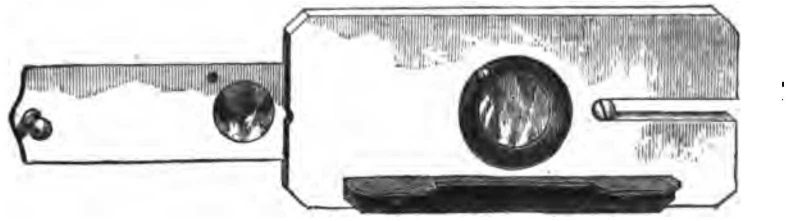


HIGH PRESSURE BOILERS.

be very considerable—though to some extent dependent on the kind of iron used in the boiler as well as in the temperature—and often explosions thus ensue from the "breaking of the back" of the boiler. To keep the diameter of these boilers within bounds, the French have largely employed the compound form known as the Elephant boiler (Fig. 14). A boiler slightly differing from this in detail, but on the same principle, bears the name of the Retort boiler, Fig. 15. The next improvement aimed at economy, and gave us the Cornish boiler, Fig. 16. To obviate the weakness of the larger flued boilers of this class, Mr. Fairbairn introduced the Double-flued boiler, Fig. 17, about twenty-five years ago. These boilers are very safe, and in somewhat extensive use, though by no means to the extent they merit. Considerable numbers of Butterley boilers have been constructed (see Fig. 18), but although they are economical, they are very weak against pressure, and therefore proportionately dangerous. Many minor varieties of boilers might be mentioned. One class of boiler—from its dreadfully destructive nature—claims attention, namely the class used in ironworks. These boilers, surrounded by brickwork, and exposed to the fierce flames from the puddling furnaces, would be sufficiently destructive in any ordinary situation; but, placed as they are, in the very midst of a number of men, amongst whom, when they explode, they scatter a death-dealing shower of bricks, iron, and water, with the frequent addition of some of the hot iron from the furnaces, the carnage produced is often frightful.

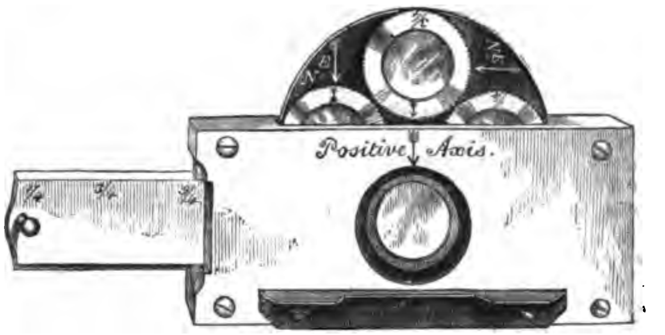
The Multi-flued boiler (see Figs. 19 and 20), demands but little notice, as it has not been found satisfactory in practice, since its economy in fuel is more than counterbalanced by its being troublesome to clean. The Multi-tubular boiler is still more economical in fuel, but also still more difficult of access for cleaning. It is also liable to leak at the bottom, and from those two causes is wanting in durability. It is particularly unsuited to foul feed-water. Amongst the improvements made in boilers of late years Adamson's

FIG. 1.



Blankley's Simple Sliding Selenite Stage.

FIG. 2.



Blankley's Compound Selenite Stage, giving 28 changes of tint and colour.

ACCESSORIES TO THE MICROSCOPE. *Described on page 462.*

flanged joints in internal flues, and Galloway's conical tubes occupy most important places. The strength afforded by the flange joints is very great, and when the frequent collapse of long flues is taken into consideration, is very important. Galloway's tubes, Fig. 21, not only materially strengthen the flues, but they also add a most efficient heating surface, as the flame and gases strike almost at right angles to the metal, while the water rises at a slight angle from it, the best possible conditions for evaporation—and thus they are valuable economisers of fuel. They also cause a very brisk circulation, which further tends to economy, and to the preservation of the boiler by equalizing the temperature of the water throughout, and so preventing unequal strains. It is probable that if inner tubes were added, as shown in Fig. 22, that the efficiency would be still greater, as such inner tubes would separate the water into two currents, upwards and downwards. All the boilers we have hitherto noticed, differing as they do largely, *inter se*, have one peculiarity in common, namely, that they each contain a large volume of water and steam. In case of an explosion there is, therefore, a correspondingly large supply of destructive material. Further, they are each to some extent deficient in economy of fuel, as they allow the heated gases to *slide* to too great an extent along their heating surfaces, not breaking up the current sufficiently; and they are also, as a rule, wanting in circulation. These last objections do not apply much to Galloway's boiler, the first does. Many attempts have been made to so construct boilers as to be free from these objections, and also to carry high pressures. An early labourer in this field was Dr. Ernst Alban, of Plau, who produced a very able and exhaustive treatise on boilers about a quarter of a century ago. He discusses pressures up to 1,000lb. per inch. He was the originator of some very ingenious water-tube boilers. As these boilers have, however, become obsolete, they hardly fall within the scope of the present article. James and others proposed tubular boilers, having an extra inner tube to promote circulation. These inner tubes by no means answered the purpose for which they were intended, as the upward and downward currents met each other at the tops of the two tubes—inner and outer—and the circulation was far from being satisfactory. Mr. Field combatted this difficulty by splaying the top of the inner tube, which thus become trumpet-shaped. That the "Field" tube answered its purpose may be gathered from the favour it enjoys and the large number—upwards of 60,000—in use. It has been found extremely applicable to fire engines, as it is a very rapid generator, so much so, that steam of 100lb. per inch has been raised from water at about 45° Fahr. in 7½ minutes, in a boiler fitted with these tubes. These boilers are extremely suitable where quickness, high pressure and economy of fuel are required; and where constant and competent supervision is given to the firing and "feeding." They are not likely, however, to be generally adopted for factory and other uses where more liability and neglect exists.

We have now to notice a boiler which is, perhaps, in most respects the best yet introduced. The one we allude to is Howard's Safety Boiler. This boiler possesses the following requisites of a good steam generator:—It affords ample heating surface of the very best kind for efficiency, as the flames and currents of gas are thoroughly broken up by the alternations of the vertical tubes. It offers a maximum amount of safety at high pressures; in fact, it is doubtful whether more than *one* tube would go at a time, even if an explosion did occur, which is very unlikely, as the tubes being small are of enormous strength, and are further, by reason of their shape, subject to simple tensile strains only, and therefore no very extensive damage would be likely to accrue. It also acts as a very efficient superheater, thus giving the two great advantages of very high and perfectly dry steam. Inasmuch as corrosion and scaling are undoubtedly the two most serious evils which have at all times attended boilers, so must importance attach to the fact that in Howard's boiler so good a circulation is obtained as to do away with the accumulation of scale. A further great advantage lies in its non-liability to injurious strains, as its construction admits of its yielding in all directions to the expansion and contraction consequent on changes of temperature. This boiler is also remarkably easy to repair. The only drawback to it lies in the rapidity with which the water will rise or fall in it. This difficulty is nowadays met, to a great extent, by Giffard's injector; but it must be borne in mind that the very class of users *most* likely to neglect their boilers are also *least* likely to adopt so beautiful a contrivance as the injector. In fact, the writer himself some little time back took out an old feed pump and put an injector in its place, which gave the utmost satisfaction. Some little time after the boiler passed from under his control, when the pump was reinstated, merely on the plea that the injector was "too scientific."

As regards the future of steam boilers, we may expect that high pressures will continue to become more general as their economy is more widely appreciated. At the same time, let us hope that the increased dangers resulting may be guarded against by an efficient system of inspection and improved workmanship and materials in the boilers, with the more extended use of double lock-up safety valves and alarums, fusible plugs, and trustworthy water and steam gauges in *duplicate*. At the present time it is dreadful to contemplate the numbers of boilers working literally at random. The writer went a few days back to a place where they had had an explosion of a boiler, which, though fortunately unattended by loss of life, had been fearfully destructive. Yet, notwithstanding this severe lesson, they had actually put down an externally-fired cylindrical boiler—a most unmanageable and mischievous form—without water or steam gauge, or even a fusible plug or alarum: its sole safeguards being a float with a stuffing-box, and a most inefficient safety-valve weighted to *sixty pounds*. At the time of our visit the steam was blowing off furiously, so that the pressure must have been much above 60lb., very likely nearer 100lb. per inch. The danger was by no means diminished by the fact that the boiler was made with lap joints, and, of course, single riveted.

If cylindrical boilers are to be used at high pressures, the bodies and flues ought to have the longitudinal joints welded, and each length rolled to a truly circular shape, The transverse joints ought all to be double butt joints, and the plates thick edged, on Alton's plan. As regards rolling a tube, why should not complete bodies and flues be rolled at once? It is only a question of size of machinery and careful design. The demand for such boilers could not fail to be large.

It is very probable that far too little attention has been bestowed on the electrical influences brought to bear in corroding the iron of boilers, where the plates and rivets differ in amount of carbonization, &c. Bessemer steel offers a very suitable material for boilers of all kinds, and of late very considerable advance has been made in its application. As a proof of this it may be mentioned that up to March, 1868—since which we have no return—three firms in Lancashire had turned out no less than 277 steel boilers, and 152 composition boilers, partially of steel.

That these numbers are far under the mark now may be inferred from the fact that the demand was then rapidly increasing. As steel of great ductility can be got capable of bearing an ultimate strain of 33 to 35 tons per square inch, the very great superiority of such a material to iron, only capable of bearing 20 to 22 tons, needs no lengthened comments. The use of steel for boilers has been much restricted by the general impression that the steel *must* be drilled and not punched. That drilling is, *per se*, better than punching we feel convinced, but is it not just as superior for iron as steel, if the latter be afterwards annealed?

With regard to punching steel plates, we have before us the results of a very careful set of experiments carried out by the Bolton Iron and Steel Company, and, from their important bearing on the question of increased safety with high pressure boilers, we give the tabulated results. Six pieces 23in. long by 7in. broad and 5-16in. thick, were cut from the *one* steel plate. Three of these were prepared by punching, and three by drilling, with ¾in. holes, 1¾in. from centre to centre, suited for single and double riveting. In a strapping machine these were then cut to the forms shown in Figs. 1, 2, and 3.

They were tested in a lever machine by dead-weight. The results are given in Table I.:—

TABLE I.*

Number of Test.	Thickness.	Area.	Breaking weight on Lever.		Weight per sq. in. of section drilling.	Weight per sq. in. of section punching.
			Tons	cwts		
1 D.	$\frac{5}{16}$	0·5437	19	8	35·32	
1 P.	$\frac{5}{16}$	0·55625	14	17		26·690
2 D.	$\frac{5}{16}$	0·55	20	10	37·27	
2 P.	$\frac{5}{16}$	0·5625	13	5½		23·735
3 D.	$\frac{5}{16}$	0·5466	19	18	36·40	
3 P.	$\frac{5}{16}$	0·5593	12	12½		22·570

It will be noticed from this table that the punching has a deteriorating effect of 26·4 to 37·8 per cent., being an average of 33 per cent. Examination under a powerful glass revealed the cause of weakness, and led to the trial of annealing. In the following table are given the results of sixteen tests carried out at Chatham Dockyard. The results are furnished by Mr. Barnaby, Assistant Constructor of H. M. Navy.

In these experiments eight plates of steel had each four holes of 0·66in. diameter punched in them. Each plate was then cut in two, and one piece of each annealed. The plates were ½in. thick. The testing was performed in an hydraulic testing machine. The average ultimate strength of the eight annealed plates rises as high as 32·839 tons per inch of section; that of the unannealed plates was only 21·097 tons. Thus it will be seen that there is a difference of 11·742 tons in favour of the annealed plates, equal to 55·66 per cent. It is further well worthy of notice that the annealed plates are very much more reliable, as they show a difference of only 5·416 tons between the two extremes, while the unannealed vary as much as 9·372 tons.

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* Extracted from Transactions of the Institution of Naval Architects, 1868.

TABLE II.*

No. of sample.	Size of Sample.	Breaking Strain				Breaking strain per square in.	
						Annealed.	Unannealed.
		Tons	cwt	qr	lb		Tons.
1 A	2·28 × ·475	21	0	0	0		19·69
1 A	**2 28 × ·475**	**35**	**15**	**0**	**0**	**33·010**	
2 A	2·33 × ·47	28	17	2	0		26·369
2 A	**2·23 × ·475**	**31**	**15**	**0**	**0**	**29·991**	
3 L	2·18 × ·47	28	0	0	0		24·469
3 L	**2·23 × ·48**	**37**	**7**	**2**	**0**	**34·229**	
4 L	2·23 × ·47	23	17	2	0		23 781
4 L	**2·23 × ·48**	**37**	**17**	**2**	**0**	**35·397**	
5 A	2·23 × ·475	20	0	0	0		18 885
5 A	**2·23 × ·48**	**32**	**17**	**2**	**0**	**30·274**	
6 A	2·28 × ·475	19	10	0	0		18·005
6 A	**2·28 × ·475**	**33**	**17**	**2**	**0**	**31·273**	
7 L	2·23 × ·475	18	0	0	0		16·997
7 L	**2·23 × ·475**	**35**	**10**	**0**	**0**	**33·522**	
8 L	2·28 × ·475	25	17	2	0		22·891
8 L	**2·23 × ·475**	**35**	**17**	**2**	**0**	**33·876**	

Note.—The annealed portions are shown in antique type.

It is advisable in making steel boilers to use double butt joints and double riveting, as otherwise the rivets will sheer with far less than the breaking strain of the plate; unless, indeed, the rivets used be so large as to gain strength to the detriment of the plate. The proportions given by Mr. Henry Sharpe, of Bolton, are for 5-16in. plates, diameter of rivets, 9-16in., pitch, 1⅞in., double riveting; material of rivets, mild steel. With these proportions two tests gave the following excellent results, with plates taken at random from a large quantity of steel boiler plates which were being rolled to order by the Bolton Company (*a*), drilled plate 42·9 tons, and (*b*) punched ditto, 39·11 tons per square inch of net sectional area. Mr. Sharp further experimented as follows:—

A punch of 11-16in. was used; first, in the ordinary way, with a bed ⅞in. bare, producing the hole shown in Fig. 4; then a bed, ⅞in. in diameter was used, giving the result shown in Fig. 5. The plates were dressed to the form shown in Fig. 6. When tested, which was done without annealing, the taper-holed plates gave an average of 32·527 tons per square inch of net sectional area; the plates with straight holes, 26·004 tons. These taper holes must offer advantages to riveting up.

It is certain that the desire for economy will lead to the more extensive adoption of high pressures, heated feed-water, and the super-heating of steam. As regards the heating of feed-water, we may notice "Green's Economizer" as a very efficient apparatus. Its chief peculiarity, as is well known, consists in the scrapers—which are very slowly moved up and down by simple gearing—to clear off the soot from the pipes through which the feed is passed. By this clearance the pipes are kept efficient in absorbing heat. Very considerable saving of fuel has been effected by the use of this apparatus. Waters's heater is exceedingly suitable for non-condensing engines. It possesses the advantage of thoroughly heating the water to the boiling point, and also of causing the deposit of its earthy matters as mud in the heater. With the increase of pressure, the frequency and destructiveness of boiler explosions will increase unless efficient means be taken to combat the dangers spoken of.

Any one who will read the reports of any of the very excellent boiler associations will be convinced that, if boilers were all well made to begin with, as regards workmanship, design, and material, well mounted with efficient duplicate safety-valves (locked), water-gauges, alarums, steam-gauges, and fusible-plugs, and finally, properly inspected, explosions would be few and far between. It is to be hoped that the Bill on this subject, introduced by the hon. member for Dudley, may either become law or lead to even more efficient legislation. Let us hope also that the barbarous system of buying boilers at per ton may give way to an intelligent mode of valuation. When this is done, and the great value of pure feed-water recognized, we may expect an explosion to be a rarity.

A further improvement required is the entire remodelling of "Crowner's quest-law," by which a coroner, who knows little or nothing of boilers, is assisted (?) by a jury, who usually are chosen as though it were desirable to get those who know "nothing of anything."

We want a competent tribunal to inquire into all explosions, accidents on railways, in mines, &c., whether actually fatal or not. At present we witness this absurdity, that a minor accident may occur by which *one* life is sacrificed, and *two* coroners set to work; on the other hand, an accident which maims hundreds for life will not move one coroner, unless some case of death should result. These are the abuses of a bygone age which have dragged on to the present.

ACCESSORIES TO THE MICROSCOPE.

No. I.

(*Illustrated on page 461.*)

IN connection with the polarization of light, the crystal commonly known as selenite has played an important part, and by its aid some very remarkable effects have been produced. Microscopists have not been slow in applying it to their pet instrument, and various arrangements have been invented to get the best effects, so that the objects viewed by its aid, might be seen to the best advantage. A short time since Mr. F. Blankley brought before the notice of the Fellows of the Royal Microscopical Society, two forms of selenite stages, which possess two great advantages: first, simplicity of construction; and secondly, the ease with which they can be worked.

It may not be known to all our readers that different thicknesses of selenite give different colours, and that the structure of some objects can be seen much better with one colour than with another. It will therefore at once be seen how desirable it is to view each object under every tint, so that the best effect may be secured.

Fig. 1 consists of a small brass stage, 3¼in. long and 1¼in. wide, in the centre of which is an aperture through which the object is viewed. On the under part of the stage is a dovetail groove, into which is fitted a brass slide containing three or four selenites, which work as freely as the investigator may desire. A small spring stops the slide when the selenite is immediately under the aperture.

Fig. 2 represents the compound stage, which consists of a brass stage of similar dimensions to the one just described; and, in addition to the brass slide, has a revolving diaphragm with three selenites, each made to rotate, and a clear aperture, so that the object may be viewed with a single film if desired. In this stage each selenite is much larger than those in the small one, and is marked in quarters, so that the colours obtained may be registered and turned to at any time.

To increase the variety of colours and tints, rotate each selenite until their cleavage is at the right angle of the positive axis of those on the slide.

The positive axis of each selenite in the diaphragm is marked coincident with those in the slide. By working each film as thus described, twenty-eight tints and colours will be obtained, and can be recorded for further reference. It will be observed that the whole of the changes are obtained without moving the stage or taking the object out of the field or focus, thus saving much time and trouble. They are made by Mr. Swift, 128, City-road, London, who is preparing a complete list of changes that can be effected by them.

ORGANIC LIFE.

By H. B. Baker, M.D., of Wenona, Mich., U.S.

THE ORDER OF CREATION OF LIVING BEINGS, FROM BIOLOGICAL EVIDENCE.

BEGINNING with the highest organism, we know that man takes food, which is then still further organized into the human tissues, and thus in early life he grows; and throughout life can only, through continued use of food, maintain his existence. It is also known that he is only able to assimilate matter that has been, to some extent, previously organized; and this is true not only of man, but of all animals. Even *infusorial animalcules* require for their existence the presence of organized food, either animal or vegetable. Cer animals require animal food, others can live wit out that; but some can maintain life without least food derived from the vegetable kingdom.

Following down the scale of organization, we fi that vegetable life and growth require the prese of matter arranged at least into binary compoun Vegetable tissues are made up of carbon, hydrog oxygen, and nitrogen, but, so far as known, the elements are always obtained by plants from matt organized or arranged in compounds such as ca bonic acid, ammonia, &c.* These compounds m be, and at present are, in part derived from t animal kingdom, though not necessarily so, for th result from the breaking down of vegetable matt and may be naturally produced by union of th elements.

Although the animal kingdom cannot be mai tained without vegetable food, the vegetable kin dom may be without animal food; and althou vegetable life and growth cannot be maintai without matter arranged at least into binary co pounds, these compounds which serve as food plant-life can be formed and maintained with the aid of animal or vegetable matter. The an kingdom is then essentially primarily supplied food from the vegetable kingdom, and this, in from binary and higher compounds. The co compounds, chemistry teaches us, are formed b union of simpler ones, and the simplest by union of elementary atoms.

These seem to be universal laws, to which are no known exceptions.

Food is essential to the growth of all organi Growth being an increase of the elements of w a body is composed, in certain definite proporti and having the arrangement proper to the grow body, it is in fact a continuation of the process organization, and the food required for growth m at least be required for the first organization creation; for *the food of all organisms contain a proper form their constituent elements.* If crystal be placed on the solution from which it wa formed, it will, under proper conditions, grow. On condition to its growth is the *supply of its prope* food, which consists of the *same elements, havin* the same arrangement as *required for its first fo* mation. The seed of a plant exposed to *moisture* absorbs water, and sap or food is formed from the material stored up in the seed which had been separated from the watery portion of the sap contained in the parent plant; when its supply of matter, which by the addition of water serves as food, is exhausted, more is supplied from the surrounding air and soil. Like the crystal, so long as its proper food is not furnished, the germ of th seed remains stationary; and when again, unde proper conditions, supplied with constituent matt through the action of the organizing forces nature, it grows. Animal tissues grow by mea a supply of blood, the composition of which di in different kinds of animals, but is essentially same solution as the blood of the parent from wh the germs or eggs of each were formed. In these cases it is not necessary that the solution the food should contain only the constituent ma but that must be present.

It is, moreover, important to notice that this c stituent matter must be to a certain extent p viously organized. This may, perhaps, be be understood if we notice first the formation of crystal, which may be considered as illustrating formation of all organic germs. Crystals form solutions having the organization proper to crystal; the solution must not only contain elements of which the crystal is composed, but must be arranged in molecules, correspondin the crystalline compound. For instance, a sol may contain soda, chlorhydric and sulphuric and crystals of chloride of sodium will not because the constituent elements, although p are not combined or arranged with the prop nite relation to each other. Crystals of sul soda will form from such solution, und per conditions, because its elements are bined.

The pollen and seeds as well as buds of pl formed from the sap, which is the pla selected from the surrounidng earth and air; matter organized in the manner peculiar to plant; it is, in fact, the germ of the plant in solut and seeds may in a manner be said to crystal from it. The spermatic fluid and eggs of anim are formed and perfected in an analogous man by compound molecules, separated or secreted fr the highly organized animal fluids. The format of the fluids from which these crystals, seeds, a eggs are formed, requires the presence of the fo proper to each, and it must consist of their cons tuent matter properly arranged.

From what is known concerning the laws whic govern the maintenance of life by food, organ growth, the essential nature and constitution food, the formation of the germs of organisms an the formation of chemical compounds, we see justified in concluding that animal life is alwa necessarily preceded by vegetable life; that this is always necessarily preceded by a certain amount of arrangement of elements into binary and more complex compounds; that the complex compounds are universally formed from simpler ones, and the simplest by union of the elementary atoms. We can thus trace back the order of creation, or evolution of living beings, to the chemical elements.

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* Transactions of the Institute of Naval Architects, 1868.

* It seems proper to state that this article was writt before the writer had seen or heard of Professor Hu ley's lecture on "The Physical Basis of Life."

THE BEGINNING OF LIFE. ITS LOWEST FORM, AND THE SIMPLEST ORGANISMS.

In studying the creation of living organisms, if we start with any of the higher animals, and trace back the life of an individual, we find it to begin in an organized form of matter, an egg. But the egg is a complex substance, and, although some of the conditions to its formation and development into a living being are well understood, studied by itself it is difficult to understand the creation, beginning, or source, of its vital force; and, if we understand from whence the force is derived, it is still difficult to see what gives direction. If we direct our attention to the vegetable seed, we meet with the same difficulties. In order that we may understand the creation of the higher organisms, it may be well to search out the lowest, and begin the study of life in its simplest form; and, that we may be able to recognize the object of our search, we should have a reasonably perfect definition of the word life, and an idea of the characteristics of living beings. A complete and perfect definition is difficult, and is not assumed to be here given; but it will be sufficient for our present purpose to say that, from the word life, we receive an impression of certain phenomena attendant upon changes which occur in organized bodies as results of their experiences of force. This definition is perhaps incomplete, but, in fact, any attempt at a perfect definition must necessarily be unsatisfactory so long as only the higher forms of life are considered. We cannot properly define a thing until the whole of it be somewhat understood. However, if we bear in mind our imperfect definition, and keep in sight the higher kinds of life which we do understand, we can search for the lowest, which we may not, and when the whole has been considered, a definition may be more satisfactory. Let us, then analyze the characteristics of the higher living beings from which we have received our first ideas of life, and learn their essential nature. By reducing these characteristics to their lowest terms, we ought to deduce an ideal lowest form of life.

The prominent phenomena which characterize living beings are—1. Organization; 2. Definite Chemical Composition; 3. Definite Form; 4. Growth; 5. Continual Change; 6. Motion; 7. Reproductive Power.

Our idea of life being mainly formed from our knowledge of these characteristics, the ideal lowest form should have them in the simplest degree.

Commencing the search by considering them singly, we notice first that living bodies are organized.

According to the ordinary definition, an organism is a body consisting of organs, or mutually dependent parts having functions. The lowest organism should consist of the least number of mutually dependent parts, having functions of the simplest character.

The least mutually dependent number would be two—and, as the smallest portion of matter imaginable is called an atom, nothing less than that could be conceived as having a function; and, as the functions of two precisely similar atoms would be least contrasted, and of the simplest character, the lowest organism should consist of two equal atoms organized or arranged, so that its existence as an organism would depend upon the functional activity of each, which might consist in their mutual attraction for each other. This would be the case in a molecule consisting of two atoms of a chemical element. And, as the atoms of an elementary substance are alike, their functions would be equal.

We notice, next, that living bodies have a definite composition; they consist of definite proportions of certain elements definitely arranged. Arrangement implies relation, and would require, at least, the presence of two units. The simplest definite proportions would be equal, and as the least portion of matter is the atom, a definite compound reduced to its lowest terms should consist of two equal atoms arranged with the simplest definite relation to each other.

As to form, we should expect to find the lowest life, having definite form, of the greatest simplicity.

Complexity of form results from complex arrangements of heterogeneous elements; the greatest simplicity of form will result from the simplest arrangement of like elements. Simple definite forms are found in crystals of the chemical elements, gold, copper, iron, sulphur, phosphorus, carbon, &c., which usually crystallize in simple cubes or octahedrons.

Growth is an increase of the elements composing the body, in the proportion and having the arrangement proper to it. The simplest requirement for growth would be the smallest equal proportions of one element with the simplest definite atomic arrangement. This might be the case in bodies consisting of one element.

The changes occurring in a living body to a certain extent, result from the forces acting upon it. As the atoms of an elementary body are alike, and, subjected to the same force, vibrate alike, and the atoms of different elements are unlike, and vibrate differently, few or many changes will be produced by a given force, according as it acts upon a body consisting of one or many different elements. A given force should therefore produce the least number and variety of changes by combination or rearrangement, and by mutual reactions of constituent matter and force, will be least where atoms of only one element are present.

Motions result from force, and the greatest variety of motion will be produced by forces acting upon the greatest number and variety of elements. Motion of the simplest character results from the action of force upon homogeneous matter.

Reproduction consists, essentially, in the generation of new bodies, and communicating to them the properties characterizing the parent, as regards both matter and its arrangement. The reproductive process should be simplest where the body to be reproduced is simplest, and we have seen that this must be the case when it consists of the least organizable quantity of one kind of matter, viz., of two atoms of one chemical element.

If we now sum up these several least requirements, we find that, from this analysis of the characteristics of living organisms, it appears that, reduced to their lowest terms, they must consist of *two atoms of a chemical element arranged with the simplest definite relation to each other*. This should be the *beginning of the lowest form of life*, and we also found this to be the lowest ideal organism. It is represented by the ultimate molecule, which may be the nucleus or beginning of a crystal of a chemical element.

The conclusion here reached by deduction will no doubt be at first regarded with astonishment, and without inductive proof it is not expected that this view can be received except by those already prepared by a knowledge of such proof; but the evidence which the writer has seen on the subject is such as to convince him that the same conclusion may be reached by other and more satisfactory methods of research. This method of first presenting the subject has, however, been selected because it seems to show, from a study of the somewhat imperfect idea of life, what is necessary to its perfection. Consideration of the subject from this stand-point first, may prepare some minds to study it thoroughly without the prejudice which might otherwise prevent; and, finally, because the building up of any structure is greatly facilitated by first perfecting a definite plan, so that the position and relation sustained by the component parts may be readily seen as soon as each is presented.

It is believed that the generalization indicated may be made and established with great advantage to the study of biology. The plan of the creation or evolution of living organisms is thereby rendered much more simple and easy of comprehension, as may perhaps be made to appear at some future time.

The ideal lowest form of life and the lowest organism we have found to consist of "two atoms of an elementary substance arranged with the simplest definite relation to each other," and we know that there are existing in nature such combinations of matter. In a previous part—"The Order of Creation of Living Beings"—it was pointed out that their creation could be traced back to the chemical elements as its starting-point. From this lowest form of life there is a constantly-ascending scale up to human life. From this simplest organism there is a constantly-increasing complexity of combination and organization up to the human organism. An attempt will be made to show that the phenomena attendant upon changes occurring in the simpler combinations which may be called primary organisms resemble, and are in fact similar to, those which are recognized as characteristic of living beings. We shall find how perfectly they accord with our definition of life.

Beginning the subject inductively, let us first consider organization; that being an acknowledged characteristic of at least the higher living beings, and the first one mentioned in our analysis.

The word organism has heretofore, I believe, only been applied to those compounds which have *visible* distinctions of parts; leaving out, among those which have not such distinctions, some which were nevertheless considered living. "The lowest living things are not, properly speaking, organisms at all; for they have no distinctions of parts, no traces of organization"—(Herbert Spencer). Before the microscope revealed its world of living beings, the general idea of organisms probably included only those whose organs or distinctions of parts were visible without its use; some minute moving bodies were no doubt by some considered living, although their organs could not then be distinguished. Afterward, with the aid of the microscope, their organs were plainly seen, as were also myriads of other organisms. With the microscope other minute moving bodies have been brought to view, and are now considered living, although their organs cannot be distinguished. We have again reached a point where a still higher vision is required to enable us to see a mutual dependence and distinction of parts, and again show that the lowest living things are organisms.

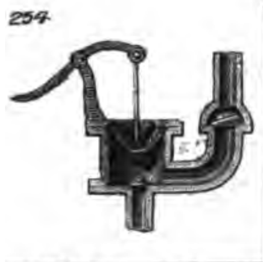
This higher view is furnished us through a knowledge of chemistry, which teaches that there is a *mutual dependence of parts which extends to the molecules, and even to the ultimate atoms of all definitely combined matter*. A definitely chemical compound consists of definite proportions of matter definitely arranged. For instance, albumen is composed of carbon, hydrogen, oxygen, and nitrogen, in certain proportions, and arranged in a certain manner: if either the proportion or the arrangement be destroyed, the matter no longer constitutes albumen. The several elements of which it is composed may be considered as organs performing essential functions, their mutual dependence being absolute; for, if one be removed, the compound is destroyed. Probably the presence of each atom of each element is essential to the existence of the compound, so that a molecule of albumen may be considered an organism, although not in accordance with the idea heretofore entertained. The same may be said of a molecule of water or of any other such group of atoms definitely arranged. Albumen was selected as an example, because the lowest living things revealed by the microscope cannot, by the aid of the highest magnifying power, be distinguished from mere minute particles of albumen.

Whether the lowest living things can be properly called organisms, will depend upon the definition of the words organism and organ. According to the ordinary definition, an organism is a body consisting of mutually dependent parts having functions, and an organ is one of such parts. The word organ, as appears from the above quotation, has heretofore been applied only to *visibly* distinct parts having functions, &c., although the definition in our standard dictionary is similar to the one given above, and has no such requirement.

The standard definition will allow of its use in the extended sense that I wish, viz., to denote any mutually dependent parts of definitely-combined matter having separate functions, whether or not the part or function be capable of demonstration to the single sense of vision. It is essential to a right understanding of scientific problems, that the terms employed should have a precise meaning. If the words organ, organism, and organized, cannot appropriately be used in connection with all definitely-combined matter, and must, on account of old associations, be restricted to such compounds as have visible distinctions of parts, then it would seem to be advisable to invent new terms which shall, in a word, or as concisely as possible, embrace all such compounds, and thereby render easy this comprehensive and general view. But if this be done, the old words left as heretofore, there is then no well-marked limit or beginning of organization, for what is visible to one, under certain circumstances, may not prove so to others, and again the limit would vary with the magnifying power used. If however, the old terms (organism, &c.) be retained and thus defined, it will still be easy to distinguish between visible and invisible organs; the invisible organization may be denominated primary, as it undoubtedly is, to vegetable and animal organization. In my opinion, the science of biology will at present be best facilitated by thus extending and defining the words used. The important reason for wishing thus clearly to define and extend their meaning is to collect under one general view the prominent phenomena attendant upon matter arranged in definite compounds. At present certain highly-complex, definite compounds are called organisms; certain others, less complex, living things, but are not considered organisms, because not having visible organs; others, nearly as complex as these last, are called organic, because heretofore only found in organisms; others still complex, are called inorganic chemical compounds. The prominent fact connected with all these structures is, their definite composition and definite atomic or molecular arrangement: and the certain and regular phenomena attendant upon their experience of certain conditions are believed to be in consequence of this definite composition. This broader generalization seems to me to be useful, taking in as it does all definite combinations, and distinguishing them from amorphous, non-arranged, or, according to my view, unorganized matter. If this be done, as heretofore indicated, the beginning of the simplest organization will be where the first two atoms unite with a certain or definite relation to each other, to form a definite compound. In accordance with the foregoing views, life is conceived to be manifested by all organized matter, the kind of life depending upon the character of the organization.

Among scientific men, at the present time, the tendency is to look for the lowest organization and the beginning of life among the pretean compounds; and protoplasm is the name given to what many now consider as the connecting link between inorganic matter and living organisms. It seems to me, however, that they are not searching deep enough; that protoplasm is about midway between amorphous matter and the highest organisms, and cannot profitably be considered as the beginning of life or of organization, although it may be, as the beginning of the two highest organic kingdoms—the

MECHANICAL MOVEMENTS.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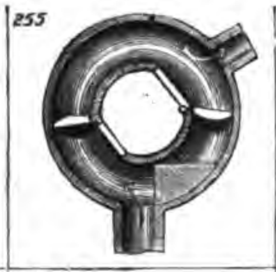
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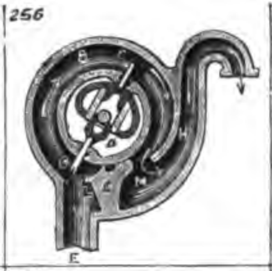
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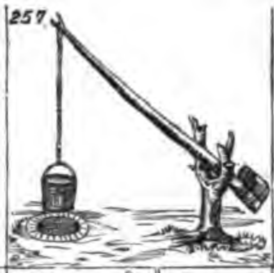
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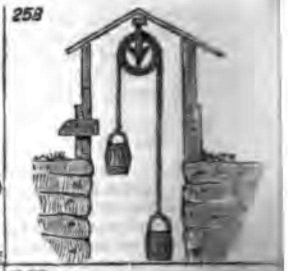
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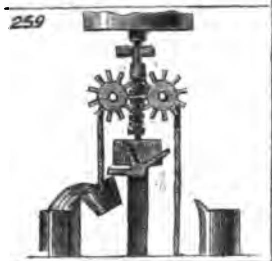
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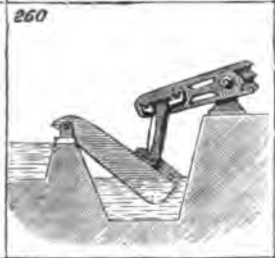
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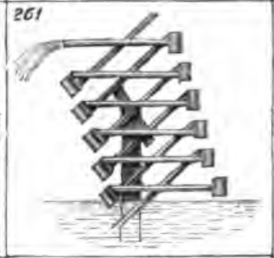
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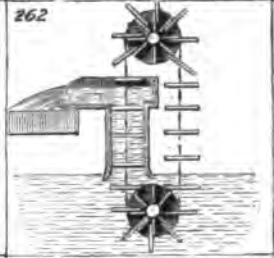
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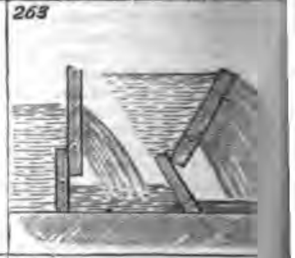
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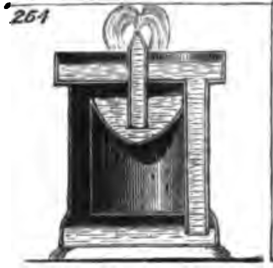
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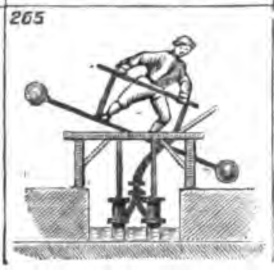
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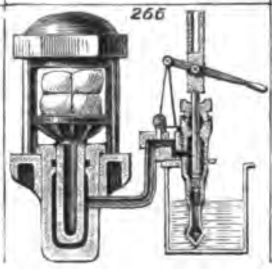
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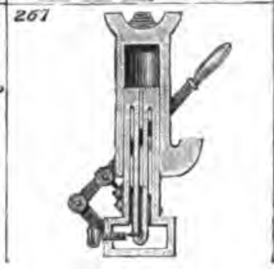
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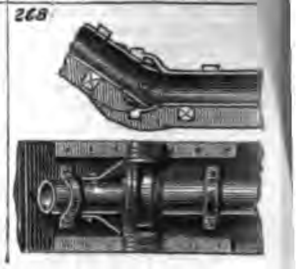
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vegetable and animal. I prefer to consider the diamond as one of the lowest organized forms, and with my mental vision distinctly see the beginning of organization and the conditions for life where, through certain conditions of force, the first two elementary atoms are enabled to manifest their mutual attraction, and affectionately and definitely embrace.

We have, however, considered only one of the characteristics of living beings; we have still to consider, in this connection, definite chemical composition, form, growth, continual change, organic motion, and reproductive power.

Definite Composition of Organisms, and Consequent Definite Function.—Proximate analysis of the higher organisms shows them to be composed of various compounds, such as water, sugar, starch, fats, albumen, fibrin, &c., which are called proximate principles. Ultimate analysis of these proximate principles shows them to be definite chemical compounds, essentially the same in all organisms of a kind; but, to a certain extent, peculiar to each kind, either in quality or proportion.

Water is essential to the composition of all the higher organisms; each kind of organism having, within certain limits, its own peculiar, definite proportion, which is essential to its existence as an organized form.

Although free, uncombined water is always the same under the same conditions, the properties of organisms, formed by its combination with other substances, in great measure depend upon its proportion and manner of union.

The sugars, as existing in various organisms, are more or less peculiar to each. Sugars derived from the maple, cane, grape, or beet, can usually be distinguished from each other, and from those derived from other sources, by their obvious characters. It is generally possible, by observing the flavour, to tell the source from which honey has been collected. Animal sugars, no doubt, differ, although, as yet, they are not as well understood. There is doubtless, much to be learned concerning the various kinds of sugar, but chemical examination has demonstrated that many of these different kinds have different chemical composition.

The grains of starch, from different organisms, may generally be distinguished by viewing them through a microscope: their forms being different, they have, at least, a different arrangement of elements.

These simple compounds, consisting of few elements, can, consequently, have few modifications. Water, consisting of quite simple proportions, of only two elements, is always water, and we know of only one kind of pure water. Sugar and starch, consisting of several atoms each of three elements, exist under several modifications of composition, as regards proportion and arrangement of elements.

(*To be concluded next week.*)

Some new minerals composed of oxides of lead and antimony have been discovered. M. Descloizeaux is engaged on the study of their crystallography

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MECHANICAL MOVEMENTS.

(*Continued from page 448.*)

254. Diaphragm forcing pump. A flexible diaphragm is employed instead of bellows, and valves are arranged same as in preceding.

255. Old rotary pump. Lower aperture entrance for water, and upper for exit. Central part revolves with its valves, which fit accurately to inner surface of outer cylinder. The projection shown in lower side of cylinder is an abutment to close the valves when they reach that point.

256. Cary's rotary pump. Within the fixed cylinder there is placed a revolving drum, B, attached to an axle, A. Heart-shaped cam, *a*, surrounding axle, is also fixed. Revolution of drum causes sliding-pistons, *c*, *c*, to move in and out in obedience to form of cam. Water enters and is removed from the chamber through ports, L and M; the directions are indicated by arrows. Cam is so placed that each piston is, in succession, forced back to its seat when opposite E, and at same time other piston is forced fully against inner side of chamber, thus driving before it water already there into exit-pipe, H, and drawing after it, through suction-pipe, F, the stream of supply.

257. Common mode of raising water from wells of inconsiderable depth. Counterbalance equals about one-half of weight to be raised, so that the bucket has to be pulled down when empty, and is assisted in elevating it when full by counterbalance.

258. The common pulley and buckets for raising water; the empty bucket is pulled down to raise the full one.

259. Reciprocating lift for wells. Top part represents horizontal wind-wheel on a shaft which carries spiral thread. Coupling of latter allows small vibration, that it may act on one worm-wheel at a time. Behind worm-wheels are pulleys over which passes rope which carries bucket at each extremity. In centre is vibrating tappet, against which bucket strikes in its ascent, and which, by means of arm in step wherein spiral and shaft are supported, traverses spiral from one wheel to other, so that the bucket which has delivered water is lowered and other one raised.

260. Fairbairn's bailing-scoop, for elevating water short distances. The scoop is connected by pitman to end of a lever or of a beam of single-acting engine. Distance of lift may be altered by placing end of rod in notches shown in figure.

261. Pendulums or swinging gutters for raising water by their pendulous motions. Terminations at bottom are scoops, and at top open pipes; intermediate angles are formed with boxes (and flap valve), each connected with two branches of pipe.

262. Chain pump; lifting water by continuous circular motion. Wood or metal discs, carried by endless chain, are adapted to water-tight cylinder, and form with it a succession of buckets filled with water. Power is applied at upper wheel.

263. Self-acting weir and scouring sluice. Two leaves turn on pivots below centres; upper leaf much larger than lower, and turns in direction of stream, while lower turns against it. Top edge of lower leaf overlaps bottom edge of upper one and is forced against it by pressure of water. In ordinary states of stream, counteracting pressures keep weir vertical and closed, as in the left-hand figure, and water flows through notch in upper leaf; but on water rising above ordinary level, pressure above from greater surface and leverage overcomes resistance below, upper leaf turns over, pushing back lower, reducing obstructions and opening a bed a passage to deposit.

264. Hiero's fountain. Water being poured in upper vessel descends tube on right into low intermediate vessel being also filled and more poured into upper, confined air in cavities water in lower and intermediate vessels and in munication tube on left, being compressed, drives by its elastic force a jet up central tube.

265. Balance pumps. Pair worked reciprocal by a person pressing alternately on opposite ends lever or beam.

266. Hydrostatic press. Water forced by the pump through the small pipe into the ram cylin and under the solid ram, presses up the ram. Th amount of force obtained is in proportion to the lative areas or squares of diameters of the plunger and ram. Suppose, for instance, the plunger to be one inch diameter and the ram thi inches, the upward pressure received by the would be 900 times the downward pressure of plunger.

267. Robertson's hydrostatic jack. In this ram is stationary upon a hollow base, and cylinder with claw attached slides upon it pump takes the water from the hollow bas forces it through a pipe in the ram into the cy and so raises the latter. At the bottom of there is a valve operated by a thumb-screw back the water and lower the load as gradually may be desired.

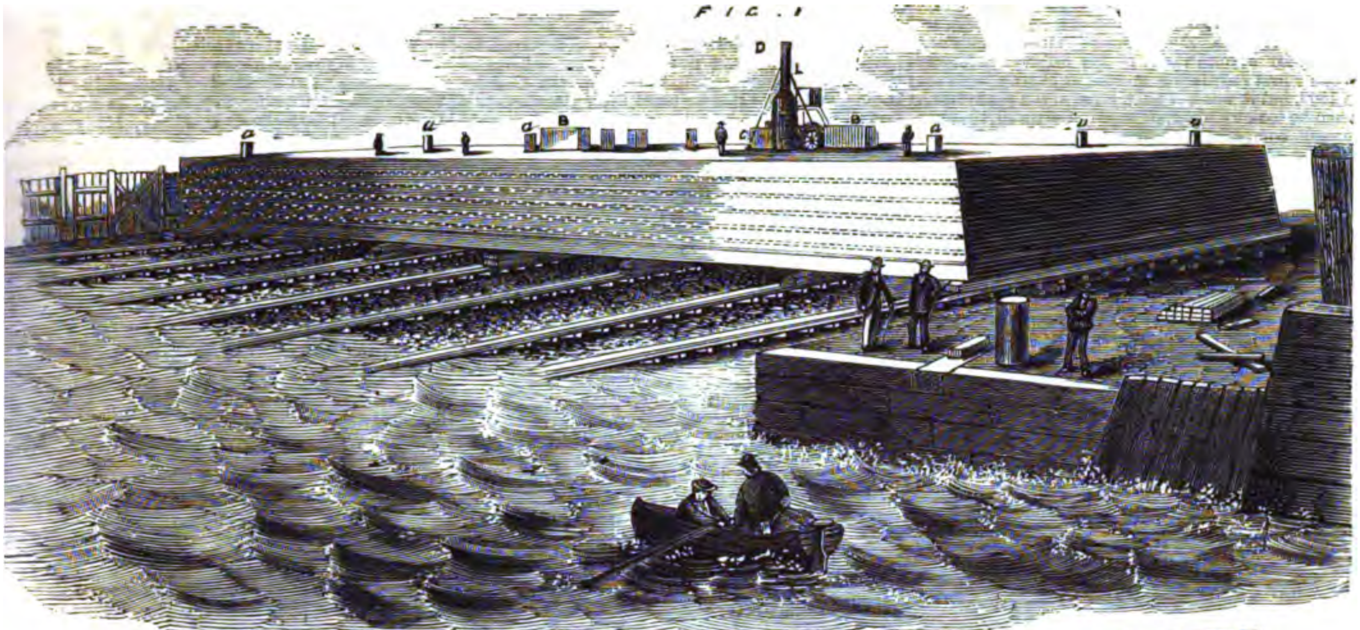
268. Flexible water main, plan and section. pipes of 15in. and 18in. interior diameter, havi some of their joints thus formed, conduct wat across the Clyde to Glasgow Water-works. Pip are secured to strong log frames, having hing with horizontal pivots. Frames and pipes were p together on south side of the river, and, the nor end of pipe being plugged, they were hauled acro by machinery on north side, their flexible structu enabling them to follow the bed.

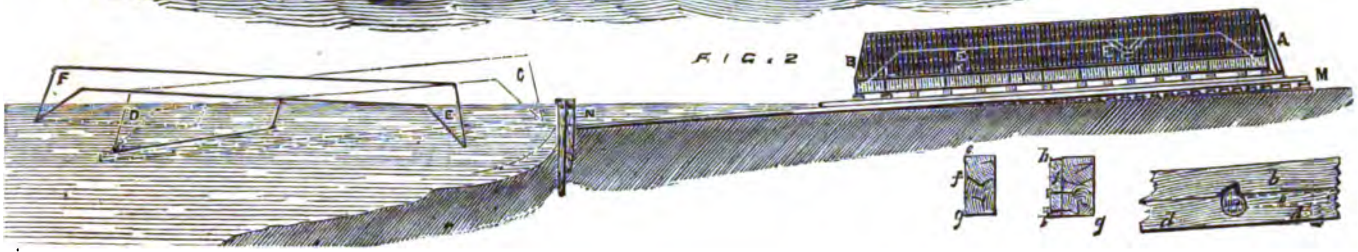
(*To be continued.*)

A NEW PHOTOMETER.—A photometer, invented M. Nagent, is based upon the formation of a column liquid partially opaque, which may be drawn out un the length is such that the light from an illuminati body ceases to be visible through the liquid. T length of the column, which completely obscures t light, starting from the point where the column thinnest, gives a measure of the intensity of the lig under examination.

LAUNCHING A GREAT CAISSON.

FIG. 1





THE launching of the caisson for the Brookyn terminus of the East River Bridge, says the *Scientific American*, which was quickly and easily acomplished on the 19th March of the present year, was considered a noteworthy feat of engineering.

Our engravings show he caisson on the ways, s it appeared when ready o be launched, and also ome details by which the onstruction of the ways nd the plan of procedure n making the launch may e comprehended.

FIG. 3

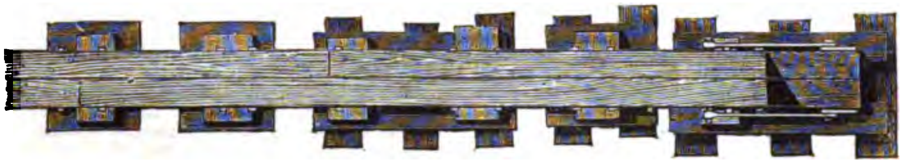


FIG. 5

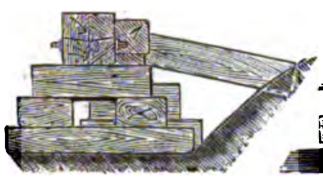
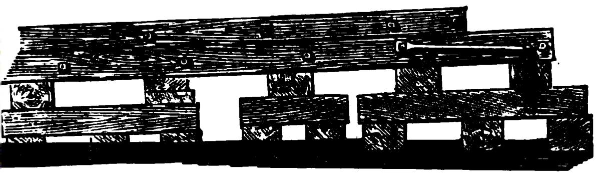


FIG. 4



The structure was put together with its longer side parallel to the river bank, and about 100ft. distant from it, and the ways upon which it rested were seven n number, and each about 180ft. in length. These ways were laid in such a manner that their upper faces were curved to a radius of about 12ft., and at a slope which made the chord of his arc form an angle of about 5°, the curved ine of the arc being some 13in., and the upper nds of the ways 15·6ft. higher than the lower nds. By this means an accelerated motion was given to the caisson in the latter part of its ransit; the increased velocity it thus obtained enabled it to overcome the great resistance it encountered from the water when it struck the river broadside on. The details show the form given to these ways, and it will be observed that they rest upon cross and longitudinal timbers: the letters *f g* refer to the bearing pieces of the fixed ways, and *e f* to the sliding ways attached to the underside of the caisson. The surfaces of the former of these were cut to an angle, as shown, that of the corresponding slide being made to fit, in order to insure a perfectly true motion of the caisson in the process of launching. Besides this, timbers *h l* were bolted to the inside of the two outer ways, which projected above the sliding surface, in order to check any swerving tendency. To insure a means of casting loose the caisson from every point at the same moment, a check cam, shown in the detail, was fixed into each of the ways near the upper end. The cam at the point where it took the bearing of the sliding way was provided with a projection which held it fast against the timber, and it was kept immovable by means of a lever secured by ropes at its extremity. These ropes being cast off simultaneously, the cams were thrown over, and the caisson was free to move equally throughout its length. The position of the caisson upon the ways when ready for launching is clearly shown in the figures. The position of the air chamber is indicated by the dotted lines, H K L, and at E is shown a partition, which was constructed to divide the air chamber, and prevent the air from any sudden movement from one part of the caisson to another, which would have affected its stability. The dotted lines C D show the position assumed by the structure just as it left the ways, and E F represents it after it had been launched and had come to rest in the water.

The caisson inclosure extends some 250ft. along the river, from thence back about 300ft. The caisson itself has a frontage on the river of 168ft., and a depth of 102ft., the basin in which it is being sunk extending a few feet more in each direction. The caisson is, in effect, a box made of heavy timbers, 16ft. in depth, and divided by like heavy timbers into six compartments. This great compartmented box, without a cover, was turned bottom upwards and floated over the spot which it now occupies. Several layers of timber were then securely bolted over the entire upper surface, increasing its already immense strength, and sinking the structure until its sharp edges—protected by heavy iron plates—rested upon the bottom of the basin.

The problem was, and is, to sink this enormous caisson through mud and earth and boulders 40 or more feet, until a firm ground is reached, there to leave it as the foundation for the immense towers of the bridge that is to be constructed. This is effected by maintaining and constantly changing an atmosphere, and at the same time excluding the water from each of the compartments of the caisson; thus furnishing means for carrying on the work of excavation to the best advantage. The means to this end are a supply of air forced by steam-driven pumps through pipes and hose into the caisson chambers, and a sufficiency of weight on the upper surface of the caisson to counteract the buoyancy alike of timber and air, and maintain the caisson at all times firmly on the bed of the excavation. This weight is provided by commencing at once the erection of the towers. For this purpose the entire surface of the caisson is covered with blocks of heavy stone, the interstices of which are filled with the best cement. As the caisson sinks, other tiers of stone will be added, and when it rests upon its final bed the towers will be carried up their full height.

COMPOUND ENGINES.

IN the year 1776, when Jonathan Hornblower first began experimenting upon the expansion of steam in two cylinders successively, there were probably no engines in use supplied with steam at a much higher pressure than two or three pounds per square inch above the atmosphere. Viewed by the light of our present knowledge, the employment of the double-cylinder system under such circumstances appears little better than an absurdity, and it is not to be wondered that, after some years of trial, it was found that Hornblower's engines could not compete successfully with the single-cylinder engines of Watt. To this result, the fact that the independent condenser invented by Watt in 1769 was found to be a necessary adjunct to Hornblower's engine, no doubt, in some measure contributed. Thus matters remained until early in the present century, when, almost simultaneously, Richard Trevithick and Arthur Woolf pointed out that, in order that steam should be worked expansively with economical results, the initial pressure must be much higher than had hitherto been used. Trevithick applied high-pressure to Watt's ordinary single-cylinder or Cornish engine, while Woolf revived and modified Hornblower's engine, and, by working it with high-pressure steam, obtained results far beyond those of the original inventor. Woolf's first engine was erected at Meux's brewery in 1806, but it was not until some seven years later, when he took up his residence in Cornwall, that the second competition between single and double-cylinder engines can be said to have fairly commenced. At first the economy obtained by Woolf astonished the Cornish engineers, but ultimately they found that high-pressure steam applied to the single-cylinder engines produced equally good results, and thus, for the second time, the double-cylinder engine was beaten from the field by its more simple rival.

The facts we have stated are well-known matters of history, and we should not have alluded to them here had it not been that at the present time they possess a special interest. During the past ten years or so the double-cylinder engine has been again revived, and both on sea and land results have been obtained with it which justify the opinion that, in all cases where great regularity of motion or great economy of fuel is desired, it is *the* class of engine which should be adopted. Of course such a complete reversal of the former decisions on the single *versus* double-cylinder engine question is not likely to be at once universally accepted, however conclusive the proofs may be to those who analyze them; and there are, accordingly, not wanting those who, either not caring or not being able to investigate matters for themselves, fall back upon the results of Hornblower's and Woolf's days, and, ignoring present data, maintain that there is "nothing in" the compound engine. Under these circumstances it appears to us worth while to point out why the results of the rivalry between Watt and Hornblower, and Trevithick and Woolf, cannot be considered to apply at the present day; and at the same time to show why, in our opinion, the compound engine is likely to take a still higher position in the future.

We have already stated that in the days when Watt and Hornblower were rivals, the pressures of steam used were so low that the degrees of expansion requisite to develope the capabilities of the double-cylinder system were unattainable; and we may therefore dismiss this competition as not requiring discussion here. In the competition between Woolf and Trevithick, however, the circumstances were different, and the pressures of steam and degrees of expansion used were such as have since been adopted in compound engines with highly satisfactory results. This being the case, and it being also an undoubted fact that the double-cylinder was eventually beaten by the Cornish engine, the question is asked by some engineers why, at the present time, compound engines are daily growing in favour.

To be able to answer this question, it is necessary to understand clearly what advantages the double-cylinder possesses over the ordinary single-cylinder engine. These are really but three in number, and of these three but one can be said to directly conduce to economy of fuel, the other two relating more to the economical maintenance of the engine, and hence affecting the consumption of fuel indirectly. Theoretically, of course, the expansion of the steam in two cylinders successively possesses no economical advantage over an equal degree of expansion carried out in a single cylinder; and practically, there is a certain loss involved by the employment of the double-cylinder arrangement, owing to the loss of pressure in the passages by which the two cylinders are placed in communication. Any loss due to this cause, however (so long of course as proper proportions are used), is far more than counterbalanced by the fact that, in the double-cylinder arrangement, the cylinder receiving the high-pressure steam is never cooled down much below the temperature of that steam, and the low-pressure cylinder, in fact, forms a kind of heat-trap between the high-pressure cylinder and the condenser. This fact, which constitutes the first great advantage of the double-cylinder arrangement, has long been well known and recognized; but there has apparently been in many quarters a disinclination to estimate it so highly as it really deserves. All, however, who have carefully watched the performance of compound engines—and especially engines working with high degrees of expansion—must have become convinced that this advantage is one of vast importance, and that it is almost to it alone that the high duty obtained from well-constructed double-cylinder engines is due.

The second advantage of the compound engine, and the one perhaps that is most generally attributed to it, consists in the regularity of motion which can be obtained with it, and the facilities it affords for vastly reducing the sudden strain thrown on the moving parts at the commencement of each stroke. Of this advantage we need not speak further at present. The third advantage lies in the fact that with the compound engine the effective differences of steam pressure tending to cause leakage past the pistons and valves are much less than in the single-cylinder arrangement, and the difficulty of keeping these parts tight is therefore greatly diminished and the friction reduced. This advantage is one of which we have spoken more fully on former occasions.

We must now point out why the advantages we have enumerated did not enable the engines of Woolf to compete successfully with the Cornish engine, and to do this we must draw attention to a fact which, although it can scarcely have escaped notice, has yet so far as we are aware never been advanced to account for the double-cylinder being an unsuccessful rival of the Cornish engine. This fact is that the first and great advantage which we have mentioned as attending the employment of the double-cylinder system is possessed in a great degree by the Cornish engine also. In other words, it follows, from the manner in which the Cornish engine is worked, that but a small proportion of the surface exposed to the fresh steam from the boiler is ever reduced to the temperature due to the vacuum formed in the cylinder by opening the communication with the condenser. Let us consider, for instance, the case of a Cornish cylinder having an 80in. cylinder, 10ft. stroke, working with a cut-off at one-sixth. In such an engine the piston would probably be about 12in. deep at the edge, and the length of the cylinder between covers would be about 11ft. 4½in., thus giving 2¼in. of clearance at each end. Now, when the point of cut-off is reached, the internal surface exposed to the steam would consist (disregarding steam passages) of the area of the top cylinder cover + the area of the top of the piston + the surface of the cylinder itself between the piston and cover, or in all about 15,645 square inches. On the down stroke of the piston being accomplished, the equilibrium valve would, of course, be opened and the piston caused to perform its upward stroke by the load at the pump end of the beam, the communication with the condenser not being open until the equilibrium valve had been closed and the piston had reached the top of its stroke. Under these circumstances the only portion of the 15,645 square inches of surface we have mentioned, which is exposed to the cooling effect due to the formation of the vacuum within the cylinder, is that which projects below the piston when the latter is standing at the top of the stroke. Thus, in the 15,645 square inches was included the internal surface of the cylinder for a length of 22¼in., and of this length 8in. will extend below the piston when the latter is at the top of its stroke. But the surface corresponding to the length of 8in. is but 2,010¼ square inches, or but little more than one-eighth of that exposed to the steam at full boiler pressure. Moreover, this surface of 2,010¼ square inches is exposed to the cooling motion due to the formation of the vacuum for but a very brief period; whereas, in the ordinary double-acting rotative engine, those parts of the cylinder surface which have been most highly heated are exposed to the cooling action during an entire stroke.

These facts, while they show that the double-cylinder arrangement possesses no such advantage over the Cornish as it does over the ordinary single-cylinder rotative engine, and thus explain to a great extent the result of the Woolf and Trevithick competition, afford also an important reason for the economy of fuel which has attended the employment of the Cornish engine. It will, in fact, be seen from what we have stated, that in the Cornish engine the piston and equilibrium valve serve—although less perfectly—much the same purpose as the second cylinder in the compound system, and that, therefore, a competition between the double-cylinder and Cornish engines was a very different thing to the competition between compound and single-cylinder rotative engines, such as is going on at the present day. Moreover, in the competition with the Cornish engine, the second and third advantages which we have mentioned as attending the double-cylinder arrangement, went almost for nothing, and thus the result of the Woolf and Trevithick is altogether fully accounted for.

We have said that we anticipate the more and more extensive adoption of the compound engine, and the reasons for this are, we consider, self-evident. As steam of higher and higher pressure is used, the action of the second cylinder in preventing the cooling of the surfaces exposed to this steam becomes of more and more importance; while, as higher degrees of expansion are resorted to, the greater equality of driving pressure obtainable by the double-cylinder arrangement rapidly increases in value. The compound engine certainly does not possess the charm of novelty; but it possesses the greater charm of having proved by its performances that it is well entitled to the esteem of users of steam-power.—*Engineer.*

ON A SIMPLE METHOD OF CONSTRUCTING HIGH ELECTRICAL RESISTANCE.

By Samuel E. Phillips, Jun.

AT present resistance-coils are mostly made with German-silver wire; and a set of coils equalling 10,000 B.A. units forms a box of convenient size. But in electrical research resistances of several million units are often useful; and to duce such with wire in the ordinary way woul both expensive and cumbrous.

Latterly Mr. Hockin has used selenium for purpose. Fine glass tubes with a platinum blown in at each end and filled with different according to the resistance required, have also largely used; but these latter necessarily give variable results, owing to polarization and ele lysis; and the former, I believe, are some difficult to construct.

Requiring a high resistance for some experim I made one as follows:—Upon a strip of vul 6in. long by 1in. wide, I ruled several pencil with an ordinary HB pencil in such a manne to produce a continuous line about 3-16th of an wide, and 4in. long. At the extremities of th I rubbed the pencil plentifully over a space as as a six-penny piece, upon which I firmly sc two binding-screws by means of "nuts" u neath, and, gently dusting off all superfluous p bago, varnished the whole with several coats c shellac varnish.

The above arrangement gave me a resistan slightly over two millions B.A. units. It w structed three months ago, and up to the p time the resistance has remained very cons have tested it repeatedly with 100, 200, a cells, and have always obtained the same within very small limits. It is also be steady with prolonged battery contact.

Mr. G. Preece has kindly tested a resistanc in the above manner for me, and finds it ve stant, only getting an alteration of about cent. for 5° Fah. I have mounted a vulcanit with twenty binding-screws, giving a wide-ra varied resistances by combination or otherwis hope shortly to make some experiments with view of determining the ratio of its alteratio difference of temperature.—*Philosophical Maga*

BOILER INSPECTION.

WE have before us the latest report of Fletcher, the chief engineer of the Ma chester Steam Users' Association, presented at th meeting of the committee, held on July 26th. From this document we find that during the past tw months 485 visits of inspection were made, an 1,106 boilers examined. In these no fewer tha 207 defects were discovered, 14 of them bei dangerous; and there can be little doubt that least a moiety of these fourteen dangerous defe were prevented from resulting in explosions by timely inspection of the officers of this associati

It appears from this report that during the year ending June 30, 25 explosions have occu killing 47 persons and wounding 49 others fewer than 12 boilers exploded within th two months (killing 12 and injuring 20 pe not one of which was enrolled in the as ciation. In nine cases the scene of the catas has been visited, and detailed particulars and, as on all previous occasions, investigatio shown that these explosions have sprung fro simplest causes; *e. g.*, six were due to malconst tion, one to external corrosion, one to inter corrosion, and one to shortness of water; whi the four others sufficient particulars have not received to allow of a positive opinion being for

To show how necessary it is that some eff periodical inspection of boilers should be ext we will instance an explosion which took pla Tuesday, June 21st, at an iron works, and from the failure of a plain cylindrical exte fired boiler, at a longitudinal seam of rive the fire, at which repeated repairs had be cuted. The facts with regard to this expl of interest, and demand more than a passi It appears that a competent independent had examined the boiler in 1864, at the the owners, and condemned it as uns pressure at which it was worked. In 186 inspector examined it again with the sam but the boiler was worked on at the pre pressure nevertheless. In 1870 it burst, kill people.

At the inquest, three engineers were found after having made a careful examination, coul account for the explosion, and thought the b was perfectly safe at the pressure at which owner worked it, and that "he exercised a discretion in so doing," notwithstanding tha boiler had been burst in consequence, and that were then engaged in investigating the death two persons killed thereby. The jury return verdict of "Accidental Death;" but, in spite of evidence given by the three engineers just refer to, stated that they considered the owner had co mitted an error in judgment in working the bo at the pressure he did after he had been advised the independent inspector already referred to, reduce it. To those who are endeavouring to so the problem of making efficient periodical bo inspection general throughout the country, such explosion and such evidence are pregnant w instruction.

Another explosion, of rather peculiar natu happened at about half-past five on the afterno

Friday, May 27th, killing two persons. It was sed by the boiler of an auxiliary or donkey ine employed on board a passenger steamer, ow decks. This boiler was not examined by an er of this association, but it is reported that explosion arose from the rending of the internal ng of the fire-box from overheating of the plates sequent on shortness of water.

t the inquest it was stated that this shortness vater and consequent overheating arose through blow-out tap being left open through oversight, that against such oversights science could pro- no remedy, so that the explosion was acci- ntal.

Not having received a detailed report on this tastrophe, Mr. Fletcher offers the following re- arks thereon with some diffidence; but it appears portant to point out that before the view can be cepted that modern science is powerless to pre- nt such explosions, it must be proved that all its pliances have been exhausted. Was such the se in the present instance? As blow-out taps ve been found occasionally to be left open through ersight, they are sometimes equipped on board ip with a guard, arranged so as to prevent the y being withdrawn unless the plug be turned so to close the tap. Again, to give warning of ortness of water, from whatever cause that may ise, fusible plugs adapted for marine boilers may employed,—not those attached to the crown of e furnace which for many reasons are objection- le on board ship, but those fixed at the end of a pe carried up from the boiler, as already explained the association's printed reports for January, 365, and November, 1869. Before therefore it can concluded that such explosions are unavoidable, must be asked whether these two simple appli- nces, in such common use elsewhere, have received fair trial. If not, it cannot be considered that uch disasters are accidental, but that there is very reason to conclude that they might be pre- ented by efficient boiler mountings.

These instances are surely sufficient to convince ny one of the need there is for some systematic nspection of boilers, especially when it is shown so learly what a large amount of good in the way of revention has been achieved by the Manchester team Users' Association.

IMPROVED PORTABLE STEAM ENGINE.

(*Illustrated on page* 469.)

WE learn from a pamphlet issued by the makers, Messrs. J. C. Hoadley & Co., of Lawrence Mass., United States, that "an attempt is made in this engine to superheat the steam, mildly, yet effectually, and to secure all the advantages of a steam jacket around the cylinder, with the utmost simplicity and increased economy. The principle means employed are:—

"1st. Surrounding the cylinder by the waste gases, the products of combustion, on their passage from the smoke-box to the smoke-pipe; securing thus a 'smoke-jacket' instead of the well-known 'steam-jacket.'

"2nd. Placing the feed-water heater in the smoke-box, below the cylinder, so as to reduce the temperature of the gases to a safe point before they reach the cylinder.

"3rd. Conveying the steam from the governor-valve, which is located within the steam dome, through the steam space, the whole length of the boiler to the flue-sheet, and thence by a curved pipe through the smoke-box to the steam-chest; by which means it is safely yet thoroughly dried and slightly superheated."

These objects, it is asserted, are attained in this engine, which has 7in. diameter of cylinder and 10in. stroke, weighs, exclusive of running gear, ,500 pounds, and is capable of exerting permanently and economically 15-horse-power. Indeed, it is said to have been run for several weeks to drive he machine-shop of its builders, which, with other work driven by the same water-wheel, is known to equire from 25 to 33-horse-power; a very credit- ble performance for an engine usually rated at 10-horse-power. The boiler is lagged with wood, and cased in sheet iron, with brass bands. This practice, common in England, has not been generally adopted, hitherto, by American engineers. It adds something to the bulk of the boiler, a little to the weight, and considerably to the cost; but the makers claim that it adds in an equal or greater degree to its efficiency.

FRICTION.—IX.

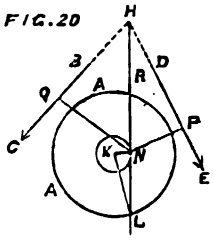
By C. Draper, A.B., L.C.E.

(*Continued from page* 250.)

Friction of an Axle.—So far we have had no question involving the friction of surfaces other than plane; but we shall now investigate the condition of equilibrium of a body supported by and capable of turning round an axle.

It is quite clear that since an axle turns in its bearings the diameter of the latter must be slightly greater than that of the former, so that they are in reality only in contact in a single point, or, to speak more correctly, in a single line parallel to the axis, whose length is equal to that of the bearing.

FIG. 20



In Fig. 20, let A A L represent the transverse section of an axle, let B C and D E represent two forces, Q and P, acting on the piece supported by the axle. To fix the ideas, let Q be the resultant of the weight of the piece and the forces to be overcome, and let P represent the force required to cause the piece just to move round the axle A A L, it is required to find the magnitude of P (whose direction is supposed to be given) and the magnitude and direction of the resultant of P and Q. Produce C B and E D to meet at H. Let H L be the direction of the resultant of P and Q. Now, since, by the nature of the question, P is on the point of causing motion, the resultant of P and Q must make at the point L, where it cuts the circle, an angle equal to ϕ with the radius L K, for L is clearly the point of contact between the axle and its bearing, and L K is the direction of the perpendicular at the point of contact, and therefore in accordance with the principle already laid down, viz., when a body just commences to slide on another body the resultant of the forces acting on it must make with the normal to the surface (point or line) of contact an angle equal to the angle of friction, the angle H L K must be equal to ϕ.

Let K L = r, and from K let fall a perpendicular K N on H L, then K N = $r \sin \phi$, so that in order to draw H L we must describe a circle round K with a radius equal to $r \sin \phi$, and draw from H a line H L touching it in N. To find now the magnitude of P, from the point N on H L draw the perpendiculars N Q and N P; then, since the moments of two forces round any point on their resultant are equal and opposite, we must have

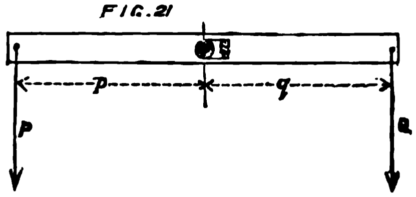
$$P \times NP = Q \times NQ, \text{ or } P = Q \times \frac{NQ}{NP}.$$

Having now the value of P, we have for the magnitude of R, the resultant of P and Q, by the well known formula

$$R = \sqrt{P^2 + Q^2 + 2PQ \cos. CHE}.$$

When P and Q are parallel, R is parallel to them both, and equal to their sum or difference, according as they act in the same or opposite direction. In this case Q N, K N, and N P, are in one right line. The above applies to all cases of the Lever and the Wheel and Axle when friction is taken into account. Thus if a force P be applied at the end of one arm p of a straight lever to overcome a parallel force Q acting at the end of the other arm q, and if r be the radius of the axle, Fig. 20 is reduced to Fig. 21, the same letters indicating corresponding points in each.

FIG. 21



Here N P = $p - r \sin \phi$, and N Q = $q + r \sin \phi$.

$$\therefore P = Q \times \frac{q + r \sin \phi}{p - r \sin \phi}$$

In fact, the forces P and Q, instead of balancing round the centre of the axle, which they would if there were no friction, balance round a point N, nearer the predominating force P by the distance $r \sin \phi$.

As the coefficients of friction of axles are generally small fractions, especially when a lubricant is used, ϕ will be a small angle, varying in fact from about 3° to 5°; consequently $\sin \phi$ will be very nearly equal to $\tan \phi$ or μ, so that in the above formula, we may, without appreciable error, substitute μ for $\sin \phi$,

$$\text{therefore } P = Q \frac{q + \mu r}{p - \mu r}.$$

From this formula we see that the smaller r is, or the less the diameter of the axle, the less will be the effort required to overcome the friction.

Example 17.—Fig. 22 is an isometrical sketch of a rough weighing machine, frequently erected where building is going on, in order to check the weights of the materials supplied. It consists of a scale pan A hung from the end of the short arm of a long timber lever, whose axis or fulcrum is at B. Given the dimensions and weights of the beam &c., and the coefficient of friction, it is required to know at what distance from B a weight W of 56lb. must be hung in order that the beam and weight may be just counterbalanced by one ton placed in the scale pan.

The beam is of oak, 20ft. long, 1ft. deep, and 6in. wide, weighing 55lb. to the cubic foot; the point of suspension of the scale pan is 2ft. from the axis, which is 3in. in diameter, and whose coefficient of friction is 1-5th. By an experiment, the beam with the hook and axis attached, balances at a point 7ft. 8in. distant from the axis; the centre of gravity is therefore situate at this point. The beam weighs 20 × ½ × 55 = 550lb., the hook weighs 18lb., and the axis 34lb. We have therefore the following forces acting on the lever, 2,240 + weight of scale pan = 2,352lb. at C, 550 + 18 + 34 = 602lb. at D, distant 7ft. 8in. from B, and 56lb. at the required distance x from B. The resultant of these three forces must act at a point distant $r \sin \phi$ from the centre of the axis, and on the side of the axis next c. The moment therefore of 2,352lb. must be equal and opposite to the sum of the moments of 602 and 56 round this point. Now since $r = 1\frac{1}{2}$ and $\sin \phi$ = 1-6th nearly, we have $r \sin \phi = \frac{1}{4}$in., therefore 2ft., less ¼in. or 1ft. 11¾in., is the distance of 2,352 from the resultant, similarly 7ft. 8¼in. and x ft. 0¼in. are the distances of 602 and 56 from the same point. This is further shown in the diagram, Fig. 23, where the axle is shown greatly enlarged.

FIG. 22

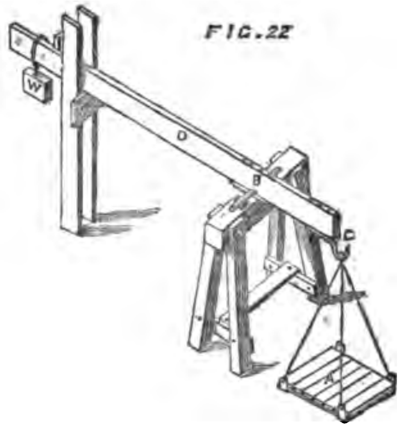
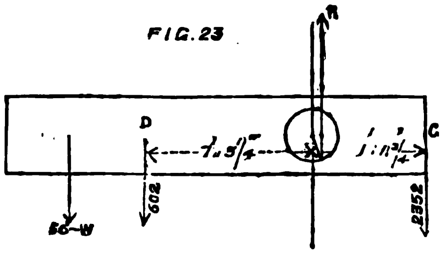


FIG. 23



Reducing these distances to their lowest terms, namely a quarter of an inch, we have—

$$2352 \times 95 = 602 \times 349 + 56 (x + \tfrac{1}{4})$$
$$\therefore \quad 13328 = 56\,x$$
$$\therefore \quad x = 238 = 4\text{ft. } 11\tfrac{3}{4}\text{in.}$$

Now had there been no friction, we should have had simply:—

$$2352 \times 2 = 602 \times 7{\cdot}25 + 56 \times x$$
$$\therefore \quad 339{\cdot}5 = 56 \times x$$
$$\therefore \quad x = 6{\cdot}06 = 6\text{ft. } 0\tfrac{3}{4}\text{in. nearly.}$$

Therefore, owing to the friction, the 56lb. weight must be placed 2ft. 1¼in. nearer to the axis than if there were none.

We shall now consider the question of how much work is lost during each revolution of a shaft in its bearings. In this case, the resultant of the forces acting on it will be the resultant of the weight of the shaft, together with whatever wheels, &c., may be supported on the shaft, the forces to be overcome, and the forces which drive the shaft, which may be transmitted through a band, connecting rod, &c. In the latter case the magnitude and the direction of the resultant force will be continually changing, so that we can only arrive at an average result.

In Fig. 20, let R be the resultant of all the forces acting on the shaft, or the pressure of the bearing against the axle; then the shaft will just commence to revolve when R makes an angle ϕ with the radius (as was shown above); the friction overcome is then $R \cos \phi \tan \phi = R \sin \phi$, since $R \cos \phi$ is the normal pressure; this friction is overcome for a distance $2\pi r$ during each revolution, therefore the work lost during one revolution is $2\pi R r \sin \phi$. In most cases $\sin \phi$ is practically equal to $\tan \phi = \mu$.

Example 18.—The weight of the cranked shaft and fly-wheel of a steam engine is 1¼ tons; the diameter of the shaft is 4in.; if the engine makes 30 revolutions per minute, determine approximately the units of work expended in turning the fly-wheel for one minute, if $\mu = {\cdot}05$.

Taking 1¼ tons or 2,800 pounds as the resultant pressure, we have for the work lost:—

$$\frac{30 \times 22 \times 4 \times 2{,}800}{7 \times 12 \times 20} = 4{,}400 \text{ units of work per minute}$$

Example 19.—A grindstone, whose diameter is 4ft., turns on an axle 2in. in diameter; the belt by which it is driven slips when making 15 turns per minute; find the number of turns it will make before it stops if the coefficient of friction is 3-40ths.

The work accumulated in a rotating body is equal to the product of its moment of inertia into half the square of its angular velocity. Let R be the radius of the stone, M its mass, and ω its angular velocity at the instant the band slips; then $M\frac{R^2}{2}$ is its moment of inertia, and therefore $M\frac{R^2}{2} \times \frac{\omega^2}{2}$ is the work accumulated in it at the same instant. Now, when the stone has stopped revolving, all this work has been expended on friction; let n be the required number of turns, and r the radius of the axle, then the work spent upon friction is equal to $n \mu M g 2 \pi r$. Equating these two values we have $n = \frac{R^2 \omega^2}{8 \pi r \mu g}$. In this example r = 1-12th, $R = 2$, $\omega = \frac{\pi}{2}$ since the angle described in one minute is 30π, therefore $n = \frac{2 \times 2 \times \pi^2 \times 12 \times 40}{8 \times \pi \times 3 \times 32 \times 2 \times 2} = 1{\cdot}96$.

SCIENTIFIC SOCIETIES.

◆

QUEKETT MICROSCOPICAL CLUB.

THE fifth annual general meeting of this club was held on Friday evening, July 22nd, at the University College, Gower-street. Peter Le Neve Foster, Esq., President, in the chair. According to the annual report of the committee which was read, the club still maintains its popularity and success. It numbers over 500 members, and meets for the prosecution of microscopical inquiry and discussion twice a month through the year. Mr. Peter Le Neve Foster, in vacating the presidential chair, which he had so ably filled during the past year, delivered his valedictory address, in which he called attention to various open questions in microscopical science, which were fields well worth the labour required in their investigation, and which he considered the members might undertake the study of with pleasure to themselves and advantage to the world at large. Professor Lionel S. Beale, F.R.S., was elected President for the ensuing session, and Messrs. Arthur E. Durham, F.R.C.S., Peter Le Neve Foster, M.A., Henry Lee, F.L.S., and Dr. Robt. Braithwaite, F.L.S., were elected Vice-Presidents, while Messrs. Allbon, T. W. Burr, F.R.A.S., Witham M. Bywater, and Charles F. White were elected to fill four vacancies on the committee. The proceedings terminated in a *conversazione*.

LETTERS TO THE EDITOR.

◆

[We do not hold ourselves responsible for the opinions of our correspondents. The EDITOR respectfully requests that all communications should be drawn up as briefly as possible.]

*** All communications should be addressed to the EDITOR of the ENGLISH MECHANIC, 31, Tavistock-street, Covent Garden, W.C.

All Cheques and Post Office Orders to be made payable to J. PASSMORE EDWARDS.

◆

"I would have every one write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks: a vice from whence great inconveniences derive their original."—*Montaigne's Essays.*

*** IN order to facilitate reference, correspondents when speaking of any Letter previously inserted will oblige by mentioning the numbering of the Letter, as well as the page on which it appears.

◆

RECTIFYING THE CIRCLE APPROXIMATELY.

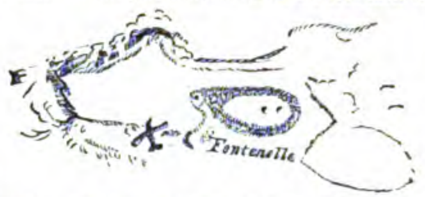
[157] SIR,—What I admire in the construction by "A Member of the ENGLISH MECHANIC Scientific Society," is its relative simplicity. My own method was even simpler, but considerably less exact. Mr. Drach's construction seems quite inadmissible. It involves the division of the diameter into 1,000 parts. Now if this be done, we may proceed at once to secure by construction an approximation true to the ninth decimal place. Thus, take 3 diameters and 141 thousandths, this gives 3·141. Take 592 thousandths and diminish in the proportion of the diameter to one thousandth. This gives 3·141592. Diminish one thousandth in the proportion just named, then take 153 thousandths, and diminish in the proportion of the diameter to this 100,000th. We have then, in all, 3·141592153.

Theoretically this is quite as satisfactory a solution as Mr. Drach's. In fact, if we are to admit the *long division* of the diameter as part of a geometrical solution, I can see no reason why we should not proceed thus:—Divide the diameter into 10,000,000,000,000,000,000 parts, and add 1,415,921,535,897,932,014 such parts to three times the diameter; we shall thus have the circumference exact to the 16th decimal place.

True, this plan (like Mr. Drach's) is not practicable; but that is a detail. RICHARD A. PROCTOR.

THE CRATER FONTENELLE.

[158] SIR,—I send you a sketch of the crater Fontenelle and neighbourhood, which I took on the twenty-first day of the moon of the last lunation, at two in the morning. You will perceive on the left a cross made by the peculiar arrangement of ridges and crater. This I never saw before, having examined the spot only when the sun was rising on the moon. When, however, I looked on this part of the moon on the 19th inst. the cross was very apparent and striking. This morning, the angle of light having changed a little, it was less apparent. Is this the cross mentioned by Mr. Webb, page 99 of "Celestial Objects," and of which he says he has "looked for it repeatedly in vain"? It does not stand, however, on the exact spot shown in his map. As I have seen no answer to query of "H. A. C." (4216) I may tell him ζ Hercules can be divided with 8¼in. Browning, with speculum, power 400 to 500. He will find the companion s.p. very close to the primary, which now and then is only elongated. The air must be good and the telescope nicely focussed on a single star of the same magnitude. Would "H. A. C." turn his telescope on ε Lyra and tell me if he sees a very small star on the left of ϵ^2. I have seen it twice, and also another of which I cannot tell the exact position now, not having set it down at the time.



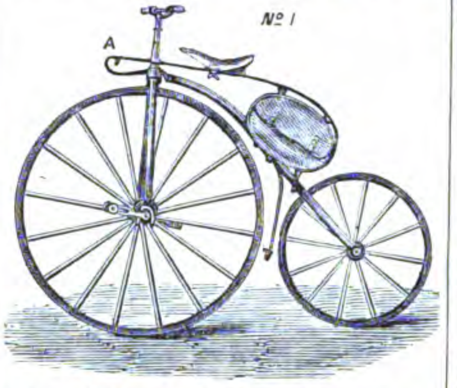
FOREIGNER.

THE COVENTRY BICYCLE.

[159] SIR,—The bicycle of which I send two illustrations is now generally known as the Coventry bicycle, from the fact that bicycles of this description were first made there, and invented by Mr. J. Stanley. Our readers will see by the illustrations that both have their springs jointed in front of the socket of the machine at A, by which means a greater length of spring is obtained and a greater degree of elasticity produced at the back. The spring is turned down and fastened on what is commonly known as the backbone of the machine, thereby leaving the bearing of the back wheel quite free, by which means it allows a stud to be firmly screwed on one side of the back fork by means of a nut. The one side of the fork is taken right away, and so allows the back wheels to be taken off more readily, there being only a nut to unscrew to set it at liberty. The step, too, was first put on these bicycles.

On No. 1 is seen a leather travelling bag for letter carriers or for luggage. On No. 2 this is done away with, and a scroll spring substituted, the spring of No. 1 being merely unscrewed from off the backbone and the scroll fastened on in its place. A pin is then put through the two springs at B, and so made quite firm; this gives still more freedom to the spring. And another improvement is seen on No. 2, being a wheel guard (which effectually prevents the rubbing of the wheel against the legs), and a foot-rest at the front of the wheel, which is decidedly better than the continual jar on the calves of the legs in the French machine. As will be seen from the illustration, the foot-rest C and wheel guard D are all in one piece, and can readily be added thereto. I have been rather particular in my explanations, and hope they will be satisfactory to some of our correspondents. J. R. D.

Nº 1



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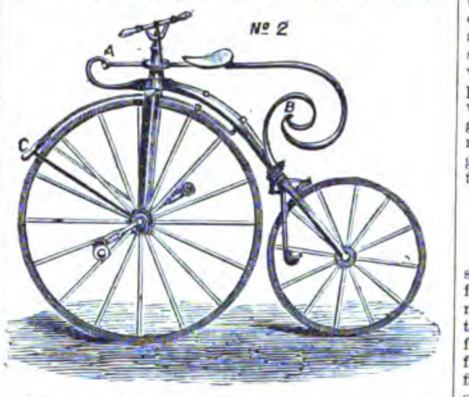
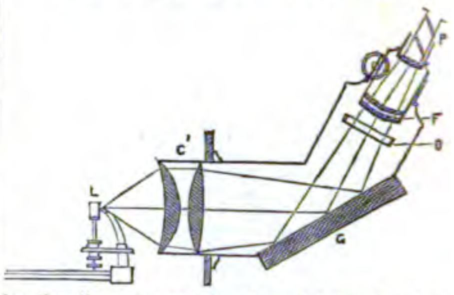


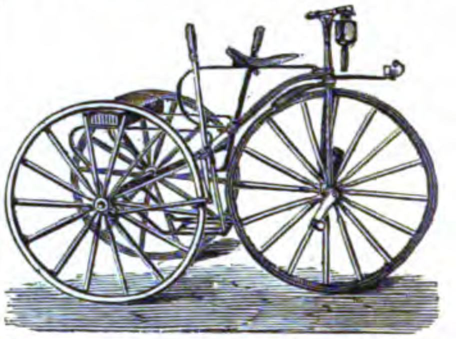
THE POLARISCOPE.

[160] SIR,—If you have nothing more worthy, perhaps you will give "E. H. J." the benefit of the accompanying diagram which I have copied from a little *brochure*, published by Houlston & Wright. "The contrivance consists of two tubes inclined to each other at an angle of 56° 45′, and truncated at their points of junction, the oval space thus formed being closed by twelve pieces of thin crown glass, the lowest of which is blackened to absorb the polarized ray. This instrument *replaces* the *object-glasses* of the lantern, of which the condensers should be 3½in. in diameter." L is the source of light which passes through the condensers C′ falling on crown glass G, inclined at the polarizing angle; this reflected and polarized light passes through the aperture O, in which is placed selenite or other objects; it is then focussed by the object glasses F, and once more "polarized and *analysed*" by the Nicol's prism P, and projected on the screen. This is said to be the best form of this enchanting philosophical toy, and I do not think a less intense light than the *lime* light (oxy-calc.) would succeed, and the disc should not be more than 2½ft. in diameter. Perhaps some of your able optical contributors can supply a better form. I shall be grateful for instruction. SABLE.



IMPROVED TRICYCLE.

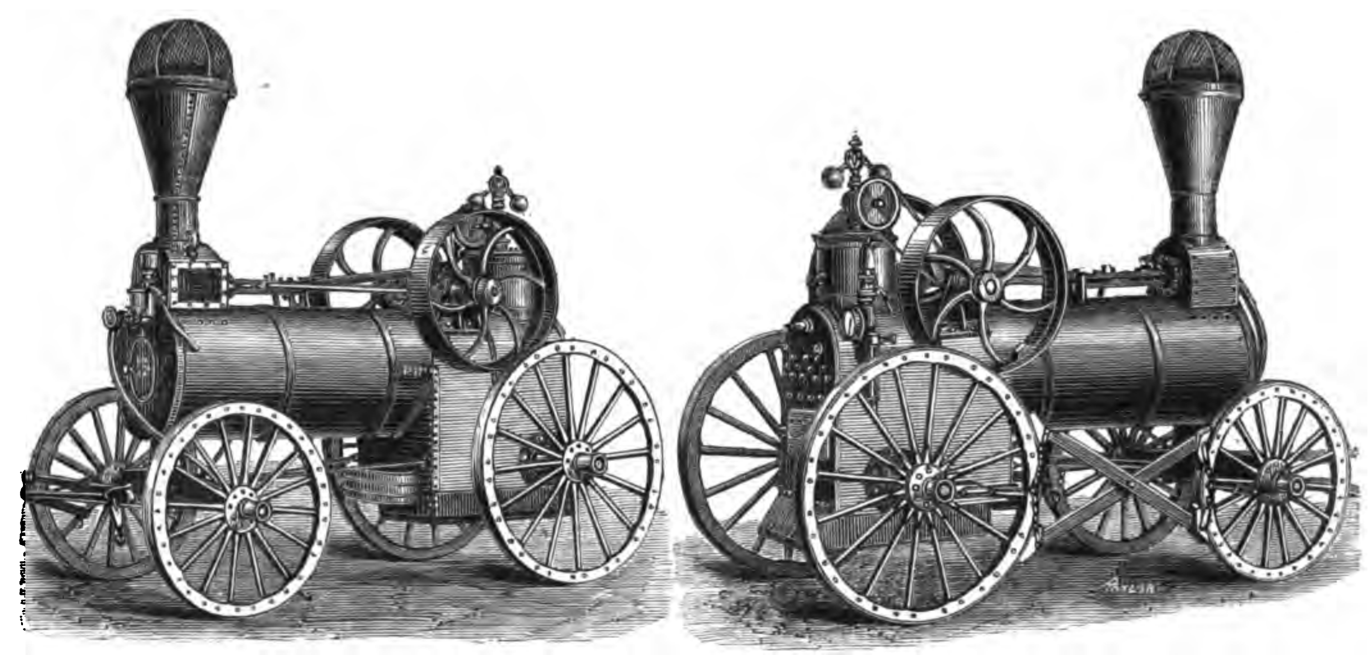
[161] SIR,—I take the liberty of asking for the same benefit you have given to numbers of velocipede inventors and schemers, *i. e.*, to place before your readers a new and simple two seated tricycle. It is hardly necessary to give full details, as the photograph shows very clearly the construction of it. It comprises many advantages, being easily worked, comfortable to ride, will turn in its own length, or any corner, the two hind wheels being at liberty upon the hind axle (this is a very important advantage). It is very elegant in appearance and very durable, and will carry either ladies or gentlemen upon the hind seat, their feet being at rest; and with very little fatigue two persons can go a long distance in a few hours. It was designed and manufactured by Messrs. Payne & Sons, Thrapstone, for a gentleman in Havant. In my opinion it will surpass anything in the way of tricycles up to the present time. I have (from your first introducing velocipedes in the MECHANIC) noted the various suggestions and opinions of correspondents, but I have not seen anything like this. Many ideas have been good, while many others have not been worth the trouble and time. TRAVELLER.



WARD'S FLUTE.

[162] SIR,—The attention of your readers being somewhat engaged on the subject of flutes, I should feel much obliged to any brother reader who will give me an opinion upon a flute invented, and the invention accompanied with a pamphlet, by Cornelius Ward, formerly of Tichbourne-street. It is professed to be founded upon thoroughly scientific principles, but the fingering is entirely different from any other, whether old or modern. It runs through two and a half octaves without any cross fingering at all. Perhaps the greatest peculiarity is that the silver cork in the head is raised or depressed by an eccentric, in correspondence to certain marks upon the slide. Another singularity is that the lower C and C sharp is manipulated by the thumb of the left hand.

I am conversant with Carte's silver flute fingering; in fact, I played upon one for some time. I possess a Boehm, and have tried Clinton's and Siccama's, but Ward's possesses peculiarities which are absent from all the others. Moreover, in his pamphlet, he claims not only no cross fingerings, but perfect equality of tone and tune in all keys.



IMPROVED PORTABLE STEAM ENGINE. (*Described on page* 467).

The easiest key is one flat; and four sharps is as easy as three, because the D sharp is made by the thumb of the left hand, and by keeping the thumb down, all the other fingering remains the same throughout.

PROPELLER.

THE FLUTE.

[163] SIR,—In your impression of the 8th inst., I find a letter on flute fingering, signed "T. S. G." As that letter is calculated to do harm to the "uninitiated," I trust you will grant me space for the publication of this one. The tuning slide of a flute is merely intended to flatten the pitch a little, not to put the instrument in another key. To tune the D natural down to D flat it would require the slide to be pulled out about 1in., and that would (for the time) utterly destroy the proportionate division of the instrument. It would appear to me that "T. S. G." thinks that it does not matter much where the holes and keys are placed.

The difficulties are the same whether playing in extreme flat keys or extreme sharp ones; and those difficulties cannot be surmounted by any clumsy expedient, but by the careful, patient, slow, and diligent practice of scales and studies in all the keys. The eighteen studies of Berbiguier and Dressler's scales are the best things I know of.

There is no royal road to flute-playing any more than to any other art or science, and it is only by the practice of such things as I have named that "perplexed fingers" will find relief. HENRY CHAPMAN.

HANDWRITING.

[164] SIR,—May I ask an opinion on the almost illegible style of writing now so generally practised? It appears that the farther it is possible to depart from the true, correct, and beautiful form of the letters the more *stylish* the writing is, according to prevailing opinion. How has it come to pass, that such deformity in writing is tolerated, and even considered excellent, whilst in any other art such a departure from truth would be considered a mark of ignorance and vulgarity?

W. S. A.

CURIOUS SENTENCE.

[165] SIR,—The curious formation of the sentence given on p. 423, letter 92, is better seen when the text is arranged in the following manner:—

S A T O R
A R E P O
T E R E T
O P E R A
R O T A S

But are not the makers of such puzzles guilty of loss of time? I can quote, as similar examples, the *Pugna Porcorum per potatorem porcium poëtam præclarem*, a poem of 290 verses, all the words of which begin with the letter *p*; and a little Portuguese work, in five chapters, the 1st without *a*, the 2nd without *e*, the 3rd without *i*, the 4th without *o*, &c. This is so much more difficult that in that language the definite articles are *o* and *a*. But too much space taken already—I end.

BIBLIOPHILUS.

ON THE PIANOFORTE.—FROM "W. T."

[166] SIR,—I beg permission to answer several correspondent's questions—some addressed generally to your readers, others at the special request of the "Harmonious Blacksmith."

"Piano-felts—and what I *felt* on reading the question."—Mr. Tim Bobbin says, No. 3855, that he should like to see hammer and damper felts "made" in England. May I tell him that he can see any quantity thereof that he is willing to purchase. But although this is the strictly grammatical interpretation of his words, I am willing to assume that he wishes to see, not the felt, but the process of making it.

Having "presumed to assume" that he means this, I further presume, and I hope he will forgive my presumption, to give him a bit of advice, founded on my experience of "London society." It is, that when you solicit a favour, it is best to make a respectable appearance. Let "Tim Bobbin" alter his costume from the traditional shirt sleeves and porter pot, in which he is usually represented, without a cravat — and put on a clean shirt, unexceptionable tie, a gentlemanly suit of black broadcloth—*i.e.*, not the 60s. suit of the advertising tailors, who don't know how to cut a coat, unless it be for fast men, betting men, and other men *than* gentlemen, but do know, only too well, how to make the money of their customers, *cut* out his pockets into theirs—also a gentlemanly "chimney pot," without abnormal brim or crown. If the latter is adorned with a broad crape band, all the better, for this imparts an additional air of respectability—people who don't reason closely, inferring that your band would not have been so broad if you had not received a considerable legacy; and, above all, don't forget unexceptionable boots and well-fitting kid gloves.

Having prepared himself thus far, his next step should be to visit the *purlieus* of Soho and Leicester-square, where, by the exercise of a little tact and discrimination, he will be able to select, for a small consideration, and in addition, a suit of the externals I have recommended him to assume, a "distinguished foreigner," for whose especial behoof, he is anxious, during his flying visit to England, to see the process of felt making as one of the "sights of London."

Both being thus properly "togged" (I trust Mr. Editor, your familiarity with the tongue of Cicero will enable you to perceive this word is a legitimate descendant of the classic Roman toga), Mr. "Tim Bobbin" being "disguised," not as usual, in liquor, but in unusual toggery—and having practised the proper position of his H's—may safely venture to No. 14, Hanover-street, Long Acre, the offices of the Wandle Patent Felt Company, Limited, and after duly presenting his own, and his "distinguished" friend's cards, let him ask to see the respected manager of the said company, whom he will find to be one of the most gentlemanly men it has ever been my good fortune to be acquainted with—no small consolation, considering the unavoidable rubbing of shoulders one is often obliged to endure with those to whom inclination would prefer giving a wide berth. Let Mr. "Tim Bobbin" then prefer his very modest request, and I have no doubt he will receive all the attention he can possibly expect.

If Mr. "Tim Bobbin" pondered the matter for a twelvemonth, could he devise a better plan for eliciting a trade secret? Stay—I must very earnestly beg his pardon. Commercial considerations cannot, of course, influence so highly respected an individual. No, by no means. It is but the laudable desire to add to his stock of knowledge. Go on then, Mr. "Tim Bobbin," and prosper.

W. T., Pianoforte Tuner and Repairer.

BRINSMEAD'S HISTORY OF THE PIANOFORTE, AND A "LEETLE" MORE.—LETTER II.

[167] SIR,—The advent of the celebrated twelve apostles in 1760 is duly recorded. The author seems to think their mission was to convert the British barbarians of the period from the love of their old not very *sweetheart* the harpsichord to that of the piano. I have a strong suspicion that they had no more consciousness of this mission *than* the very many of their countrymen who emigrate to the United States of America have of *their* mission to *civilise*—or, rather to *improve* off the face of the earth — the Red Indians. Like astute Scotchmen, at a later time in Britain's history, they followed the example of the Phœnicians, and came to England for "tin"—or at least for more lucrative employment than their own country afforded them. These apostles "with a mission" seem to have been quite content to subside into obscurity; unless, indeed, some of them afterwards cropped up under the names of Zumpe, Pohlman, Buntebart, and Co., several of whose productions yet exist; for instance, the Joannes Zumpe, fecit A.D. 1776, which was in the possession of Mr. Ramsay, of Bury, in 1802. According to Capel Loft, Sir George Smart possessed a square piano, also made by Zumpe, in which some of the keys were divided as they were in some spinets and harpsichords, to produce what are incorrectly termed quarter tones, for amending the unavoidably imperfect intonation of instruments which are limited to twelve intervals. Although the Zumpe, dated 1776, is the earliest square piano certainly made in England which I remember to have read of, it is probably far from the first made here; for squares were not uncommon in Germany at least nineteen years before; and if Plenius could copy a hammer harpsichord, surely sufficient ability must have existed to copy a square piano, although I am willing to admit it is, from its excessively narrow scale, by far the most difficult form of the instrument to "finish" satisfactorily.

That square pianos were pretty well known on the Continent long before the advent of the apostles—I mean the high Dutch ones—is conclusively proved by the fact that Old Bach played on several "forte pianos" made by Silberman, at the palace at Potsdam, in 1747. As an engraving of one exists—which is copied by Rimbault (page 119)—it has rather thin round legs, but is not half so ugly as some made long after in England; but then we must allow for the public taste in the times of the Georges. From it we may pretty confidently assume that their legs were all "quite on the square."

That harpsichords with hammers added to jacks were not very uncommon on the Continent I have already stated. They seem to have been in pretty extensive use during the latter portion of the first half of the eighteenth century; for example, the Reverend Poet Mason, the inventor of the celestinettes, writes to his friend and fellow poet Gray, in 1765, "I have bought, at Hamburg, *such* a pianoforte, and *so cheap*. It is a harpsichord *too* (sic) of two unisons, and the jacks serve as mutes (query as *dampers*) when the pianoforte *stop* (it was the age of *stops* to stringed instruments) is played, by the cleverest mechanism imaginable." Perhaps, after more than a century's experience, we may be excused for doubting the extraordinary "cleverness" of this unknown mechanism, for nothing fit to be termed clever has come down to us; but I dare say that —like the calculating boy, George Bidder, Esq.—it was thought very clever in its day. It is rather amusing to read on, for with the self-abnegation of a modern Englishman, who has bought a new and better horse and is tired of his old one, he proceeds to ask his friend and fellow-poet "won't you buy my Kirkman?" It is very remarkable how willing poets and even parsons (both of whom are well known to abhor that filthy lucre which is—very incorrectly—said to be the root of all evil) are, benevolently to "sell" at once their left off chattels and their friends.

Mr. Brinsmead goes on to say that the piano became a very popular concert instrument, basing this statement on certain announcements yet extant of its intended use, such as Michael Arne's presiding at the pianoforte (query the harpsichord) in Dublin Theatre, and its employment for accompanying the voice of what would now be termed, in music-hall phraseology, "a lady vocalist," *i.e.* Miss Brinkley, as early as 1767. He might as well also have stated that the elder Dibdin was the accompanist in this first recorded public use of the pianoforte. The instrument he used might have been a pianoforte proper—which, it having been announced by that name, it probably was—or it may have been a hammer harpsichord of English or German manufacture. There is no impossibility in its being English, for we have home-made pianos a year older, not to mention that the "apostles" might then have been hard at work converting the musically-barbarous natives of England from the idolatry of harpsichordism to orthodox "pianoforteism," with a success rivalling that of the South African bishop, whose missionary labours among that *little known* native tribe of African idolators, who rejoice, or ought to rejoice, in the euphonious name of Kanoodoodoodooldums, were, in both senses of the word; so very "graphically illustrated" by the clever author of the celebrated Bab Ballads.—N.B.—He wrote this *veracious* (for as the noble author of "Zanoni" would have put it, he presents to us the *real*, if not the actual) history of that bishop's Christian-like doings, in the way of reconciling religious differences, in a most earnest and truly Christian spirit, although truth compels me to confess he only *did* it *in* "Fun."

I feel tempted (*only* just *for once*) to digress, and say a *few* words about Dibdin. This musical genius, who built the Circus, now the Surrey Theatre, another theatre in Beaufort-buildings, which he named the Sans Soucy, and yet another which he called by the same title—now, I believe, the auction rooms of Messrs. Bonhams, in Leicester-place, from whence I have abstracted (after paying for it) many a pleasing picture, not to mention "certeynge and sundrie" pianofortes and other musical instruments. Dibdin, was, I believe, the first Englishman who gave musical entertainments unassisted. For some of these he composed his celebrated nautical songs, one of which asserts that a sweet—(well, he might be *sweet*, all things considered)—little cherub *sits* up aloft, for the humane purpose of "looking out" for the life of poor Jack. How he, with his peculiar conformation (which however much it might conduce to *sweetness*, and if not *light* itself, certainly *lightness*, as every Christian is so posteriorily constituted as to require the assistance of Baxter's celebrated back "shove" can testify) could sit, is just one of the many things no fellar can understand. Dibdin's sea songs were *extremely* popular in their day, and had the credit of greatly assisting to man the navy. I should be inclined to suspect that with all our Jack Tars' patriotism (often accompanied by a strong desire for prize-money), that constitutional safeguard—yclept the pressgang—now, I am very sorry to say, a thing of the past, for Conservatives to regret—had just a *leetle* to do with this matter. But then John Bull has long worshipped shams; why should he not worship musical shams as well as others?

Dibdin was accustomed to accompany his songs by a very complex musical instrument of his own design—a sort of organized piano—which I believe had pipes, drums, bells, triangles, and other sources of harmony (query of noise and dissonance), which my own father—who knew him personally, and often "sat under him," I mean attended his performances—told me was very effective indeed. Now I have heard several similar instruments of English and foreign make, and, in a certain sense, I have no doubt whatever it was like them, very effective. The poet says or sings, 'Tis distance lends enchantment,—certainly quite as true of the whole generation of such "stunners," as it is of any view, earthly or celestial, within the power of our telescopes. Nevertheless, I should be very glad to know what has become of it, and see it added to that collection of queer old odd fiddles and other things in the Museum, which *Punch's* polite juvenile miss very improperly termed *funny*, to the horror of her governess, who very properly told her never again to use so shocking a word in public, most especially not in the sacred precincts of South Kensington Museum; for said she, "Government objects to such a term being used to describe works of art. My dear, you ought to say 'curious' or 'very remarkable;' and *never* to use so vulgar a word as funny." I trust, if Dibdin's instrument is yet in existence, its present owner will either present it to the nation or sell it for a valuable c-o-n-s-i-d-e-r-a-t-i-o-n.

That the pianoforte superseded the harpsichord in the theatrical orchestra at a very early period is an obvious mistake. I must doubt—although often employed to accompany the voice, when it was wheeled on to the stage when needed—that it did so generally until about seventy years ago, perhaps not so soon; for until about 1810 it was so weak in tone that the harpsichord continued to surpass it in power. One of the most powerful harpsichords ever constructed was burned in the fire which destroyed old Covent Garden Theatre; but whether another succeeded it in the new structure, or it was replaced by a pianoforte, I have been unable to ascertain; but I rather think it was so superseded; for I do not remember that the old harpsichord maker I knew, who was about seventy years of age in 1833, and who was very enthusiastic about the burnt harpsichord, ever told me that it had a successor of the same species as itself. As he was very familiar with the lost one, and, until I showed him mine, would not believe it was possible to make one which could exceed it in power, and felt great interest in this and other harpsichords generally, often lamenting our degenerate modern taste for the piano, I think he would have told me if it had not been the last of its race in the Theatre Royal Covent Garden. I have since feared showing him my instrument was an act of cruelty to the animal, for it dethroned his favourite idol; he was compelled to admit the greater power of mine, which is the only instrument deserving the title of "consort" harpsichord I have had the pleasure to hear; but as a description of it is published in No. 275 of the ENGLISH MECHANIC, I, *as usual*, eschew vain repetitions.

It is quite certain the piano did not come into general use as a solo instrument in the concert-room until the masterly playing of Musio Clementi was heard, and "took the town by storm." Not only was Clementi a very "stronghand" on the harpsichord, but, for his time, a very great pianist. Some of his compositions are far from easy. The great Thalberg, at the Exhibition of 1851, told your very *practical* correspondent "W. T." that, excepting his own compositions, he seldom or ever practised anything but "Clementi's Gradus ad Parnassum," a work I strongly recommend to the whole generation of young lady players, it being a collection of remarkably "easy" exercises. When *they* have *mastered* them, they need little fear anything else within the reach of their fingers. Indeed, if young ladies' hands could command twelfths, I fear we should not greatly admire them—I mean the hands, not the twelfths—any more than we admire big female feet; for, be it known to all men and women, that the female foot should not quite equal the Queen's foot—I mean the third part of her standard yard—or twelve inches imperial measure.

Our pianoforte historian seems strangely misled by his reading. "How readest thou," is a question I think it would sometimes puzzle him to answer. He says that very ingenious mechanician, Merlin, tried in 1774 to effect a *compromise* between the harpsichord and piano (by combining both), which had then nearly superseded the former. The patent of Merlin lies before me, and I can find no trace of any attempt at compromise in it. Merlin simply proposes to do, by better means, what had been done on the Continent, and probably in England also, at least half a century before his time—viz., to put hammers to harpsichords in addition to its jacks. That he afterwards constructed three unison grand pianos, with jacks added, is nothing to the purpose. Robert Stodart did it soon after; and so far from this indicating that the piano had superseded the harpsichord, it rather indicates that the harpsichord yet maintained the lead, or at least, yet had so much influence that the pianoforte-makers thought their instruments could not stand alone. So far from the piano having generally superseded the harpsichord at this time, it is likely that if the books of Tschudi, Broadwood, & Co., and Kirkman & Co., were obtainable, they would show more than a score of harpsichords made for one grand piano; and probably if we had similar returns of all the small pianofortes and spinets, the latter would show a very large majority, although perhaps not so large as the preponderance of the number of harpsichords over grands.

Probably Robert Stodart never made a harpsichord proper in his life; but even he, by the invention of a check inserted into the key, remedied the chief defect of Christofali's action—viz., the long drop of the hammer into its cuneiform rest after the hopper had been "set-off," by means of this check, probably gave the grand pianoforte the greatest impetus towards its adoption for use in the concert-room it ever received; for from Stodart's time until the so-called double action of Sebastian Erard was invented but little further improvement was made in the mechanism of this instrument. Indeed, but little more was required to make it as perfect as any mechanism could be, in which the hopper is made to escape from beneath the shoulder of the hammer butt. Erard first showed us how to do this, and yet to retain the capability of repetition, formerly confined to single actions without checks; but like most inventors—I plead quite as guilty myself of committing this fault as any one who has attempted to improve pianoforo actions can do—he first did it in a very complex, however efficient manner. From the sin of complexity, that firm are yet far from free. With all the consideration due to commercial requirements, and making every allowance for the very natural independent feeling which renders first-class firms unwilling to adopt the improvements of small makers, however excellent their designs may be, I have often wondered that Messrs. Erard have not adopted Stumpf's modification of the principle of their own action, which I find does its work in my experimental grand piano equally well, if not better; *i.e.* it enables the player to repeat the blow with the key equally low, or even lower than can be done with the mechanism used by Messrs. Erard—for I can do it with certainty, by allowing the key to rise rather less than the sixteenth part of an inch, the hammer being effectually checked between each blow, however rapid the repetition. Surely it would be no dishonour to Messrs. Erard to adopt what is only a simpler and improved method of carrying out the principle of the invention of the talented founder of the firm, especially when it is considered, that by doing it, the action is so greatly simplified that the number of centres of motion is reduced from six to two, irrespective of that of the damper. Through error we arrive at truth, and through complexity we—in mechanical designs and constructions—arrive at simplicity.

Merlin's, and his predecessors', combination of jacks with hammers, afterwards carried out by R. Stodart and others, is very effective when properly done. I knew an instrument of this kind, with two ranks of keys, in a satin-wood case, compass five octaves complete, *i.e.*, 61 semitones, which bore the name of Longman and Broadrip, A.D., 1790, the same date as my harpsichord. It was a vile piano, restrung with three about No. 8 wires to each note, but the harpsichord action brought out very fair tone, excepting the bass, which being strung much too light was weak. I think so well of this combination that it is quite possible I may carry it out in a bichord grand; it affords a very pleasing variety.

In page 52, Mr. Brinsmead describes what is termed the old man's head action, *i.e.*, the hammer lifter, which *does not escape* or hop off like the hammer lifter of a modern piano, whence its not very appropriate name of grasshopper. N.B.—The inventor of this was not John Gieb, as Mr. Brinsmead, who copies the mistakes of others, states, but Christofali, whose action has a true escapement.

It is by no means "sartain sure" that the old man's head is the very oldest of pianoforte actions. I have gone into this subject in another paper, but will just say that the first record of its alleged invention by Schroeter, A.D. 1716, is subsequent to Christofali's escapement action. Maybe the tangent of the clavichord, with clothing on its top, had been used to strike strings (*à la* dulcimer) before any old man's head (inside a musical instrument) was treated—as it was the custom to treat a traitor's, *i.e.*, stuck up on a stake or pole—for the tangent wire fulfilled this duty to the head of "ye ancyente man" inside the, perhaps, reversed dulcimer or clavichord with open strings tuned to the chromatic scale. This kind of old man's head, however "soft" (young men's heads never are soft of course!) would not "damp," *i.e.*, stop the vibrations of a string unless held against it, any more than a modern pianoforte hammer does. Unless the player lifted his finger instantly it would indeed block most "consumedly," but it is astonishing what you can do when you are used to it—like the *lucky* eels who were benevolently supplied with many skins, and had to endure their being successively taken off. We have Sterne's authority that it was nothing (query, to them or the fish wife?) when they were *used to it*, which they could not well have been if they had not been mercifully provided with many cuticles. I have seen a pianoforte maker's shopman—I sincerely beg his serene highness's pardon for giving him a designation so *infra dig.*, I should have written gentleman; of course they are all gentlemen in so refined a vocation as pianoforte making—the gentleman, I was saying, who condescended (for a consideration) to play very pleasingly on the instruments in his employer's shop, and to exhibit their excellences (and hide their defects also) from the would-be purchaser, who, probably from his "touch" not having been sufficiently "cultivated," could not play on any of them at all. I say I have seen him run his fingers over the keys of an instrument (*every hammer of which blocked dead against its strings*), and lift up each finger from the key just as if the latter had been a "hot potato," supposing so refined a person could have conceived the existence of so vulgar a comestible as a hot murphy necessarily must be, for "are they not sold in the streets," certainly not so cheap as sparrows during the first century, for we don't buy that poor man's luxury, the "hot potato"—by the way, it is considered rich man's luxury at Evans's—quite so *cheaply* as the market price of sparrows—*i.e.*, two for a farthing—query some other fraction of a denarius. Can it be possible that Queen Anne's, or any other farthings, were then current in Judea? But not being a numismatical any more than I am a mathematical person, of course I cannot possibly know that Cæsar's image and superscription were not impressed on farthings. But to come back to our subject, after this slight digression, or compound of digressions, I remark that Mr. Brinsmead states that with the old man's head action the blow was very feeble, but I may also remark this is not an essential character of that action; indeed, there can be no difficulty whatever in perceiving that it might be made to impel the hammer with as great velocity, and consequently cause it to strike as forcibly as the common grand or any other action can do. Nay, if the old man's head be *wide and thin*—I forget the ethnological word for this conformation—and it be stuck up rather high (*à la* traitor's) it is obvious that it will approach nearer to the hammer's centre the farther the keys be depressed in front. Now, this condition of things, so far from causing the hammer to strike a feeble blow, conduces to the very reverse; for it is obvious that the nearer to the hammer centre the old man's head, or lifter, acts, the faster C.P. it must impel it, and the merest tyro in mechanics knows that the faster a hammer of given weight be impelled the harder it strikes. But, as many persons resemble the writer in desiring the *experimentum crucis* they can—if so minded and desirous—give the policeman on the "beat" half a crown to try the effect of striking their own *whole* one with his truncheon when moved at greatly varying velocities. After they have had *sufficient* experience I can assure them, supposing their previously whole crowns be not "crackit," as the Scotch say—*i.e.*, made into half-crowns, or yet smaller *fractions* (I hope not *vulgar* fractions)—in other words, if their thick skulls be not fractured, and their memory totally destroyed by the experiment, that their doubts will be completely solved, and they, being *saved by suffering*, will become true believers ever after. I fear I shall get but the *small thanks* for this benevolent *good advice* (gratis), which, the poet says, is *yet its market price*.

I have been induced to favour the *gentle* reader with this analysis of this perhaps oldest and most primitive of pianoforte actions, because in comparatively recent times the old man's head—like that of an irrepressible nigger—has popped or cropped up again. The grand pianoforte mechanism of Messrs. Hopkinson is an arrangement for making the old man's head—in this case literally a wooden head, as usual, but with his hat off—do modern work, and I must say they have made him do his modern work extremely well. Instead of putting his head on an inflexible pole (like that of an ancient wrong-doer, treated *secundem artem*, according to the humane practice of our ancestors, who put the dangerous class speedily out of pain, and thereby saved no end of money in county rates and model prisons), Messrs. Hopkinson *put* it on a *leg*, with a knee joint, so that his old head (modernized to suit the requirements of a pianist of this period) might be made to *bow* to the requirements of modern society. In their action the old man's head, although *it* be but a wooden block, cannot *block* the hammer against the string, because, as in our Schroeter's and Mason's actions, it cannot lift it quite up to the string—in a word, he is a short-legged unipede. N.B.—This action, although but a one-legged affair, cannot possibly be made to resemble "our Mary Anne's letter," for it don't come (or go) *hopping*. Unipede as it is, it cannot *hop*—*ergo*, it is not properly what is termed a hopper, or, somewhat absurdly, the grasshopper action. To prevent the hammer from rebounding from the old man's head, a habit it had, which was —however *soft* that head might naturally be, or however soft artificially it might be made—the torment of the player, Messrs. Hopkinson apply Robert Stodart's common grand check to it; and it is in making provision to allow the further descent of the key, which would otherwise block the hammer against the string, that the ingenuity of its designer, (whose name is Mata, if I don't forget), is displayed. This is effected in manner following:—that is to say, when the lifter has raised the hammer as nearly to the string as it can safely be adjusted to do, a lever comes into action which compels the old man to bend his knee-joint. This not only prevents his head from rising any higher, but actually compels him to do the polite by *lowering* it. Under these circumstances it is obvious that not only does the further depression of the key bring the check within the radius of the hammer's circular path, but it also, by shortening the hammer lifter, affords ample room between its top and the shoulder or surface of the hammer butt (against which the said lifter acts to raise the hammer) for the hammer to fall against the check. Thus it will be perceived that there is no escapement or hopping off, properly so called, no danger of blocking, but also combined with absolute certainty of the checks acting properly. I need hardly add that the hammer strikes the strings with just the same force in this as it does in every other action which impels the hammer at the same rate. It cannot be greater or less so long as its weight and velocity are unaltered. It is, in my opinion, one of the very best grand actions in use. It feels *extremely* nice under the finger, enables the performer to play with great expression, and repeats the blow by a very small rise of the key in front, which is a combination of very good qualities.

The remainder of this more or less veracious history I have already characterized. It consists chiefly of matter which Rimbault thought good enough to print, A.D. 1862, from whose work it is copied almost verbatim, even down to the list of patents for so-called improvements in harpsichords, spinets, pianofortes, &c., but in this matter he has indeed gone beyond his predecessor, who terminated the list he published in 1862, with Hopkinson A.D. 1851; following so worthy an example Brinsmead terminates his list, published in 1870, in the year of grace 1862, with the illustrious name of John Broadwood—I beg pardon, I ought to have written, my only excuse is that old associations have such power over us—the illustrious name of John Brinsmead, the alleged father both of Edgar and of cheap pianofortes, *Eureka*, *Magnus*, *est veritas et prevalebit* (query, will, in time, prewail a bit). It is, of course, quite indisputable that among the many patents which have been taken out for improvements in pianofortes since Brinsmead's crowning mercy, A.D. 1862, there could be not even one worthy record, no doubt filial veneration—not to hint at commercial interests—compelled our "Sweet Edgar"—by the way I fear the name of the "sweet" individual recorded by the poet was not Edgar but Edwin, but *n'importe*, both at least are genuine Saxon, and, as the very practical Yankee philosopher put it "it's all the same and it don't matter." After such a "crowning of the edifice" with the name of the author's respected progenitor, it would ill become a mere outsider, like an ignorant blacksmith, to comment on the refined taste (combined with a somewhat acute perception of probable material advantage), which is exhibited by the exclusion of so many more recently patented inventions. So having, perhaps you will think, said quite enough already (I fear too much) anent this matter, I to the great relief of yourself and your readers, only say one word more, which word is, Finis. The Harmonious Blacksmith.

LINK MOTION.

[168] Sir,—I am sorry I replied to Mr. Wheatley so rashly on p. 352. I ought to have taken more time to think it over; but as I am not at home until the week's end, nor do I see my Mechanic until then, I could not possibly reply as I should have done; this, and the way Mr. Wheatley commences his attack, led me on rather too rashly, but I will endeavour to do better in future.

I am very thankful to Mr. Wheatley for reminding me of my want of knowledge of the link motion. He says he is afraid "I know very little of the link motion." I may inform Mr. W. at once that I do not know very much about it, not one quarter of what I should like to know, but what I do know I have proved by experience, having applied the link motion to Cornish valves as well as slide valves. I have also seen the link worked with one excentric and rod. Now if he will make a model of the former (Cornish valve), and one to the latter, I think he will know a little more about this motion by the time he has done so. I may state for the last five years I have had a locomotive to keep in repair, and about two years ago I had to take all the lap off to enable it to go up an incline (that had just been finished) with the same weight as before. Now there were parties there, like some of your correspondents, who thought the valves were spoiled, and that if the regulator leaked the engine would not stand still; but, to disabuse these parties of their prejudicial disposition, I brought it to the level, placed the lever in the centre notch and turned the steam on, but could not get a puff out of her, but by shifting the lever a notch or two she answered to it immediately, but by bringing the lever into centre notch again she came to a stand-still, with the steam on all the time. This, I think, will be proof sufficient for Mr. Wheatley that the centre of link has no motion, provided the excentrics are in their proper places.

I will now say a word or two to my friend James F. Ryan. Whenever he makes a drawing of excentric never let the excentric rod point to the diameter; that is not its proper place. The place for it to point is the common centre of excentric, and its vibration is something less than the throw of the excentric vertically each side of the horizontal line. I am very thankful for the diagram for my instruction (or rather destruction provided I swallow it), but beg to say that it is a waste of space, as the same diagram is the production of Mr. Baskerville, of the 17th of June. It is the taking of the diametrical centres that is leading them astray.

I now ask Mr. Wheatley and Mr. Ryan of what use are so many notches in quadrant if we have so much motion in centre of link? I always thought the first notch from centre was the minimum, and the end notch the maximum; in fact, common sense must tell them that a link 1ft. 4in. long travelling 5¼in. each end, but in opposite directions, and each end making the return stroke at the same instant, must make some part of that link motionless as it were. If we put the lever in centre notch we have no motion in valve, but if we place it in next notch we have the amount of motion, and, as I said before, the maximum is when in end notch. Now how can this be unless the centre of link is, as it were, the centre of motion to two distinct levers? If we say we have 2¼in. of motion in centre of link then we might say that we have three motions in that link—one to run the engine the right hand, the other to run it the left hand, and the third one (which is the 2¼in. Mr. Ryan speaks about, and the 3¼in. Mr. Baskerville says the middle of the link should have), or that supposed to be in centre of link, is to run the engine any or no way, but which is the very thing J. W. Bedford wants to get without—viz., "steaming and exhausting when the lever is in centre notch."

In conclusion, let these gentlemen draw out a link 1ft. 4in. in length, and take 5¼in. as vibration for valve; divide one-half the link in four (treating that half as a lever whose centre of whole is as centre of motion), and we shall have for the end notch 5¼in. of vibration, and for the next 4in., the next 2⅝in., and the one next to centre notch 1⅛in. of vibration respectively; and thus we require nine notches in quadrant—viz., four each side of centre notch corresponding to the four divisions of one-half the link, consequently giving us complete control over the amount of opening required for that valve, to suit the difference of loads the engine has to lift or draw. James Harrison.

[169] Sir,—I have read with much interest the discussion on "Link Motion" carried on in the columns of our Mechanic, and think that it will go a great way in clearing up the very hazy notions entertained by the great majority of working engineers on this beautiful motion. Will you kindly give me space to correct an error into which Mr. Ryan has fallen in the diagram sent for the instruction of Mr. Harrison?

In the diagram in question, with the excentrics in the position shown, *the rods ought to be crossed*. This, it will be evident, very much reduces the amount of vibration. It is quite possible so to proportion the length of the rods that there shall be no vibration.

R. H. M.

HARMONIUM REEDS—THEIR CHANGES IN PITCH.

[170] Sir,—We ought all to be ready to obey the new "order," which, in right of your premiership, you have issued, calling upon us to see that no question goes unanswered. Every one must acknowledge it to be a good stroke of practical wisdom to exhibit weekly the "unnoticed queries," and it should be a pride amongst the subscribers, each in his own speciality of acquirement, to keep the list within the least possible limits. Mindful of the duty, I reply to those questions which have personal reference to my own studies.

"Amateur Tuner" (4295, p. 407), enquires concerning the tuning of harmoniums; the remarks I make will also answer the question of "J. H. F.," some numbers back, on the subject of tuning. The observation of an amateur tuner is quite correct as to facts: harmonium reeds do fluctuate in pitch under variable pressure of wind, and necessarily so. It is the nature of the free reed. "Freedom" presupposes the tendency to go astray. Stronger wind sets a greater portion of the reed in motion than an average pressure does; lighter wind throws less length into vibration, therefore virtually the reed itself varies in length. In fact, the reeds never vibrate entirely up to their roots, but only more or less in extent according to the degree of force exerted by the wind upon them. Within average force the differences of pitch arising are scarcely observable, although we know they must exist; but when the flexion becomes a strain on the fibre of the metal then the variability reaches extremes, producing dissonance.

The predominance of such fluctuations will very greatly depend on the character of the sound-board. Improperly scaled channels favour discrepancies of pitch, whilst truly sympathetic channels have a compensating influence, restraining the wildness of the variations.

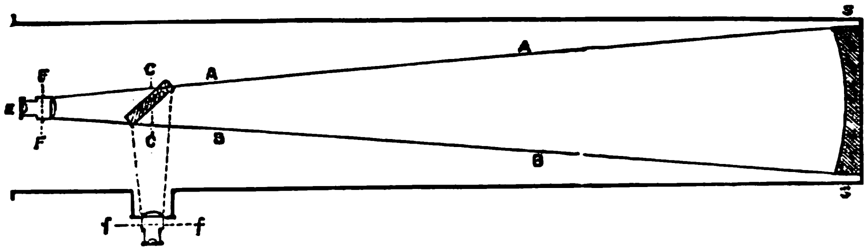
The defect is not peculiar to harmoniums only, it pertains to all wind instruments, and is but partially overcome or modified by art. The student would do well to remember that every art is a compromise, whether in governing man or materials. After all the skill of the maker has been exercised every instrument betrays imperfections. The soloist on a wind instrument finds that an art of intonation is required, he needs to tone each note as he wants it, and excellence in this gives him supremacy amongst his fellow artists.

The questioner will immediately respond—"I would know this art,"—we can only reply that he must acquire it in patient work; it cannot be told. When we are engaged in finishing and perfecting an instrument we are rehearsing the part of the artist who is to play upon it, reducing the imperfections of intonation, and, as far as possible in us lies, are smoothing the difficulties he would have to conquer himself before his music could give the satisfaction to the ear which both artist and audience desire; hence the anxiety of the artist to obtain a fine instrument—hence the ambition of the maker to produce one. Yet the finest possible instrument leaves full scope for the artist, only that it permits him to devote his, skill to the finer grades of excellence, the rougher work has been done for him in patient rehearsals and repeated trials of effect.

Amateur musicians, like amateur politicians, are too much bent on demanding a system of perfection—too much inclined to rely on formal methods, and to think that everything may be done by rules and regulations. In respect of musical instruments they will soon find it is not so; experience will show how much they must of necessity yield to the peculiarities they meet with in order to attain real utility. It is best to recognize defects as inherent in the nature of the harmonium, and we are then better able to judge how far they are to be influenced by skilful treatment, or veiled by art, and perhaps made subsevient to agreeable results. The practice of tuning, although so important a matter for music, is but distantly related to musical feeling; it is an arithmetical operation, a calculation by the ear. Many of the best tuners have been men without musical knowledge, and devoid of musical feeling; the talent is special, like the talent for figures, even as a man may be a good accountant yet possess no aptitude for the conduct of trade, or may be a good architectural draughtsman, yet have but little sensibility to the painter's effects of colour. Supposing a man has a talent for tuning, it will require from two to five years practice to render him competent. I cannot, therefore, advise the amateur harmonium builder to undertake tuning his own instrument; his desire of assuring his friends that he did everything himself he had better sacrifice to the more humanising regard for his friends' ears. It is hardly probable, under the most favourable suppositions, that he would be successful in his early efforts in tuning—his time would be wasted and the practical usefulness of his instrument be lost; for I take it to be that it has some musical service in its design, and has not been got up as a child's puppet-show for friends to be condescendingly interested in. An harmonium intended for use should, if possible, be tuned by a practised tuner, who, if only of moderate skill, will have an advantage over an inexperienced hand. It is then open to the possessor to make whatever incidental changes his own taste may suggest; indeed, it is likely that minor changes and shadings may be desirable, for it is not every tuner has an ear for quality, and the amateur who possesses the higher susceptibility to musical feeling may thus find ample range for exercising his skill; and should his temerity lead him to any extravagant temporary derangement the tuner will be able to bring it back again into a sane condition.

The amateur bent on experiment and content to spoil a set of reeds would do well to get up an extra specimen and test it by side of the professional work; he will learn more by this than by his own unaided efforts. Instruction in the arithmetics of tuning should be sought in one of the manuals on the subject; unless entered into with thoroughness of detail an exposition in these pages would be useless, and therefore I prefer to advise the study from its rudiments. A little book, at a shilling, called "D'Almaine's Art of Tuning," may be obtained through any bookseller.

In the process of tuning the bellows should always be kept as nearly as may be at one even power, about half the strength of springs, remembering that single notes tuned will show more variation under changing pressure than will be exhibited in actual use when chords and running passages distribute the strain of the wind. A discreet tuner strikes the mean in the general display of the instrument, humours each reed according to its strength or weakness, and endeavours to leave it in that condition which, on the whole, will be most generally serviceable in combinations of chords and most agreeable in the average effect; for the tuner should also be able to associate the voicing and regulating the reeds with the more mechanical operation of tuning. The ability to do so is rarely found, but when it is, that tuner is highly prized. No two tuners tune exactly alike, and there are different systems of tuning adopted from personal preference. It is an accepted doctrine that all octaves should be tuned perfect. As regards the harmonium this doctrine I do not hold to, believing it can be shown as theoretically reasonable, and practically more agreeable that they should be something less than perfect; but this and many other matters in tuning form too complex a study to be understood by a merely cursory explanation. Hermann Smith.



TELESCOPIC.

[171] SIR,—In accordance with "C. G.'s" request (p. 430) I give him a method by which he may find the proper diameter of a plan for any sized Newtonian reflector.

The aperture of the speculum being given, its solar focal length is next found, and a diagram (similar to that given above) is to be correctly drawn to any convenient scale; previous to this, however, the largest field and lowest power eyepiece proposed to be used with the telescope is selected, and the diameter of its field lens measured. In the diagram, S S represents the speculum, and the short line F F its focal length; upon this line the eyepiece E is supposed to be placed in such a position that the diaphragm is coincident with the line F F. The diameter of the field lens being correctly drawn to scale, next draw lines A A and B B from the extreme margin of the lens to the margin of the speculum, and these lines will represent the practical working limit of the cone of reflected rays. The next thing to be found is at what point ought the plane to intersect this cone of rays. This is found by first measuring the semi-diameter of the telescope tube and adding to it the distance beyond its outer side at which the focus is supposed to be thrown. Suppose, for instance, the tube is 10in. diameter, and the focus F F is 3in. distant from the large tube, the total distance of the focus from the centre of the plane would have to be 8in. This then would be the distance of the centre of the plane C C, from the focal line F F, and the diameter of the cone of rays at the line C C, gives the size required for the actual aperture of the plane. It is of course, advisable to have the plane just a trifle larger than the cone of rays demands to admit of necessary play in its adjustment.

This, I believe, is the most correct rule; but to those who desire a simpler method I may say that if the plane is 1-5th the diameter of the speculum, that will be found sufficiently correct in most cases. As to "C. G.'s" query respecting the polishing of specula, I may say that, in general, fitfulness of movement arises chiefly from irregularity of size in the facets of the polisher, and may be almost entirely overcome by attention to this point. I find the time required to produce a good polish is from three to four hours, but this varies according to the hardness of the glass and the amount of cohesion between it and the polisher to harden. The pitch rosin may be added, or (as Herschel recommends) it may be melted with sufficient heat to vaporize some of the essential oil which it contains. I find this quite as effectual.

W. PURKISS.

READINGS FROM THE GLOBES.

[172] SIR,—Geographers have fixed upon the latitude and longitude of a place in order to determine its position upon the terrestrial globe; and astronomers have fixed upon the right ascension and declination of a heavenly body, or upon its latitude and longitude, in order to mark its place upon their maps and celestial globes; but mariners, besides latitude and longitude, require the course which a ship ought to take upon the pathless tracks of the mighty deep, as without correct guidance they may endanger the safety of their vessel. As they make use of the mariner's compass to direct them, it is necessary for them to know upon what points or rhumb-lines they must steer in order to reach their destination; and consequently the value of accurate knowledge upon these points cannot be too highly estimated. We propose then (1) to define the angle of position between two places upon the earth's surface and the angle of position of a star; (2) to show how to find such by forming the triangle upon the globe; and (3) to point out how to verify the results by working them out by the proper formulæ for this purpose. The angle of position shows the true bearing of one place from another, or the exact direction which the arc of a great circle would take to reach it; and this great circle is represented by the quadrant of the globe; but it is necessary to bear in mind that it is not the direct course which a ship must steer, for the magnetic needle being of small size as compared with the bulk of the earth, makes equal angles with every meridian over which it passes. Thus, if a ship were guided by the mariner's compass, according to the true bearing, as found by the angle of position, it would make equal angles with every meridian over which it passed, and would be carried out of its right course, for the quadrant of altitude or great circle does not make equal angles with every meridian over which it passes. If the magnetic needle were sufficiently long, and pointed from one place to the other, the course, as found by the angle of position would be correctly taken; but mariners find it necessary to guide their vessels by the bearing which the mariner's compass gives as calculated by a Mercator's chart, which is constructed by the parallels of latitude being made at right angles with the meridians; and it is only on the equator, or a meridian pointing north and south, that the angles of position coincides with the bearing by mariner's compass. They therefore steer their course by what is called a rhumb-line, which cuts all the meridians which it crosses at equal angles, as the magnetic needle does; but the angle of position shows the true bearing of one place from another upon the earth, or the direction which a ship would take if the two places were in sight of each other. The angle of position of a star, which I understand is used in some astronomical calculations, is the angle which that particular star makes with the pole of the ecliptic and the pole of the equator. Thus let P (Fig. 2) be the pole of the equator upon a celestial globe, and P the pole of the ecliptic, and A the star Arcturus; then the angle P A P would be the angle of position of the star Arcturus. These angles of position may be determined by the globe approximately; that is, sufficiently near to enable us to compare their results with those which have been worked out by the formulæ in trigonometry. If, for instance, we wish to find the angle of position between London and Constantinople, (Fig. 1) we must bring London to the meridian, and having screwed the quadrant over it we must pass its graduated edge over Constantinople, and measure the angle upon the horizon (taking care to have London in the zenith), which will be found to be 104° from the north towards the east. To find the angle of position of Arcturus by the celestial globe, we must bring Arcturus to the zenith, then we can chalk out the triangle or pass the quadrant from Arcturus over the pole of the ecliptic and we shall find the angle on the horizon, viz., 22° 26′. We shall then be in a position to use the formulæ to verify our results; and the formula for this purpose is the same as used to find the shortest distance between any two places, namely, Given the two sides and the included angle to find the other angles. The two sides will be the complements of the latitudes and the included angle the difference of their longitudes, and the angles at the base will be the angles of position of the two places; but to find the angle of position of a star, we have three sides given to find the angle A. The three sides are P A the complement of the declination, P P the obliquity of the ecliptic, P A the colatitude, and the angle may be found by the formula

FIG. 1

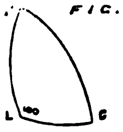
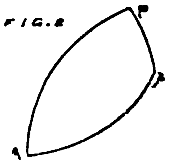


FIG. 2



$$\cos \tfrac{1}{2} A = \sqrt{\frac{\sin s \sin (s-a)}{\sin b \sin c}}$$

where s denotes half the perimeter of the triangle. Thus in a commercial country like this the study of the globes becomes important, as it gives us elementary ideas of geography and astronomy, by which the mariner may not only know the direction in which one place lies in respect to another, but can tell with precision the precise spot where his ship happens to be.

T. S. H.

P.S.—In letter 6, p. 372, col. 2, line 12, for A C read B C.

DISSOLVING VIEW PAINTING.

[173] SIR,—With your kind permission, I propose, in the course of a few weeks, to offer a detailed and practical course of instruction on the higher class dissolving view painting, the result of nine years' experience. It is a fascinating pastime, and the great enjoyment it enables one to afford others is to me its strongest recommendation. To place glass-painting within the reach of those who cannot make their own drawings, printed outlines and photographs are sold for colouring by most opticians. Of these I hope to speak in a suitable place, but I state *en passant* that nothing surpasses a *superior* "*hand-painted* slide *in oils*," which will always keep its place in the market, and command its price. I venture to remark, as a nameless one, simply for the encouragement of the earnest-minded, who can bring patience, care, and a *moderate* amount of skill to the work, that when I took up the art, I could but make a modest vignette in *tolerable* drawing, and only a short time since I disposed of some of my later views (on the Rhine) for ten shillings each. If those interested will kindly follow the directions, &c., which, by the aid of our invaluable paper, I may give, I think I shall be rewarded by hearing that many have arrived at highly respectable results, while some will have produced "things of beauty that will remain joys for ever."

SABLE.

THE BICYCLE.

[174] SIR,—In reply to N. G. Lamborne, I beg to say that my answers to his queries are the result of nearly two years' experience in the delightful exercise and pleasure of bicycle riding. As regards learning to ride I accomplished that in about an hour, on an incline of a hundred yards or so. I first learnt to balance myself on the machine by taking my legs off the ground and letting the bicycle run down this incline; I then placed one foot on a treadle and got it into the motion; then the other foot's turn came, and last of all I placed both feet on the treadle. After occasional practice for a day or two I could ride the machine nearly as well as I do now. I find, like T. Cooke, the best and easiest way to propel the machine is to place the seat well back on the spring, so that one can give a forward-downward push instead of only a downward one. Riding on this plan, I can beat all the riders in my part both in speed and distance, as the motion is not so tiring, &c., as the other. The twisting about of the machine from side to side of the road, showed that either the rider was not up to his work or that his machine was out of order. I have not found any danger to result from riding a bicycle in narrow roads, and unless a rider should lose his presence of mind, or be unable to manage the machine, I do not think an accident likely to happen. I cannot say, from experience, of the danger or otherwise of jumping into the saddle when one wishes to mount, but I should think it is a dangerous practice. I should recommend a would-be purchaser to buy a machine of such height that he could touch the ground with his feet when mounted, and he will find it a very great convenience. A good rider never, or very rarely, loses power over the bicycle. The great secret in turning corner, &c., sharply, is "never take your foot off the inside pedal or treadle," or the pressure exerted by the outside foot overcomes the inside, and down you go.

The leg guards, which are generally fitted to bicycles now, effectually prevent all splashing and rubbing of the thighs. "Husband" has given the best mode of taking a bicycle up hill, and like "E. S." I shall believe in ruptures when I feel the effect of them.

MUZZLE LOADER.

"INDUCTORIUM'S" COIL.

[175] SIR,—I must apologize for not sending you the description of my coil before; I do so now, trusting it may not be too late for the several correspondents who were inquiring about it.

In the Exhibition of 1851 there was a large coil by Siemens and Halske, made on the vertical principle, which gave extraordinary results, as perhaps some of our readers may remember. This coil was made out of a solid block of ebonite, cut into parallel grooves, into which the secondary wire was wound, the primary being quite detached and slipping into a core in the centre of the coil. Now it occurred to me that it was an unnecessary trouble and expense—which in a large coil would be immense—to cut these vertical channels out of the solid ebonite, as the tension in each of the compartments, if they were made small, would not be great enough to leap over the interval between each alternate channel; accordingly I proceeded to construct a coil as follows:—I give the size of my present one; your readers can alter the size to suit their own several requirements.

I took an ebonite tube about 18in. long, 3in. in the bore, and ½in. thick; on each end I cut a screw on the exterior, for about 4in., and on them I fitted two nuts (all ebonite), 5in. in diameter; these nuts form the two ends of the coil, and serve to screw the discs all together, leaving about 3in. of the tube clear at each end—*this is very important*.

I next cut out about 80 or 90 discs or rings of thin ebonite, No. 20 wire guage, so as to slip on the ebonite tube, and between each disc I put a ring of ebonite, about an ½in. thick, and the same in depth. Now these discs are not all the same size in diameter. Suppose the distance between the two nuts to be divided into three parts, I make the depth of the discs of the middle division double that of the two ends; this is also important, as the inductive effect of the core is greatest at the centre and *nil* at the two poles, so that it is desirable to get as much of the wire as possible on the central part of the coil.

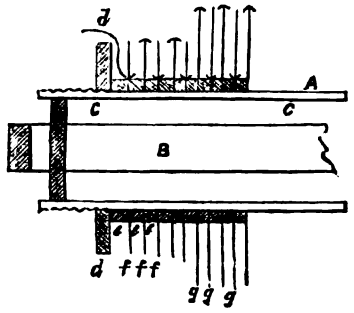
Thus then I have 90 discs or thin rings, 60 of which are 4½in. external diameter, and 30, 5½in. I have also 90 small rings, fitting the tube, and ½in. square. I then *build up* my coil as follows:—I screw on the nut at one end, leaving about 3½in. clear from the end, then I put on a small ring, then a thin disc, then a ring and another disc, and so on, till the whole 90 are thus arranged; taking care, as I said before, that the larger 30 discs occupy the central part of the coil; then I screw on the nut to the other end, and make all tight. I ought to mention that *every alternate* thin disc has a hole drilled through it, just above the small ring, for the wire to pass through, and I put a small *loop* of wire in each hole *previous* to putting them on, as a convenience for pulling the wire through; which, without this forethought, is very troublesome to do. On the two ends are screwed two supports to attach the coil to the base board.

Now for the winding. *Don't wind in the lathe*. I made a temporary stand, and supported the coil on two axes with two handles.—the object of this will be seen presently. Slip the end of the wire, by means of the loop before mentioned, through the hole in disc No. 2 (supposing you to begin at the left hand); then wind and fill up the *first channel*, the end of which will be the left-hand terminal. *Then turn the coil round*, join on the wire to the end you pulled through, and fill up the channel No. 2, but *wind the reverse way to No.* 1. again reverse the coil, and proceed as before, and so on till all the channels are filled; then solder the outside ends of every alternate pair together. The coil will thus be filled with a continuous spiral of wire joined, or connected alternately at the inside and outside of each channel. *Before winding the wire, soak the wire in a boiling mixture of 3 parts of paraffin (solid) and 1 part white wax—this is most important.* Perhaps it would be better, though more trouble, to let it pass through the hot solution as you wind it on. I used the former method.

I think I have clearly explained my plan of construction as regards the secondary wire. I may mention that my primary consists of No. 10 cotton-covered wire, wound in three layers on a bundle of soft iron wires about 1⅝in. diameter. The wires are slightly insulated by a covering of tape soaked in paraffin and wax, and each layer is also insulated by a few thicknesses of gutta-percha tissue. The whole, when wound, forms a cylinder which will just slip into the ebonite tube.

In a coil of this construction it is impossible to break down the insulation *if your tube is a good and sound one;* and the insulation of the wire with the paraffin stops all small leakages, so that you utilize every part of the induced current, and hence you require very small battery power. The one that I have described has given good thick sparks of from 3in. to 4in. in length with one cell of Groves's battery, the platina of which is 2in. by 4in.; and the secondary wire that produces this extraordinary result is, as nearly as I can calculate, about 4 miles.

My condenser is made as follows:—I took about 60 sheets of ordinary good demy paper. I had a sheet-iron dish made, about the size of the paper, in which I heated, by a Bunsen's burner, the above-mentioned mixture of paraffin and wax. Into this boiling mixture I dipped each sheet. I find, however, that it cools so quickly that it has not time to drain off; so that there is much more than is required. This is easily obviated by holding it before a fire, and it will drain off, leaving, when cold, a beautiful pearly-looking sheet of splendidly insulated paper. And the whole process is so simple and expeditious, not occupying, for the 50 or 60 sheets, about a square foot in area, more than an hour, or two at the most. I send a small sketch which may make my description somewhat clearer. I trust that this description may be of some assistance to your readers. **Inductorium.**



P.S.—My thanks are due to "Sigma" for his notice of the air-pump. I wish he would state definitely what vacuum he got with a Tate's pump by the gauge, as I have one which I cannot get to act at all well. I am making one on Newman's plan, the result of which I shall be glad to let your readers know, if interesting. Can any one inform me the best oil to use with air-pumps, that will not get thick and clog the valves? All that I have tried do so, and thus impair their action.

WALL DECORATION.

[176] Sir,—In reply to "Faber" (4330), the preparation of a wall for fresco painting is a work of time and great carefulness, for on the goodness of the work depends in a very great measure the durability of the painting. If the wall is already covered with plaster or laths it should be cleared, and the bricks thoroughly scraped and afterwards well chipped. See that the bricks are in good condition and perfectly dry, and then proceed to lay on the first coat, consisting of river sand and the best old lime, mixed to about the usual thickness. This should be laid on so as to leave a level but rough surface. At some places on the Continent small flint pebbles are mixed with this composition to give the requisite roughness. This groundwork should be allowed to dry thoroughly; indeed, unless the lime is old, it will be some considerable time before it will be safe to put on the *intonaco* or painting-surface. This should be prepared with the very best old lime, perfectly free from grit. An excellent material is prepared from the limestone of Durdham Down, Bristol. The lime is mixed in troughs to the consistence of milk, and is then passed through hair sieves into jars, where it is allowed to settle, and the water is poured off. It is then ready to be mixed with the sand (fine quartz sand, well sifted, is the best), in the proportion of one part lime to two parts sand. The implements used to float on the last coat are made of wood or glass, but trowels of iron may be used if free from rust, and care is taken not to press the iron too forcibly on the intonaco. When the lime and sand coating is ready to be laid, the rough cast must be wetted thoroughly, and the intonaco floated on in two coats, the last with rather more sand than the first. The thickness of the two should be about 3-16ths of an inch. After these are spread, go over the whole with a roll of wet linen, which will remove the marks of the trowel, and prevent the surface being too smooth. The drawing may now be traced, and when the intonaco has become firm enough to just bear the pressure of the finger the first washes of colour may be put on. If the painting is intended to be large, of course only sufficient plaster is put on to serve for the part which can be accomplished in the time at the disposal of the painter. It should be remembered that this portion should end at the edges of some bold outline, as flowing drapery, a pillar, &c. **Sabbas.**

SOLAR PHOTOGRAPHY.

[177] Sir,—In the 239th number of the English Mechanic appeared an article entitled "Astronomy and Photography in England and elsewhere." I must confess that after reading it I could not help experiencing feelings somewhat akin (as I imagined) to those of the writer of the article; and those were of extreme dissatisfaction at the results of the English operations in India last year during the solar eclipse; and also respecting the state of celestial photography at Kew. I do not purpose in this communication to go into the photographic chemistry as practised in that establishment, or as practised by the photographic section of the Indian expedition, but to draw the attention of your astronomical contributors and readers to a few remarks in the above-mentioned article, as it is likely to lead into wrong paths of inquiry, to avoid certain defects such subjects are liable to, one of which was present in those otherwise splendid American photographs of the solar eclipse last year. The writer alludes to a phenomenon I investigated some 9 years ago, the results of which I communicated in 1861 to the London Photographic Society, and again, more recently, to the photographic journals. These remarks are as follows:—"It is interesting to note that the well-known line of increased light, which is frequently seen in photographs in which a light and dark object are in immediate contact, is noticeable in all the prints of partial phases of the eclipse, the line of light being on the sun's disc, where the dark edge of the moon is immediately in contact with it. Whether this is due to light reflected from the back of the plate, or to the tendency of development to increased reduction of silver on the edge of a light part in contact with a black, upon which silver is deposited, is uncertain." It is this line of light or halo, associated with a light and dark body when in immediate contact, that I wish to direct attention to. I have not had an opportunity of examining these photographs; consequently, I must be guided by the writer's description of them. He speaks of this line of light as "being on the sun's disc." This I presume is the fact. What about the cause? Concerning the latter the writer seems to be undecided, as he says it may be due to reflected light from the back of the plate, or to undue deposition of reduced silver. This statement seems to me to indicate a little confusion of ideas. He makes mention of two causes, each of which is likely to produce the effect mentioned. The first of these causes, some two or three years ago, I designated as "optical halation;" the latter as "mechanical halation." Now any one who has studied the subject of photographic halation must be familiar with the two kinds here mentioned. They are two distinct phenomena, and give rise to two distinct effects, and consequently can be traced to two distinct causes. The appearance known as optical halation is a line of light on a dark object, which is in immediate juxtaposition with a light object, and is traceable to reflection of light which has passed through the film which has been acted upon by the bright image. This reflection is effected by what is commonly known as internal reflection of the glass—the negatives, of course, being taken on glass plates. But the spreading of the light is effected by means of the semi-transparency of the film. The remedy for this defect is to make the back surface of the glass plate non-reflective, either the whole of the rays penetrating the film or only those which have a photogenic effect on the film. This is done by bringing into optical contact with the back surface either a black or yellow substance. When this is done, the line of light on the dark object in the picture (positive) disappears. But the writer of the article alluded to says that the line of increased light or halo is on the sun's disc, so the effect on the American photographs cannot be due to this cause. Besides, the Americans were the first to apply this principle to rid themselves of this defect. Whether they did so on this occasion would depend upon the necessity for it. If their chemicals were in such a state as would allow of the use of thick films they might be able to do without any backing to the plates.

Now that we have eliminated one of the supposed causes of the defect, we are in a better position to deal successfully with it. We now come to the increased line of light on a *light* object in juxtaposition with a dark object. This is brought about by quite a different cause, which is probably mechanical, though peculiar conditions of the chemicals may favour its development more at one time than at another. It will be interesting to know whether rapidity or slowness of development of the image has anything to do with it. Be this as it may, it is a common practice during development to give the plate a rocking movement with a view to mix the developer and silver thoroughly together and so bring about evenness of development. If one part of the film is not exposed at all, and another in close proximity is well exposed, the developer which is in immediate contact with the film of both will be dissimilarly affected. The one over and in immediate contact with the unexposed part will be the richer of the two of silver particles, this by the tilting of the plate will be brought over the part exposed, the extent will be proportionate to the kind of rocking movement given to the plate. The result of such movements will be that the edges receiving a richer supply of silver from the unexhausted parts will be developed more than those having the old developer continually passing to and fro over their surface. This I am disposed to think is the cause of the increased line of light on the sun's disc as represented by the American photographs.

In order to obviate this defect, I would suggest that the plate be moved about as little as possible, or the solution be poured on and off—first from one end and then the other—or by developing in a bath. The latter, at first sight, would seem the most promising, as it would give a free supply of developer, and that too of more uniform strength over the whole surface than can be obtained by the usual method.

Our English operators will do well to see to these matters before the next expedition sets out on its journey, and be certain that all has been done that can be done to remedy these defects, and let us see, on its return, that its photographic operations have been at least equal to the Americans', if not superior to them, if that is possible.

Those interested, and requiring more minute particulars, will find the subject fully discussed in the following papers, to which I have had the honour of communicating my views from time to time:—*The Photographic Journal*, Nos. 108 and 110; *The British Journal of Photography*, Nos. 140, 226, 233, 239, 426, 431, and 460; *The Illustrated Photographer*, Nos. 22, 25, 28, 32, and 56. **G. Marlow.**

ACCIDENTS OF THE WORKSHOP.*

[178] Sir,—As the *British and Foreign Mechanic* is now amalgamated with the English Mechanic I send you the continuation of this subject, which was commenced in the first named journal on July 2, p. 342. It may be as well to give a short résumé of the contents of the previous part. The mechanic, always in the midst of moving machinery or climbing scaffolding many feet from the ground, is continually liable to accidents, and a knowledge of what to do, and what not to do, will be found of very great use. In the first place, where the accident is apparently serious, the clothes of the injured man should be loosened, and he should be laid on a door, or shutter, or a plank. An attempt should be made to discover whether any bones are broken, and if there is profuse bleeding it should be arrested immediately. Where there is a cut or gash, if the blood is scarlet and comes in throbs or jumps we know that it is arterial blood, *i. e.*, comes *from* the heart; bleeding of this kind is stopped by tying a ligature (a narrow strip of linen) between the wound and the heart. But if the vital fluid is of a dark colour, and flows steadily in a stream it is venous blood, and is going back *to* the heart; in this case the ligature should be tied or pressure applied between the extremity of the limb and the wound. After the wound has been well washed, a compress of a pyramidal form made of linen rags or lint should be applied, apex downwards, and bound firmly round with a bandage. Before applying the bandage it should be saturated with water, or a little simple ointment placed on the part next the wound. If the gash is long a stitch or two should be passed through the edges with a bent needle and silk,—each stitch tied separately. If the bleeding of the artery be stopped by the pressure of the finger or the ligature, the compress may be dispensed with, and a piece of lint folded three or four times placed over the wound and bound down with a bandage. If the wound is of such a nature that pressure will *not* arrest bleeding, especially where one or more of the arteries of some magnitude have been severed, more forcible means must in these cases be applied; the offending artery must be sought for, and when found drawn out by means of what is called a tenaculum, which resembles a shoemaker's sewing awl; when this is not at hand a large pin bent, or a pair of tweezers with fine points; may be used. When the artery is pulled forward it should be tied with some thread two or three times double, and if there are others they should be treated in a similar manner. It must be observed that the extremity of the divided artery *nearest the heart* should be secured. After the blood vessels have been tied the wound should be washed, if caused by an instrument covered with foreign matter, or if not it is always well to cleanse it; but allow as little water as possible to enter the opening, for it has a tendency to swell the flesh and increase the gaping, especially if warm water is used. Any piece of glass or dirt may be removed by a dry sponge. When cleansed the edges are to be brought together with a few stitches or adhesive plaster, and a bandage bound round in the ordinary way. This should be removed daily to see whether the wound is inclined to slough or discharge matter; when such is the case what is called the "water dressing" should be resorted to—this is merely the bandage or rag covering the part to be kept saturated with water. In some cases "proud flesh" may form; then, as in sloughing, a little nitrate of mercury ointment may be applied. It is best, on the whole, not to meddle with the dressed wound more than to keep it clean, which is a great thing, for it must be borne in mind that the best healing doctor in the world is nature, she can and does perform what no human being can or ever will, and the surgeon's motto is to assist and not interfere or interrupt nature. When it is found that the edges have adhered to each other the stitches may be removed, also the bandage, and a little simple ointment applied on some lint or linen rag, which will prevent the part being injured by dust and other irritating matter, and assist in healing the wound by excluding the air. The cause of wounds being irritated and prevented from healing through not being excluded from the air is from the fact that the atmosphere is impregnated by millions

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of minute invisible animalcula which is so elaborately explained in Professor Tyndall's lecture on "Dust," which I should advise all my readers to obtain. This *savant* has demonstrated beyond all reasonable doubt that were it possible for all the air we breathe to pass through a filter of cotton wool before entering our lungs that life would be prolonged many years. In proof of this observe the advanced age to which farm labourers live to what those do who are living in the foul air of our great cities. But I am going from my subject, though I could write many pages on what I have just alluded to, but it would be turning from the path upon which I have set out.

Other means are to be adopted when the hemorrhage is obstinate, such as the application of ice or very cold water to the part. Cold is one of the best stiptics we have, and seldom fails to do good; it not only contracts the gaping mouths of the arteries but also those of the wounds, thereby arresting bleeding. The ice can be applied directly to the wound, if clean, or be wrapped in flannel or a piece of linen rag, and on the cessation of the flow the wound bandaged as before directed.

Cases have been known where the artery has only been partially severed; in such instances contraction is impossible; therefore it is necessary to complete the division with a lancet. This should be left for a medical man to do, for it is an operation that requires a knowledge of the venal and arterial system. It should on no account be attempted by a novice, unless medical aid is unprocurable, and this appears the last resource to save the person's life by stopping the bleeding. This is founded on the known tendency of arteries to self-contract on division. The danger in this operation is that an inexperienced hand may, instead of completing the division in the already wounded vessel, injure others in the act, and so in trying to do good do a great deal of harm, and make matters worse than before. The safest and surest mode of arresting hemorrhage, when the wound is of some magnitude, is by tying the blood-vessels; this, when effectually done, is unsurpassed by any other means relating to external bleeding. It should be borne in mind, that *all* the arteries must be secured, else bleeding may proceed after bandaging, and the patient unconsciously lose an alarming amount of blood.

In my next letter I shall speak of internal hemorrhage. FREDERIC J. M. BUTT.

WEIGHTS OF CHEMICAL SOLUTIONS.

[179] SIR,—I am afraid I cannot be of much use to "Alkali," as regards finding the amount of *pure anhydrous soda* from the density of the *black ash* solution; probably other readers may contribute what he requires. If the solution contained nothing but pure caustic soda, the percentage might be approximatively determined by the use of Dalton's table.

To use Dalton's table the specific gravity must be known; and this is calculated by multiplying Twaddell's degrees by 5, and adding the results to 1000:—

$$\begin{array}{rl} 80^\circ \text{ Twaddell} \times 5 = & 400 \\ & 1000 \\ \hline & 1400 = \text{specific gravity.} \end{array}$$

or by substracting Beaumé's degrees from 144 and then dividing the same number by the result:—

$$\begin{array}{l} 144 \\ \;\;9^\circ \text{ Beaumé} \\ \hline 135 \end{array} \qquad \frac{144}{135} = 1·066 \text{ or } 1066.$$

When the specific gravity is found, reference to Dalton's table will show the percentage; but to avoid any calculation, I have worked out a table, showing Beaumé's degrees with Twaddell's, and also the real specific gravity.

Percentage of sodium oxide (Na_2O) in solutions of the hydrate.

Specific Gravity.	Beaumé's Degrees.	Twaddell's Degrees.	Percentage of Anhydrous Soda.
Water = 1			
1·56	55°	112°	41·2
1·50	51°	100°	36·8
1·47	49°	94°	34·0
1·44	47°	88°	31·0
1·40	44°	80°	29·0
1·36	40°	72°	26·0
1·32	37°	64°	23·0
1·29	34°	58°	19·0
1·23	29°	46°	16·0
1·18	23°	36°	13·0
1·12	16°	24°	9·0
1·06	9°	12°	4·7

The above will probably not be of much use to "Alkali;" I merely give it, thinking it may be of some use to a few of your readers—saving them the trouble of calculation, &c.

"Alkali" must remember too, that the above table is for the percentage of soda when present in solution as a *hydrate*, and not as a carbonate; in which latter state it is present in *black ash* mixed with sulphate, sulphite, or sulphide, either separately or together, with a little hydrate and some undecomposed salt; it will therefore be seen that the table is useless for the estimation of the carbonate when it is present in solution.

The only correct method by which the exact composition of the liquor may be known is by an analysis; this may be either gravimetric or volumetric; the latter is preferable in this case.

The filtered liquid is diluted to a given volume, from which a given or known volume may be abstracted for the special determination.

The chlorine, sulphuric, and carbonic acids may be thus determined, as also the amount of hydrate in the free state.

From the result of this analysis, we calculate the percentage composition of the liquor, and having that knowledge, we may readily form an idea of the quantity of *caustic soda* or crystallized carbonate which may be obtained from it.

Theoretically, 62 parts of anhydrous soda should produce 106 parts of anhydrous carbonate, 286 of crystallized carbonate, or 80 parts of the hydrate. 80 parts of the hydrate would of course in its turn form the same quantites; but if it only contained 60 per cent. of the hydrate, the quantities obtained would be 3-5ths of the above—viz., 63·6 of anhydrous carbonate, 171·6 of the crystals, and would only correspond to 37·2 parts per 62 of anhydrous soda (Na_2O).

GEORGE E. DAVIS.

THE SUN'S PARALLAX.

[180] SIR,—Allow me to say a few words in answer to "Veritas's" letter on page 425. It is evident that if the data of a calculation be correct, and the reasoning false, the result must necessarily be incorrect. Now, in my letter, on page 402, I wished merely to point out the false reasoning, and correct the error of "Veritas." And if we assume the data given by him on page 228 to be those "which are generally accepted to be true," it is plain that the parallax found by him in the same letter cannot be "that which is generally accepted to be true," because the reasoning is false. For aught that *I* know, not being an astronomer, the parallax may be correct, but if so, the data cannot be. Surely "Veritas" does not want figures to enable him to see this? HUGO.

LATHE CONSTRUCTION.

[181] SIR,—I am sorry not to be able to comply with the wish of "H. D. C., Captn. R.E." (letter No. 138), as I am not in the least an ornamental turner, and I have already written one letter to you (see p. 333 of the current volume) on this very subject. Had I the inclination and could I afford the time to do it, I have the kindest invitation from the gentleman at Halifax, who supplied the photograph of the cutting engine (p. 12), to go to visit him and make drawings of all his apparatus. I do not believe that there is a better shopful of tools in the world than his, for they were not bought at a sale nor ordered wholesale from a maker either, but made consecutively to drawings and directions given by their possessor to a workman who yields to none for accuracy in putting his work together, commencing about October, 1846, when I saw the first pieces of his lathe in hand. As it is, however, I cannot undertake to go down to Yorkshire and spend a week making drawings and putting together again all the things I should have to take to pieces. Had I fancied fancy work, I should have done so long ago. If the R.E. Captain is stationed at Chatham, I may in my capacity of Engineer-Volunteer officer, have the pleasure of being in his company at the Field Works Inspection there on an early day, and shall be glad to discourse on the subject of lathe work.

J. K. P.

CONIC SECTIONS.

[182] SIR,—While thanking "F.R.A.S." for his reply, it being hardly an answer to my question, may I observe that it is scarcely what I require? I hope that I may consider myself sufficient of a mathematician to understand, at least, the rudiments of conic sections.

What I wished was for your correspondent to decide if the definition I gave was correct, as, a dispute having arisen at a recent meeting of the Mathematical Society that is based on it, I was asked to get it decided. The point, therefore, is, Is the definition I gave rigidly correct?

Also, the vertical plane of a conic section is the plane passing through the vertex and parallel to the plane of the conic section.

That the circle is a conic section is of course indisputable, but if it may be regarded scientifically as an ellipse the definition of De Morgan, that all ellipses have two foci and a minor and major axis, will be apparently incorrect.

At the same time I must thank Mr. Proctor for his opinion, and I presume he regards the conic section produced by a plane passing through the vertex of the cone a hyperbola, with its curves passing through its centre, and having only one principal vertex, and with its asymptotes identical with the sides of the conic section.

Otherwise a plane diverging from the slant side of a cone, and cutting the cone, will not be a hyperbola, if it cut the vertex of the cone.

α URSÆ MINORIS.

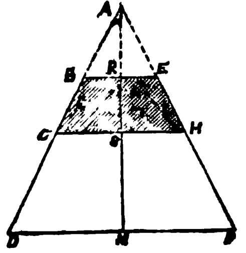
THE MICROSCOPE.

[183] SIR,—I shall have very much pleasure in acceding to the request of "An Axmouth Resident" (see letter 124), and will with your permission, provided no other correspondent volunteer in the interim, commence a series of articles on "The Microscope: How to Choose and How to Use It," in the course of a few weeks, say about the third week in August.

As regards mounting in Canada balsam, your correspondent finds, as have all mounters, that air bubbles are a plague and a vexation. If the balsam be tolerably fluid he has only to keep his slides for a few days at about 70 deg. to 80 deg. of Fahr., and the bubbles will gradually work their way to the edge of the cover, and will disappear. If I can spare time as the autumn draws on I shall be glad to contribute a few papers on mounting. H. POCKLINGTON.

FRUSTRUM OF CONE.

[184] SIR,—



R M = 12 feet.
B E = 2 „
D N = 4 „
B R = 1 „
D M = 2 „
R S = x

$$AR + RM : MD :: AR : RB$$
$$\therefore AR \times 12 : 2 : AR : 1$$
$$\therefore 2AR = AR + 12$$
$$\therefore AR = 12$$

Hence the height of the *whole* cone = 24ft
„ weight „ = 44238

Again, weight of cone A B E = 5529·216
Add 4 tons .. .. .. = 8960·00

Then, weight of cone A C H = 14489·216

Again 44238·728
14489·216

29744·512lb. = weight of frustrum C H E

$$\text{Since } CS = \frac{AS}{12} = \frac{12 + x}{12}$$

we have

$$\frac{\pi\left(\frac{12 \times x}{12}\right)^2 \times (12 - x) \times 440}{3} = \frac{\pi\,(12 + x)^3 \times 440}{3}$$

$$= 14489·216 = \text{weight of cone } A\,C\,H$$

$$\therefore (12 + x)^3 = \frac{14489·216 \times 144 \times 3}{3·1416 \times 440}$$

$$= 4528·194\text{lbs.}$$

$$\therefore 12 + x = 16·54$$

$$\therefore x = 4·54$$

$$\text{Again, } AR + RS : CS :: AR : BR$$

$$\therefore 12 + 4·54 : CS :: 12 : 1$$

$$\therefore CS = \frac{16·54}{12} = 1·378$$

Hence C H = 2·756 = diameter of section,
and M S = 7·46 = length of gun reduced.

CHRIS. HALDANE STOKES,
Captain (late) R.

GAS BY A NEW PROCESS.

[185] SIR,—I have copied the following from the *Times* newspaper, a few years ago. I forward it with the hope that some one (or more) out of the numbers of readers of our MECHANIC can [illegible] an apparatus of the kind, and also understand the process of the manufacture of the gas afterwards. If there could be found among the many readers who could and would do this, I am sure of this he would get an immense custom, and it would be a boon to numbers—your humble servant for one.

"GAS BY A NEW PROCESS.—An experiment in gas lighting, by Count de Val Marino, was made yesterday evening on a piece of ground at the back of [illegible] lane. A small gasometer was erected which was connected by tubes to a furnace, containing three retorts, one of which was partly filled with water; a second with tar; and both being decomposed in the [illegible] retort, formed the sole materials from which the gas was produced. The process appeared to be extremely simple; and the novelty of the experiment consists in the fact that the water and tar were the only materials employed, though the inventor says that any kind of bitumen or fatty matter would answer the purpose equally well. After the lapse of about half an hour after the commencement of the process the gas was turned into the burners, and a pure and powerful light was produced, perfectly free from smoke and of a pleasant smell. The great advantages of this kind of gas over that produced from coals consists, it is said, in the cheapness of its producing materials, the facility with which it is manufactured, and the perfection to which it is at once brought without the necessity of its undergoing the tedious and expensive process of condensation and purification, for in this instance as soon as the preliminaries were completed, the light was produced in a perfect state within a few feet of the gasometer which, although of inferior size, was said to be capable of affording light for at least 500 lamps or burners. The price is estimated not more than one-third that of coal-gas, equally available for domestic use, and such that small gasometers might, at a trifling expense, be fitted up at the back of grates in private dwellings, from which the gas could be conveyed in India-rubber bags to any part of the house, thereby preventing the many accidents which occur by the use of tubes or pipes."

I do hope we shall hear from some of the readers of our MECHANIC that they will at once undertake the manufacture of the apparatus, and for trifling royalty instruct any person in the process and manufacture of the gas. JOHN FLEET.

THE FLUTE AND FLUTE PLAYING.

[186] Sir,—I am pleased to find the old flute has found a friend to speak in its favour. I have had twenty years' practice on the old instrument—one of Rudall's—and agree with Mr. H. Chapman that the fault generally speaking is with the performer rather than with the flute. When playing, I have heard the remark, "Well, I cannot bring such a tone as that. I do not know how it is, I cannot do it." But I knew, and the secret lies in this, that a great mistake is made in endeavouring to blow as loud as possible. This is not the way to bring sweet sounds from your instrument: quite the contrary. I have no doubt all find a difficulty in learning, no matter what flute they possess; and if you do not sometimes make *fingerings*, possibly you may find it awkward in some passages to play as you would wish; for instance, C sharp in alt. to C natural, and many other instances. The best scales I know are James's, published at sixpence each.

I have spent many a delightful hour with Nicholson's Beauties, the Fantasias of Tulou, Kuhlau, Berbiguier, Dressler, Fürstenau, Devienne, Vern; but I think the most difficult of all is Drouet's music. Yet all these flautists performed upon the old flute, and found, I should suppose, no particular difficulty in playing the music they wrote. No doubt the instrument is imperfect, and many of them very much so; but I can play with violins, violoncellos, and pianos without playing out of tune, and if one can do it there is no reason why another should not. I can go from D below the line to upper B in alt. in a moment, and in some of Berbiguier's music it is a case of necessity to do so, and that perhaps for sixteen bars following each other. I think it a great mistake to have the lower C keys at all. By the bye could any of your readers give me the name of the author of a flute instruction book which has at the end of its preface, numbering 32 pages, full music size, the following quotation:—

Qui variare cupit rem prodigialiter unam,
Delphinum silvis appingit, fluctibus aprum.
Hor., *De Arte Poetica*, 29.

It has chapters on sound, tone, fingering, tongueing, time, double-tongueing, staccato, &c., shakes, &c., objects of practice, musical expression, modulation, variations, and examples in each.

T. Cridland.

[187] Sir,—As an amateur flautist, I have perused with much pleasure the letters upon this subject from several of your correspondents.

I should not have troubled you with this note, had not the letter in your last issue from Mr. H. Chapman appeared to me to "hit the nail upon the head," and it goes a long way to settle the different opinions as to the merits of patent and ordinary instruments. For several years I used the old fashioned eight-keyed flute, and when by practice I had obtained sufficient knowledge of the instrument to blow it *in tune*, I yet found it imperfect in the lower notes—viz., from G to lower C; the latter I could not at all depend upon producing. I then got hold of a "Siccama" and with the indifferent practice my profession allows me, I find the lower register most powerful and easily produced; the only difficulty I find is, that, being a *self-taught* player, there must be some systems of fingering upon the "Siccama" and the old eight-keyed that I am ignorant of. Will Mr. Chapman kindly inform me if there is a scale for the "Siccama," and if so, where I can procure it? A great advantage of the "Siccama" is, that it varies little or nothing in playing. When using the eight-keyed with a string band I was frequently obliged to flatten it (by the tube), as it sharpened half a note, or more. My "Siccama," I find, alters nothing with an hour's steady playing, and I can with imperfect practice depend upon my flute being in tune. A friend of mine possesses a Carte Boehm, in silver, and although he can execute passages more brilliantly than I can, inasmuch as the fingering in the upper and lower octaves is the same (at least he says so), yet his *tone* is not equal to mine upon the "Siccama," and I believe, had I the time to practice he enjoys, my instrument is far superior to his. In conclusion, I can heartily endorse Mr. Chapman's opinion that, "practice makes perfect," and that if your flute-playing readers cannot, like myself, devote sufficient time to practice, there is no instrument like the "Siccama" in price and efficiency.

Flautist.

[188] Sir,—In reply to J. R. Rendle, I would say that I did not presume to direct professionals, but only to assist amateurs who cannot give time to acquire perfect mastery of the flute. I could always make better music in the way I have described, being able to give more attention to the blowing, as the fingering required less. If any one tries the method, and finds he cannot blow in tune, he has only to give it up, and no harm done. The upper octaves of the flute have the same distances between their notes as the lower, which is *theoretically* wrong; yet, in practice, the lower notes, with an increased pressure of wind, give their octaves with sufficient truth.

The players on keyed brass instruments have separate joints to alter the pitch, the intervals of their valves remaining as before. I do not see why flute players should not try for a similar accommodation. I believe the best way would be to have two flutes, one voiced in D and the other in D flat, by construction, using either as the occasion required. I am sure the relief to all but extraordinary players would be great, and the expense of the pair need be but a fraction of what is charged for first-class instruments.

T. S. G.

EXTRACTS FROM CORRESPONDENCE.

PRE-ADAMITE OR PRE-HISTORIC MAN.—J. Sargent says, "Your correspondent 'T. S. Conisbee' is rather too hasty in pronouncing me a sceptic without knowing my reasons for making the remark I did upon this subject. I merely wished to see a few arguments for and against it, in order to see the view generally adopted by scientific men, which the letter of 'H. P.', Hull, appears to show."

A CURIOUS SENTENCE.—"Mus" says:—Your "correspondent's letter on the above, that appeared July 22, was very strange. It is such a curious sentence, that when I went to school I don't recollect the word 'Arepo,' nor can I find it in the dictionary; and last, though not least, I never recollect seeing an imperative in 'o' before. If 'Reg. Pilkington' can give me a proof that I'm wrong, of course I'll give in. True, it's some time since I left school, but I think I remember enough to know he's wrong."

REPLIES TO QUERIES.

*** In their answers, Correspondents are respectfully requested to mention in each instance the title and number of the query asked.

[2662.]—WATER METERS—are all constructed on the principle that "a given quantity of flowing water performs a given quantity of work." The water flows from the supply pipe, through a filter into a drum, which is caused to revolve by the passage of the water. This drum is fitted with a spindle, which sets in motion a train of wheels that register the amount in gallons on a dial plate. The meter of "Fidus Achates" is doubtless out of order, or possibly the water is supplied at different pressures, which would make a difference, but not to such an extent as he has experienced.—H.U.

[2672.]—DRAUGHT WANTED.—H. Gregorieff should make a flue to the chimney, he will get a good draught as wanted. If the boiler stands above the ground he must make the flue slope down at a gentle angle, and make the flue large enough, for it requires a large flue to make a good draught. I know several as far from the chimney as that one will require to be, with good results; arch it over in the usual way.—Heather Jack.

[3812.]—CONDENSING ENGINE.—Condensing engines do not make a noise. The valves in the hot well and on the bucket make the noise. If they are fitted with India rubber valves there is very little noise and very pleasant working.—Heather Jack.

[3828.]—PRESERVING KID BOOTS.—If "Old Scrub" will rub her kid boots with a little cream, and polish gently with the palm of the hand till dry, it will keep the kid soft and good. Sour milk will spoil the kid.—Housewife.

[3842.]—STEEL WIRE.—"J. R. Y." can obtain steel wire of any gauge he may require at most of the London tool shops. I would, however, suggest to him the great superiority of the English gongs, which are made on a totally different principle, and of different wire to those used in American clocks. Doubtless it is to the American gongs that "The Harmonious Blacksmith" refers, when he reminds "J. R. Y." that "wire gongs have a very disagreeable tone." Those made in England which have come under my notice have anything but "a disagreeable tone," the imitation of the church bells being excellent—Rogo.

[3912.]—REVOLVING FRAME FOR SHOP WINDOWS.—"Pitman" should get a spring barrel like those in eight-day clocks. With a few wheels and pinions properly arranged he can make a frame that will revolve one way all day long.—H. U.

[3918.]—ENAMEL.—A dead white enamel is made by calcining together two parts of tin and one of lead. Of this combined oxide one part is melted with two parts of fine crystal and a very little manganese, all previously ground together. When the fusion is complete, the vitreous matter is poured into water, and the "frit" is dried and melted anew. The pouring into water and fusion are sometimes repeated four times, in order to secure a perfect combination. The crucible should be carefully screened from smoke and flame. The smallest portions of oxide of iron or copper will destroy the value of this enamel.—H. U.

[3926.]—FORCING WATER.—It will require more power to force the same quantity of water at the same speed and to the same level through a pipe 180ft. long than through one of only 30ft. in length, because there is the friction of the water in the pipes to be overcome. This depends on the velocity of the water; and assuming, in the case in point, a velocity of 3ft. per second (a very usual one) the extra power required would be equal to raising the water 9in. higher. As the friction increases as the square of the velocity, a velocity of 6ft. per second would be equal to an extra head of 3ft., and so in any other ratio.—Q. Q. R.

[3949.]—REPUBLIC OF GUYANA.—This Republic was mentioned in the *Times* some weeks ago in an article about an ex-officer of the British navy settling there. It seems to be in the north of South America, I think near Venezuela.—Bernardin.

[3961.]—BISULPHIDE OF CARBON PRISM.—The best cement for putting together glass prisms, to be filled with bisulphide of carbon, is a mixture of common glue and West India molasses. Make a tolerably liquid glue, and add about one-eighth the quantity of common molasses. Lay the metal or glass form, ground to a suitable angle, with its face up; then place the glass plate upon it, and apply the cement on the under side with a brush, and allow it to flow by capillary attraction between the glass and the form; repeat this operation several times if necessary. This is better than to wet the edge of the glass at the outset before attaching it to prism. The stopper to the prism can be cemented in the same way, and in filling with the bisulphide of carbon, always leave a small space for the expansion of the liquid. The prism should be kept in a cool, dark place, and ought not to be agitated previous to using, as the light is in that case unequally refracted.—S. J. P.

[3975.]—VALUE OF COIN.—An Oriental one; not worth more than a shilling above the value of the metal. —Henry W. Henfrey, M.N.S., &c.

[3982.]—WORKS ON SOAP MAKING.—I think that among the French manuals of the "Collection Roret" there is a "Manuel du Fabricant de Savon." Apply to a French bookseller.—Bernardin.

[4002.]—MUSLIN.—I know of nothing to restore the colour to muslin or cotton when faded; but if "Beta" will boil the muslin dress with plenty of black soap and soda for an hour or two, and afterwards bleach in the open air, it will become pure white. I have done this often. —Housewife.

[4005.]—CLEANING INSIDE OF GUN BARRELS. —I should recommend the following process for cleaning the inside of gun barrels:—"Turn an ashen rod a few inches longer than the barrel, and so nearly of the size of the bore as to allow of the following process: Let one end of the rod be cut lengthways, so as to make a slit of 6in. in length, into which slit enter as much of fine emery paper as will completely fill up the bore of the barrel, taking care, in folding the paper tightly round the wood, that the emery surface is outward. Force it into the barrel by screwing it downwards from the top to the bottom, and repeat the process till the barrel is as clean and polished as when it left the maker's hands. No sand or coarse stuff of any kind should be used." Extracted from "Blakey's Shooting," Routledge.—Muzzle Loader.

[4007.]—TO CURE HERRINGS FOR DOMESTIC USE.—Draw out the gills and gut without splitting the herring, lay in a tub and sprinkle with coarse salt, and leave them for twenty-four hours to bleed; then have a good barrel and put in a layer of herrings and a layer of coarse salt, alternately, till the barrel is firmly packed full; press down with a weight till the salt is melted to brine, and cover them; remove weight, and cover to exclude air, and they will keep for a year.—Housewife.

[4009.]—HEATING BOILERS WITH GAS.—"Corn Factor" will find but little economy in heating boilers with gas: indeed, it stands to reason it must be far more costly. Nothing is more certain than that the perfect combustion of a given weight of fuel produces a constant amount of heat. Gas consists of only a portion of the combustible elements of the coal from which it is distilled, and this portion costs at least as much as the total weight of coal from which it is extracted. If, then, it is more economical than coal, it must be because a greater proportion of the heat generated is utilized. There may be some difference in favour of gas in this particular, but nothing like such an advantage as will make good the difference in cost per heat-unit. The object of all boiler-furnace makers nowadays is to thoroughly utilize the fuel and obtain all the heat possible from it. As regards supplying boilers with hot water, there can be no question of its advantage; in fact, where economy is studied it is always done, or attempted to be done, as the numerous "feed-water heaters" illustrated in "our" Mechanic show. It is only from the fact that gas can be instantaneously kindled and extinguished, added to the fact that the majority of our cooking stoves waste half the heat that might be generated, that there is any economy in the use of gas as opposed to coal. Gas is, of course, much cleaner and more convenient.—S. A.

[4011.] — PRICKING BARRELS OF BARREL ORGANS.—I believe that barrels of musical boxes, organs, &c., are pricked off by fastening a sheet of paper round them with the dots printed on it to act as a template for drilling the holes.—G. W. A.

[4014.]—MEDICAL ELECTRICITY.—To the first question it is disputed whether a secondary current is any use or not. Halse contends that the secondary current is no use. Dr. Althus uses both currents. Coils are so constructed that either the first or secondary current can be used at discretion. Dr. Althus also uses the continuous current without the coil, which requires a large number of cells, and which is different in its effect and superior in some diseases to a current got by means of a battery and coil. O'Bec may study the whole subject if he is willing to purchase Dr. Althus' book, which is published by Longmans, Green & Co., and costs 15s. To the second question: Yes; but the coil he describes is not made that way. Wires are branched from various lengths of the wire, No. 0 giving a very short part of the coil, the second giving an additional part, No. 16 giving the whole length, which is the highest power. Such a coil is troublesome to make, and were the first current to be used as well as the second, two set of studs would be required; one for the primary coil, and one for the second; and which would be a very complicated coil indeed. The best way is to get a coil made with two connections for the first current, and two for the second, and a brass tube to draw out for the regulation of the power of the current.—M. D.

[4096.]—SODA WATER.—If any of your readers should try to make soda water, &c., by the process given by "Joe" in the number for July 15th, they will most likely fail in the attempt, as a very small quantity of carbonic acid is contained in unslaked lime. What "Joe" probably intended was "*unburnt limestone*," which is a carbonate of lime, and would therefore be capable of giving off a considerable quantity of carbonic acid gas. Chalk is the material most commonly used for the purpose. There should be a washing vessel between the generator and that containing the water to be aerated, and it is necessary that all the vessels should be capable of standing a very considerable pressure, otherwise the beverage produced will be of a very tame character.—F. C. S.

[4118.]—ANNUITY QUESTION.—Will you allow me to state that the result of a vigorous computation comes out = 15·6884 years; 2nd, that the arithmetical principles stated by "R. M." (p. 404), lead to the correct year; but inasmuch as the time is not proportional to the amount to be paid, the fraction of the 16th year is not truly found by his method; 3rd, that the principles stated in page 357 lead up to 63 years, which is too long a period. In corroboration of these statements I beg to refer to two similar questions in "Morrison's Mercantile Arithmetic;" also, to one similar, but rather more complex in "Todhunter's Algebra."—M. L.

[4118.]—PROBLEM.—As "Gimel" did not correctly answer the problem, I submit the following short method:—Put $a = 1{,}05$, $b = 2000$, $c = 187$, and $T =$ time, then by log. arithmetic we have $T = \log.\ \frac{c}{c - ba - 1} \div \log a = 15{\cdot}68352$ years, the time required.

The preceding appears to me to be a very natural solution as the question is worded, but if it be considered as to find in what time a given annuity (c) at a given (a) rate of interest will be equal in present value to a given sum (b), the equation will be $\frac{c}{aT} \times \frac{aT - 1}{a - 1} = b$, as is well-known, which comes to the same as that above, and proves the truth of the preceding method.—F. L. H.

[4198.]—DE-MAGNETIZING STEEL.—There is no liquid that I am aware of that will de-magnetize steel; the idea savours much of the days of the alchemists; but the balance and other steel parts of the watch mentioned can be de-magnetized, either by heating them (though that would most probably spoil them), or by reversing their magnetism just to such an extent as to neutralize it. It might be rather a tedious operation, but could be done somewhat in the folllowing manner:—Suspend the balance wheel by a fine thread or hair, and notice which are the *north* and *south* points of the wheel. Then touch the wheel with a small horseshoe magnet, placing the *similar* poles together, *i. e.*, the north to the north, and the south to the south. With a little care I think the wheel may be successfully de-magnetized.—Q. Q. R.

[4219.]—TIGHTENING PIANO PINS.—The plan "Man of Necessity" suggests—viz., that of driving wooden wedges between the wrest pins and the wood plank of his piano, for the purpose of tightening the said pins in their respective holes, is an impossibility. The only remedy is to put in a larger set of pins which will well fill the holes. I only recommend this plan to him because he is evidently an amateur. My own mode of proceeding would be to rebore the plank for pins from two to three sizes larger than the existing ones, for the purpose of thoroughly clearing the holes of canker and rust, which, if left, often creates what is technically known in the trade as "jumpers," *i. e.* the pins won't turn smoothly in their holes, but move with a succession of jumps, and then good bye to all comfort in tuning. If he prefers my first plan, let him take one of the present pins to Mr. Meek, music smith, Windmill-street, Tottenham Court-road, and order a set of pins to pattern, but one size larger. If he prefers the second and better plan, let him order them two or three sizes larger. But I must warn him that this presupposes a nicety and steadiness of hand in reboring, and the ability to shape and fit his boring-bit to his pins, which he knows best whether he possesses. The pins (extra in number for a grand), will cost him 3s. 6d. or 4s.; boring bit, to be had at Buck's, in Tottenham Court-road, 4½d. If, now, he gets into a mess, it will not be the fault of your correspondent,—W. T., Pianoforte Tuner and Repairer.

[4263.]—TODHUNTER.—Let me thank the "Fellow of the Royal Astronomical Society" and Mr. Proctor, Mr. Rendall, and also "Anon" and "Bernardin" for their responses. I know all about the decimals, and the two right angles, and so forth. I only quarrel with the word "invariably," and I am pertinacious enough to still think the word objectionable, because calculated to confuse beginners. Query—If a lesser luminary than "Todhunter" used it would it not be condemned? Is it not of a piece with the resemblance of the two niggers, "Cæsar and Pompey are exactly alike, 'specially Pompey?" Such is the "invariably." It would, I think, have been more correct if "Todhunter" had stated that the symbol π denotes the ratio, &c., and also it is (disadvantageously) employed to denote *another aspect* of the same. This is the reverse of "invariably." As well say that the pound sterling value is invariably represented by the golden sovereign, whereas it may be by two half-sovereigns, four crowns, eight half-crowns, ten florins, twenty shillings, forty sixpences, 240 pence, &c. If I was a great man I would make "Todhunter" right by keeping π for the ration, and using a different symbol for the circular measure, say the same inverted, ⊓, or the Sanskrit p, which is प; anything would be better than using an "invariable" system for different purposes. Is it not best to admit that Todhunter is wrong, and that the usage of the scientific world wants mending, as much as our weights and measures; like as even Newton used to speak of "his mistake" in using "Algebra" (see Preface to Pott's Euclid). By the way, can you spare me space to express that I bow most cheerfully to your stopping my tilt against the Algebra windmills? You are our captain, Mr. Editor, and we bow to your behests. In fact, it may tend to show how serviceable and convenient is the English Mechanic when I mention that the bare fact of so many persons more ready than able to immolate me as an algebra heretic quite answered my main object. Yes, our paper is an "institution" by which we can not only teach and inquire, but also feel the pulse of our own aims and crotchets; nor will you, it seems, let any of us go too far. —Gimel.

[4262.]—CORNISH ENGINES.—ERRATA.—I have to apologise for two blunders in my note on the above. In line 28, page 458, for D E K read D and H, and in line 42, for "the centre of piston cross-head" read E. I should have observed at this point that when the beam is placed at the half stroke, above or below the horizontal, the piston rod must be got quite upright, or *plumb*, before striking the arcs of circles for finding the fixed centre of radius rod.—J. K. P.

[4283.]—WARPED CABINET LID.—Let "J. B." damp his carpet about 9in. wide and the length of the lid, and place the same with the hollow side on to the carpet or floor, as either would do, and let it remain so (say) twelve hours; it will bring the top quite straight if it is not bound at the end by clamps or mouldings. —Cabinet Maker.

[4290.]—FOOD.—If "Tau Tau," p. 406, obtains "Hints to Dyspeptics," written by Dr. Grindrod, Malvern, I think he will find it answer his purpose. It is a small work, and may be had direct from the Dr., as above.—J. C. S.

[4304.]—NAPKIN RINGS.—The plan I have adopted as to marking napkin rings has been as follows:—I have first traced the letter with a pen or pencil upon the ivory or box rings, and when to my satisfaction, I have gone over it with a solution of three parts nitric acid and one part turpentine, and have never found it fail.—Z. Barnard.

[4305.]—SILVER COINS.—The first coin of "N. T. B. M." is a silver denarius of the Roman Emperor Antoninus Pius; who reigned from A.D. 138 to A.D. 161. The other coin I am not able to identify from the engraving.—Henry W. Henfrey, M.N.S., &c.

[4306.]—SILVER COIN.—"Giles's" coin is one of the earliest Roman silver. It is believed to have been coined by the Romans, in Campania, about the year 207 B.C. *Obverse*, a double head, like that of Janus. *Reverse*, Jupiter in a *quadriga* (four-horsed chariot), gallopping to the right; holding a thunderbolt and a sceptre; behind him, a small figure of Victory. It is a double denarius or small medallion. Value, about 15s.—Henry W. Henfrey, M.N.S., &c.

[4306.]—SILVER COIN.—A Roman family denarius; I think, Furia.—Bernardin.

[4307.]—HORIZONTAL *v.* VERTICAL ENGINES.—Horizontal engines are generally preferred to vertical, as they can be driven at a greater speed on account of being more securely fixed to their foundations. They are also more compact, and more cheaply made than the vertical.—Cuthbert.

[4309.]—"BARTON'S SELF-ACTING FEED-WATER HEATER."—The float is a copper ball, diameter in accordance with size of cock required to supply the heater with water.—S. Crompton.

[4313.]—SILKWORMS' EGGS.—In answer to "C. H. B.," the eggs of the common silkworm do turn brown soon after they are laid, which colour they keep until they are hatched in the spring. May I ask if there are any of your correspondents who have had any experience this year with the Japanese and North American species—Bombyx, Pernyi, Yama-Micfi, and the Ailanthus worm? The failures last year were attributed to the heat. How must it be this year?—George E. Davis.

[4313.]—SILKWORMS' EGGS.—They *ought* to turn of a dark colour a few days after being laid. If they do not they are certainly unfertile.—A. S. C.

[4313.]—SILKWORMS' EGGS when laid are of a bright yellow colour, but usually change in a few days to a blue or slate.—Harry G. Newton.

[4314.]—RULE WANTED.—Assuming the weight to be in cast iron the following will perhaps be intelligible. A cubic foot of cast iron = 450lb., therefore the cubic contents of the weight = $\frac{60}{[illegible]}$ = ·1333 cubic feet. — 9in. and 14½in. are equal respectively to ·75ft. and 1·2083 ft. — ·75 × 1·2083 = ·90622 — $\frac{\cdot 1333}{\cdot 90622}$ = ·14715ft. = thickness of required weight, which may be brought to inches thus—·14715 × 12 = 1·76580, so that the weight will be rather more than 1¾in. thick.—Harry G. Newton.

[4314.]—RULE WANTED.—Multiply the length, breadth, and thickness together, and when the dimensions are in inches, multiply the product by ·26 or $\frac{26}{100}$ for cast iron, by ·28 or $\frac{28}{100}$ for wrought iron, and by ·3 or $\frac{3}{10}$ for cast brass, which will give the weight in lbs. conversely. Divide the given weight by the fraction for the metal as given above, which will give the number of cubic inches required. Then multiply the known length by the breadth, and on dividing the number of cubic inches in the given weight by this last product, the thickness of the weight will be given in inches.—Q. Q. R.

[4316.]—A DIFFICULT QUESTION.—As I read this question it seems to me that there are three rings, tubes, or hoops spoken of. The first tube has an extreme diameter of 12in. Its "covering hoop" is to have a tension of 4 tons per square inch, and it ("this second hoop") is to have a diameter of 18in. This, again, is to be covered with a "third hoop" the diameter of which is to be found. The ambiguity seems to arise from the mixed use of the words "tube and hoops," when "tube" would have been the best word to use.—Q. Q. R.

[4320.]—BREAM FISHING.—There is no better method to entice bream to the hook than to bait the river over night with grains, throw about a bucketful in the part you intend to fish (a wide and deep part is the best) and get up with the sun and begin operations; bait with wasp grub or gentles, use a fine but strong line, keep as far from the river side as possible; bream are very shy fish, therefore you must fish cautiously; they bite best when there is a light breeze; if they will not take grubs or gentles try well scoured worms; a running line will be required. Two or three rods and lines may be used at the same time.—A Young Tyke.

[4321.]—WATERPROOF.—A short time ago I had a waterproof coat which had been laying by some time, and was very hard, and a friend of mine (who had been in India) restored it to its original state by dissolving a handful of best grey lime in half a pailful of water, and wipping the coat at the parts that were hardened, doing so twice, at about three hours interval.—J. P. K.

[4322.]—SEWING MACHINES.—I had a sewing machine, and found it leave loops, loose ends, and catches, and a succession of loops on the hooker; but I found, after trying it different ways, that by altering the hooker so as to drop a little later, or the needle and feeding bar a little sooner, it would go all right.—J. G.

[4323.]—GLASS BURNING.—In answer to "Kemp," for instruction on furnaces, I should say if the old one has done well get another like it; but I can give him the following, and he can judge of their respective merits. Build of brick, between 30in. and 40in square, an aperture 6in. from bottom for fuel, then some bars are placed across the furnace like a flooring, above which is another aperture to receive the trial pieces of glass. Over the flooring is placed an earthen pan, at the bottom of which is placed two or three layers of quicklime, with pieces of glass between them. The use of the lime is to give a regular heat to the painted glass, the first stratum of which is placed upon the uppermost layer of lime, and all the pieces to be burnt at once are in like manner disposed horizontally, with a layer of lime between them, and the last stratum of glass to be covered with the lime. The furnace is then covered with tiles and luted close, with the exception of four or five small apertures to serve as chimneys. Of course it will heat gently for the first two hours, and then raised gradually to the heat required for the fusion of colours. This point must be ascertained by occasionally examining the trial pieces in the small apertures.—D. F. Ashton.

[4325.]—PLANTING.—What does "M. N." mean by "slitting" and planting house plants? Geraniums, calceolarias, verbenas, and such-like plants are "struck" [illegible] the year round in "houses" and frames; but generally in the autumn. The best time for striking fuchsias is in the spring, when the young shoots are about an [illegible] and a half long, and before the wood has become [illegible] —Saul Rymea.

[4325.]—HOUSE PLANTS.—Take cuttings of [illegible] which I suppose are fuchsias, calceolarias [illegible] geraniums, now and next month. Cut them [illegible] and plant them the next. This is important, that the wound may have time to dry. Strike the first two [illegible] glass; geraniums in the open border, in full [illegible] potting them before the first frost. Morse, of [illegible] Gloucestershire, sends for two stamps a catalogue [illegible] cuttings every January. They are supplied in [illegible] condition, and with ordinary care a stock of [illegible] may be raised at a small expense.—Amateur.

[4328.]—MOUNTING MICROSCOPIC OBJECTS.—[illegible] should recommend "C. R. H." to obtain "Davies [illegible] the Preparation and Mounting of Microscopic Objects," published by Hardwicke at 2s. 6d., by careful attention to which, together with the exercise of a little thought, he will be able to mount any object he may come [illegible] I should advise him on no account to commence [illegible] such objects as whole crickets, but to take parts [illegible] sects, as legs, eyes, heads, spiracles, gizzards, &c. [illegible] will be found much easier by a beginner, and [illegible] nish him with more interesting slides than [illegible] the insect entire.—J. Sargent, Jun.

[4328.]—MOUNTING MICROSCOPIC OBJECTS.— Petals of flowers are rarely capable of preservation [illegible] their colour is not sufficiently persistent. [illegible] of pelargonium petals may be stripped off, [illegible] glass slip; and mounted in Balsam-potass [illegible] them. *Thick* objects require a *cell*, which [illegible] glass, wood, vulcanite, or of almost anything. For [illegible] objects cells cut from thick card answer the [illegible] admirably. A common gunwad punch serves [illegible] them out. I have of late used Pumphrey's vulcanite cells for all purposes; they are cheap and efficient. Wings of insects rarely require any medium. Wings [illegible] *Lepidoptera* should be mounted dry; "*opaques*" of [illegible] *tera*, *Neuroptera*, and *Hymenoptera* are also usually [illegible] "transparents."—H. P.

[4328.]—MOUNTING MICROSCOPIC OBJECTS.—[illegible] fear Mr. Sutton's reply to Query 4328 savours a little more of *theory* than of *practice*. He appears to speak of the process of soaking in liquor *potassæ* as simply to render the object transparent *and to soften it so that it may be pressed flat*. In my *idea, the real object of* soaking in liquor potassæ *is to dissolve away the whole* of the fleshy parts, so that *nothing but skin and muscle* remains. I should not advise "C. R. H.," or any *other* amateur, to attempt at first any object so large and complicated as a cricket. To begin, let him take a flea; put it alive into a vessel containing liquor potassæ (it will sink to the bottom in a day or two); let it remain for a week] or ten days, when it should be taken out with a camel's hair pencil and put into a saucer of clear cold water; have ready a stout glass slide 3in. × 1in., and another piece of same glass 1in. square,; place the insect (still in the water) on glass slide, and the 1in. square on top; by pressure the whole inside will come [illegible] It will then require very careful washing with camel's hair pencil in at least two waters; *float* it on to [illegible] glass slide; cover with thin glass, and tie [illegible] cotton. Put it aside for a day or two to dry; [illegible] it tied as it is into a vessel containing [illegible] where it may remain for a week, or rather less [illegible] will be ready to mount. In mounting, I use [illegible] paraffin lamp, over which I have contrived a [illegible] "hot plate." I first heat the balsam by the fire [illegible] quite fluid; then place it handy on my hot plate [illegible] another part of which I have a small stock of [illegible] slides. With a camel's hair pencil—which I always [illegible] in my balsam—put a drop, according to size of object to be mounted, on to heated slide. With a needle [illegible] object off the slide where it was tied to soak in [illegible] and place it wet with turpentine into middle of the balsam; then take up a clean glass; cover [illegible] heat it over lamp, and place over object. Secure the whole by small brass clip, and place near fire for [illegible] the day, after which lay aside in secure place for a [illegible] when it may be cleaned and covered.—A. A. F.

[4329.]—THE MICROSCOPE.—In answer to "Sa[illegible] the microscope I should propose for his purpose [illegible] be a Student's from one of the London makers— Swift, Collins, or Crouch—from either of these [illegible] procure a good microscope for about the same [illegible] paid to a shopkeeper for an inferior foreign article [illegible] the bye, I saw at the Workmen's Exhibition [illegible] microscopes, by the first of these makers, the [illegible] of which I would specially recommend "Sa[illegible] examine, as from the description given there of [illegible] Student's I should think it the article to suit (presuming all there stated to be correct). A few hints may [illegible] out of place as to the best construction for such [illegible] The stand should be firm and sufficiently heavy to prevent vibration, and so well balanced that it will [illegible] show indications of falling over when placed at an [illegible] The bar or coarse adjustment should move steady, without shake, and with the same amount of tension all [illegible] length. The stage to be of sufficient size to allow the use of a frog plate, zoophyte trough, &c., with a second plate to move over this, allowing motion in all directions. The aperture in the stage should be perfectly central with the optical tube, and with *a tube fitting for all* [illegible] *stage apparatus*; for the fine adjustment choose one that is known *as the lever arrangement*, that is to say, the cylinder into which the objective is screwed is raised and depressed by a lever and fine thread screw; this [illegible] the only reliable form, and the only one I know that gives a *central lift*. The points wherein to test such an instrument *in its mechanical parts* will be for the bar [illegible] coarse motion. Apply the ¼in. objective and illuminate by the mirror, care being taken that the light is [illegible] oblique; to insure this place the lamp in front and [illegible] the same plane as the mirror, and incline the mirror [illegible] an angle of 45°, the light will then be thrown through [illegible] object—a diatom is about the best—and with the [illegible] milled head carefully focus, and note if, by raising [illegible] depressing, the object vanishes in a direct line *and* [illegible] from the edge of the field. The same test should [illegible] used for the fine adjustment; this should focus quick [illegible] sharp without the object moving from the part of [illegible] field of view it occupied in the first instance. Such strument with a 1in. and ¼in. object glasses, a live box, age plate, and thin glass covers will be all "Sabbas" quires for a commencement.—C. C. S.

[4329.]—THE MICROSCOPE.—"Sabbas" has asked is question of another correspondent, and it is almost breach of courtesy for me to reply thereto. A few words ay be excused perhaps. The universal microscope of mith & Beck, the "Student" of Messrs. Wheeler, arker, Dancer, &c., &c., *ad lib.*, will be cheap and fairly ood. Field's Society of Arts is a fair instrument and ery cheap (£3 3s.) But I think the cheapest, and for s price the best, is one made by Winspear, of Hull, in., ½in., and ¼in.; good objectives and a useful stand or £5. An application through the Sixpenny Column would find either of these gentlemen.—H. P.

[4334.]—ECLIPSE OF THE MOON.—I hope, for the sake of the querist, that abler pens than mine will also give an explanation of the interesting phenomenon to which he calls attention. The reason, I believe, that we see that part of the moon *at all* which is immersed in he shadow of the earth is that the sun's light is reracted or bent by the earth's atmosphere in such a ray that part of it falls on the moon, although the earth between it and the sun. "Lunar" will see that this ght arises from an entirely different cause from that een on the shaded portion of a nearly new moon, which simply due to *reflection* from the earth's surface. The ed colour is caused by the sun's rays passing obliquely hrough the various strata of the earth's atmosphere in he same way that we have red tints at sunset and sunise. The earth, on the 12th, must have represented a ingular appearance from the moon. It would have ppeared as a black globe (of course entirely hiding the un) surrounded by a luminous red ring.—Algol.

[4335.]—IRISH MOSS.—It is used for jellies, feeding attle, sizing yarn or paper pulp; in Bavaria for clarifyng beer.—Bernardin.

[4336.]—TONGA BEAN WOOD—or better, Tonquin ean wood, does not come from the same tree which roduces the Tonquin bean, as its common name might ead anyone to suppose; but from a straggling sea-side hrub of Tasmania. Its odour is similar to that of the Tonquin bean, hence the name. The botanical name is *lyxia buxifolia*, Dogbane order, or Apocyneæ. Samples were exhibited in 1862, in the Tasmania court. At the ast Paris exhibition Cochin China presented samples of bark of *Alyxia odorata*, quoted by Mr. Eug. Rimmel in his 'Book of Perfumes." Among the novel odorous prolucts it may be the same plant.—Bernardin.

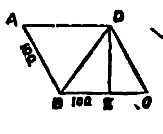
[4342.]—READINGS FROM THE GLOBES.—"Keith n the Use of the Globes" is a most excellent authority n the subject. The last edition, as given in Messrs. Longnan's catalogue, corrected to January, 1870, is enlarged nd improved by Professor Taylor, Le Mesurier, B.A., and acob Middleton, price 6s 6d. The variation of the compass is about 20° to the west. In the year 1865, wishing o know the exact variation of the compass, I addressed note to the Astronomer Royal, and he very politely answered it. If "St. E." would do the same, giving his locality, he would no doubt be similarly treated. Mr. Proctor and F.R.A.S. have also given the variation in these columns.—T. S. H.

[4342.]—VARIATION OF THE MAGNETIC NEEDLE.—During 1868-9 the westerly declination of the magnetic needle was observed at nine stations in the northern counties of Scotland—Nairn, Elgin, Banff, and Aberleen. The difference found was three-quarters of a legree, and the mean of all = 24°·4. In the south of England it is 19°·5. From these data "St. E." may find, by interpolation, the declination at any intermediate station.—M. L.

[4344.]—WEIGHTS OF CHEMICAL SOLUTIONS.—I really cannot undertake to work out calculations except when they relate to matters with which I am myself dealing. Like our friend "F.R.A.S." I have a very strong abhorence for "doing sums." It is easy to extract from chemical books, such as Storer's "Dictionary of Solubilities," tables showing the amount of each salt present in solution at varying temperature, and, in some cases, also formulæ for calculating the quantity at any density or temperature; but these even would not give such information as is asked, because they relate to pure substances, while soda ash is a commercial body of irregular composition. Thus, 50° Twaddel is sp.g. 1·250. A solution of caustic soda at ordinary temperature of this density would contain some 16 per cent., of carbonate of soda about 26 per cent.; but a solution of soda ash of this strength would give very different products, according to its own composition. "Alkali" would do well to *experiment* on the subject, for information so gained is far more valuable and enduring than cut and dried statements.—Sigma.

[4347.]—TUNING BY EQUAL TEMPERAMENT.—I have heard of French, Latin, and German "without a master," but I never heard of tuning ditto. Who *can* explain such a thing *concisely and explicitly*? And who, among your readers, except "A Would-be Tuner," would wade through it, even if you, Mr. Editor, would grant the requisite space. Let a "Would-be Tuner" pick up any old square at a broker's, or auction room, and take lessons in tuning of some competent tuner for a twelvemonth. Both instruments and tuners swarm in London; so he can have no difficulty in that respect. Let him practise five or six hours a day; then let him article himself as an improver for two or three years, at a nominal salary; or, failing the latter, at no salary at all; when if his ears have no constitutional defect, he will be able to go out into the world and take his chance of a crust with the rest of us. I know no other mode of obtaining his wish, unless he has the advantage which I possessed in my youth of having the run of a large factory with over 100 pianos in it in various stages of progress, among which I could tune, under my father's superintendence. "Would-be Tuner" knows best the facilities he possesses in this respect. I have supposed he has literally none, and have, therefore, given him the best advice in my power under such circumstances.—W. T., Pianoforte Tuner and Repairer.

[4348.]—PROBLEM.—Draw the parallelogram A B C D, having the angle A B C = 150°, and the sides A B, B C, equal, each representing in magnitude and direction a force of 100lb. Then the diagonal B D = the resultant of these two forces.



From D draw D E at right angles to B C –.

$$\text{The angle } D E C = 90^\circ;\ I C D = \frac{360 - 300}{2}\ 30^\circ\ C D E = 60^\circ.$$

$$\therefore D E C = \tfrac{1}{2} \text{ an equilateral triangle,}$$

$$\text{and } D E = \tfrac{1}{2} D C = \tfrac{1}{2} A B = 50.$$

$$(\text{Euc. } 1\ 47)\ D C^2 - D E^2 = F C^2 = 86{\cdot}6 \text{ nearly.}$$

$$100 - 86{\cdot}6 = B E = 13{\cdot}4.$$

$$B D^2 = B E^2 + D E^2 =$$

$$= 13{\cdot}4^2 + 50^2 = 2679{\cdot}56$$

$$B D = \sqrt{2679{\cdot}56} = 51{\cdot}7, \&c.$$

$$\text{Resultant} = 51{\cdot}7, \&c.$$

Draw figure similar to the above, making the given angle 120°. Let A B, B D, represent as before forces respectively of 60lb. and 160lb.

$$\text{In triangle } C E D = \text{angle } C E D = 90^\circ \text{ (Const.)}$$

$$\text{Angle } G D C = \frac{360 - 240}{2} = 60^\circ, \text{ and } D C E = 30^\circ.$$

$\therefore$ for same reason as above, $C D = \frac{1}{2} C D = \frac{1}{2} A B = 30$ and $C E^2 = 60^2 - 30^2 = 3600 - 900 = 2500$ (Euc. BR., 1.47),

$$C E - \sqrt{2500} = 50.$$

$$B E = 160 - 30 = 130$$

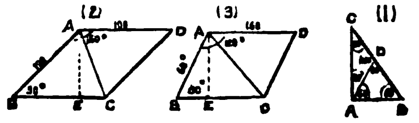
$$(\text{Euc. } 1.\ 47)\ B C^2 = B E^2 + C E^2 =$$

$$= 130^2 + 50^2 = 8900 + 2500 = 16900.$$

$$B C = \sqrt{16900} = 140 \text{ (nearly).}$$

P.S.—If I mistake not the above questions are proposed by a private student preparing for the London Matriculation Examination, and are taken from Newth's 1st Book. Pray allow me to inform "Amicus" that he cannot hope to pass the above-mentioned examination by working from this book. Better get Newth's larger work, or better still, Warmell's "Mechanics' Hydrostatics, &c.," published by Groombridge. "Todhunter" is excellent, but requires a knowledge of trigonometry.—C. H. W. B.

[4348.]—PROBLEM.—From Euc. I., 32, constructing



as in fig. 1, angle B A D = 60. I conclude that "*if in a right-angled triangle one angle = 30°, the opposite side = half the hypothenuse*," hence (problem A) resultant of two forces of 100, meeting at an angle of 150° (*v.* fig. 2), I have $A E = 50$, $B E = \sqrt{100^2 - 50^2} = 8{\cdot}66$, $E C = 100 - BE$, $A C^2 = A E^2 + E C^2$, hence $A C = 51{\cdot}76$. Analagous solution for the second problem (*v.* fig. 3).—Bernardin.

[4353.]—ROAD MEASURING.—In answer to "J. T. S." relative to the above, I can inform him that the machine usually used by the Metropolitan Police for such purposes (as in case of disputes with cabmen, &c.) is a single wheel mounted in a light frame, with a handle to push and guide it with, and a connecting rod in gear, with a few wheels which are under a dial marked with the miles, furlongs, and 10 yards; two hands or pointers show the distance traversed by the wheel. I believe the pedometer is only used by amateur walkers, and requires to be regulated according to the step of the wearer, and even then is not entirely to be depended upon for any degree of accuracy.—Tometer.

[4355.]—ART DEGREES AND MATRICULATION EXAMINATIONS.—Having had much to do with regard to the Matriculation Examination, London, I feel competent to answer "Beriro." The subjects required are, algebra (i. quadratics), arithmetic, geometry (Euclid i.v.), mechanics, optics, hydrostatics, chemistry (non-metallic elements, &c.), Latin, French, Greek, English, also history of Greece, England, Roman Empire, &c., but by application to Dr. Carpenter, 18, Saville-row, "Beriro" would get a syllabus, with requisite information. The fee is £2, times of examination, January and June. I know of no degree that can be obtained in England without matriculating. A German M.A., Ph. D., &c. &c., may be obtained any day, by anybody, by payment of from £10 to £20. Valuable hints on matriculation will be found in the "Assistant Masters' Journal" No. II., Allman, 463, Oxford-street, price 6d.—H. W. B.

[4356.]—COPAL VARNISH.—"A Youth" might add a quarter of a pint of japanners' gold size; if stiff, a little turps; but at the same time cannot understand good varnish not drying under 60 hours. Think he must have got some linseed oil in, if so it never will be good.—One in the Trade.

[4358.]—COPAL VARNISH.—Your varnish is none the worse for drying so slowly, but much more liable to stand well. If you wish it to dry quicker put in a little liquid dryers (terebine), this will hasten its drying, and not destroy the gloss.—H. C. C.

[4359.]—AMBER BEADS.—I do not know of any way to polish amber beads; but to distinguish real from false ones, take a piece of silk, and after warming it, rub the bead with it for a short time, and then place a few small pieces of paper or feathers on the table, and bring the excited bead near them; if it be real amber, and the process quickly performed, the feathers or paper will be attracted. It is best to hold the bead with a piece of glass tubing or sealing wax.—F. Walker.

[4359.]—AMBER BEADS.—"L.'s" beads are most likely only imitation ones, for the great majority of beads sold for clouded amber are but a mixture of gums, which are soft and also easily amalgamated with fatty matters and become dull and dirty on the surface as well as scratched. The false amber is easily shown. Scrape a small portion of the suspected material to powder, and if it dissolves in turpentine, whether hot or cold, it is not amber. Real amber has a smooth clean feel, and does not scratch readily. Putty powder will restore the polish to real amber.—Q. Yorke.

[4361.]—METHYLATED SPIRIT.—This is made from spirits of wine spoiled by a portion of naphtha, which, of course, prevents it from being used for tinctures.—H. C. C.

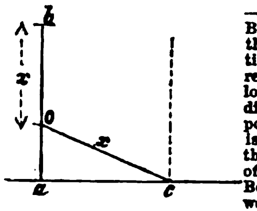
[4361.]—METHYLATED SPIRIT.—Methylated spirit is made by mixing one part of turpentine with nine parts of alcohol (plain spirit distilled from any grain). The only reason of mixing the turpentine with the spirit is to prevent its being drunk as a beverage, whereby the revenue would be affected. It is allowed to be used in preparing tinctures, and for any purpose connected with medicine, art, or science.—T. L. H.

[4363.]—LIMEWASH ON MASONRY.—The lime being an alkali, any acid should dissolve it. The cheapest and strongest acid for the purpose is the brown oil of vitriol of commerce, spec. grav. 1·712, price three-farthings per pound. Probably 1lb. of the acid to a pail of water would do the work required, the wash to be applied with a brush.—J. L. H.

[4369.]—EMIGRATION.—The Government have published a small pamphlet on Emigration to Australia, price 2d. It contains a mass of valuable information. Let "Jobber" get it. Any bookseller can obtain it for him, or Messrs. Longmans & Co., Paternoster-row, will send it direct.—F. R. G. S.

[4370.]—PROBLEM.—I suppose "Sunbeam" wants the two parts of the pole and the base to form a triangle. If so, the pole must be cut 45·5ft. from bottom to touch the required point in the base.—W. Felton.

[4370.]—PROBLEM.—54·5ft.—Beacon Lough.



[4370.]—"PROBLEM."—If I understand "Sun Beam's" question aright, the following is the solution he requires:—Let $a\,b$ represent the pole 100ft. long, and C a point 30ft. distant from a; o is the point at which the pole is to be cut; let x be the length of the part cut off. Then by "Euclid, Book 1, proposition 47," we have $x^2 = a\,c^2 + a\,o^2$ but $a\,c^2 = 30$ft., and $a\,o = 100—x$. Thus we have—

$$x^2 = 30^2 + (100-x)^2$$

$$x^2 = 900 + 10000-200\,x + x^2$$

$$200\,x = 10900$$

$$x = 54{\cdot}5\text{ft.}$$

T. W. P.

[4375.]—RED BRONZING.—This is done by the same process as green bronzing, but using red lacquer.—H. C. C.

[4376.]—COD LIVER OIL.—"A Mechanic" should try milk, and drink a good quantity of it in the day. If he finds that it makes his head ache, as probably it will, commence with a wineglassfull or even less, until his system becomes used to it and increase the quantity daily.—W. H. C.

[4376.]—COD LIVER OIL.—Let me assure "A Mechanic" that there can be no better substitute than Devonshire cream. A Kentish friend of mine, a tradesman, a fine tall (unmarried) man, of the name Braund, told me that he seemed quite to be sinking in consumption—weak, hectic, *spitting blood*, &c. He was ordered to take cod liver oil, but his system nauseated it utterly. He then was recommended to try Devonshire cream, and it thoroughly re-established him. At the time he stated this to me he was not stout, but fairly fleshy, vigorous, and full of work. I advise "A Mechanic" to eat it out of a "slop basin," with a dessert spoon. The price of the cream now in Devonshire is 1s. 6d. a pound; in London, more; almost all good dairymen keep it or can get it. I think I remember a place for it on the west side of Berners-street, Oxford-street, London. In the country, in a general way, it is the same price as fresh butter. It is the best lubricator for the wheels of existence.—Gimel.

[4376.]—COD LIVER OIL.—The only substitute for cod liver oil that I have ever heard of is cream, either scalded or raw. This is vastly more palatable than cod liver oil, but not in any way so efficacious.—Q. Yorke.

[4376.]—CODLIVER OIL.—The following is a good substitute, and very palatable:—A bottle of port wine, 2oz. of isinglass, and 2oz. of sugar candy. Put these ingredients into a jug, and let them remain 12 hours, then set the jug in a saucepan of boiling water for an hour. When the isinglass is dissolved all is ready. It may be taken warm or cold.—J. L. H.

[4377.]—TEMPERING BRACE-BITS.—Let "A Mechanic" get his brace-bits a little hotter than a blood heat in a slow fire, and plunge them in a pail of cold water; take them out and rub with a Turkey stone slip on one part of the bit just to brighten, and then hold the shank of the bit over or on a very hot piece of iron. When he sees the bits let down to a deep gold, an eighth of an inch from the cutting part, plunge in cold water again.—W. Reed.

[4377.]—TEMPERING BRACE-BITS.—"Mechanics" brace-bits may be re-hardened by heating them to a blood red and plunging into water, and drawing the temper to a deep straw colour. I see so many questions relative to tempering steel that a short article from a correspondent able to do it properly would, I am sure, be acceptable. There are very often two or three queries in a number relative to this simple process in practical mechanics.—G. W. A.

[4378.]—HOW LL.D.'s ARE MADE.—I doubt rather an "Ambitious One's" query being *bona fide*. If it is, I can but say that he must exert himself and gain a position worthy of the honour if he wishes to become a D.C.L., which is purely an honorary degree conferred on distinguished persons. To become an LL.D., he must go through the usual academical course and examinations.—Q. Yorke.

[4379.] — BORING CYLINDERS FOR MODEL ENGINE.—I should have thought that if "Sabbas" had been able to bore his cylinder to his satisfaction he would certainly have been able to form the steam passages in it. I drill a hole in the face of the flange and meet it by one from the valve face; sometimes I drill two holes side by side, and drill a series of holes in the valve face converging upon the two passages beneath (of course for an oblong port), and chip out the metal between the holes to form the port. He says he has no tools and knows nothing of the work. I should give it to a workman to do under the circumstances.—G. W. A.

[4383.]—WEAK EYES.—A very efficacious way of strengthening weak eyes is to daily pour into them while *open*, a tumbler of cold water. For sores about the eyes, one of the best remedies is the sulphate of zinc ointment sold in the chemist's shops.—J. L. H.

[4389.]—LATHE.—"Young Amateur" should buy some elementary work on turning, say "The Lathe and its Uses," then he would not find himself so lost. To make a quantity of backgammon men or such like work, let him first turn a cylinder of the proper diameter, then with a parting tool cut into the required number of pieces, which should be wide enough, or rather, thick enough, to allow for finish. To chuck these, use a spring boxwood chuck with binding ring of a suitable size, which he must learn how to make, as being an essential addition to his stock of chucks, first turning the discs on one face then on the other. Or, a plain boxwood chuck some 5in. or 6in. long, with the cut of a coarse saw through it longitudinally, carried as near to the end when it is screwed on the lathe as may be safe without splitting it in half, ending this cut with a round hole made with a bit. Make an opening on the face of this chuck slightly too small for the discs to be turned, open the jaws with a wrench, and snap the work in. The spring of the wood is quite sufficient to hold anything of the diameter of backgammon men.—Q. Yorke

[4391.]—SCREW TAPS, Etc.—Bichromate of potash will case-harden iron screws of small diameter; sufficiently so that they will cut a steel die (carefully softened) if they are used with a light hand. Shape the screws first like a tap, and when *very* red hot, apply plenty of the potash, and plunge into cold water. If they get too brittle, they must be tempered.—Q. Yorke.

[4393.]—STEAM-TIGHT JOINT.—If W. Reed would mix a little red and white lead together, get some hemp, twist it loosely together in the shape of cord, or the size he wants, work the lead well into it, lay it on the manhole door joint, then screw it in its place, he will find it steam-tight.—J. G.

[4396.]—STEAM-TIGHT JOINTS TO MANHOLE IN BOILER.—If W. Reed would get a piece of ½in. lead pipe, or ¾in., according to size of boiler, then solder the two ends together, then flatten out the pipe and make it fit round the lid of boiler; afterwards place some good red and white lead on both sides of level collar, then bolt it down and screw up tight, which will prevent any further escape of steam.—J. W. H.

[4398.]—MELTING SPELTER FOR BRAZING.—Borax is commonly used as a flux in brazing, though even with this "Deeside" may find a difficulty in brazing brass to wrought iron. The brass pipes have to be specially made for the purpose I believe.—Q. Q. R.

[4397.]—SCREW TOOLS FOR SCREW PLATES.—If "Faber" wants to make a set of small taps for his screw plate, let him forge some 6in. square saw files, or let him get some cast-steel about a 32nd part of an inch fuller than the holes in his plate, soften them (by making them red-hot and burying in dry ashes), and then screw them about 1½ in. in length with his plate. After screwing, file them tapering square ½ of an inch, just leaving the notches of the thread on the angles, and harden and temper the same, as in answer to "Mechanic" (4377), only let them down to a very pale straw colour.—W. Reed.

[4399.] — INTERNALLY-GEARED LATHE. — The circles of holes on the outside of the internal wheel are intended for a dividing plate for wheel cutting or ornamental turning, exactly the same as any ordinary single-geared lathe would have, and are used in conjunction with the spring index. Upon examination, the internal wheel of my lathe appears to have had the teeth cast in it (most probably from a metal pattern), and the bottoms of them have been cleaned out with a flat-bottomed drill to form the circular bottoms of the teeth (they are represented square in the drawing by mistake, and as the wheels stand I have 14 teeth instead of 12 as explained), and the points have been "topped" by the turning tool. "Deeside" will see that it is impossible to cut this wheel with a revolving cutter, because there is no "thoroughfare;" therefore, I would suggest a plan by which I think he will be able to do it. Let him make a turned pattern to the dimensions of the drawing (or reduced proportionally), the recess in it to be equal to the diametrical distance from point to opposite point of the wheel (allowing for turning out) which will be 6 7-16th in. Let him turn up the casting, and by means of the dividing plate drill a series of sixty holes on the circumference of a circle whose diameter is 6 11-16th in., just a shade larger than the pitch line 6⅝in.; these holes form the bottoms of the teeth and the metal between the edge of the hole, and the circumference of the recess is then to be chipped away neatly and so forms the tooth. He can "slot-drill" the teeth if he likes, and then only the corners will have to be rounded with the chisel. The size of the drill is 3-16th of an inch. I think the above is a *practical* way of going about this job, and is the method I should pursue if I had it in hand. If any other correspondent can suggest a better I am sure "Deeside" will be obliged to him.—G. W. A.

[4400.]—MICROSCOPIC OBJECTS, DIATOMS, Etc.—Diatoms are everywhere. Perhaps Weymouth would answer "Hunter's" purpose as well as most places. Seaton, in Devonshire is also a good microscopic ground. There are chalk cliffs, plenty of seaweeds, corralines, sponges, and sometimes a cuttle. Exeter is close at hand, with Budleigh (where there are plenty of diatoms), and the Exe mead at Woodbury. Dorchester is hard by Weymouth, and its chalk affords an abundance of very fine Foraminifera. At Portland, "Hunter" can secure fossil wood; and in the marshes, away towards Poole, plenty of microscopic mosses and lower algæ. Where does "Hunter" live? Where would he like to go?—H. P.

[4403]—MECHANICS.—I am really in as great a fog as "Alyssum" upon this question. It *may* be possible, but I have been always taught the contrary. No *simple* machine will perform the necessary work.—C. H. W. B.

[4406.]—MECHANICS.—"Alyssum's" question might have been put a little more definitely, although, perhaps, his real error lies in his fear of encroaching on your valuable space. However, for the sake of illustrating the mechanical principle he seems to have in view, we may suppose the small weight to act on the short arm of a lever, and the larger weight on the long arm. The ratio of these arms would have to be as 1 to 12. Suppose the short arm to be 1ft., then the long arm would be 12ft. Let a weight of 1lb. act at the end of the short arm, and a weight of 100lb. at the end of the long arm. By pressing the short arm down through a vertical distance of 1in., the end of the long arm will move through a height of 12in. We have now to find the pressure which, applied to the end of the short arm, will raise the weight of 100lb. at the end of the other. Let x = this pressure to make equilibrium. By the principle of the lever we have

$$1 \times 1 + x \times 1 = 100 \times 12$$
$$1 + x = 1{,}200$$
$$x = 1{,}199\text{lb.}$$

If this pressure be applied through a vertical space of 1in., the weight of 100lb. will be raised 12in.—T. W. P.

[4407.]—MAMMOTH.—"Naturalist" will find, I think, a nearly perfect skeleton of the *Elephas primigenius* in the British Museum.—F. Walker.

[4410.]—TURNING SPHERES.—"J. D. L." had better try to turn his billiard balls by hand; first with practice and a template. They can be done so easily enough; anyway, they must be chucked in boxwood, and when they are nearly finished, in a chuck to fit the exact hemisphere; in which chuck let there be a good rubbing of chalk to make them hold. Presupposing that the ivory is free from scratches, polish with whiting and water of the consistency of cream, used with a soft rag; dry, and then use dry whiting; and for the last, to complete the gloss, rub with a faint touch of clean oil on a fresh rag.—Q. Yorke.

QUERIES.

[4412.]—WRITING INK.—Could some reader kindly inform me what may be done to prevent writing ink from turning bad this hot weather—if there is anything that may be put in it?—J. G. M.

[4413.]—FEED-WATER HEATER.—Seeing a description of feed-water heater by "One Eye," in your journal of July 22nd, I beg to remind him of the great liability to back pressure in heaters of this construction. In good faith, and with every desire for mutual information, I would kindly ask "One Eye" has he ever taken diagrams in order to ascertain the amount of back-pressure since using the heater? If he has not, I would strongly advise him to do so, as I am afraid what he is gaining in one direction he may lose in another. I am also thankful to "One Eye" for his testimony in confirmation of the practicability of raising feed-water (by exhaust steam) to 212°. At the same time I cannot help doubting the economical efficiency of his contrivance, until supplied with a diagram taken when the feed-water is being admitted into the heater. Would "One Eye" kindly send me one?—S. Crompton.

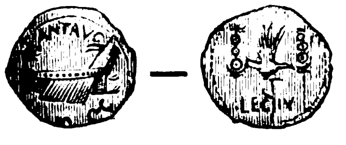
[4414.]—HEIGHT OF OBJECT.—How can we ascertain the height of an object, say twenty yards on the opposite side of the river, the width of which river we do not know? The simplest way, without having recourse to instruments or algebraic formulæ would oblige.—Enquirer.

[4415.]—CURIOUS PROBLEM.—In the English Mechanic for July 22nd, p. 415, Prof. Balfour Stewart asks what becomes of the energy of the cannon ball after it has struck the target? He says it is stopped by percussion. But what would be the result if an "irresistible" force came into contact with an "immovable" body?—Saul Rymea.

[4416.]—PHOTOGRAPHICAL.—Could any of the readers of the English Mechanic tell me, through the medium of this paper, the cause of silver prints becoming such a foxy red? I find such a difficulty in exciting the paper. If I float, say a dozen sheets, the silver bath becomes discoloured; in printing the prints become a foxy red; and in toning they get brown instead of black. I have likewise in my working negative bath had such a quantity of brown negatives, and nothing I can do to it makes the negatives black. If any one of our readers can help me, they will be conferring a favour on many more, who have no doubt experienced similar difficulties.—John.

[4417.]—SAFETY VALVE FOR KITCHEN BOILERS.—I saw noticed somewhere, sometime ago, a safety valve for kitchen boilers. Can any of your readers kindly tell me the maker, and whether this safety-valve answers the purpose of making the boiler absolutely safe? Mine is a cast iron one. Is there any possibility of expansion pipes becoming closed, except by frost?—Osmond Dobree.

[4418.]—SILVER COIN.—Perhaps some of the readers of the English Mechanic will kindly inform me what the coin is, a sketch of which I enclose. It is of silver, and rather thick.—A Young Beginner.



[4419.]—WATER GLASS.—Will any of your chemical subscribers be kind enough to give a form for making water glass?—Johnson.

[4420.]—VACUUM IN CONDENSING ENGINE.—I have a 30-horse condensing engine, and by the indicator I have only 10lb. vacuum. On Saturday we took out the air-pump piston, and found the springs to be a metal ring that goes inside the brass one; and the only way to extend the brass ring is to hammer the metal ring larger, and I think it would soon go back to its original size. So we took out the springs and put laggs in their places, but were pressed for time, and the joiner had only deal wood by him, and that not very dry. The laggs are 3⅝in. long, 1½ in. thick, and the piston is 18in. diameter, and it was a good fit. But to our surprise we have only 9lb. vacuum—1lb. less than the old piston—when working a ¼in. less than the cylinder. Can any brother reader tell me the cause? The air pump is in the centre of the condenser, and the injection pipe is at right angles to the eduction pipe, and nearly meets.—J. B.

[4421.]—MAKING FLANNEL ADHERE TO BRASS.—Any correspondent who will kindly inform me how to make flannel adhere to brass will oblige.—A Subscriber.

[4422.] — REVERSING ENGINES.—Can a pair of engines (steam) be reversed by two excentrics? An answer through your columns will oblige an old subscriber.—Fieldus Wesson.

[4423.]—TO "MUS."—Would "Mus" give me the following information:—My prints, when finished, have a brown leathery appearance instead of that pleasing black which we have with professional prints. I follow Jabez Hughes' instructions, and all goes well until above result. P.S.—What good account can old [illegible] of silver baths be turned to?—J. B.

[4424.]—COFFEY'S APPARATUS FOR DISTILLATION.—Could any reader give me any information about Mr. John A. Coffey's patent apparatus for distillation? There is mention made of it in the *Lancet* of June 11th, 1870, page 844, which *represents* it as a paraffin oil which can be heated to 1160° Fah. with little or no expansion and no evaporation. Has it ever been used for raising steam in a boiler, and if so, with what success? Any information would be of great service to me, as I cannot find any one who knows anything about it.—J. T. T.

[4425.]—MALLEABLE CAST IRON.—Thanks to "Associate of the Royal School of Min es" for the information given through your valuable journal [illegible]. Will he, or any other kind friend, answer the following questions:—Where can I get Dr. Percy's work, [illegible] And if I can get the specifications of patents [illegible] under the above head without applying personally [illegible] if Cumberland hematite pig iron, or any other [illegible] first refined in a small cupola with charcoal, [illegible] into small pigs, and afterwards melted in [illegible] or pot furnace, makes good malleable castings? Will this be cheaper than using fluoric acid? and if [illegible] spar or limestone would do as a flux in the [illegible] coal cupolas?—A Young Caster.

[4426.] — STEAMING BONES PREVIOUS TO GRINDING.—Where can a good apparatus be [illegible] and what price, second-hand? Is there a better [illegible] than steaming them? What books are published on the composition of artificial manures?—Farmer.

[4427.]—CASE-HARDENING.—Will one of your practical correspondents inform me how to case-harden the inside sliding cylinder of a poppet head without scaling? I have turned it bright and smooth and am afraid of spoiling it at the last moment.—W. H. B.

[4428.]—COIL.—Could any reader tell me the proper proportions of primary and secondary wire suitable for a 5lb. coil, and the proper gauge?—T. Butler.

[4429.]—TINNING AND BRAZING.—Can any one inform me if there is a work published on "Tinning and Brazing," as I wish for some information respecting the tinning of copper goods?—A Subscriber.

[4430.]—PUTTING THE SHOT.—Will any brother reader kindly inform me what size the patterns must be in wood for 18lb. and 20lb. shot? A plain answer will suit.—Round Shot.

[4431.]—MENDING EBONITE BATH.—I have an ebonite bath 15in. by 12in., and having had the misfortune to place my foot through one side, would be glad if any of your readers will tell me how to repair the same. I have the broken parts.—J. B. Clarkson.

[4432.] — "ISOMETRICAL."—"Isometros" conveys his best thanks to "J. K. P.," and is sorry he has [illegible] understood his query. What he wanted was the proportion the major and minor axes of ellipse bear to each other, and to the diameter of the circle to be represented. N.B.—I do not wish the lines of original [illegible] ing to be reduced to "isometrical proportions," [illegible] the isometric representation of original [illegible].—Isometros.

[4433.]—MARKING COTTON CLOTH.—Can [illegible] correspondent inform me as to what is the [illegible] nature of the acid or other substance in use at [illegible] and bleaching works for marking the distinguishing number or mark on the (cotton) cloth before process [illegible] to bleach it; the mark being put on so as to [illegible] the party to whom the cloth belongs? The substance used will resist the effect of boiling in time, then [illegible] ing in spirits of salts, then boiling in soda ash, [illegible] steeping in a solution of bleaching powder, then [illegible] ing in spirits of salt again, and sundry washings [illegible] hot and cold water, and will yet retain its property of resisting any dyeing process to which it may afterwards be subjected, leaving the number showing out plain [illegible] white ground.—B. D. F.

[4434.]—TAPS AND D IES.—Can any reader [illegible] if I can make left-handed taps and dies out of a [illegible] taps and dies for right-handed work? If so, please describe the *modus operandi*.—W. Reed.

[4435.]—CHANGING RED CORAL TO PINK.—[illegible] any one tell me if I can weaken the colour of [illegible] so as to make it pink? If so, how?—W. Reed.

[4436.]—BEE KEEPING.—Have any improvements been made in Woodbury's frame hive since the [illegible] described in Payne's Bee Keeping?—J. R. W.

[4437.]—FLUORIC ACID.—Can any reader inform [illegible] whether fluoric acid is chemically made in America; and if so what is about the price of it; and if not whether fluor spar can be got there, or rather is it found there?—J. K. H.

[4438.] — COTTON SPINNING. — An "Inquirer" would feel obliged if your cotton spinning friends will give their opinions as to the following questions:—In a single engine, 48in. on the wire, cylinder being 45in. diameter, and running 140 revolutions per minute, what speed ought a 24in. doffer to run, also a 6in. carding roller, when the engine is carding 400lb. of middling American per week? Also, what speed ought a 9in. licker-in or taker-in to run in the same engine?—Inquirer.

[4439.]—MATHER AND PLATT'S PATENT PISTON.—I am working one of "Mather and Platt's" patent pistons, and should feel obliged if any brother engineer could inform me how to take it to pieces for cleaning, and how to put it together again.—C. S. A.

[4440.]—WHEELS AND PINIONS OF WATCHES, No. 1.—Would "Horologer" kindly inform me how many teeth each wheel, and how many leaves each pinion of a watch should have; and if a watch 1in. 8-10th, 8 size, should have as many as a watch 1in. 9-10th, 20 size? Where are the seven jewels in watches placed? In which size watch is a scape wheel with eleven teeth placed = a fifteen teeth and thirteen teeth wheel? An answer will greatly oblige.—B. E. Loddy.

41.]—WATER BAROMETER.—I would feel ob- to "Cornubia" if he would favour me, and I am many more, with a fuller description of his water meter. I have been experimenting with that of instrument for the past eight or nine years, and d be glad to give a description of mine, in which ury is used, if you thought proper. Meantime, I d like to know what provision he makes for correct- he influence of temperature on his barometric tube. out this it cannot be known to what extent the rise ll is due to that or density. I would also wish that ard was shown on a larger scale, as it is too con- in its divisions, and so to explain all its parts and ions that one might venture to make a similar one? NIUS.

442.]—CROQUET.—Will some reader give me the iculars for making a set of croquet. I wish to know length and thickness of the mallet head, the length thickness of the mallet handle (the thickness at h end of the handle), the number of hoops required, the size of the opening in them, what sort of wood uld the different articles be made of, the simplest for turning a wooden ball perfectly round, the size colour of the balls, and in what order are the colours ted on the starting posts? I also wish to know what clips are?—WOODMAN.

443.]—MOTIVE POWER FOR VELOCIPEDE.—I been expecting to see some account in your paper of nall high-pressure engine applied to a velocipede. boiler could be heated with asbestos (instead of l) and oil lamps. It would not take above ¼-horse- er to move a four wheeler, with india rubber tires, to ry two passengers. Weight of carriage to be 8cwt. ess. Will any of your correspondents kindly suggest of copper boiler, cylinders, size of tank, probable t, and whether practicable without danger? All bicycle l velocipede riding is attended with great labour, ich tells seriously on hilly roads. If some small com- ct contrivance can be used as a motive power, and e from danger, there would be a ready sale, which uld amply repay the ingenuity of the fortunate in- ntor. Awaiting information on the above subject.— IOS. STANHOPE.

[4444.]—JELLY-FISH IN STONE.—The slabs used r paving London Bridge are spotted with greenish- llow marks, of varying shapes and sizes. A friend lls me these spots are the petrified bodies of jelly-like sh imprisoned during the formation of the rock from hich these slabs were cut. Is this really so? I wish me of our correspondents would tell me something out them.—MEDUSA.

[4445.]—ASPHALTE FOR GARDEN PATHS.—Can y one tell me if I can use asphalte for garden paths; hat would it cost; and how do you lay it down?— BBAS.

[4446.]—MOUNTING MICROSCOPE OBJECTS, rc.—What is the best method of mounting the otiferæ, or Wheelbearers? Has any one tried the nall rubber rings as cells for mounting in liquid? ow do they answer?—H. U.

[4447.]—BOGIE ENGINES.—Some of these have been use on the North London line. Are they any lvantage; and do they save anything?—SLEEPER.

[4448.]—TRUE MERIDIAN.—Will some of my fellow- aders explain the best way to find the "True eridian," and also let me know how much difference there between the present magnetic meridian and that 1860?—YOUNG SURVEYOR.

[4449.]—RESTORING FRESHNESS TO FILTERED ATER.—I have a most excellent animal charcoal filter, hich gives a good supply of perfectly pure and trans- rent water, but it drinks "flat," something like water hich has been boiled. I shall feel greatly obliged to ly of your scientific correspondents if they will in- rm me of the best means of restoring freshness to the ater, by passing it through a strata of some other aterial after it has been filtered.—F. P. S.

[4450.]—TO "SIGMA."—Will "Sigma" please give e a little information respecting the Smee and ichromate batteries? I have noticed that in the former ere are two large zinc plates, with a platinised silver ate between, for the negative; while in the Bichromate ere are two large carbon plates, with a small zinc etween—the two batteries appearing to me to be uite reversed. Now what I wish to know is—Firstly— re the conditions altered because the plates are re- ersed, and do the two batteries resemble each other in orking? Secondly—Which is the most powerful, and aintains its power the longest, and how long? Thirdly— hich is the most economical in working? Fourthly— re there any advantages in either over the other? and stly, ought the zinc to be amalgamated with mercury r the Bichromate?—M. R. C. S.—A NEW SUBSCRIBER.

[4451.]—MOULDS OF COINS.—Can any correspon- nt inform me with what substance I can make small oulds or impressions of coins, so as to plate them with pper with a battery?—F. WALKER.

[4452.]—LIGHTNING CONDUCTOR.—I shall be uch obliged if one of your kind contributors will vour me with particulars of a lightning conductor; hat kind of material is most suitable for the purpose; nd the best way to fix it, &c.—IRON.

[4453.]—FLATTED OIL BACKGROUND FOR PHO- OGRAPHERS USE.—Will any of your readers in- orm me how to prepare a background in flatted oil for hotographic purposes, to roll upon a stick? I have one n a stretcher, 7ft. by 6ft., which I prepared in the fol- owing manner:—1st, by tacking the canvas to the retcher; 2nd, giving it a coating of common size; and d, painting it with two coats of ordinary slate colour aint. But the difficulty I experience is this—in the amp weather the canvas slackens, and in the dry wea- er it tightens, which I think is quite the reverse with e canvas without the paint.—TYPO-PHOTO.

[4454.]—BLACK JAPAN COACH-WORK.—Perhaps me of our readers can inform me how to make black pan for coach-work? If they can I shall be grateful. J. WILLIAMS.

[4455.]—MANUFACTURE OF HARD SOAP.—Would me brother reader instruct me, through the columns of ur MECHANIC, the simplest form of plant to adopt in e manufacture of about half a ton of hard soap per ek. Anything connected with the manufacture of ustic soda department of it not necessary to explain, as I am thoroughly conversant with that myself.—OLD DIP.

[4456.]—PLUMBAGO BOTTLE BATTERY.—I will thank your able and scientific correspondent "Sigma" to have the goodness to inform me where the plumbago bottles for battery purposes can be got, and the probable cost of each, or with the zinc and binding screws complete.—ELECTRO-MAGNET.

[4457.]—STEAM BOILER.—I have a steam boiler about 20-horse power. I require two distinct classes of steam off it—viz., one class at 50lb. per inch, the other at 20lb. per inch. Would some brother reader kindly say how I may obtain it? Is there such a thing as a reducing valve to be had which would have this effect? —OLD DIP.

[4458.]—LIQUID HARNESS BLACKING. — Would some of your kind readers give me a good receipt for making the above?—R. S., Handsworth.

[4459.]—WHITE FURNITURE CREAM. — Recipe wanted for making the above.—R. S., Handsworth.

[4460.]—SLIDE VALVE, ETC.—TO MR. BASKERVILLE.—On reading Mr. B.'s letter in a back number on the lead of the slide valve, I met with several difficulties. In the first place I wanted an *accurate* description of the slide valve itself. Secondly, I was at a loss because I had never heard the words "lead," "lap," and "travel," accurately defined. Questions like the following occurred to my mind. Where is the "travel" measured from? Is it the "throw" of the excentric? What is the distance between the port holes? What is the "lap"? "Where is the lead measured from?" All these, and numerous others still remain unanswered to my mind, though I have spent some time in studying the subject; and as I am unable to procure a good work on the steam engine, I appeal to Mr. Baskerville to put me right. At the same time I would thank him to give me a sketch of a pair of excentrics and link motion slide valve and cylinder (3 3-16th in. diameter, and 6in. stroke), for a 2-horse power road steamer. What I want most are the eccentrics, link motion, and slide valve; about the cylinder I am not particular.—THOS. WATSON.

[4461.]—SCREW CUTTING.—Will "J. K. P." please reply to the following questions:—I have a 4½in centre lathe, which I am fitting for screw cutting. What pitch of wheels would you say are the best for it; 14 or 12 pitch; and how many threads to the inch for the leading screw?—H. WILLIAMS.

[4462.]—STRANGE PHENOMENON.—Observing in the ENGLISH MECHANIC an article headed the "Leaf as a Worker," I write an account of a strange phenomenon that has come under my own observation. About two years ago, while taking a walk after dark, I happened to be standing near to a thorn hedge, when I observed, in looking amongst the leaves, a flickering light. Struck with this appearance, I closely observed it night after night. I saw the same appearance on every green plant—I found the same on every stone wall; indeed, everything that I looked upon disclosed the same flickering waves of light. I conjectured what it might be; sometimes I thought it might be light absorbed by the plants through the day, and leaving them at night. I also attributed it to electricity, also to a delusion in my own eyes. I tried to show it to some of my acquaintances, some of them could see it and others could not. Since then I have observed it regularly, but cannot come to any definite opinion regarding what it is. I hope some of the readers of the ENGLISH MECHANIC will give it a fair trial and give their opinions. I see it best by looking steadily at the leaves from a distance of 5in. or 6in. upwards, and at present after ten o'clock at night.—GLOWWORM.

[4463.]—ROTATORY MOTION.—Can cold compressed air be made to produce rotatory motion without heating in any way? If so, to what pressure must it be condensed?—YOUNG ENGINEER.

UNNOTICED QUERIES.

IN future, if any query remains unanswered for four weeks, we shall insert the number and subject of the query in this list, where it will remain for two weeks, if not previously replied to. We trust our readers will look over the list, and send what information they can for the benefit of their fellow-contributors.

Since our last "Heather Jack" has answered 2672, 3812; "Housewife," 3838, 4002; "Muzzle Loader," 4005; "M. D.," 4014; H. W. Henfrey, 3975; Bernardin, 3982; "S. J. P.," 3961; "H. U.," 2662, 3912, 3918; "Q. Q. R.," 3926; "Rogo," 3842; "G. W. A.," 4011; "S. A.," 4009.

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4069	Parsons' White Brass, 311.
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4072	Harmonium Query. To "Eleve," 311.
4074	Refuse Lime, 311.
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4081	The Shiptonian Velocipede, 311.
4092	The English Concertina, 335.
4093	Range of Projectiles, 335.
4099	Observatory, 335.
4102	Galvanism, 335.
4103	Clog Iron Machine, 335.
4107	Knifeboard, 335.
4112	Gas Meters, 335.
4119	Anastatic Printing—Porous Cells, 335.
4121	To Bottle Fruits, 335.
4124	Folding Stool, 335.
4125	Screw Cutting, 335.

USEFUL AND SCIENTIFIC NOTES.

NEW USE FOR YEAST.—In some localities large quantities of beer yeast are run off into sewers and wasted. It contains from 7 to 11 per cent. of nitrogen. M. Bernier mixes about 100 kilogrammes of the yeast with about 30 kilogrammes of quicklime and 10 of gypsum, and thus obtains a manure which may be used instead of guano.

ECONOMICAL PAINT.—Skim milk, two quarts; fresh slacked lime, 8oz.; linseed oil, 6oz.; white Burgundy pitch, 2oz.; Spanish white, 3lb. The lime to be slacked in water, exposed to the air, mixed in one-fourth of the milk; the oil in which the pitch is previously dissolved, to be added a little at a time; then the rest of the milk, and afterwards the Spanish white. This quantity is sufficient for 27 square yards, two coats.

RENEWING RIBBONS.—Old ribbons will look quite renewed if washed in cool suds made of fine soap, and ironed when damp. Cover the ribbon with a clean cloth and pass the iron over that. If you wish to stiffen the ribbon, dip it, while drying, into gum arabic water. White silk gloves wash well, and should be dried on the hands.

TO MAKE OLD KID GLOVES NEW.—Make a thick mucilage by boiling a handful of flax seed; add a little dissolved soap; then when the mixture cools, with a piece of white flannel wipe the gloves, previously fitted to the hand. Use only enough of the cleaner to take off the dirt, without wetting through the glove.

DYEING HORN BLACK.—According to C. Burnitz, of Stuttgart, horn may be dyed black by a cold process in the following way:—The horn is first to be soaked in a solution of caustic potash or soda until the surface is a little dissolved, and feels greasy. Then the article is to be washed and treated with aniline black, after which it is to be slowly dried and again washed. By exercising a little care, we read that combs with fine teeth may be dyed in this way. The articles look of a dark brown colour by transmitted light, but seen by reflected light they are deep black.

THE WEALTH OF ENGLAND.—Mr. Gladstone stated at a meeting at the Mansion House on Tuesday, July 12th, that the annual increase in the wealth of the country amounts to £100,000,000 a year, of which £20,000,000 are made in the city of London. Lord Stanley, the present Earl of Derby, some few years since, calculated the increase of our national wealth at the rate of £50,000,000 per annum.

TRACTION.—The resistance to draught on dirt or gravel roads is about 148lb. to the ton. On a well-constructed macadamized road it is not far from 66lb. to the ton. On a good pavement, say granite or Belgian, it is about 33lb. to the ton, while on an iron rail track it is 5lb. to the ton. These facts show that a horse will draw about three times as much on a macadamized road as on a common road, four and one-half times as much on a pavement, and eighteen times as much on an iron rail. This conclusion, of course, implies that the horse has the same secure foothold in each given case.

TEST FOR LOGWOOD IN WINE.—Lapeyrère has discovered that that the hematite contained in logwood yields a sky-blue colour with salts of copper. Thus, if strips of good filtering paper, Swedish being preferred, are placed in an aqueous solution of neutral acetate of copper, and then dried, they can be used for testing wine. When a strip has been dipped into the wine and removed again, the adhering drop must be made to run backwards and forwards over the paper, which is then quickly, but carefully dried. If the wine be free from logwood, the colour exhibited after the strip is dried will be grey, or rose-red greyish, but if logwood is present the tinge will be distinctly sky-blue.

ANTIFLAMINE.—A material has recently been introduced at Paris under the name of "Antiflamine," for the purpose of extinguishing fire in the case of accident; it consists of aluminous and magnesian silicates reduced to fine powder and dried at 212° Fahr., 700 parts by weight; chloride of magnesium in crystals, 200 parts; sulphate of soda, 50 parts; chloride of lime, 50 parts; and tartaric acid, 1 part = 1,001. The article is supplied in a pulverulent form, and is perfectly soluble in water. It is proposed to mix it with the water in the fire-engines, the effect of which, it is claimed, is to lower the temperature and to surround the burning material with gases which will not support combustion.

NEW NAVAL LIGHT.—A French paper says that it is intended to supply several vessels of the fleet with an apparatus intended to light up the line of the horizon in dull weather, or any point of the sea-coast at which it may be expedient to disembark at night. This apparatus, placed in the fore part of the ship, is composed of an electric light and a powerful reflector. The light is produced by the combustion of two cones of coal, in communication with a magneto-electric machine. This is itself put in motion by a small steam-engine connected with the ship's engines. The reflector, on Fresnel's system, is analogous to that employed in lighthouses. This apparatus possesses such great illuminating power that, when directed upon a point of any coast, it is clearly visible at a distance of about two miles, without its being possible for the enemy on the coast to distinguish the ship bearing the light. The ironclad frigate *Heroine* carries one of these lights, which has been useful in gloomy weather to the transatlantic packets. The Russian Government has ordered several of them from the French inventor, and proposes placing them in the port of Cronstadt. Speaking of this system, the Austrian Admiral Tegethoff, the victor of Lissa, used to say that if he had had the assistance of such lights he should have annihilated the Italian squadron while anchored in the roads of Ancona. It is, in fact, known that one night, very shortly before the battle of Lissa, the Austrian fleet approached within reach of the cannon of the port of Ancona. Admiral Tegethoff thought he could distinguish through the darkness a thick smoke, showing that the Italian vessels were getting up their steam, and were about to weigh anchor. Such a reflector as that recently invented would have permitted him to see that he was mistaken, and that the fires of the hostile squadron were not lighted. The fate of those motionless vessels would have been decided.

ANOTHER TESTIMONY.

Sir,—I will thank you to have the goodness to re-insert my advertisement in your valuable journal. The extensive circulation of the English Mechanic I had never any reason to doubt, but since my advertisement appeared in the Sixpenny Sale Column therein, on the 17th June last, I have had the most positive proof of the truth of the allegation, orders having been sent to me from so many different parts of England and Ireland, as well as from *Les Iles de la Manche*, which clearly shows that your now well-conducted paper is much esteemed and very popular in the three Kingdoms, and other countries.

J. B. Cockburn, 4, Moss-street, Paisley, N.B.

ANSWERS TO CORRESPONDENTS.

*** All communications should be addressed to the Editor of the English Mechanic, 81, Tavistock-street, Covent Garden, W.C.

The following are the initials, &c., of letters to hand up to Tuesday morning, August 2, and unacknowledged elsewhere:—

Barry Close, W. F. D., H. Brown, F. R. A. S., J. R. W., J. M. S. S., Rev. E. W., D. H. & Co., Atom, M. L., N. & Co., O. H. D., H. B., O. & B., Ajax, J. Mills, E. J. R., Rev. E. J., M. D., Rev. E. Kernan, J. B. F., J. R. W., Geo. Crowe, R. A. Proctor, The Harmonious Blacksmith, J. N. Trayler, T. A., E. A. Burnell, A. F. H. Pocklington, R. G. Bennett, An Ambitious One, J. T. Sprague with M.S.S., F. R. A. S., with do.; Exeter, with do.; H. P. Hull, A. Crouch., R. F. D., E. H. B., C. H. W. B., R. A. Proctor, Rev. E. Firman, S. Hewitt, Old Dip, Lex, J. B., Junr.; W. Airey, Urban, One in a Fix, A. W. Z., Berero, A Chip, John Elwell, Inductorium, Giles, Hy. W. Reveley, Omega, I. J. Mc'Cartey, J. W. Boord, Thos. Fletcher, S. Light, P. C. Hobden, Normal, H. Childs, Hobby, Kansas Emigrant, An Old Subscriber, Experimentalist, Jas. Maston, George Macrai, W. Driscoll, T. A. Burge, J. Lomond, W. J. W., J. Stanlake, Beta, W. F. Trinder, H. Cumington.

H. H. Gillett.—We do not know the address.

H. C. informs us that Dr. Bedford is not an M.D. or LL.D., but Ph. D. He does not give the information that "An Ambitious One" asked for—the exact sum such a degree costs.

D. G.—Mr. Perry does advertise.

A. Mc'M.—You deprive your suggestion and congratulation of value by refusing to send your name and address appended.

Hy. Mack.—We do not answer through the post.

A Working Man.—We cannot give an opinion on the qualities of P.'s sewing machine materials or those of any one else.

A Fellow of the Royal Astronomical Society has written us a letter referring to our remarks on the *Astronomical Register*. As we have no desire to prolong the controversy as to the merits or demerits of that journal, an extract from "F. R. A. S.'s" letter must suffice. He says, "I did inadvertently in my letter to you institute a comparison in certain points between the Mechanic and the *Register*, but the gist of my complaint was that I could never get any numbers of the latter until some days after they were due." We are sorry we have not kept "F. R. A. S.'s" letter, or we would cheerfully insert it now.

Chas. Hall (Leeds).—We know nothing of it. You had better apply speedily to the late proprietor.

R. C. Hobden.—Its insertion was countermanded, then ordered again, and then again countermanded, by your agents.

Saw Mill (Glasgow).—Thanks for your efforts and good wishes.

E. M. Tydeman.—No.

Inspector Cockburn.—We cannot entertain your offer. Others might wish to do the same, and what you offer out of zeal for the lifeboat might be imitated for the purpose of fraud.

A. Frisby.—A similar problem ("The Goat and the Grassplot") has been recently asked and answered. Such queries are not very practical, and we therefore grudge space for their frequent insertion.

W. R. C.—Your proposition, though well meant, is impracticable. We supply copies wholesale only to the trade, and it would cause confusion in the business relations between the wholesale and retail newsvendors. Besides, it would entail some expenditure on us, which we hardly feel called upon to incur.

A. Harrison.—We cannot undertake to be the medium of such communications.

Not a Saddler.—Reply something like a puff.

N. T. D.—Yes, the letter came to hand, but was rejected on account of its great length, like many other communications of late.

E. Stake.—Your long letter on cotton spinning is not inserted on account of its very great length; it would occupy a page of the English Mechanic.

Inventor.—We cannot afford space for an illustrated notion, so that it might be criticised.

J. Stanley, of Coventry, writes that *he* is the designer of the velocipede spring.

R. P. S.—Reply to problem would occupy too much space.

G. Mansfield.—A nice design enough, but a description of the arrangement in the pedestal of the aquarium would be more acceptable.

Q. A. R.—"Sutherland's Handbook of Painting and Decoration." Abel Heywood & Co., Manchester, or series of articles now appearing in the *Building News*.

R. O. F. S.—Consult advertisement pages.

F. J. S.—The information you require would fill a number. We think Cassell, Peter, & Galpin, publish a small "Guide to the Civil Service."

Tometer.—Have mercy upon our printer, and be content with your abbreviated signature. Thanks for your congratulations.

John Fleet.—You are mistaken when you say that we "eulogised" the paint. We simply laid before our readers a plain statement of the merits claimed for it by those who make and sell it.

A. L. B.—You are an irregular or an inattentive reader, or you would not ask for information on two subjects which are at present being treated on in our pages.

D. F. Ashton.—Your impressions are too bad to engrave. The coin appears to be a copper token of the reign of Queen Anne.

M. L.—The weekly number will go to Australia all right, but the monthly part must be paid for at book-post rate.

Geo. B. Howard.—Search at the Patent Office.

Liverpulian.—It might amuse, but could not interest our readers.

J. P. Richardson.—Messrs. Leroy's address is Gray-street, near Philpott-street, Commercial-road, E.

Mr. Jeffreys ought to have some other recommendation for his "studs and solitaires," to claim a notice in our columns, than his having "the distinguished honour of presenting them to the Prince of Wales." We did hope that the Workmen's International Exhibition would be free from the enervating spirit of flunkeyism.

G. Spheric.—Try and not write nonsense.

John Tod, Jun.—See answers to correspondents last week.

J. P. J.—Condense what you have to say in one half the space, and the letter shall appear.

J. R.—You will see that we have decided to devote a portion of our advertising space to Wanted advertisements, under the head Employment Column.

Shorthand.—John Organ, T. Cridland, and N.T. have written in defence of Pitman's system, but as they go over ground that was pretty well covered by preceding correspondents we must omit their letters. Mr. Edward Williams has sent us an improved system, but as it involves elaborate woodcuts his letter is not inserted.

J. B. T., W.W., and Rev. W. H. express their satisfaction with the manner in which "unnoticed queries" have been answered.

Mus.—We should be glad to receive the drawing or photo.

T. Bush.—A drawing of the ventilating apparatus you refer to appeared in the *Building News* of Nov. 27 and Dec. 18, 1868. It is the invention of W. Potts, Handsworth, Birmingham.

Enquirer.—We should think you would only be entitled to a month's notice, in the absence of any agreement or trade custom to the contrary.

R. Hodges.—There are no such works published.

X. X. X.—Charges are the same for the repetition of such advertisements.

Collimator.—Try F. J. Cox, Ludgate-hill.

W. B. Harvey.—No letter is unnoticed by us. Sometimes correspondents ask questions which have been but very recently answered, without troubling to refer to back numbers. We do not remember your former letters.

E. Hatchin.—Recipes for making jams have recently appeared. Second query can only appear in "Sixpenny Sale Column."

S. Elliott.—Thanks for good wishes. Your resolve to "subscribe to no more prize-offering journals" is a wise one.

The Microscope.—"C. R. H.," Swindon, thanks "H. P., Hull" for his recent contributions, and trusts that such an interest may be evinced by our readers as may encourage him and others to devote attention to this hitherto rather neglected subject.

THE INVENTOR.

APPLICATIONS FOR LETTERS PATENT DURING THE WEEK ENDING JULY 26, 1870.

2036. R. Sellar, Huntly, improvements in the construction of double-furrow ploughs.

2037. W. E. Wimby, Edgbaston, improvements in rails and chairs for railways.

2038. J. F. Parker and E. Sunderland, Birmingham, improvements in the manufacture and melting of iron and steel.

2039. J. Hull and G. Hibbert, Partington, improvements in machinery or apparatus for printing boulinikon, linoleum, kamptulicon, &c.

2030. J. E. Hughes, improvements in the formation of roadways, pavements, and such like surfaces. A communicatiun.

2031. W. Owen, 47, Wind-street, Aberdare, improvements in railway and other wheels.

2032. H. M. Ramsay, 2, Russell Villas, Pope's Grove, Twickenham, improvements in the treatment of sewage or other liquids or solutions.

2033. C. H. Plowright and W. Plowright, Deeping St. Nicholas, an improved wind engine or apparatus for obtaining motive power.

2034. S. Norton, Chester, improvements in valve taps.

2035. J. N. Paxman and H. M. Davey, Colchester, engineers, for an invention of improvements in steam boilers.

2036. J. Henderson, Hazlefield House, Auchencairn, improvements in the manufacture of iron and steel, and in furnaces to be used in such manufacture.

2037. J. Dyus and G. J. Parry, 28, New Charles-street, Clerkenwell, improvements in mechanism arranged in combination with the locks of boxes, dressing and other cases.

2038. A. L. Taylor, Aylesbury, improvements in apparatus for warming, vaporising, and causing a free circulation of fresh air in horticultural structures and other buildings.

2039. J. A. Mason and J. Williams, Holborn, improvements in sewing machines.

2040. W. M. Ross, Melbourne, Victoria, a new propulsion engine to be used for propelling bodies through the water and through the air.

2041. H. Redfern, Nottingham, improvements in the manufacture of ball valves.

2042. W. Hagget, West Camel, Somerset, improvements in ventilating houses and buildings.

2043. J. E. Makins, King William-street, London, an improved spring fastener for windows.

2044. W. Robinson, Old Bailey, improvements in the manufacture of iron.

2045. T. M. Hopkins, of Worcester, improved means for drying substances impregnated with moisture.

2046. J. E. Duyck, Glasgow, improvements in treating mineral oils.

2047. J. H. Lloyd, M.D., Llangefni, Anglesey, improvements in utilizing and deodorizing sewage.

2048. C. Bartholomew, Doncaster, improvements in treating sewage.

2049. G. Phillips, 74, Tufnell Park-road, improvements in [illegible] paring charcoal for decolorising syrups.

2050. A. V. Newton, 66, Chancery-lane, improvements in [illegible] for sewing machines. A communication.

2051. W. E. Newton, 66, Chancery-lane, improvements in [illegible] and other mirrors. A communication.

2052. B. J. B. Mills, 85, Southampton Buildings, improve[illegible] in ovens. A communication.

2053. St. T. Baker, King's-road, Chelsea, improvements [illegible] pigeon traps from which pigeons are shot.

2054. D. Jones, Inverness, improvements in door fastenings.

2055. W. R. Lake, Southampton-buildings, improvements [illegible] wheels for railway carriages and other vehicles. A communication.

2056. F. J. Newton, 28, Wollaton-street, Nottingham, [illegible] Mosley, Elm Avenue, New Basford, improvements in [illegible] apparatus.

2057. T. A. Warrington, 8, Duke-street, Adelphi, improve[illegible] in ventilators.

2058. W. Creswick, Rotherwood, Rotherham, improvements [illegible] apparatus for lubricating the axles of colliery [illegible]

2059. A. H. Wharton, Heckmondwike, improvements in [illegible] manufacture of carpets.

2060. J. Petrie, jun., Rochdale, improvements in [illegible] washing or scouring wool.

2061. W. E. Newton, 66, Chancery-lane, improvements [illegible] A communication.

2062. J. Mason, Erdington, Birmingham, and [illegible] Gravelly Hill, Birmingham, improvements in the [illegible] steel.

2063. J. J. M. Sills, Nottingham, an improved [illegible] watercloset.

2064. R. T. Shiells, Edinburgh, improvements [illegible] vegetable matter.

2065. J. H. Johnson, 47, Lincoln's Inn-fields, [illegible] the production of sulphuric and hydrochloric acids [illegible] of potash and soda, and also of chlorine. A communication.

2066. J. H. Johnson, improvements in explosive [illegible] fuses. A communication.

2067. J. Hunter, Leith, improvements in [illegible] substances.

2068. J. Ashwin and R. Carter, Birmingham, improvements in lockets.

2069. H. Howard, Preston, and T. Taylor, [illegible] improved positive differential motion.

2070. T. Burrell, Stockton-on-Tees, improvements [illegible] for marine engines.

2071. T. Higgs and J. Elliott, Holborn, improvements [illegible] regulators.

2072. A. Turner, Leicester, improvements in the [illegible] of elastic fabrics.

2073. W. E. Newton, 66, Chancery-lane, improved [illegible] apparatus for tawing or dressing skins. A communication.

2074. W. J. Johnson, Allendale, improvements in [illegible] condensing metallic and other fuels, gases, and smoke.

2075. R. Bailey, Barrow-in-Furness, improvements in [illegible] lating and heating rooms and other places.

2076. L. E. Mouline, Vals Ardèche, France, an improved [illegible] of reeling silk.

2077. H. Dubs and S. G. Goodall-Copestake, Glasgow, [illegible] provements in combining or coupling locomotives.

2078. E. Cowles, Hounslow, and P. Brash, *Leith*, improve[illegible] in the manufacture of candles.

2079. E. Dittrich, S. Petersburgh, and *F. Mills and J. Lei*[illegible] Manchester, improvements *in the manufacture of the reeds* [illegible] ployed in looms for weaving.

2080. F. J. Baynes, *Holloway-terrace, Holloway-road*, [illegible] improved carving rack.

2081. H. Doulton, High-street, Lambeth, improvements *in* [illegible] valves.

2082. G. Sparagnapane, Bishopsgate-street Without, improv[illegible] means of dyeing or colouring articles.

2083. W. E. Newton, 66, Chancery-lane, improvements in apparatus for the manufacture of gas. A communication.

2084. G. C. Philcox and T. Saint, 165, Goswell-street-[illegible] improvements in marine chronometers and other time-keepers.

2085. W. L. Mitchell, Kirkcaldy, Fife, improvements in [illegible] for weaving.

2086. B. C. Scott, Saint John's Wood, improvements in [illegible] engines.

2087. J. B. E. Defontaine, No. 60, Boulevart Sébastopol, [illegible] improvements in dredging machines.

2088. W. L. Anderson, Clarendon House, Caterham, [illegible] ments in propellers.

2089. O. Walch, Paris, Boulevard de Strasbourg, [illegible] improved machinery for pressing matches.

2090. P. Schwartz, 19, Boulevard Prince [illegible] provements in means or apparatus for facilitating [illegible] tion of the uppers of boots and shoes. A communication.

2091. H. Atkinson, 38, Wharf-road, City-road, [illegible] swing.

2092. J. E. Sherman, Maine, U.S., improvements [illegible] tion of iron and steel.

2093. J. Wilkinson, Leeds, improvements in the [illegible] machinery for cleaning and finishing carpet fabrics.

2094. T. P. Bayes, Orange, New Jersey, U.S., [illegible] washing machines. A communication.

2095. H. Brooks, 81, Cumberland-market, Regent's [illegible] provements in the manufacture of stoppers for bottles.

2096. W. G. Gard, Breaston, Derby, an improved [illegible] serving meat, fish, poultry, &c.

PATENTS SEALED.

216. R. S. Dale and C. Schorlemmer, improvements in [illegible] colouring matters.

220. G. E. Harding, and P. Wright, improvements in [illegible] machines.

230. W. S. Underhill, improvements in steam engines.

237. C. Lungley, improvements in the construction of [illegible] vessels.

240. W. F. Dearlove, improvements in apparatus for [illegible] or mincing substances.

264. W. Orr, improvements in ornamenting Scotch [illegible] bonnets.

272. R. Dick, new or improved modes and means [illegible] and insulating the wires of electric telegraphs.

292. J. Fisher and H. Fisher, improvements applicable [illegible] boiler and other furnaces.

295. G. Broadhurst, J. Swindells, and J. Kershaw, [illegible] ments in india-rubber manufactures.

301. N. J. Holmes, improvements in the application [illegible] extinguishable signal lights for marine and other purposes.

349. G. Dumont, improvements in apparatus for the [illegible] of argentiferous leads.

383. A. Foley, and H. Foley, improvements in the production [illegible] photographic pictures or designs on veneers and solid wood.

391. G. Eguillon, improvements in the mode of reducing [illegible] friction of pivots turning on oscillating levers.

433. W. Wieldon and J. Beck, improvements in cocks [illegible] valves.

868. A. Barlow, improvements in jacquard mechanism [illegible] weaving and other purposes.

977. C. Wilson and J. Peebles, improvements in equilibrium slide valves.

1270. A. M. Clark, improvements in traction and locomotive engines. A communication.

1598. W. V. Pulliam, improved self-adjusting couplers for [illegible] necting and disconnecting railway carriages.

247. A. D. Brown and W. Brown, improvements in machines for cutting curved and irregular forms.

252. B. Conci, an improved portable scaffolding.

257. J. C. Haddan, improvements in apparatus for taking [illegible] registering votes.

276. T. Lee, W. Lee, and E. Lee, improvements in mill bills.

280. E. Brasier, streaking and cleaning hemp, cleaning tow, washing wool, and heckling, cleaning, or washing [illegible] fibrous materials.

THE *ENGLISH MECHANIC* LIFEBOAT FUND.

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FRIDAY, AUGUST 12, 1870.

THE WAR.

ALMOST every man in Europe feels more or less interested in the vast and unnecessary war which is devastating the fairest portions of Europe. We will not, in these columns discuss the flimsy pretext for the war. We regard it as a crime against humanity. There is no doubt that one of the parties in the strife has been "swift to shed blood." No one can forecast the results of the war; we do not, in fact, remember a single historic war that has answered the purposes of its originators. There is, however, one side of the question which wears a hopeful aspect, and which we may record with satisfaction in a scientific journal. Cowper said, "War is a game that, were their subjects wise kings would not play at;" and, for the first time in the history of Europe, we see symptoms of an awakening of the *people* to a true conception of the measureless evils of war. The Paris correspondent of the *Morning Post* says:—"The children of industry begin to question why they should be slaughtered and ruined to satisfy the pride and ambition of sovereigns and statemen. The international trade-unions, the improved education of the working classes, the better knowledge which the people now have of each other—originating in the facilities of railway communication and the interchange of opinion which arises from international journalism—are causes which affect the state of public opinion amongst the working classes of all Europe, calculated some day, if not in 1870, to produce political events of the most comprehensive character."

Let us add to this an extract from the Workman's Peace Committee in London, of which Mr. Edmond Beales is chairman, and Mr. W. R. Cremer the secretary:—"Peace is to us as the breath of life. War, that great curse and scourge of mankind, is especially our deadliest foe, for we are ever its most numerous victims, whether as regards the interruption of employment from national distress, or our enrolment in military service. Here, then, comes the question we would urgently press on your immediate and serious consideration. Why should we continue to suicidally furnish the means of our own destruction? Without us, war must cease; for without us standing armies could not exist. It is out of our class that they are formed. Moreover, without our labour the turreted war-ship and the rifled cannon, the needle-gun, the Chassepot, the mitrailleuse, and every other murderous instrument that the perverse ingenuity of man has invented for the annihilation of his race, could neither be fabricated nor made available for their sanguinary purposes. Surely it is time, then, for us to show our power, to prove ourselves a self-preserving power, and also a power for the happiness and blessing of all our fellow-men. We have no wish, whatever may be our individual sympathies, to side with either party in this lamentable war. The working men of Germany, the working men of France, are equally our brethren. It matters not to us, and we verily believe it matters as little to them, who is the prince or person selected by the Spaniards—if they cannot do without a king—to nominally rule over them. What concerns us—what we see and feel is in the enormity that, upon any such a pretext, or for any real or imagined affront, which the arbitration of a few honest and impartial men would honourably adjust in an hour, hundreds of thousands of human beings should be arrayed against each other in mortal combat, about to steep the fields of France and Germany in their life-blood, and myriads of happy homes be plunged into measureless misery and woe. The prospect is one that only fiends could contemplate without horror!"

Perhaps we could not select a more emphatic condemnation of the present war than the one uttered by M. Ollivier, May 16, 1868, in the French Chamber:—"War (he said) many persons think necessary, and that there is a question of honour to be settled between France and Germany. This is said, written, propagated—but, according to me, war would be a disaster. I do not speak in the name of fraternity, in the name of those sentiments which have nothing to do with politics—I speak in the name of interests. Experience has confirmed the saying of Montesquieu, 'Men of war have been the ruin of Europe.' War has never done anything, never settled anything. In vain you will be victorious, in vain repulse Germany and conquer the Rhine; after victory you will be able to disarm less easily than before the war. You will be obliged to augment your armies, and the public uneasiness will not cease. War is therefore, according to me, a solution impracticable, wicked—an empiricism. The true solution is peace, peace with disarmament, peace with liberty; that liberty without which peace is neither glorious nor sure." These words were uttered about two years since, and strange to say M. Ollivier is one of the prime agents of the war.

Mr. Gladstone, at the Mansion House, did not speak in exaggerated language when he said:—"In the name of wounded humanity, in the name of grieving civilization, in the name of our religion, afflicted with what it witnesses, I do record that nothing more deplorable, nothing more dismal has marked, perhaps, the history of mankind, and certainly the history of mankind in our time, than this, splendid indeed it may be, but awful spectacle, in which nations of the highest civilization, with institutions the most perfectly developed, with celebrity established in every department of history, with the first positions of the civilized world to which it is possible for any nation to attain, are pushing on their troops by hundreds of thousands, and almost by millions, for deadly conflict, for causes which is it very difficult to appreciate."

The words spoken by Mr. Disraeli in the House of Commons, a few hours after the first sad news reached this country, may form a fitting conclusion to this protest against a wicked and gigantic war:—"I hear, sir, superficial remarks made about military surprises, the capture of capitals, and the brilliancy and celerity with which results which are not expected or contemplated may be brought about at this moment. Sir, these are events of a bygone age. In the last century such melodramatic catastrophes were frequent and effective; we live in an age animated by a very different spirit. I think a great country like France and a great country like Prussia cannot be ultimately affected by such results; and the sovereign who trusts to them will find at the moment of action that he has to encounter, wherever he may be placed, a greater and more powerful force than any military array—and that is the outraged opinion of an enlightened world."

ELECTRICITY—ITS THEORY, SOURCES, AND APPLICATION.

By J. T. Sprague.[*]

(*Continued from page* 388.)

147. Peroxide of Manganese Battery.—Various peroxides have been employed to surround the negative plate and furnish the oxygen. Peroxide of iron has been frequently suggested mainly on account of its cheapness and commonness—common rust, hematite ores powdered, red ochre, all may be used, and will answer; but a little consideration of the following remarks will show that no sort of advantage is to be gained by the use of iron oxide instead of the peroxide of manganese, because it has all the objections of the latter with no kind of superiority; and, under the circumstances, cheapness is so very small a matter as to be quite out of consideration. Peroxide of lead, however, possesses real advantages in that its electro-motive force is very high, and consequently a battery in which this is used gives the greatest "intensity" of any known form. Its expense, however, is considerable, and so is its trouble, and I will not take up space by further reference to it.

In point of fact the peroxide of manganese is the only one of these substances practically useful. Its employment was first suggested by De la Rive, many years ago, but the difficulties which soon present themselves to those who use it have prevented it coming into common use; on the other hand, it has many good qualities, which have led recently to its quiet appropriation by several trading makers, and it has actually been patented under the name of the "Leclanchè" cell. For cases requiring a large current—as in plating—or for magnets or coils, it is absolutely useless; for a small occasional current, on the other hand, as for ringing bells, household signals, &c., it is one of the most useful forms; though the statement made by sellers that the cell is calculated to work for "three years" is, of course, pure nonsense. Like every other form it can yield a current equivalent only to the quantity of material used in it, which will be exhausted in a greater or less time according to the work done; and this depends upon two things—the quantity of the excitant and the quantity of the manganese.

148. The peroxide of manganese, otherwise binoxide, is, on the atomic notation, $MnO_2 = 87$; two of these atoms enter into the reaction producing Mn_2O_3 sesquioxide of manganese, and O one atom of oxygen; and hence, as this oxygen is 16, while the equivalent or our electric unit is 8, it follows that the atom of peroxide is also the unit, as 87 of it by weight yields this 8 of oxygen; but this is the pure substance, while the commercial manganese contains often a large per centage of impurity. In addition to this, as no solution occurs, the action takes place only on the surface of the particles into which the material is divided, and hence a considerable portion may escape action; it is therefore impossible to fix upon any quantity as the electric unit; it may range from 100 to 200 grains or more. The peroxide is a good conductor; the resulting sesquioxide is not a conductor, and the same is the case with the corresponding lead oxides—hence the action tends to diminish; and a main object must be to spread the material in as thin a film as possible over a large area of conducting surface. This is most readily accomplished by crushing carbon into various sizes, from a pea down, sifting out the larger and packing them tightly in a porous jar, in layers, so that the particles are in firm contact among themselves, and with a plate or bar of carbon, which forms the main plate or conductor; the very fine particles should also be sifted out and ground to an impalpable powder, with two or three times their bulk of the manganese, then mixed with the intermediate pieces and sifted into the spaces left between the larger pieces till a tolerably compact mass is formed. When the liquid soaks into this and the action is set up, a very large area is thus exposed, which compensates for the inherent slowness of the action itself, and reduces the internal resistance.

A very small surface of zinc is sufficient, and it generally is one or two small cast rods or rolled strips suspended in the outer vessel.

149.—The Excitant.—Either common salt or sal ammoniac are usually employed, though others will answer. It may at first sight seem difficult to say why sal ammoniac at 6d. per lb. should be used if common salt at 3lb. per penny will answer; but as a couple of ounces of the chloride of ammonium will charge a cell, such as the ordinary Leclanché, and do the amount of work for which alone it is properly fitted for several months, the question of economy dwindles to a very small matter against the higher electromotive force the ammonium chloride gives over that furnished by the sodium chloride. The reason for this higher electro-motive force is, that soda displaces ammonia from its salts, and, of course, in doing so loses force; therefore, when both are decomposed the sodium salt has less to yield. In the one case, caustic soda is generated within the porous cell; in the other, ammonia is set free and given off.

As these salts are so largely used in electrical operations, it may be useful to give complete information as to their solutions. Ammonium chloride, NH_4Cl. = 53·5, or, allowing for impurities, the unit is 55 grains, being 127 units per lb., and at 6d., the cost per unit is ·0472 of a penny. Its solubility varies according to temperature. My own experiments, which agree with figures given by various authors, made 1,000 fluid grains of a solution saturated at 62° Fahr. weigh 1,076 grains, and contain 288 grains chloride, or 5·24 units. Sodium chloride, $NaCl$. = 58·5, or, commercially, its unit is 59, giving 119 to the lb., and its cost per unit ·0028 of a penny. Unlike most salts, its solubility varies very little with temperature; at 62° its specific gravity is 1·208, the contents of 1,000 fluid grains, 322 grains, or 5·46 units. Its solution is, therefore, somewhat stronger than that of the ammonium salt, and still more so in cold weather.

As the action produces zinc chloride, and this has a tendency to form double salts with alkaline chlorides, a deposit of crystals of these is soon found to form on the porous cell, and still more freely on the zinc surface, obstructing the action

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[*] Sigma.

It is, therefore, desirable occasionally to remove these by soaking in pure water.

150. Experimenting with a Leclanché cell, which I purchased as about the best type of this form, it gave at first 43°, falling to 30° in ten minutes, and 23° in one hour. Connecting again after several days rest it gave 30°, falling to 20° in ten minutes; and, after several weeks doing no work but these tests, it gives 20°. Its charge was about 5,000 grains of solution of ammonium chloride, being about 3¼oz. of the salt, or 25 units, of which probably only about ten would be effective, the rest being wasted by forming the double salt; and certainly all the work the cell has done would not exceed 2 units; on the other hand, two of these cells would have the same electro-motive force as three Daniels'.

151. **Sulphate of Lead Battery.**—In this we leave the principle of supplying oxygen at the negative plate, but we have an insoluble matter there. It has several forms. Originally the porous cell was filled up with the sulphate surrounding a metallic plate or rod; a patented modification consists of a stout copper wire, to which are fixed several saucers, also of copper, tinned, for holding the metallic salt and preventing its solidifying in the porous cell, so that it may readily be replaced. This is, no doubt, a great improvement, though it is very doubtful whether the sulphate of lead battery is worth improving, notwithstanding that many simply practical people highly approve of it. Its defects will easily be seen on a little consideration. The electro-motive force is low; the cell is usually worked with common salt for the solution, and in this sulphate of lead is to some considerable extent soluble, hence lead finds its way to the zinc plate and sets up local action. Then the action is expensive; sulphate of lead $Pb\,S\,O_4$ has an atomic weight of 303, half of which is the equivalent, but as the commercial article is usually very impure, the unit cannot be taken at less than 159, which is about equivalent to the work I have found it to do. This gives 44 units to the pound, and a cost per unit of ·1364 of a penny, and hence the cost of working this cell is—

1 unit of zinc at 7d. per lb. ..	·0330
1 ,, sulphate of lead......	·1364
2 ,, salt, as before........	·0056
	·1750

and if we only add 5 per cent. by local action, which is below the truth, we have the cost per unit ·1838 of a penny, but as in actual working a large portion of the sulphate of lead would probably be left undecomposed, this would be greatly exceeded, making the cell one of the most costly to work.

The cell has the merit of very fair constancy, and yields a large current for some time, so that for some purposes it would be very useful. One of the patent cells gave me at first, on short circuit 48°, rising in an hour to 52°, at which it remained for four hours; for some days after I used it in electroplating, after which it gave 37°. and as it was worked fell to 20°. The porous cell becomes clogged with a brown deposit due to the lead, but which is removed by nitric acid, and the sulphate in the saucers swells considerably, so that they should not be filled too full.

152.—The chemical reaction which occurs in the sulphate of lead battery is very complicated, and entirely different from what might be expected. It would naturally be supposed to be similar to that of the Daniel; that the sulphuric radical of the salt would be transferred to the zinc and metallic lead deposited. The action is altogether different; the chloride of sodium is polarized and broken up, the chlorine uniting with the zinc, and the sodium set free at the negative plate. Where there is in actual contact with this plate a particle of lead sulphate, this is decomposed, and the expected action takes place, lead being set free and sulphate of soda formed; but a large part of the negative plate is not in this intimate molecular contact with the lead salt, and the nascent sodium appears to be actually set free so far as to decompose the water, and at the same time some of the neighbouring lead salt for hydrogen gas is set free to a small extent, which causes the swelling of the sulphate, which is partly reduced to sulphide instead of metal, and a considerable quantity of sulphide of sodium is also produced. The relative proportions of these actions depend apparently on the rate of the action, and I think that the slower this is the more is the salt reduced to pure metal.

It may be observed that if this battery were largely used the residuary product might be reformed into the sulphate by acting on it with a cheap nitric acid, which would generate sulphate of lead from the sulphide direct, and the nitrate of lead formed would be precipitated as sulphate by sulphuric acid. A white powder is also formed from the zinc, which might be available as a paint.

153.—**The Sulphate of Mercury Cell.**—This, which is called from its inventor, the Marie Davy Cell, is of use only in circumstances requiring a small intermittent current of great force; thus, as it gives no trouble, requires no care, and gives off no unpleasant fumes, it is very useful for domestic telegraphs, &c., but it is quite useless for employments requiring large quantity. Originally, it consisted of a porous cell, with a rod of carbon packed with the mercury salt; then the porous cell was abandoned, and a peculiar arrangement employed, in which the carbon was at the bottom of the vessel; but now it is usually a simple zinc and carbon pair, the latter of which extends to the bottom of the vessel and dips into a mass of the sulphate. The vessel is then charged with water, which dissolves a small portion of the salt slowly, and this sustains the action, the acid radical acting on the zinc, the mercury depositing on the carbon from which it falls, and collects as metal at the bottom. The action can, therefore, only be sustained at the slow rate at which the salt enters into solution.

There are two sulphates of mercury. The proper one is what used to be called the bisulphate, now the mercuric sulphate $Hg\,SO_4$, with the atomic weight 296. It is obtained by heating in an evaporating dish two parts by weight of mercury with five to six of the strongest sulphuric acid until only a dry white powder is left. This is the required salt, which hot water turns into the yellow "turpith mineral," and which does not actually dissolve unchanged, but forms an acid salt with the water. The equivalent is half the atomic weight, or allowing for impurities 150 or 45·66 units per pound, which at 3s. 4d. per pound is ·8750 of a penny per unit. The cost of working is thus very high, but it is reduced partially by the mercury recovered, and for the special purposes for which alone the cell is useful; this is of little consequence, being compensated by the steadiness and convenience of the cell.

154.—There are various other forms of battery—many useless—some, such as Grove's gas battery, highly interesting from a theoretical point of view; others, like the chloride of silver form, very powerful, but not of general use; though this latter, where the material could be obtained for about the value of the silver it contains (as might be at some of the refineries) would be really a valuable and economical cell. But I have now dealt with all the forms I can remember of any general interest and practical value, and therefore conclude this part of the subject, but with the intention of soon describing a new form which I am experimenting upon. In the next paper the subject of measurement and galvanometers will be dealt with.

COMETS AND METEORS.

By Richard A. Proctor, B.A., F.R.A.S.

Author of "Other Worlds than Ours," &c., &c.

(*Continued from page* 435.)

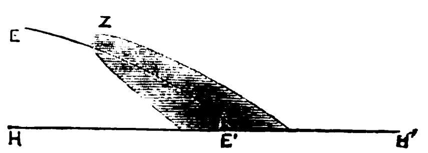
If we are led by the consideration of meteors and comets to a satisfactory interpretation of the zodiacal light, we may be well satisfied with the results of our researches, for there is scarcely a single problem in the whole range of astronomy which presents so many difficulties as this one.

Let me draw a distinction here between two very different classes of problems presented to the astronomer. To determine the physical characteristics of a certain order of celestial objects may be a problem which overtaxes man's highest powers, whether of observation or of reasoning; but nearly all questions connected with the position or motions of celestial objects seem only to require the fulfilment of certain conditions in order that we may resolve them quite satisfactorily. Those conditions are mainly a certain relative proximity of the object in question, and certain motions, either on its part or on our own, by which we may be enabled to see it in different directions and so estimate its position.

Now the zodiacal light, if we regarded its physical constitution, might prove too difficult a problem for us to solve. But regarded simply as a celestial object, whose figure and position we wish to determine, the zodiacal light seems at first sight precisely such an object as we might hope to deal with most satisfactorily. It is undoubtedly within manageable limits of distance. It is often very clearly visible. We can view it from varying stations, at different seasons, and so on. Yet, despite all these advantageous circumstances, the zodiacal light has undoubtedly proved a *crux* to astronomers. Its peculiarities have been such as to lead to the promulgation of quite discordant theories; nor can it be said that any theory hitherto put forward (so far as I know) accounts for all the peculiarities of this phenomena.

I hope, however, to be able to show that the results we have been considering lead to a complete solution of all the geometrical difficulties (if we may so speak), presented by the zodiacal light. I proceed to consider what those difficulties are; in other words, to give an account of the principal phenomena presented by the zodiacal light. Let it be carefully remembered that a theory to be admissible must give an account of *all* the phenomena; or, at least, not be definitely opposed by a single phenomenon. On this account our very difficulties may be of service to us, by enabling us to reject theories which otherwise it would perplex us to choose among.

Speaking generally, the zodiacal light may be described as a faint tongue of light, visible above the horizon after sunset and before sunrise, and extending *as if from the concealed sun* along the neighbourhood of the ecliptic. The figure shows roughly what is the usual aspect of the light, H H′ being the horizon, E E′ the eclipse, S the hidden sun, and Z the vertex of the zodiacal light. But as the position of the ecliptic is continually changing on our skies, the position of the zodiacal light changes with it. It is most favourably seen, of course, when the ecliptic—shortly after sunset or shortly before sunrise—is inclined at the greatest possible angle to the horizon. The former case happens in February and March, the latter in October and November. Hence the zodiacal light can be seen most favourably in the evening hours of spring and in the morning hours of autumn.



In places near the equator the zodiacal light can be seen all the year round, both in the evening and in the morning hours, because there the ecliptic is always much more nearly vertical than with us; and besides, the twilights are shorter.

Wherever the zodiacal light can be seen at all—or within latitudes some 65 degrees north and south of the equator—it affects in this way the neighbourhood of the ecliptic; it sets as regularly as a celestial object in the evening and rises as regularly as a celestial object in the morning; so that we might be disposed to conclude at once that it is no mere terrestrial phenomenon, were it not for certain peculiarities presented at times by this object. Indeed, as will be seen presently, the evidence is far too strong for any serious question as to the cosmical character of the light; but there is yet good reason for feeling doubtful where and what it actually is.

In the first place the extent of the light arises from time to time. Sometimes its vertex lies but 70° or so from the place of the sun, at others it actually exceeds 90° or even 100° from him. When it is remembered that no object travelling within the earth's orbit, as Mercury and Venus do, could ever appear so far from the sun as 90°, the significance of such an extension of the zodiacal light will be seen at once.

Then, again, the brightness of the zodiacal light is not constant. At times, for example, it is very difficult in our latitudes to see the light at all, even on clear evenings or mornings and at the proper seasons; at other times no one can possibly fail to recognise the light when once its position has been pointed out; while occasionally the light has been so brilliant that it has been mistaken for the tail of a vast comet. This happened in March, 1843, during the visit of the great comet of that year, when many persons took the zodiacal light for that amazing object. It is doubtless to a temporary increase of brightness of this sort that the phenomenon described by Nicephoras, in the following terms, must be ascribed:—"There as seen at that time," he says, referring to the ear of Rome's capture by Alaric, "above the oncealed sun, a strange cone-shaped light, mis-ken by the ignorant for a comet, but without a ead. It was a sort of flame, self-luminous, like lamp, and giving a light altogether different from ar light. . . . . The place and motions of this ject changed. At first it was where the sun ses in spring; then it extended along that part the zodiac which lies opposite the last star of e Bear, its vertex lying westwards. When it d travelled for more than four months along e zodiac it disappeared. Sometimes its vertex as sharper, giving it a lengthened form; then it came shorter again, &c."

Further, the position of the zodiacal light has en found to vary, and that in a manner far too arked to be referred to such variations as charac-rize the position of planetary orbits. Thus, st March, Captain Noble observed the zodiacal ght to be inclined at a considerable angle to the liptic, its axis seeming, on a rough estimate, to e inclined some 20° to that circle.

Lastly, it has been asserted that the zodiacal ight can be seen at certain seasons, in tropical untries, on both sides of the heavens at once, n other words, that before the evening glow in he west has disappeared the morning glow in he east has come into view. Professor Smyth, the Astronomer Royal for Scotland, found this certainly not to be the case when he observed the zodiacal light under exceptionally favourable circumstances at Teneriffe; but it may be admitted as at least possible (considering what we have already seen of the variable extension of the light), that occasionally the zodiacal light may be thus visible at opposite sides of the horizon. Nay, the astronomer Liais asserts that the zodiacal light sometimes spans the whole sky from horizon to horizon. Although this has been regarded as incredible, yet I can see no reason why so very definite an assertion respecting the zodiacal light should be rejected; and though I would not care to found a theory upon it, I should be inclined to look with suspicion on a theory which did not serve to explain the observation.

Now let us consider what these peculiarities — those at least which are beyond all question—require from us in theorizing respecting the zodiacal light.

The brightest part of the light is seen, whether in the morning or evening, precisely under the same circumstances as the inferior planets, Venus and Mercury; and, undoubtedly, if a multitude of minute planets travelled between the orbits of those planets, we should recognise the diffused light reflected to us by such bodies in precisely those regions, and under precisely those circumstances, in which we see the bright part of the zodiacal light. It needs only an extension of this to the case of a disc of small bodies travelling within the orbit of the earth, or in places extending slightly beyond it, to account for the general aspect of the zodiacal light.

But then we fall immediately into difficulties. A disc, such as we have supposed, would occupy a position (regarding it as a whole) as constant as that of the Saturnian rings, or even more so. We have seen that the zodiacal light shifts very markedly. We cannot conceive the components of this disc as distributed otherwise than with a certain general uniformity. So distributed, the light they would send us would vary little. We have seen that the light of the zodiacal light varies in a very remarkable manner. Nor could such a disc expand or contract to any considerable extent, assuming, as we are bound to do, that its constituents travelled according to the laws of gravity around the sun. But we have seen that the extension of the zodiacal light is very variable.

The difficulties are not diminished by the supposition that instead of a disc the zodiacal light represents a ring of small bodies, as Humboldt imagined.

Accordingly, some astronomers (Heis first, I believe) have suggested that the zodiacal light may be due to a ring of bodies round the earth; for some of the observations made upon the object, seem to correspond to this arrangement. It is clear that the earth's shadow would hide the parts of such a ring lying opposite to the sun, and so the visibility of the ring after sunset in the west, and before sunrise in the east, would be accounted for.

But then we fall into fresh difficulties. If this ring is tolerably close to the earth its apparent position ought to be affected by a difference in the position of the observer; yet if we put the ring far off—say as far as the moon—we ought always to see the light on opposite sides of the heavens at midnight, precisely as we see the moon in all parts of her orbit, except when just in that small circular region where the earth's shadow falls across that orbit.

Nor are the variations of the light at all better explained by this theory than the former.

Then there remains another theory, according to which the zodiacal light is a phenomenon of the earth's atmosphere, and self-luminous. For instance, electrical discharges, excited as in the case of the aurora, have been adduced in explanation of the phenomenon. Such a theory accounts very well for the variations observed in the zodiacal light, but not at all for the constant features of the gleam. The particular region of air which would need to be illuminated, in order that the zodiacal light seen at any one station, might be accounted for, would be overhead as regards places not many hundreds of miles distant, and so people at such places should see the light vertically above them; whereas, at those very places the zodiacal light is actually seen situated very much as at the first station. Again, if at any one station the evening aspect of the zodiacal light were thus accounted for, at other stations this illuminated air would be due north; at others, due south; at others again, due east; yet all these stations would lie within such limits of distance that, according to what we know of the zodiacal light, the gleam lies actually towards the west *for all of them*. Yet again, considering only one station, we can perceive no reason why the illuminated air should have the particular tongue-figure necessary to account for the aspect of the zodiacal light, why it should set in the west—or rise in the east—like a celestial body, why it should follow the varying position of the ecliptic, and so on. We are compelled to abandon this theory, then, like the rest.

But there the object **is**; its light comes from some region or other; the relations it presents are very definite. We must not suffer ourselves to be defeated in an inquiry of this sort. Let us go over the ground again, and see whether any one of our theories, though not acceptable in itself, may not suggest a theory which will meet all the requirements of the case.

We turn to the terrestrial theory, and find no hope in that. We consider the theory that the zodiacal light is due to a ring surrounding the earth at a greater or less distance, and we are forced to admit that no shape or dimensions which we can give to the ring will suffice to account for the peculiarities and variations of the object. In fact, we find new objections the more carefully we consider this theory; it leaves the symmetrical figure, the systematic rising and setting, the changes of apparent position with longitude in the course of the year, wholly unaccounted for.

Thus we become tolerably confident that it is to some modification of the first theory, according to which the zodiacal light consists of bodies moving around the sun, that we are to look for the solution of our difficulties.

A set of bodies travelling in nearly circular orbits around the sun and within the earth's orbit, failed so totally to explain the peculiarities of the zodiacal light, that though forced to look to that particular region of space for the bodies really causing the light, we are compelled to abandon the theory that those bodies can travel nearly in circular orbits. But if these bodies travel in eccentric orbits, lying yet completely in the sun's neighbourhood (by which I mean, not travelling much further away than the earth's orbit) we have by no means got over our difficulties. Since according to this view the same set of bodies goes always to the formation of the zodiacal light, and since those bodies travel in a short period round the sun, we should have the zodiacal light nearly constant in brightness; and whatever variations there were would take place in short periods. There would be nothing to account for any of the three marked forms of variation considered above; either the variation of brilliancy, and especially the sudden access of brilliancy at certain widely separated seasons, or the change in the apparent position of the light, or the remarkable variation in its extension from the sun's place.

If we give to the constituents of the disc of bodies eccentric orbits of far wider range, we seem to recognize a way—though at first sight not a very easy way—out of our difficulties. Anyhow, we may somewhat hopefully regard this new view, since it appears to be absolutely the only one left us to deal with. As there must be some solution of the problem, and, as every other conceivable solution has failed us, we have *a priori* reasons for feeling confident that now at last we are on the right track.

To begin with, we need no longer speak of the bodies as hypothetical, since we have already seen that the space within the earth's orbit *must* be occupied with bodies whose paths carry them far out into space—some of them even beyond the orbits of Uranus and Neptune. Whether these bodies be comets, or meteors, or associated systems of comets and meteors, we have at least the material we require.

But, also, we no longer have to account for variations as a difficulty, but to look for them as a natural consequence of our theory. We have seen that there must be a continual flux in the condition of the more richly aggregated part of the family of meteoric and cometic systems regarded as a whole. Even such an observation as Captain Noble's—exceptional as it doubtless is—would be fully explained if we regarded it as due to the simultaneous arrival of the richer parts of three or four meteoric systems (or even of one very rich one), inclined about twenty degrees to their ecliptic. There is nothing in the inclination, in the degree of richness involved, or in the concurrence of three or four such arrivals, which is in any way contrary to what we already know of the nature of meteoric systems.

Yet once more,—this theory accounts for even those remarkable observations according to which the zodiacal light has been seen in the east and west at the same time—and if Liais is to be believed, right athwart the heavens, from the eastern to the western horizon. Just as a multitude of minute bodies within the orbit of Venus accounts for the appearance of the zodiacal light in those parts of the heavens where Venus is seen, so the existence of a multitude of bodies within the orbit of Mars would account for the appearance of the zodiacal light along the whole of that arch where Mars travels on the heavens. Undoubtedly it would only be as a very exceptional thing that the meteors would be seen out there, for their general sparseness of distribution outside the earth's orbit (as proved in the preceding papers), and their faint illumination there, owing to increase of distance from the sun, would cause this diffused light to be ordinarily invisible to us, and always exceedingly faint. But from time to time the arrival of the richer parts of several meteoric systems, suitably placed, might be expected to be discernible in tropical latitudes by light such as Liais saw across the southern sky

I have hitherto omitted all reference to what the spectroscope has taught us respecting the zodiacal light. Angstrom's observations that this light gives a speculum of bright lines, corresponding in position to those of the aurora spectrum, may seem at first sight fatal to the theory above enumerated—which would be very awkward, for there remains, as I have said, no other theory to consider. But it must not be forgotten, that nearly the whole light of the zodiacal light might be reflected solar light, and yet its spectrum only show the lines above mentioned; for light collected into a few lines (in this case three) may be discernible where twenty times as much light dispersed into the rainbow-tinted streak, forming the solar spectrum, would be wholly unrecognizable. Now, it is worthy of notice, that one of the lines in the auroral spectrum corresponds to an iron line; and the only way in which we can understand the presence of iron in the upper reigons of our air, is by referring it to the continual arrival of meteoric matter. This being so, electrical discharges, excited by the sun's action, and taking place between the constituents of the zodiacal light, would quite as well account for the bright lines in the zodiacal spectrum as the discharges excited by the earth's much fainter action account for the lines indicating the presence of corresponding meteoric material in the upper regions of our own atmosphere.

If the American astronomers are right in saying that the same lines appear in the spectrum of the corona, we arrive by an independent process at the conclusion involved in the above interpretation of the zodiacal light as compared with what has been already established about the corona, viz., that the corona is simply the richer part of the zodiacal light.

Thus comets and meteor-systems, the zodiacal light, the corona, and the aurora, have been brought into close association. If these views are elucidated by future observations, a series of hitherto perplexing phenomena will be simultaneously interpreted.

Here, for the present, I take leave of the subject; but at some future time I hope to return to it. I have so far looked at only one aspect of this many-sided subject; there are others as well worth studying, and associated no less intimately with the economy of the solar system.

THE END.

THE WORLD: ITS FORMATION AND ANTIQUITY.

By ARTHUR UNDERHILL.

(*Continued from page* 436).

CHAPTER VI.

ABOVE the metamorphic or primary series lie the secondary formations, and in the lowest system of this group first occur those important aids to geology—fossils, or animal and vegetable remains.

This class is divided into seven systems, viz. (taking them in order of superposition and commencing with the lowest), (1) the Cambrian; (2) the Silurian; (3) the Devonian, or old red sandstone; (4) the Carboniferous; (5) the Permian, or lower new red sandstone; (6) the Triassic, or upper new red sandstone; (7) the Oolitic, or Jurassic; and (8) the Chalk, or Cretaceous systems.

The first five of these groups are termed the *Palæozoic* systems (*palæos*, ancient; *zoos*, life), because they contain the remains of life in forms totally different to any existing at the present period.

Since it will be necessary in this and the future portions of my treatise to use certain technical terms in relation to the fossil remains of present and bygone races of beings who have peopled the earth, I think that at this stage a little digression for the purpose of explanation would be advantageous, and I therefore entreat my readers to carefully commit to memory the following list of the different genera of animals:—

VERTEBRATA (having a backbone) are divided into four orders—viz.: 1. MAMMIFERS (or such as suckle their young), examples, man, dog, horse, &c.; 2. BIRDS; 3. REPTILES; 4. FISHES.

ANNULATA (ornamented with a ring) are split up into six orders—viz., 1. INSECTS—examples, bee, flies, &c.—2. MYRIAPODS (thousand footed); examples—centipede, millepede, &c. 3. ARACHNIDES (spiders); examples—spider, scorpion, vermin, &c. 4. CRUSTACEA (shell coated); examples—crab, lobster, &c. 5. CIRRHIPEDS (hair footed); examples—the anatissa—certain beings which cling to the bottoms of ships. 6. ANNELIDES (little-ringed); example—the common earthworm.

MOLLUSCA (flabby or jelly-like) are divided into five orders—viz., 1. CEPHALOPODS (head-footed); examples—nautilus, cuttlefish, &c. 2. GASTEROPODS (belly-footed); example — black-snail. 3. BRACHIOPODS (arm-footed). 4. CONCHIFERA (shell-bearing). 5. ACEPHALA (headless); example—oyster.

RADIATA are divided into three orders—viz., 1. BRYOZOA (sea-weed life). 2. ECHINODERMATA (spiny-skinned); example—star-fish, &c. 3. POLYPARIA; example—coral zoophyte.

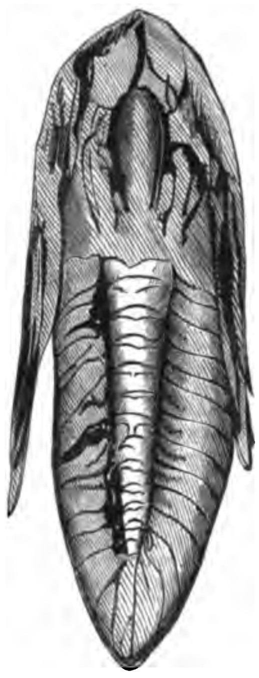
PROTOZOA (first life) are of a threefold order—viz., 1. FORAMINIFERA (having an aperture) so termed because the air-shell is divided into partitions, each of which is united with the succeeding one by a small aperture. 2. AMORPHOZOA (mis-shapen life); example—sponge, &c. 3. INFUSORIA (existing in infusion) infinitely minute animalcules, 40,000 of which would but fill a cubic inch.

Having now described the classification of the animal world, I will again resume the description of the secondary formation. Pursuing my former method I shall commence with the Cambrian system, which lies immediately above the clay slate. It is principally composed of slates, schists, and limestones, and is met with mostly in Wales and the northern counties of England. At the period of the formation of this system it is evident from the fossil remains that the temperature was far greater than that which prevails on any portion of the globe at the present time. Too torrid for terrestrial vegetation or animal organization, life was confined to the cooler habitation of the sea; *it*, however, swarmed with lowly organisms and plants whose remains we now find deep buried in their stony vaults.

The strata of this group are of considerable thickness, occasionally attaining that of 20,000ft., and it must therefore have taken a long period for its deposition. The system is of extensive prevalence in Bohemia, Sweden, Russia, Canada, and New York State, and it therefore follows that such localities were subaqueous or submerged at the time of its formation. The fossils of this system are of a very low nature, such as seaweeds; specimens of *Radiata* called *Oldhamia radians*, a species of *Brachiopod* termed *Lingula* (Fig. 1), and *Trilobites*, which last deserve a somewhat longer description. Trilobites, then, were a species of the genus Crustacea. From Fig. 2 you will observe that their form is that of an oval divided into three divisions; they are supposed to have lived in the lowest depths of the ocean, and there to have existed on the molluscs which were not provided with a shelly armour. But the most remarkable portion of these beings is their eye, which, although minute in itself, would, even if composed like that of ordinary animals, be a wonderful piece of microscopic handiwork, is rendered infinitely more wonderful by the fact that it is made of over 400 separate eyes, so placed as to allow of vision in every direction at the same time. Such an organism proves that it was not by a series of experiments, beginning at the least complex, that the Creator formed the organic world; for there is infinitely more complexity and delicacy of design in a Trilobite's eye than in the gigantic limb of an elephant or a mastodon.

1

2



The scenery of the Cambrian system is very bold and bleak, its slaty strata being split into rugged peaks, whose precipitous sides render any attempt to gain their summits perfectly futile. The pass of Llanberis exemplifies this wild aspect most effectively, and fills the spectator with feelings of awe and admiration. The Cambrian system is rich in metals, supplying quantities of silver, iron, tin, and copoer ores, the getting of which affords employment to hundreds of miners. In the next chapter I shall enter upon the consideration of the Silurian system.

(*To be continued.*)

MICROSCOPICAL JOTTINGS IN TOWN AND COUNTRY.

No. V.

THE *foot* of the fly will well repay our careful study; for the foot proper, as distinguished from the leg, is furnished with a most elaborate arrangement for enabling the creature to ascend vertical and polished surfaces, or even to walk with its body downwards in apparent opposition to the force of gravity. The arrangement by which this is brought about consists of a pair of expansions with which each foot is furnished: around the edges of these expansions, called *pulvilli*, are ranged rows of minute discs (only visible by the aid of a high power), which seem to act as "suckers." The foot must be mounted in balsam. The rules laid down for the proboscis will apply.

The common spider is an interesting object to the microscopist. There is the foot, with its serrated claws; the spinnerets situate at the posterior extremity of the body, and usually six in number; the wonderful organs of vision—eight commonly, or six—either grouped together or ranged on the head, differing from the eye of the fly in being single; and last, but not least, the mouth, with its jaw and poison gland. T
may all be mounted in balsam.

Lepidoptera. —Wings mounted as op
Amongst common English species the *P*
natus alexis and the peacock are, perhap
most suitable. They should be laid nicely
slide with a shallow cell around them,
may be of card or thick paper, and covered
a thin glass square or circle. Scales from
wings are also very interesting as transpa
for moderately high power. From a F
kindly given me by a friend who [illegible]
Howden, I have secured some very [illegible]
dore scales that display their beaded [illegible]
beautifully under a ¼in. or ⅛in. *Fee*[illegible]
these are very beautiful. *Antennæ* al[illegible]—
The former are often very good, may be
mounted in balsam, and also as dry opa
Their respiratory system is simple and
study. *Honey Bees and Wasps.*—The
leg and foot of the bee is most interes[illegible]
stings of both bee and wasp are easily m
and are worthy careful observation. [illegible]
nicely mounted dry is good. *Caterp*[illegible]
interesting for their feet, their breath[illegible]
or spiracles, and their respiratory tubes
The creature may be dissected in water
a small pair of scissors, and the orga
being carefully washed, may be mounted
or in balsam. Amongst *Vertebrata* we
large field, and we cannot now do mo
glance at a few of the more prominent
Prick our fingers and we get blood—al
interesting object. From the cow we
milk and see its oil globules. From the
of any vertebrated animal we have hair to
in balsam for polariscope or ordinary
Hair, perhaps, requires more than a p
note. Take human hair; mount it in
after a good cleansing and a soaking in tu
tine, and then subject it to a thorough ex
nation with ¼in. or ⅛in. Its structure is
this :—Externally there are the [illegible]
flattened cells that form the *cortical* lay
next to this there is a peculiar fibrous sub
forming the principal portion of the sh
diffused through which is the colouring m
where that is present: and lastly, w
in the centre of the hair, the medull
stance or pith. So that our readers
that the hair-dresser's notion of the
that it is a quill—is wide of the mark, and
that a truer similitude would be [illegible] a twig
or rush.

From a joint of meat we may obtain muscular
fibre of great interest under a high power—say
at least, a good ¼in.—adipose or fatty tissue,
for sectionizing, yellow *and* white con
tissue, &c.

From fishes we can get scales. A piece
skin in balsam affords a magnificent po
object; and a fragment of sole-skin af
equally splendid opaque object for *lo*
Scales may be mounted dry for ordinary
nation, and in balsam for polariscope.
the most beautiful for the latter are sole
plaice.

Our readers will have noticed tha
ignored the existence of the vegetable
hitherto, although it has been in that
that my work has hitherto been done.
too late to touch upon the matter furth
point out a few directions in which
and amusement may be found, and tr
chances of life to afford me future occ
touching upon them in detail.

Pollen.—Easily obtained, and to be
dry in a cell just deep enough—tha
compositæ of mallows and passion fl
beautiful. The anthers may be moun
the pollen *in situ* for low power opaqu
—Sections mounted dry, and in fluid, or
for ordinary light or polariscope. *Le*
tions of), also hairs and scales—all very
ing and easy of collection and mounting
—Fronds in fructification as dry opaque
a series of several dozens, and have not
exhausted the store. Many of mine th
exotic.

I have now brought this rambling
herent series to a close, and pending th
ance of my papers on the microscop
should favour their publication—I will
editor and the readers of the MECHANI

H.

The Scott Foundry, at Reading, Pa., ha
the manufacture of a rifled cannon, which
is designed to throw a hundred-pound ball t

SCIENCE FOR THE YOUNG.[*]

By the Rev. E. Kernan, Clongowes College.

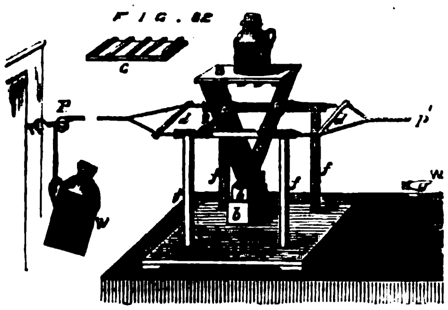
Application X.

Inclined Plane.

(Continued from page 418.)

THE only practical result of theory is that the finer the angle of the wedge (and of the inclined plane) the smaller will be the value of P, and consequently the better the effect of the wedge. This principle of the wedge can be illustrated, and some of the forces which it has to overcome shown, by the appliance in Fig. 82.[†] The wedge A is formed of two pieces of timber hinged at the edge below. They are kept asunder above by a plate of wood B. At different distances on the plate B are slips (shown apart, at C), which serve to keep open the wedge at different angles.

FIG. 82



From a roller at either side of the wedge passes a cord to a pulley, placed level with the rollers, and fastened as may be convenient; for instance, to the window and door trimmings of a room. The frame *f f* and base D with blocks *b b* are only to keep the wedge and rollers in position until the weights W W are hung upon the cords, and P placed upon the "back of the wedge." A convenient sort of weights for this apparatus are jars (see figure); they are in themselves heavy and can be well proportioned by water, which will also serve to increase their general weight. Thus prepared, a series of experiments may be exhibited with the apparatus.

Experiment I.—Fix the wedge at its smallest angle, make P (at a guess) somewhat heavier than shall be required for equilibrium, when the heavy weights W W are allowed to act. Let W W act. By "feeling" the wedge (raise it a little) it will appear whether P is, or not, too heavy. If it be too heavy remove some of the water (in P) until P shows no tendency to push the wedge down. One block *b* may now be removed (the second is left for fear of any accidental slip down of the wedge), equilibrium is completely established, and the great power of the wedge may be somewhat estimated by the difference of the weight P, and the sum of W W. This experiment will be more striking if the base with supporting frame be removed (drawn *down* from under the rollers); there is then nothing to meet the eye but the forces in equilibrated action.

Experiment II.—Restore block *b*, stop the action of W W (by any convenient method—a second cord, a block, &c., to each), remove P, and open the wedge (to next pair of slips) wider. Replace P, *hold it* on the "back" by additional weight or otherwise; allow W W to act. The weight of P in the first experiment is no longer able to command W W; the wedge is pushed up if the *holding* force on P be *diminished* still more; if it be *suddenly removed*, the wedge may be suddenly shot out from between the rollers. Should this exciting conclusion be intended, there must be some provision for saving the wedge, &c. from injury. The experiment may be continued by pouring water into P until the now broader wedge is in equilibrium. Remove P, open the wedge still wider, replace P, &c.; again the same action of W W as above. Thus is shown experimentally the great practical principle of the wedge, "that the smaller the angle the better the action."

Experiment III.—Make W W as heavy as the cords can safely bear, open the wedge wide, and place on its back a P sufficient for equilibrium. When W W are allowed to act, the strain on the cords (which will perhaps even render a musical note if made to vibrate) gives a good idea of the intense resistance of a body to the splitting action of a wedge. This "impression" of force, becomes *startling* by removing quickly the cap of the wedge; the two plates, A A, slap together with a violence which gives a most appreciable proof of the very great force that the wedge had resisted.

Wedge App. I.—Cutting Instruments.—As these are all wedges, single or double, they work better or worse as the practical principle is more or less observed. Therefore the finer the edge, *i.e.*, the *longer* the edge, the better. The limits of reducing the cutting angle must be ruled by the work to be done. The harder, tougher, &c., the material, the wider must be the limiting angle, for the wedge of the cutting instrument having to overcome a greater opposition requires more of its own particles in the line of action to bear against the increased resistance.

Wedge App. II.—The Arch.—This very important element of architecture, would require, to do it justice, knowledge beyond the present reach of the student; a good notion then of its principle of action must suffice. In general terms, therefore, it may be said to consist of a number of wedges so laid together, that the force from their own weight, and from any weight that may be superadded, is transferred *to*, and opposed *by*, an *infinite resistance*, or what in the possible circumstances is equivalent to an infinitive resistance. By *infinitive resistance* is to be understood a resistance capable of *permanently* arresting the action of the force under consideration. In regard of this force such a resistance is practically *infinite*.

The wedges which compose the arch A, Fig. 83, are called the *voussoirs*, *a a* . . . Of these the chief is the centre one, A, commonly called the key-stone. The voussoirs start at either side from what are called the *abutments*, B B. Now, supposing the materials capable of resisting as long as the weight of the voussoirs, *a a* . . .—and whatever weight may be added above—passes to the abutments, the arch is safe. But if the resultant of the forces pass outside the line of the abutments, the resultant *may* take effect—the arch may be burst *in*, *out*, or *up*—the voussoirs (the wedges) yielding as in No. II. of the wedge experiments. Fortunately this giving way is to a *certain extent* prevented by the surfaces of building materials. These surfaces within limits of certain angles will not slide one over the other. These "sliding angles" being well known enter into the calculation of the stability of a given arch, which, consequently, *may* still be safe though the forces (the pressures) act slightly along a line *not* passing to the abutment. In thus considering the arch as made up of wedges, it is clear that *l'* is not the wedge as a machine, but the reverse that is required. In the arch the wedges are to be in equilibrium such that motion be impossible.

Sub. App. II.—The Screw.—There is nothing in the essentials of an inclined plane which requires that its *direction* should be a straight line. It may, therefore, wind round it until the "height" and "point" are on the same perpendicular A B (Fig. 84).

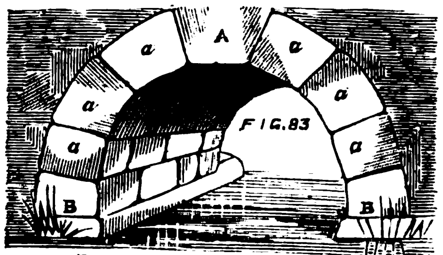
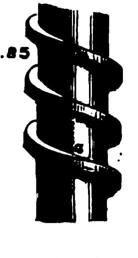


FIG. 83

FIG. 85



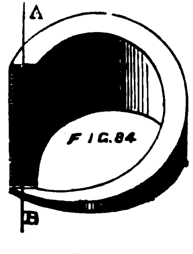
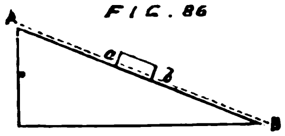


FIG. 84

The application of this principle will show *what a screw is*, or answer the first question regarding this "machine." Let an inclined plane be wound round a cylinder until the "height and point" meet as above. There is thus formed *one turn* of the screw. From the top of the "height" the same plane starts again, and winding, as before, produces the second *turn* of the screw. In the same way the 3rd, 4th, ... *n*th turn; in a word, the whole screw is constructed. It may then be described as a perpendicular series of inclined planes having the same "height and base" wound consecutively round a cylinder.

Two "essentials" of the inclined plane change their name in the screw (Fig. 85). The *height* is called the "*pitch*," *a a*, the distance between two turns; the *length* is called the "*thread*" or "*worm*" of the screw. The "base" has no special name in the screw, but is represented by the circumference of the cylinder on which the *thread* or *worm* is rolled. The action of the screw is that of the inclined plane. The force which it has to resist is frequently not that of gravitation; but the force, whatever it be, is always applied, as gravitation is applied on the inclined plane. The action of the resisting force is usually exerted by what is called a *nut*. This nut is a *hollow* inclined plane of the same *pitch* as the thread of the screw. As the nut covers usually two or more turns of the screw, the real action of the machine is concealed, and may be not clearly understood. All confusion will be removed by a return to the inclined plane (Fig. 86). Instead of the weight being placed upon a small space, *a b*, suppose it (the same weight) spread (see dotted line from A to B) over the whole length of the plane. Now such is the duty of the nut, it distributes the force over the whole surface of the plane.

FIG. 86



(To be continued.)

THE MITRAILLEUR.

THIS weapon, of which we have heard so much lately, is but an improvement of an old idea. In the Hotel de Cluny, at Paris, there is a carbine with several barrels constructed upon the principle of the revolver, which is said to have belonged to Charles IX. or Henry III. of France, but certainly dating from the period of the Massacre of St. Bartholomew. In a work on "Weapons of War," by M. Auguste Demmin, translated by Mr. C. C. Black, Assistant-Keeper of the South Kensington Museum, appears the following account of what is now called the Mitrailleur, or Mitrailleuse:—

> It is very difficult, in fact almost impossible, to classify exactly, according to the names then in use, all the different species of cannon, for very often the same piece was named differently in each large city. *L'orgue a serpentins*, which was a machine composed of a great number of guns of small bore, loaded either from the muzzle or at the breech, had each separate chamber encased as far as the muzzle in wood or metal; the chambers were fired in succession or all at once. In Germany they were called *Todtenorgel* (death-organ). Weigel, writing in 1698, says that in the arsenal at Nuremberg there were organs with thirty-three pipes to them, and that death might be said to play dance music on them. One of the earliest of these machines is in the museum at Sigmaringen. It was made at the beginning of the fifteenth century. It is loaded from the muzzle, and is composed of small upright iron cannons rudely mounted on what looks like the trunk of a tree, and moves on two round discs of wood for wheels. Another of these machines, termed *Orgue de danse Macabre*, copied in 1505 by Nicolaus Glockenthon from one of the arsenals of the Emperor Maximilian, is composed of forty square-shaped tubes firmly joined together and mounted on a stand with large wheels somewhat similar to the carriage of a field-piece. A third one, of the seventeenth century, consisting of forty-two barrels, mounted so as to form a triangular block, and to fire six successive volleys, is now in the museum at Soleure. From *Etudes sur l'Artillerie*, by Napoleon III., published in 1846, it will be seen that there were some of these machines which could fire 140 shots at once.

Similar weapons to these are, we believe, to be seen in the Tower, but they all lack the distinguishing characteristic of the Mitrailleur—rapidity of fire, or rather of continuous fire.

The Montigny (or "Christophi-Montigny") mitrailleur, now under trial in this country, is a Belgi[illegible] invention, and although similar to the Fren[illegible] weapon in construction, is supposed to be sup[illegible] it in mechanical detail. In appea[illegible] resembles an ordinary field-gun with a greatly enlarged breech-piece; but on looking at the muzzle, instead of a single bore, we find 37 holes, each about ¼in. in calibre. These holes appear as if bored into the solid gun, but in reality, 37 hexagonal steel barrels are fitted accurately together, and soldered into a thin external wrought-iron tube. This tube has a movable breech action, worked by means of a lever, and containing a spiral spring and striker for each barrel. The cartridges are placed in a movable steel breech-plate, having as many holes as there are barrels. This plate is introduced into its place at the breech, which is then closed and secured by the lever. By means of a handle resembling that of a barrel-organ, the 37 cartridges can be fired independently, and as slowly as may be desired; or by a rapid turn of the wrist, the whole number can be fired almost simultaneously, the time occupied being one second. The empty plate can be replaced by one ready filled in the space of five seconds; and a continuous fire, at the rate of ten discharges per minute maintained, being equal to 370 shots; and as each bullet weighs 600 grains, this gives something over 31lb. of lead per minute. The fire can be concentrated on one spot (the piece having but little recoil), or by means of a horizontal or mowing movement the flight of the bullets can be altered between each discharge, or during the discharge itself, so as to spread it over a wide front, somewhat in the manner of a fan. The mitrailleur is effective up to 1,000 yards. Its weight is only 400lb.; it is rifled on the Metford system. The bullet which is hardened, weighs 600 grains, and the charge of powder is 115 grains. The exact calibre is 5·34in., and the cartridge may be either Boxer or metallic, as preferred. The mean absolute deviation at a range of 500 yards is 31in.; mean angle of elevation 1' 24″. At 800 yards, the mean absolute deviation is 51in., and the elevation, 2° 5″, whilst at 1,000 yards, it is 2° 35″. The Gatling gun, in the possession of the Prussians, is a heavier weapon, and partakes more of the character of artillery. It contains ten barrels of a calibre sufficient to throw 1in. shot or shell to considerable distances. In the matter of loading and firing it is somewhat similar to the Montigny and the French mitrailleur. Whether these weapons will have the extraordinary effect expected of them remains to be seen. In certain positions, and under certain conditions, they will undoubtedly play a very important part in the needless war which is about to devastate a large portion of Europe.

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[*] All rights reserved.

[†] By a mistake of the engraver the diagram is not made sufficiently clear. The cords should pass to the roller farthest removed from it—that is, the cords from P should act on the right-hand roller as you look at the engraving, and the cords from P' act on the left-hand roller.

ORGANIC LIFE.

BY H. B. BAKER, M.D., of Wenona, Mich., U.S.

(*Continued from page* 464.)

THE BEGINNING OF LIFE. ITS LOWEST FORM, AND THE SIMPLEST ORGANISMS—(*continued*).

WE come now to still more complex compounds, the fats, consisting of *many* atoms of each of the three elements, carbon, hydrogen, and oxygen; the composition of one of them, stearin, being stated as $C_{114} H_{110} O_{13} + CHO$. Fats, as they exist in organisms, are, moreover, compound compounds compounded, for, in the higher organisms, they are made up of various proportions of oleine, stearin, and margarin, each of which is composed of a base and a fatty acid, as for instance, stearin consists of glycerine and stearic acid. There seems no limit, except the mathematical one, to the various proportions in which these fats may be combined. In some fats and oils, glycerine is replaced by other bases, and there are numerous volatile and other acids which are peculiar to fats from certain organisms.

From these facts we should expect just what we find, that the number and variety of different kinds of fats and oils are beyond computation. They are peculiar in each particular form of life in which they exist, although more than one may exist in the same organism, for they are sometimes peculiar to a particular tissue. That the oils from the various plants are peculiar to each will be appreciated when it is remembered that many of them are sold under the name of the plant from which they are derived; as rose, peppermint, olive, and castor oils. In animals, we know that the same is true; fat from the pig is lard; from the sheep and ox we have tallow, differing slightly in composition.

Most human fat contains a large proportion of margarin. As an example of different kinds of fat in different tissues of the same organism, we may mention the oil and spermaceti which are obtained from different portions of the whale.

The albuminous proximate principles have been considered still more complex compounds.

They have other elements in addition to the three before mentioned, and consist of carbon, hydrogen, oxygen, and nitrogen; some of them also contain sulphur and phosphorus in small but definite proportions.

As they exist in the various plants and animals, and in the different organic tissues, they are variously modified, although always definite compounds, and essentially the same in the same tissue of a given kind of organism.

The sap of plants, the blood of animals, and, in fact, each fluid and tissue of plants and animals, is a definite chemical compound, formed by combination of such definite proximate principles as we have been considering. As the proximate principles are peculiar to each organism, or, as is sometimes the case, to each tissue, the tissues formed by their combination are also peculiar, as, in many cases, proven by chemical analysis. The fluids and tissues, of which all organisms are composed, being definite chemical compounds peculiar to each kind of organism, *all organisms may be considered definite compounds, the composition being peculiar to each kind of organism.*

While this is in general terms true, it is not the whole truth; for, while these simple compounds, which consist of small proportions of only one or two elements are strongly marked, stable compounds, not easily destroyed, and capable of little if any modification, the more complex compounds, consisting of many atoms of several elements, are, on the contrary, more unstable, and capable of modification in various ways. The more complex the compound, the more easily modified, and the greater number of modifications possible, and consequently the more numerous the varieties, until, in those organisms which are extremely complex, no two individuals are precisely alike. Throughout their existence, they are also continually undergoing changes caused by surrounding forces acting upon their easily-modifiable tissues, and are not, therefore, precisely the same at any two periods of their existence. This is true of such an organized whole, considered as a compound, and also of the several tissues of which it is composed, they being definite compounds. In fact, the organism is changed by changing its tissues and fluids, and they by changing their proximate principles. Those tissues which are most complex are most easily modified, as well as capable of greater variability, as is seen by referring to the different tissues in the human body. The bones, teeth, and hair, being composed of a few small-atomed elements, are comparatively simple compounds, and are the most stable, resisting the surrounding forces long after the softer tissues have disappeared; they are also less susceptible of modification during life, as their rate of change is not so rapid; they, moreover, vary little in different bodies. The brain, on the other hand, is an extremely complex compound, formed by the union of complex, fatty, albuminous, and other compounds. After death, it is one of the first tissues to decay, and during life it is so easily modified as to be not precisely the same in any two individuals, or even in the same individual at two slightly separate periods of time. (The same is seen—although not as plainly—in another way when races of men are compared: those of the lower races have hair nearly alike, of one and the same colour, whereas, the higher-organized men of civilized races have hair of various shades. The brain, and consequently the shape of the heads, of highly-civilized races of men, varies more than among the uncivilized).

Beginning with the lower chemical compounds—alum and ammonia may be modified by substitution of one element for another, the former by addition and subtraction of water, &c. Sugar may be modified by addition or subtraction of the elements of water. The minute living things, seen under the microscope, which appear to be nothing more nor less than particles of albumen, may be really so, and still be (of several kinds, as albumen is known to be) variously modified, according to the organism from which it is derived. The complexity and consequent modifiability of organisms are very greatly increased as soon as any form of fat appears as a constituent. Oleine, being one of its simple forms, is itself composed of two lower compounds—glycerine and oleic acid—both quite complex. We find, under the microscope, great numbers of different organisms, which appear to be simply albuminous and oily matter variously modified. The addition of earthy matters, such as carbonate and phosphate of lime, furnishes other elements of variability, but not to such an extent as the addition of the larger-atomed elements, carbon, hydrogen, oxygen, and nitrogen. While there is probably only one kind of pure water, there are several kinds of starch, many kinds of sugar, immense numbers of albuminous compounds, and an innumerable variety of fats. The power of variability, being so rapidly multiplied by combination of compounds already variable, we can easily see that the variety of ways in which such variable compounds may be combined to form higher ones, will result in such number and variety as will be practically infinite. The human brain being one of these most complex compounds, it is easily modified by very slight experiences of force; and the variety of changes which may be effected in it, through action and reaction with its various surroundings, is beyond the power of one imagination to conceive—the imagination of one person being, as is believed, but the expression of changes possible to that one person's brain.

It seems important to fully comprehend that the phenomena attendant upon changes occuring in organisms, as results of their experience of the forces acting upon them, are dependent upon their structure, as regards matter and arrangement. Although this principle appears to be well understood in other sciences, it still seems necessary to dwell upon [illegible] here, for it has been so long and universally assumed that living organisms are endowed with a special supernatural power, vital force, or soul, communicated to them at their creation and departing from them at death, that the notion has become firmly fixed, and, although held without proof, difficult to displace without the strongest evidence, requiring for this purpose a more or less complete knowledge of the laws which govern or apply to changes of matter and force throughout the universe, and the phenomena attendant thereon. [illegible] well is the fact established, in chemistry, that a definite chemical compound always acts in the same manner under precisely similar conditions; when two substances are found that act differently under such conditions, and are found by analysis to be composed of the same elements in the same proportions, they are considered as having an arrangement of elements peculiar to each; and, in chemistry, this is, perhaps, the only satisfactory explanation possible. By reason of such different arrangement, they are essentially different compounds, as a stove is a different structure from a steam-engine, although made of the same material in the same proportions.

This reference to mechanical structures serves to remind us that in mechanics, also, it is well understood that function depends upon structure. The assumption of a vital force peculiar to each machine would be considered ridiculous by all who know how machines are constructed; and yet if a person could be supposed to exist having no knowledge of machines except their external appearance and visible movements, that person might *conclude that* some supernatural power impelled *them, and that*, when motion ceased, the soul *had left them dead*: the Chinaman's watch that "*died last night*" *illustrates* this in a manner. Biologists, physiologists, *and all* who most thoroughly understand the structure *and* function of organisms, must, it seems to me, believe that in them, as in all chemical compounds, and as in mechanical structures, function depends upon structure. Believing with Herbert Spencer, that "the doctrine that all organisms are built up of cells, or that cells are the elements out of which every tissue is developed, is but approximately true. There are living forms of which cellular structure cannot be asserted; and in living forms that are for the most part cellular, there are nevertheless certain portions which are not produced by the metamorphosis of cells." "(Principles of Biology, p. 10.)

We may, however, accept the evidence of the eminent physiologist, M. Virchow, on the subject of function as dependent upon structure, without altogether indorsing the cellular hypothesis which he so strongly advocates. "Life," says M. Virchow, "is the activity of the cell; its characteristics are those of the cell. A cell is a real body, composed of determined chemical substances, and constructed according to determined laws. Its activity varies with the substance which forms it and which it contains; its function varies, increases and diminishes, appears and disappears, with the change, the growth, and the diminution of the substance. But this matter does not differ in its elements from the inanimate matter of the inorganic kingdom, which, on the contrary, it constantly employs to perfect itself, and to which it returns after having accomplished its special duty. That which is really its own is the manner in which the matter is composed of, the peculiar grouping of the minutest particles of matter, and yet this grouping is not peculiar as to be in opposition to the dispositions and groupings which chemistry detects in inorganic bodies. That which seems to us peculiar is [illegible] kind of activity; the special functions of organic substance; and yet this activity and these functions do not differ from those which natural philosophy studies in the inorganic world.

"All the peculiarity is confined to this, namely, that in the smallest space are condensed the most varied combinations of substances, that each cell is the focus of the most intimate actions of these varied combinations, and that it thus produces effects which are met with nowhere else in Nature, because nowhere else can we find a similar intimacy of action."*

Again, referring to chemistry, we know that the freezing and boiling points of liquids, though differing with liquids that differ in constitution, are fixed for each, and are always the same under precisely similar conditions. Points at which various substances fuse and ignite are fixed and peculiar [illegible] each; in fact, there are fixed limits within which any given chemical change can only occur. Finally, the whole science of chemistry is based upon the one great truth, that *function depends upon structure*, that any given substance behaves in precise the same manner under precisely similar conditions; otherwise no analysis would be possible, for in what does chemical analysis consist? "The methods of quantitative analysis consist in bringing the substance under examination into contact with other bodies of known properties, and observing the phenomena which ensue." These "other bodies of known properties" are called *reagents*, and "the ensuing phenomena are termed *reactions*." "By means of reagents, the chemist puts questions to the substance under examination, inquiring whether it contains this or that group of chemically similar elements, or only this or that member of such group. If the question be put correctly, *i. e.*, if all the conditions under which the reaction expected can be produced by the reagent employed be carefully observed, the answer is decisive as to the presence or absence of the element or group of elements sought."—(*Handbook of Quantitative Chemical Analysis*, by Prof. R. C. Kedzie.)

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* *Revue des Cours Scientifiques.* April 7, 1866.

Since all organisms are definite chemical compounds, we see that the several phenomena which collectively make up the life of an individual organism, and which are similar to the phenomena exhibited by all other organisms of its particular kind, and different from those of any other kind, may be considered as the *reactions* which occur in consequence of its being brought "into contact" with its surroundings. In all organisms of a kind these reactions are similar, because all such organisms are similar chemical compounds.

Throughout all Nature we find that function depends upon structure, although, in living organisms, *it has been assumed* to be otherwise. I have endeavoured to point out that all organisms have definite chemical composition, which is, in great degree, essentially similar in all organisms of a kind and different in different kinds. In order to correspond with what is recognized in mechanics and other sciences as natural law, and in order to harmonize with the fundamental truth upon which the science of chemistry is based, the individuals constituting each species of organism having similar definite chemical composition should exhibit similar phenomena when exposed to the several reagents which make up their surroundings, and that they do this is a fact too familiar to require illustration. The individuals of different species or kinds of organisms, having a different composition and structure, should exhibit different phenomena when exposed to the same reagents or surroundings; and this is a well-recognized fact. Those species most nearly similar in chemical structure should most nearly resemble each other in the phenomena attendant upon their experience, and that they do so is also well known. Those tissues in different organisms which in structure closely resemble each other should have a corresponding resemblance of function. This fact is strikingly apparent, as we see when we remember that the brain and nervous system have a similar, though not precisely like, composition in all animals, and perform similar functions. The muscles of different animals are similar in structure as they are also in function.

A survey of the evidence leads us to the conclusion that the phenomena, reactions, or functions which collectively make up the life of an organism must result from its definite composition. In other words, life consists of the phenomena exhibited by definite chemical compounds while experiencing conditions compatible with their existence. As the reactions of all chemical compounds and mechanical structures are peculiar to each composition or structure, so the phenomena of any organism are peculiar to that organism, and result from the action and reaction between it and its surroundings. As before stated, "a definite chemical compound reduced to its lowest terms should consist of two equal atoms arranged with the simplest definite relation to each other."

It is intended at a future time to continue the subject by considering the remaining prominent characteristics of living beings and also mutilation of organisms.

ORGANIC MOTION; THE ACCTION OF SOME POISONS, AND THE ESTIMATION OF ORGANIC FORCE.

Certain motions, not entirely dependent upon external force, are manifested in living organisms, and are called Organic Motions. There are several kinds, visible and invisible, such as muscular, causing motion of a part, or of the individual; nervous, inducing muscular and other motions, osmotic and circulatory motions of the fluids; and molecular motion—heat, light, and electricity,

Force is the name given to the cause or producer of motion, and each kind of motion is understood as a mode in which force acts. In order to better understand the source of the force used in organic motions, we will begin with some of the most familiar kinds of matter and force, and rapidly trace them through some of their changes up to the higher-organized forms.

Through the action of the several modes of force—heat, light, attraction, &c.— elementary matter is arranged into molecules and crystals; from these the same forces, through the directing influence of germs, build up the more complex vegetable organisms; the matter and force stored up in the vegetable and lower forms of matter are, through the continued action of these forces, used in constructing the more highly-organized herbivorous animals; finally, by the further action of the several forces, matter and force, from these previous structures, are still further built up into the complex and highly-organized human being. If any of the conditions to the existence of these organisms be withdrawn, they return toward their constituent elements. All the changes have been from stable to comparatively unstable compounds, which, as we have elsewhere seen (when considering the "Laws of Chemical Change"), require force for their continuance. When, through the action of some starting force, these organisms break up, either totally or in part, into lower compounds, they undergo a change from unstable to stable, and, in accordance with the general law (elsewhere stated), force is liberated. Throughout all Nature the evolution of force is the result of change from conditions which required force for their production to conditions requiring less force. All organic motions result from changes, greater or less in amount, from unstable to comparatively stable compounds, requiring force to start them, but liberating force while they continue. These changes are, first, rearrangement of the constituent atoms or molecules; and, secondly, combination with other atoms or molecules. The rearrangement may be slight, such as that which in chemistry is termed isomeric, giving out a small amount of force, and requiring but little to regain its former vital condition, or it may be a more or less complete breaking up into new and lower compounds constituting a mode of decomposition. Probably by far the greater amount of motion result from changes by combination with other elements not necessarily forming a part of the organism, and mainly through union with oxygen. This mode of change may vary from the slight substitution of one atom or molecule for another, to be in turn replaced by one precisely similar to the first, through the continued action of the organizing forces, up to sufficient decomposition to permanently destroy the organism. In considering the liberation of force, we will follow the same order as when tracing the successively higher forms which are produced through its organizing action on matter; noticing first the crystal, then the plant, and finally the various modes of animal force. Beginning with one element, the atoms definitely arranged by force, we know that when carbon, crystallized in the diamond, is heated to redness, and placed in an atmosphere of oxygen, it unites with it, and in burning gives out some of the force used in its formation, as moelcular motion, heat and light. A certain amount of heat-force is required to start the change, and certain surrounding conditions are essential to its continuance, but under those conditions, the diamond is an unstable form of matter, and is decomposed to assume a form requiring less force for its maintenance. The decomposition of certain chemical compounds yields electrical and other modes of motion.

It is a well-known fact that the more or less complete decomposition of ordinary vegetable forms is attended by a liberation of force, generally as heat. When the steam-engine is operated by the use of wood as fuel, organic force is used for the movement of machinery; tree-power is made to aid, or is substituted for horse-power, as both of these are used to save the higher form of power exerted by man.

In this case the decomposition of the wood, by combination with oxygen, is nearly complete, and the liberated molecular motion is communicated to the water to form steam; but its continuance, as molecular motion, is resisted by the solid though moveable portion of the engine, and a certain portion is thereby converted into motion of a mass. Locomotion is thus rendered possible through the use of only the organic force of plant life. If the diamond were sufficiently plenty to be used as fuel, the same might be accomplished by the force stored up in the crystal. In the sensitive plant (*mimosa*) we have an interesting example of motion, which may be frequently repeated during its life, as the attendant decomposition, or change, is not, as in the foregoing examples, complete.

In the complete decomposition of animal organisms, force is liberated; but the complex structure of animal bodies renders possible, during life, various simultaneous changes of different characters, occurring in differently-constituted tissues, which have different conditions of stability, and in different portions of the same tissues more freely exposed to force. The great variety of changes which thus occur liberate force in a great variety of modes, causing heat, electricity, nervous, muscular, and other motions. In the higher organisms, such changes normally continue only until a certain portion of the particular tissue or form of matter has undergone this change, for the complete withdrawal of one essential element from an organism is equivalent to its decomposition. During the continuance of such changes force is manifested, and, in time, by the continued supply of proper matter and several forces, the organism is again restored to about its original condition, when it is again possible for force to be liberated upon experience of the proper starting-force. By a certain set of changes, by replacement or substitution, these phenomena of force may at intervals recur. If the replacement be made by substance not capable of, in turn, giving place to the proper matter under the natural conditions, then the succession of changes is interrupted, and if this abnormal substitution be complete and permanent, death must result; for, if an essential element combine with foreign matter, it is equivalent to its removal, and this involves the destruction of the organism. Thus, if, in passing through the lungs, the blood gives off carbonic acid, and, instead of meeting with oxygen, combines with some other element, as, for instance, chlorine, not capable of going through the changes in the tissues essential to the continuance of life, death must result. Many poisons, such as hydrocyanic and other acids, alkalies, etc., may cause death by combining with and refusing to release essential elements of the organism. It seems quite probable that the acids of arsenic may act by thus combining with the iron of the blood. This theory is supported by some facts, among which are, first, the colour of the blood is in great degree due to iron; the use of arsenic in sufficient quantities, for a length of time, causes a certain paleness of the complexion; and, secondly, hydrated-peroxide of iron has been found to be the most effectual antidote, and is supposed to act by combining with the arsenic to form a compound insoluble in the fluids of the alimentary canal. May not a similar compound of arsenic and iron be formed in the blood, and, if not insoluble, incapable of giving up the iron to go through its proper changes in the body?

The amount of force given out during any change depends upon the nature of the change, and cannot be determined from the result of any other change not precisely the same in character. In illustration: natural forces organize carbon and other elements into wood, and by its partial destruction charcoal remains; they form the compound nitrate of potassa; additional force is employed by man in pulverizing and mixing charcoal, sulphur, and nitrate of potassa, to form the highly-unstable substance, gunpowder: the application to this of a proper force starts a chemical change, and more stable compounds are formed, liberating the amount of force stored up in it, less the amount necessary to form and maintain the lower compounds. No experiments with the changes of carbon, sulphur, and potassa, or even with those occurring in compounds of those elements combined in any other way, enable us to determine the amount of force liberated during the combustion of gunpowder. It seems improbable that the amount of force given out by any change occurring in the brain can be properly estimated from any experiment with ordinary carbonaceous or nitrogenous compounds.

It can only be experimentally determined by a precisely similar change in a compound chemically the same, where the lower compounds formed shall be the same in character as those formed in the brain. The same may be said of a change occurring in the muscular substance or in any tissue or fluid of the body. Inasmuch as the different tissues and fluids have not chemically the same composition, the changes occurring in them may not be similar; they probably are, to a certain extent at least, peculiar to each; so that if the amount of force liberated by a certain change in the blood be known, the fact will not serve to prove the amount liberated by a change occurring in any other part of the body, unless the nature of the changes is known to be the same. As force is indestructible, the amount used in building up any compound, when no longer acting to maintain it, will, in some form, appear. "The force liberated by the fall of a body is equivalent to the force required to raise the body to the height from which it fell."

The amount of force liberated by any change occurring in an organism must equal the amount required to build up, from the chemical elements, the unstable compound undergoing the change, less the amount required to form and maintain the lower and more stable compounds formed during the change.—*From the Journal of Psychological Medicine.*

VOLCANOES.

IN a lecture upon this subject, delivered in connection with the Sunday Lecture Society, Mr. David Forbes, F.R.S., &c., said that, although he imagined that but very few of his hearers ever witnessed a volcano in eruption, all must have read accounts of such phenomena. As a geologist, he might be pardoned regretting that we do not possess even a single example of an active volcano in our happy isles. If the question were asked, "What is a volcano?" the simplest reply would be, "A hole in the ground deep enough to reach such portions of the interior of the earth as are in a molten condition." The eruption of Etna in 1865, which the speaker witnessed, did not proceed from the summit or main crater, but broke out on the side of the mountain, about 5,416 feet above the level of the sea. Along the fissure formed by the convulsion, no less than seven distinct cones rose up at intervals, building themselves up very rapidly from the enormous quantities of scoriæ which were

MECHANICAL MOVEMENTS.

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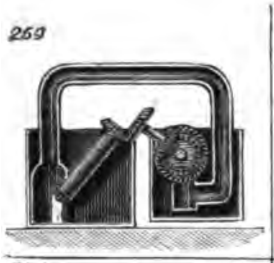

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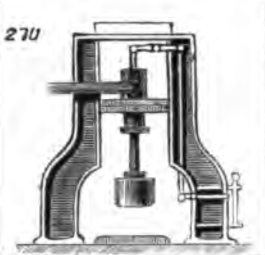

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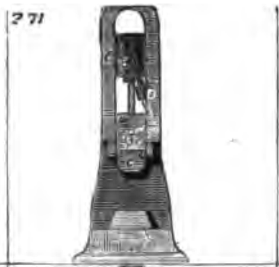

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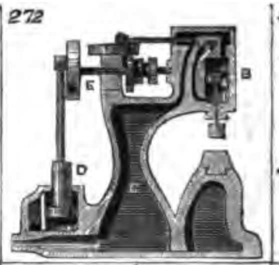

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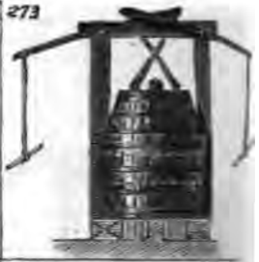

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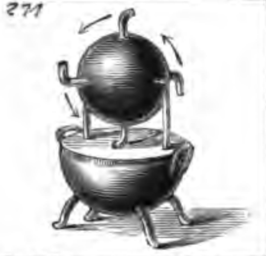

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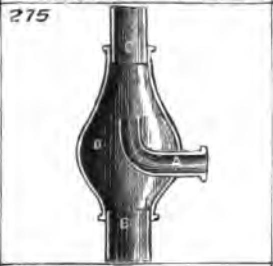

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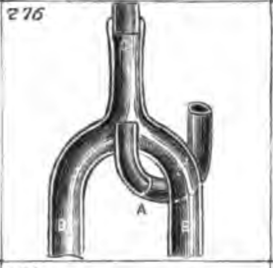

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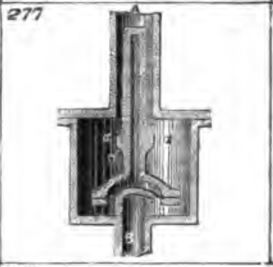

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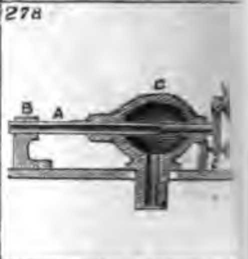

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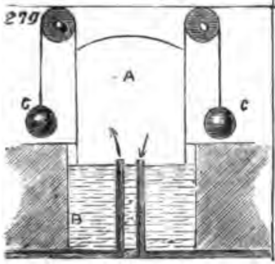

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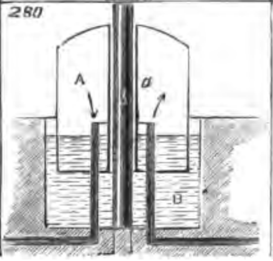

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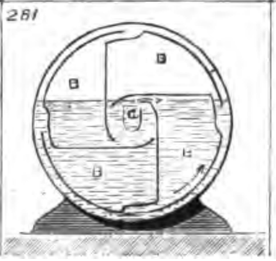

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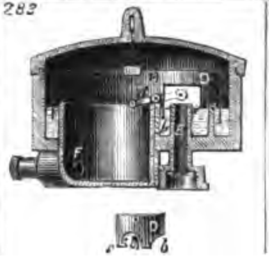

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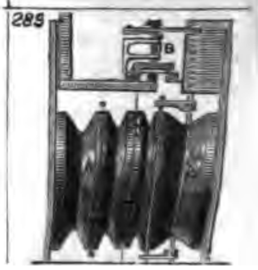


thrown up at their vents. Uniting in action, they, in a short time, formed a range of hills several hundred feet in height, and entirely changed the character of the scenery of that part of the island. The formation of a new, or the re-opening of an old, volcanic vent is usually accompanied by a terrific explosion. In 1812 the outburst of the volcano of Saint Vincent was heard in South America, some 700 miles distant. The enormous force developed by the rush of gases and vapours from the fissure may be imagined, when it is known that in the eruption of Mount Ararat in 1840, huge blocks of rock, weighing as much as 25 tons, were thrown out of the crater. Cotopaxi is said to have hurled a 200-ton rock to a distance of nine miles: whilst the volcano of Antuco, in Chili, in 1828, discharged stones to a distance of about 36 miles from its orifice. The chemical composition of the gasiform emanations from volcanoes proves that they are in greater part incombustible, and therefore does not support the idea that the body of such a column of vapour and gases could be in flames—*i.e.*, actually burning. On the outside of the column, however, innumerable brilliant scintillations are seen, of a bluish colour, due to particles of sulphur taking fire as they come into contact with the outer air, and patches of melted sulphur are splashed about, brightly burning as they fall down through the air on to the slope of the cone. The buried cities of Stabiæ, Herculaneum, and Pompeii, covered in parts to the depth of 100ft. by the ashes of Vesuvius, are ocular proofs of the vast quantities which can be discharged out of a volcano vent during an eruption. A French geologist has estimated that the volcano of Bourbon has, in the course of only two days, thrown out no less than 300,000 tons of ashes. In that greatest of mountain ranges, the Andes, commencing from the oldest period of their elevation, we find a series of eruptive rocks breaking through the sedimentary strata on their flanks, as follows :—

1. The Auriferous granites—probably at the end of the Devonian period ;
2. The characteristic Porphyrites of the Oolitic age ;
3. The Auriferous Diorites, disturbing the Cretaceous formation ; then,
4. The Miocene basalts ; and, lastly,
5. The lavas from the present volcanic forms, which occur at intervals along the whole range, from Terra del Fuego in the south, all through the Cordilleras of South and Central America, up to the Rocky Mountains.

In answering the question as to what force has played the most prominent part in determining the external configuration of the earth, the unbiassed geologist, said the lecturer, must necessarily grant the first place to the internal volcanic or cataclysmic agencies, since, had it not been for their operations, our globe would still have remained a comparatively smooth sphere.

MECHANICAL MOVEMENTS.

(*Continued from page 464.*)

269. French invention for obtaining rotary motion from different temperatures in two bodies of water. Two cisterns contain water: that in left at natural temperature and that in right higher. In right is a water-wheel geared with Archimedean screw in left. From spiral screw of the latter a pipe extends over and passes to the under side of wheel. Machine is started by turning screw in opposite direction to that for raising water, thus forcing down air, which ascends in tube, crosses and descends, and imparts motion to wheel; and its volume increasing with change of temperature, it is said, keeps the machine in motion. We are not informed how the difference of temperature is to be maintained.

270. Steam hammer. Cylinder fixed above and hammer attached at lower end of piston-rod. Steam being alternately admitted below piston and allowed to escape, rises and lets fall the hammer.

271. Hotchkiss's atmospheric hammer; derives the force of its blow from compressed air. Hammer head, C, is attached to a piston fitted to a cylinder, B, which is connected by a rod, D, with a crank, A, on the rotary driving-shaft. As the cylinder ascends, air entering hole *e* is compressed below piston and lifts hammer. As cylinder descends, air entering hole *e* is compressed above and is stored up to produce the blow by its instant expansion after the crank and connecting-rod turn bottom centre.

272. Grimshaw's compressed air hammer. The head of this hammer is attached to a piston, A, which works in a cylinder, B, into which air is admitted—like steam to a steam engine—above and below the piston by a slide-valve on top. The air is received from a reservoir, C, in the framing, supplied by an air-pump, D, driven by a crank on the rotary driving shaft, E.

273. Air-pump of simple construction. Smaller tub inverted in larger one. The latter contains water to upper dotted line, and the pipe from shaft or space to be exhausted passes through it to a few inches above water, terminating with valve opening upward. Upper tub has short pipe and upwardly-opening valve at top, and is suspended by ropes from levers. When upper tub descends, great part of air within is expelled through upper valve, so that, when afterwards raised, rarefaction within causes gas or air to ascend through the lower valve. This pump was successfully used for drawing off carbonic acid gas from a large and deep shaft.

274. Æolipile or Hero's steam toy, described by Hero, of Alexandria, 130 years B.C., and now regarded as the first steam engine, the rotary form of which it may be considered to represent. From the lower vessel, or boiler, rise two pipes conducting steam to globular vessel above, and forming pivots on which the said vessel is caused to revolve in the direction of arrows, by the escape of steam through a number of bent arms. This works on the same principle as Barker's mill, 438 in this table.

275. Bilge ejector (Brear's patent) for discharging bilge-water from vessels, or for raising and forcing water under various circumstances. D is a chamber having attached a suction-pipe, B, and discharge-pipe, C, and having a steam-pipe entering at one side, with a nozzle directed toward the discharge pipe. A jet of steam entering through A expels the air from D and C, produces a vacuum in B, and causes water to rise through B, and pass through D and C, in a regular and constant stream. Compressed air may be used as a substitute for steam.

276. Another apparatus operating on the same principle as the foregoing. It is termed the siphon pump (Lansdell's patent). A is the steam-pipe. B B, are two suction-pipes, having a forked connection with the discharge-pipe, C. The steam-pipe entering at the fork offers no obstacle to the upward passage of the water, which moves upward in an unbroken current.

277. Steam trap for shutting in steam, but providing for the escape of water from steam coils or radiator (Hoard & Wiggin's patent). It consists of a box, connected at A with the end of the coil or the waste-pipe, having an outlet at B, and furnished with a hollow valve D, the bottom of which is composed of a flexible diaphragm. Valve is filled with liquid, and hermetically sealed, and its diaphragm rests upon a bridge over the outlet-pipe. The presence of steam in the outer box so heats the liquid in valve that the diaphragm expands and raises valve up to the seat, *a*, *a*. Water of condensation accumulating reduces the temperature of valve, and as the liquid in valve contracts, diaphragm allows valve to descend and let water off.

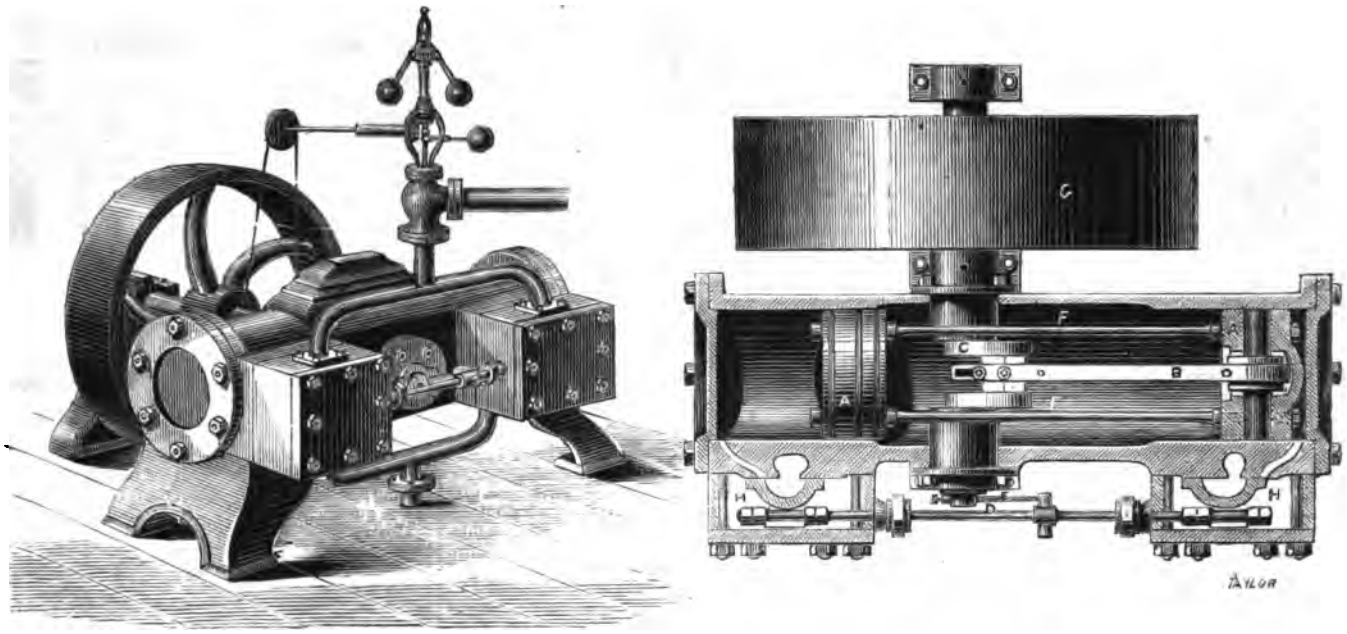
278. Another steam trap (Ray's patent). Valve *a* closes and opens by longitudinal expansion and contraction of waste-pipe, A, which terminates in the middle of an attached hollow sphere. One portion of the pipe is firmly secured to a fixed support, B. Valve consists of a plunger which works in a stuffing-box in the sphere opposite the end of a pipe, and it is pressed toward the end of the pipe by a loaded elbow lever, D, as far as permitted by stop-screw, *b*, and stop *c*. When pipe is filled with water, its length is so reduced that valve remains open; but when filled with steam, it is expanded so that valve closes it. Screw, *b*, serves to adjust the action of valve.

279. Gasometer. The open-bottomed vessel, A, is arranged in the tank, B, of water, and partly counterbalanced by weights, C C. Gas enters the gasometer by one and leaves it by the other of the two pipes inserted through the bottom of the tank. As gas enters, vessel A rises, and *vice versa*. The pressure is regulated by adding to or reducing the weights, C, C.

(*To be continued.*)

Benzine is said to render ordinary paper transparent and suitable for tracing purposes.

THE RUDDICK STEAM ENGINE.



THE RUDDICK STEAM ENGINE.

THE accompanying illustrations of this engine are taken from the *American Artisan*. The piston heads, A A, are rigidly connected by four rods, the two upper ones showing at F F. These rods insure an equal motion of the two piston heads in the same direction and at the same time. The piston being thus extended by these rods, admits of the interposition of the connecting rod B, from a wrist-pin in one piston head to the crank shaft, C, which runs transversely through the cylinder, carrying on one end the belt or fly-wheel, and operating on the other the valve stem, D, which is moved by the short arm, E, attached to a crank pin on an adjustable collar fitting on the crank shaft. The valves and steam chests are represented at H H.

The advantages claimed for this engine are :—

1st. Extreme simplicity, beyond any other make of engine. A reference to the annexed plan and explanation readily confirms this. This quality of simplicity insures—

2nd. Fewer parts, and each part contributing directly as a medium of power, and consisting only of the cylinder, piston, connecting rods, crank, valves, and valve stem.

3rd. Greater saving in repairs, on account of the fewer parts, and equal durability as compared with the best engines.

4th. Greater economy in space and weight than any other engine, and consequent economy in transportation. A 15-horse power engine, weighing less than 1,000lb., is included within a space of 42in., longest measurement, all set up with belt wheel, &c., ready to run.

5th. Can be run in any position, and at any reasonable speed. The cylinder must preserve the same right line, and the engine requires no foundation.

6th. Greater economy in use, not only from saving in repairs, but the few and simple parts in this engine do not require an experienced engineer to run and keep it in order. Any intelligent boy of fifteen could be taught to run and take all needful care of one in a day's instruction.

7th. Its simplicity insures cheapness of construction, and consequent reduced *cost* to purchasers, while at the same time its cheapness does not in the least particular affect its power and usefulness. On the contrary, its simplicity is a positive mechanical gain, using, as it does, every necessary part, and discarding all that are not directly, and in the shortest line, mediums of power. The consumption of power in the engine itself is unavoidably less, and the amount transmitted to the distributing point in like degree greater than in the case of any other engine.

It can be made of any power, from one-half horse power or less, to any required size.

WAR AND WATER.

THAT inability to apply the principles of logic, or insufficient confidence in the soundness of those principles, not unfrequently causes conclusions to be drawn which scarcely follow from the premises has long been known; thus, we are told, that in the reign of Abdallah III. there was a great drought at Bagdad, and that although the Mohammedan doctors issued a decree that the prayers of the faithful should be offered up for rain the drought continued. The Jews were then permitted to add their prayers to those of the true believers, but the supplications of both were ineffectual. As famine stared them in face, those dogs, the Christians, were at length enjoined also to pray. It so happened that torrents of rain immediately followed. The whole conclave, with the mufti at their head, were now as indignant at the cessation of the drought as they were before alarmed at its continuance. Some explanation was necessary to the people, and a holy convocation was held; the members of it came to the unanimous determination that the God of their prophet was highly gratified by the prayers of the faithful, that they were as incense and sweet-smelling savour unto him, and that he refused their requests that he might prolong the pleasure of listening to their supplications; but that the prayers of those Christian infidels were an abomination to the Deity, and that he granted their petitions the sooner to get rid of their loathsome importunities. Some conclusions about as logical have just been published by Mr. Ch. Le Maout, pharmacist, of St. Brieuc, in consequence of the drought we have recently experienced.

The connection of war and water is perhaps not studied by military officers generally, except so far as relates to the transport of large bodies of troops across seas and rivers; whilst the conclusion drawn by most non-military persons would be that the discussion of war and water must relate exclusively to naval warfare. If we accept the doctrine of Mr. Le Maout, we shall learn what lamentable results such ignorance may lead to. As Mr. Le Maout is the author of a work entitled "The Cannonades of Sebastopol, or the Cannon and the Barometer," published in 1856, it appears that he has occupied himself for some time with the question; and he considers that his observations, made during the Russian war, and published at the time, establish in an unequivocal manner the condensing action of cannon upon cloud, and consequently their effect upon barometrical indications. This action was constantly observed in Brittany in from 100 to 120 minutes, although the distance from the seat of the war was more than 600 leagues as the crow flies. During the formidable cannonades of the seige of Sebastopol he noticed that generally— n Brittany we presume—whenever the firing commenced the azure of the sky was overcast, and a fine rain or mist fell, frequently followed by heavy showers and then by wind. Afterwards, and as a consequence of these condensations, the barometrical column was put in motion, and rose at a speed and to a height proportional to the extent of the cannonade. The record of the barometrical indications represented pretty exactly the extent of the firing when the effect was not modified by some great physical phenomena, such as a volcanic eruption or a great fire. Then the rarefying force neutralized the condensing force, and the barometer remained stationary until one or the other conflicting forces ceased to operate. But still more marvellous, and what attests the extreme sensibility of the instrument, he observed, that after six memorable engagements, followed by armistices of two or three hours concluded for the burial of the dead, the barometer stopped, and remained stationary during the whole time the burial was going on; then, just after two or three hours, at the moment when the cannonading recommenced, the column again gave signs of movement upward, and by its speed made up for lost time. It was this remarkable property that enabled him to calculate the exact time that was required for the force applied in the Crimea to exert its influence in Brittany.

And it is not cannon alone that possesses this condensing action. Mr. Le Maout has found that the explosion of mines and powder-mills, and even the sound of bells, produce a similar effect. Even the simple striking of a village clock, and of those of churches and chapels, suffices, on the coast of Brittany, where they have almost constantly a humid atmosphere, to make the rain fall; but for this certain physical conditions are necessary. The wind must be blowing from the south-west and carrying rain-cloud, and the barometer must stand below 76 centimètres. In this state of things, when the temperature is not high, it is rarely that the striking of the hours does not show its condensing action upon the aqueous vapour, especially when the clouds are low, for the vibration of bells and of clocks striking only acts within a limited area. In the month of May, 1856, the year of the great inundations, he carefully observed the exact time of the fall of the rain, and found that, out of 133 times that it rained in the month, the fall occurred 76 times at the striking of the hours, 42 times at the half-hour, 8 times at the three-quarters, and 7 times at the quarter. He considers that it is the intensity of the sound, as well as the repetition, that has the most powerful effect upon the condensation of the vapour of water; and he explains that such observations cannot be made in Paris and other large towns, where so many noises are produced from fortuitous or accidental causes between the times of the striking of the clocks. Speaking generally, he maintains that all noises produced by physical or artificial causes result in the condensation of aqueous vapours. Thus the beating of the drum, and the sound of military music where brass instruments predominate, produce identical effects, and it is the same with heavily-laden wagons passing over paved streets, and with trains of loaded trucks on railways. The vapour of water being formed of myriads of vesicles of the smallest diameter, similar as to their fragility to soap-bubbles, it is not surprising that, by the powerful percussion of the aërial mass, they should break, and resolve themselves into rain. When we are enveloped in this vapour by a sky charged with rain-clouds, we are in a most impressionable medium, which for its fragility, may be compared to a palace of glass. If, under these circumstances, we fire a cannon, all will be smashed to atoms, and necessarily fall about our ears. If, however, there be nothing above us but the azure of heaven, we may fire cannon and ring as long as we like, yet nothing will fall. "It is this," says Mr. Le Maout, "that the adversaries of my doctrine of condensation will not understand; they wish, as proof of the truth of it, that rain shall fall under all circumstances."

Now, were this the sole objection to Mr. Le Maout's hypothesis, he would certainly have grounds of complaint, for it must be acknowledged that there are many experiments which can only be successfully performed under favourable conditions; but in effect he admits that, whatever may be the conditions, the success or failure of the experiment is dependent upon the merest chance, for he adopts nearly the same argument as was used by Mr. George Shepherd, an English weather forecaster, to account for the fact that no dependence whatever could be placed upon his forecasts. "But," says Mr. Le Maout, "if it does not rain upon us when we fire the cannon, or when we ring, it may rain somewhere else, especially when the sky is charged with rain-cloud within the area affected by the sonorous body. Thus, not only may rain fall in the neighbouring village, but even at immense distances, since in the great disturbances of the aerial mass by the formidable discharges of artillery at the siege of Sebastopol it often rained here (in Brittany) although not a drop fell in the Crimea." From this it would appear that our great pharmacist is not so much in want of correct premises as of ability to deal with them; but it is precisely this latter want that gives us the amusing absurdities he has treated us to. Often, he continues, the firing of the cannon and the sound of the bells clear the cloudy sky, and send the threatened storm afar.

Similar effects were observed, not only during the Crimean war, but during that of Italy, and of the Austrians and Prussians; and he observes that storms were more frequent than usual during those events. In confirmation of his views he reminds old military officers that at the siege of Antwerp the besieged were constantly under torrents of rain, and up to the knees in mud, but that as soon as the citadel was taken the rain ceased, and the weather became fine. They will remember, too, the memorable storm of hail, rain, and wind which occurred before four and five o'clock in the evening on the battle-field of Solferino, which alone put an end to the fury of the combatants, and saved the remnants of the Austrian army. In that case the physical force was accumulated by the powerful means used, which had the effect of concentrating the hurricane upon the battle-field itself, the battle acting incessantly like a suction pump. He accounts for the storm at Puebla and the non-success of French arms in Mexico in a similar manner, and it seems that even England may well be thankful that M. Le Maout's doctrine was not accepted half a century earlier. The success of England in some of her greatest conflicts with foreign nations has frequently been attributed to her knowledge of war and water; and (in another sense it is true) Mr. Le Maout attributes the loss of Waterloo by the French to the want of that knowledge. If, he observes, Napoleon I. had known this condensing power of cannon, which, by the way, he could better than any one else have observed upon so many fields of battle, he would not have undertaken, upon June 16th and 17th (the eve of Waterloo and day previous), the battle of Ligny, and the engagement with the rear-guard of Genappes, during which a storm occurred, commencing about three o'clock in the afternoon, and continuing for twelve consecutive hours to pour down torrents of water, which converted the ground into a perfect marsh, alike impracticable to man and beast. It was the twenty-four rounds fired on the retreating English columns that, in Mr. Le Maout's opinion, brought down the rain, and prevented the movement of the French troops until the following day, by which time the Prussians had arrived; hence the loss to the French of the battle of Waterloo.

It is difficult to determine whether Mr. Le Maout is the more worthy of admiration as a philosopher or as an historian; but as we are not called upon to give a decision, the question may consequently be left to our readers. We will content ourselves with explaining how the great discovery is to be turned to practical use, by recording a statement of the conditions which he regards as most favourable to success. The instructions are given for St. Brieuc, so that experimenters will have to make the necessary corrections for locality if applied elsewhere. Make the experiment with the wind blowing from the south-west and carrying heavy rain-clouds, and choose a day when the barometrical pressure averages less than 76 centimètres. Commence in the morning, before the misty bank formed on the surface of the English Channel is dispersed by the rays of the sun. The lower the temperature the better. Proceed by simultaneous explosions from one or several batteries every quarter of an hour. Upon this day all military target practice should be suspended; and if the experiment be made upon the day of a religious feast, when the bells are rung, the probability of success will be all the greater. If the experiment succeed, and it be judged that sufficient rain has fallen, transport the condensation cannons from Cherbourg to Brest, and fire again to stop the current of vapours coming from the ocean by condensing them in their passage. Thus, to have rain, fire at Cherbourg on the rainy winds of the south-west; to have dry weather, fire at Brest on the easterly winds which reach there after having traversed Central Europe, and been deprived of their vapour of water by the numerous bells in Christian churches and the noise of military exercises which they have met with on their way. There is, in Mr. Le Maout's opinion, reason to believe that if the condensation cannons, which act like a suction pump, were kept in energetic motion on the English Channel, the vapour of water would flow there and fall as rain, not only from the west, but from the Mediterranean and the Northern ocean. Is this to be accepted as a result of superior technical education on the Continent?—E. D. H., in the *Scientific Review.*

HINTS ON WATERING PLANTS.

As I have a good deal to do in various ways with amateur gardeners, I have frequently opportunities of noticing their shortcomings in a variety of particulars. In ninety-nine cases out of a hundred almost, ladies and gentlemen who are excessively fond of flowers, have a little plot of garden, perhaps a greenhouse and a frame or two, and bestow a good deal of time, money, and pains, do not realize the results they think they have a right to expect as the reward of their application. I think we may place some portion of the failure to the account of the want of tact, which Johnson defines to be "expertness and skill in the management of any affair; ready talent." Let something more go down to the lack of untiring vigilance, indomitable application. One single neglect of some particular item in the routine of management will sometimes render nugatory a whole year's attention. If the clock discontinues its ticking, notwithstanding the monotony of the process, family and business arrangements are thrown into confusion. Then, again, observation quite justifies me in saying that, in very many cases, sour mould, injudicious mixture of soil, bad potting, and imperfect drainage, completely block up the way to success. But the one great hindrance, on which I purpose for a moment or two to dwell, is injudicious watering. To be plain, there is no rule that can be laid down for watering plants in pots. Some persons ask, "Should not plants in pots be watered every day?" The answer is, "Every collection of plants in pots should be looked over every day, and those that are dry should be watered promptly and sufficiently." Let me explain what I mean by "sufficiently." When a plant is potted, there is a space between the surface of the mould in the pot and the margin of the pot; this is to hold the water necessary for the plant growing in the pot; if the space is pretty deep—say ¾in., or an inch—this space quite filled up with water will generally be enough for one dose. If the space is shallower, and the plant is very dry, it may be filled up two or three times, as the case may be, until the ball is thoroughly moistened. If the ball has got so dry that the earth has shrunk away from the sides of the pot, and the water when poured in runs away between the ball and the pot without penetrating among the roots, after the first dose has been given, draw the finger all round the opening on the top of the soil. This operation, simple as it is, will detach mould enough to fill up the gap, and the water which is afterwards given will, instead of running away uselessly, permeate the entire mass of soil in the pot. And let it be remembered that this "sufficient" watering applies to winter as well as summer treatment; it is a mistake to give plants in pots that are dry only water enough to moisten the surface of the soil. Subjects that in the summer require copious supplies of water every day, in the winter, perhaps, will not want it more than once a week; but when they do have it, give them enough. I would also persuade amateur gardeners to adopt feeders, or saucers, or pans, or whatever may be the name by which they are locally designated; these will be found to be of incalculable advantage to many plants; not the glazed pans, but those of the same material and finish as the common garden pot. First of all, the water which has passed through a pot of soil that has become dry will be retained by the saucer, and will be absorbed by degrees, according to the necessities of the plant. Then, again, the pan itself absorbs a considerable quantity of the water, and furnishes a moist, cool bottom for the plant to stand upon, most grateful to plants of all kinds, and analogous to standing on a bed of ashes or sand out of doors, where they are always found to enjoy themselves.

Further, there are numbers of plants that positively delight to stand in water. Fuchsias, all through the growing and flowering season, begonias, arums, callas, ixias, many ferns, and other things, will amply repay by their luxuriant vigour the indulgence of being permitted to stand in a pan of water.

Again, it will be a great relief to many an anxious cultivator who leaves his home in the morning, and as he takes a last look at his potted plants, to feel sure that, by leaving them a supply of water within their own reach, their necessities will be met through the length, it may be, of a long, bright, parching summer's day, to find at his return home, after the toils of business, that his plants are not only not perishing from drought, but are, perhaps, considerably improved in vigour and beauty. Only once more let me say that, in using pans, adapt them to the size of the pots—that is, let 48-size pans be used for 48-size pots, and the same with other sizes, as it will be found that, if they are too large, they contain more [illegible] than can be absorbed by the plant while it is [illegible] and, if too small, will not contain enough.

I am afraid your readers will think I give th credit for very little knowledge, but it is beca I know that a very large proportion are exp cultivators, that I can speak so plainly for t advice of beginners. But just another mom while I place two or three guards around practice I have been advocating. Let everyt placed in pans be well potted, sufficiently [illegible] and filled with roots, and for innumerable subje such as roses in pots, vines in pots, orchard-tre fuchsias, and strong-growing and free-rooting [illegible] generally, this [illegible] be found a most satisfact provision.—By William Chitty, in the *F World.*

THE EVAPORATION METER FOR BOILERS.

(*Illustrated on page 492.*)

TRIALS made at different times of [illegible] tive effect of different construction [illegible] and different kinds of fuel have shown [illegible] variations in the relative amounts of [illegible] duced. The cause of these variations [illegible] for—first, in the construction of the boiler [illegible] setting; second, in the quality of the fuel; [illegible] in the qualification of the fireman.

The fuel for steam boilers forms such a item in the expense account that it is certa the greatest importance to owners of boile make themselves familiar with the proporti which the production of steam stands to the qua of coal used, and to reduce the latter, if possible

Official trials of the evaporative effect of [illegible] ferent construction of boilers, and different qualiti of coal, give important information; *but attentiveness and skill of the fireman, a very importa* factor in the saving of fuel, *cannot be tested* by single trials, but only *by continual watching*, and increased only by *introducing a system of wages*, which depends upon the amount *of coal saved*. The important results obtained by the latter *system* is clearly proven by the fact that since its introduction in the case of locomotives, an average saving of fuel of over ten per cent. has been obtained thereby.

On railroads the record of each locomotive is made up from notes of the freight carried, and the distance travelled. The differences in the grades of the road are regulated by coefficients.

With boilers for stationary purposes, such system of control cannot be employed, for th kind of effect is generally variable, and a true [illegible] sure for them does not exist. Moreover, the [illegible] effect is dependent not only upon the engine fireman, but also on every workman [illegible] machine. A more direct index of the [illegible] the fireman is the exact measure of the [illegible] duced. At different times attempts [illegible] made to determine this point, by passing the [illegible] fed to the boiler, through a meter. Most of [illegible] meters have been condemned on account of [illegible] want of accuracy and durability. All water-me however, are not adapted to steam boilers, as th do not note the temperature of the feed-wa The chief point is not to ascertain the quanti the water evaporated, but to establish the [illegible] of heat applied to the boiler by the combustio the fuel. The ratio of the quantity of heat [illegible] useful to the amount contained in the fuel for the basis for estimating the efficiency of the fi man, and the perfection of the boiler constru The feed-water offers the means for measurin effective quantity of the heat, but it is not [illegible] to measure its quantity alone—the temperat which it enters the boiler must also be car considered.

In trials of short duration, the temperature feed water can be noted and entered in the [illegible] tion, but in practice this can not be done w[illegible] object in view is not one short trial, but the [illegible] tinuous observation which is necessary for a [illegible] plete control of the fireman.

The evaporation meter, which we here pres answers every demand. It is not damaged by t water, the measurements are correct, and it r cords the temperature of the water entering th boiler, so that on its index-dial the quantity of he made effective may be read off in heat units. will be seen on examining the annexed cut, that t water which enters the apparatus rises upwar through the channel B, and falls on the cascade over which it flows slowly downwards. By th means the feed-water comes in direct contact wi the steam of the boiler, which has free access to t interior of the apparatus through the pipe The feed-water is thereby heated to the te perature of the steam, and falls with the co densing water into the box E. It then ente through the passage F, the drum G, which conta six helix-shaped compartments. The drum is clos on one side, except the central opening, throug which enters the passage F, and is open on t other side. The lower part of the drum is immers in the semi-cylindrical basin H, the upper edge, of which is below the lower edge of the passage

The entering feed-water fills the compartments, and thereby causes the drum to revolve. The number of the revolutions of the drum is exactly proportionate to the quantity of water passing through. To reduce the friction in the journals as much as possible, the shaft of the drum rests on its two ends, at O and N, on friction rollers. The water passing out at the open end of the drum falls over the edge J, into the steam boiler. The revolutions of the drum are transmitted to the shaft L, arranged with conical packing, passing through cover K, and operating a counting apparatus, placed outside the steam-room. A small air-cock on top of the upper cover serves to permit the escape of the atmospheric air brought over by the feed-water.

As one of the merits of this apparatus we may mention that it is constructed without any packing. Moreover, the drum effects the measuring with such accuracy that it excels in this respect any other water meter, and this accuracy is not influenced in the least by impurities carried along by the feed water. The formation of scale will disturb the action of this apparatus much less than any other known water meter, there being, as already stated, no packing whatever, and all the cross sections being very large. The registering apparatus is entirely removed from the influence of water and steam. The basin with the drum, as well as the cascade, can easily be taken out and cleaned from scale either by the hammer or by treating it with diluted muriatic acid.

Another great disadvantage of other water meters is that in the case of interruption in their functions the feed of the boiler is entirely stopped; such a case cannot happen with the evaporation meter described above.—*Dingler's Polytechnisches Journal*.

SCIENTIFIC SOCIETIES.

CONFERENCE OF MECHANICAL ENGINEERS.

THE annual conference of the mechanical engineers of England commenced at Nottingham on Tuesday. There was a numerous attendance, including all the principal engineers of this country. The chair was occupied by Mr. Hawksley, of London. The following is a list of papers to be read during the conference:—"On Self-Acting Machinery for Printing Hosiery by Power," by Mr. A. Paget, of Loughborough; "On the Mode of Working and the Mechanical Appliances in the Midland Coal-field," by Mr. George Fowler, of Nottingham; "On a Steam Road Roller," by Mr. W. F. Batho, of Birmingham, and Mr. T. Aveling, of Rochester; "On the Mechanical Ventilation of the Liverpool Passenger Tunnel on the London and North-Western Railway," by the President; "On the Conclusions derived from the Experience of recent Steam Boiler Explosions," by Mr. E. B. Marten, of Stourbridge; and "Description of a Self-Acting Safety and Fire-Extinguishing Valve for Steam Boilers," by Mr. G. D. Hughes, Nottingham. On Wednesday, August 3, the best means of preventing boiler explosions was discussed. Mr. E. Marten, Stourbridge, stated that 219 explosions had occurred in England during the last four years, resulting in 315 being killed and 450 wounded. Eighty-four were Cornish or Lancashire boilers, 53 plain cylinder, 12 marine, 10 locomotive, 11 agricultural, 8 upright furnace; 6 crane, 6 rag steamers, 14 domestic, and 15 miscellaneous. The causes were:—Cornish and Lancashire, ill-formed tubes, weak combustion chambers, domes, &c.; plain cylinders, flat ends, and frequent repairs, resulting in seams and rips; marines, weak flues, &c.; and locomotives, want of stays. It was stated that the only preventive was constant and careful examination on the part of the owner. Government inspection was not recommended, as it would tend to relieve the owner of all responsibility. Mr. D. Hughes, Nottingham, brought forward a plan for the construction of a self-acting safety and fire-extinguishing valve. It was generally admired, the object being to secure boilers from the danger arising from pressure and want of water.

ENGLISH MECHANICS' SCIENTIFIC AND MECHANICAL SOCIETY.

THE fourth monthly meeting of this society was held at the society's room, Mechanics' Institute, Manchester, on the 3rd inst., when a paper was read on "The Ancient and Modern Means of Communication," by Mr. A. Tolhausen.

The speaker said that the double meaning of the word communication as being, firstly, the making known of certain things, and secondly, the means of passing from place to place, would necessarily lead him to two distinct considerations of the subject. After giving a brief outline of the different stages of written and spoken language, he compared the ancient mode of giving both diffusion and perpetuity to speech with the modern instructors of mankind "the Pen and the Press," and then proceeded to the postal and telegraphic systems as further means of communication without change of abode. The second part of the essay followed under the headings of inland and maritime conveyance, when the inland means of communication were considered, such as roads, coaches, rivers, canals, and the railroads, together with the maritime postal service. After the discussion the thanks of the members were awarded to Mr. Tolhausen for his interesting essay, and the following questions, forwarded by members, were proposed for consideration at the next meeting.

I. Give an explanation of the action of the ejector condenser, with a sketch.

II. Information required on Clayton's patent scraper, as used with the fuel economizer.

III. Any member's experience of the Birmingham patent safe and sure sectional wrought-iron boiler; how it is for steam-room, for comparative consumption of coal, and any practical information thereon.

LETTERS TO THE EDITOR.

[We do not hold ourselves responsible for the opinions of our correspondents. The EDITOR respectfully requests that all communications should be drawn up as briefly as possible.]

⁂ All communications should be addressed to the EDITOR of the ENGLISH MECHANIC, 31, Tavistock-street, Covent Garden, W.C.

All Cheques and Post Office Orders to be made payable to J. PASSMORE EDWARDS.

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"I would have every one write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks: a vice from whence great inconveniences derive their original."—*Montaigne's Essays.*

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⁂ IN order to facilitate reference, correspondents when speaking of any Letter previously inserted will oblige by mentioning the number of the Letter, as well as the page on which it appears.

SOME OF MY CRITICS.

[189] SIR,—At the risk of bringing down the wrath of Mr. Brandon on my head, I am strongly tempted (with your permission) to say a few words to a couple of gentlemen who have honoured me by criticising some of my more recent *dicta* in your columns.

And firstly, Mr. Usborne (140), p. 458, is indeed "a bold man," "taking up the cudgels" as he does, not against the present writer—who is, goodness knows, a sufficiently humble person—but against a most perfectly ascertained and well-known law of motion. It is as though a man should take credit for pluck in describing me as a bad arithemetician (which he might or might not have a distinct right to do), but who, all the while, was merely proclaiming that two and two by no means made four. Is it possible that Mr. U. has never heard of the composition of forces?

An express train on the Great Western Railway travels at the rate of 60 miles an hour; that is, 1,760 yards a minute, or 29⅓ yards in a second. Now, does Mr. Usborne seriously believe that if a missile were projected vertically upwards from the floor of a closed carriage in a train moving at this rate, to a sufficient height to retain it in the air for one second, that it would fall 29⅓ yards *behind* its initial point of departure? or, that if a man fell off the main-top-gallant mast of a ship sailing rapidly and smoothly along the Suez Canal that he would not fall accurately at the foot of the mast, because the vessel would have moved onward between the time of his starting and that of his reaching the deck?

I hope that your correspondent will not conceive that I am guilty of any want of what he is so flattering as to term my "invariable courtesy" if I counsel him to go to the next circus that comes into his part of the world, and notice carefully how anything that one of the riders projects perpendicularly returns to his hand, and does not (as Mr. U. seems to think should be the case) fall to the rear of his horse; or how the said rider, when he wishes to jump over a flag or through a hoop as he careers round the ring, does not spring forward, (he would infallibly go over his horse's ears if he did), but straight up. Having taken this easy practical lesson then, I would beg my critic to spend a shilling or eighteen-pence in any rudimentary treatise on mechanics (such as Tomlinson in "Weale's Series"), and read up the very elementary dynamics needful for its apprehension. Or he may turn to Mr. Kernan's paper on "Science for the Young," on pp. 318 and 337 of your current volume, for a *statical* demonstration of the composition of force, and so obtain an idea of how the proper motion of the engine which projects any given particle, never deserts that particle at any instant of its flight, but is always compounded with that of projection. If the earth were moving at the equator with a velocity of rotation of 10,000 miles instead of 1,000 miles an hour, and it were possible to shoot a ball absolutely perpendicularly from a gun (or rather a howitzer or bomb) in vacuo to the height of two miles, it would merely fall back into the muzzle again. After which it is scarcely worth while to remark, that Mr. Gould (p. 378 speaks, as I assume, of firing, what artillerists call point-blank from west to east, or east to west, and not perpendicularly at all; nor that "the theory of projectiles" *is* a most exceedingly complicated subject, albeit from very different causes, to those assumed by Mr. Usborne.

I have very little to say to Mr. Firth, p. 450. I will not be answerable for press errors, which I have no opportunity of correcting, and therefore he must fight out his 4h. 32m. and 8h. 32m. with your compositor. I, however, plead guilty to a *lapsus calami* in writing 28ht for 27th.

I have not discontinued—at all events permanently—giving "the times of rising and setting of some of the planets," as Mr. F. may see in the very number in which his own letter appears.

His third paragraph seems, to my obtuse perception, to be a remarkably successful imitation of utter nonsense. Suppose that I say that a certain superb instrument is situated in latitude 51° 28′ 38″ N., and longitude 0h. 0m. 0s., and that it is consequently in the transit circle room of the Royal Observatory at Greenwich. I wonder whether "it must be acknowledged by all" that "the inference or deduction is illogical?"

I have sir, a favour to ask you, and it is this: merely let Mr. Firth write your "Astronomical Notes" for September. He is, obviously, burningly anxious to distinguish himself; and if he has got it into his head that I derive the very smallest gratification from what, after all, is little better than mere compilation, the sooner he dismisses such an idea the better. I undertook these "Notes" originally at the special request of some brother correspondents in these columns, and have endeavoured to frame them in such a form as should be useful to the mass of amateur observers who read THE ENGLISH MECHANIC. I should sincerely like those of my brother readers who have employed the "Notes" to have Mr. Firth's, with his zodiacal signs, &c., &c., &c., for comparison. Besides, sir, you might sell another 10,000 copies or so weekly if it were known that Mr. F. "did the Astronomy," At all events, it would be only fair to give him the chance; as it is pretty obvious he will not fail for want of confidence, for that (as was once remarked of some one else) *Cerevisiam haud tenuem de sese existimat.*

A FELLOW OF THE ROYAL ASTRONOMICAL SOCIETY.

ERRATA IN ASTRONOMICAL NOTES FOR AUGUST.—Line 1, dele comma after "Greenwich;" line 3, sun's declination, for 1m. 31·9s. read 1′ 31·9″; line 4, "Cancer" should be *Cancri*; line 26, "point" is printed for *part*; in the second column line 9 from the end, "something" is put where I wrote *southing*; in line 3 from end, dele "then."

SEVERAL MATTERS.

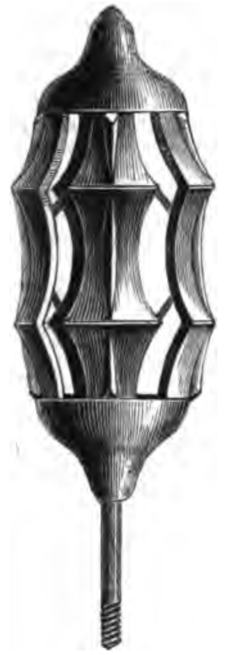
[190] SIR,—I have for some time thought of dropping you a note, and now take up my pen to do so. I must "follow suit" and congratulate you on your very good digestion. Within less than four months you have terminated the individual career of three publications by absorbing them into yourself. I have had some experience of journalism, but I think I never saw a speedier and completer change for the better than has been exhibited by the ENGLISH MECHANIC. You have enlarged your size and improved your type; you give better paper and better engravings. You give much superior information; you appear to have multiplied your correspondents, as you have certainly widened the scope and purpose of the paper. I write this without intending a word of flattery. But what pleases me most is the manner in which you have classified your contents. The information is not thrown together higgledy-piggledy, as it was a little more than a year ago. "Order is Heaven's first law," said Pope, and order reigns in the columns of the ENGLISH MECHANIC, say I. Having said so much in praise, I have also a fault or two to find—not so much with our editor as with some of our correspondents. Take, for instance, Mr. Proctor, for whom I have a profound respect. I sometimes say, "What a pity that so able, and withal so generous a man, should be so impatient of other people's shortcomings." One would have thought that his studious fellowship with the heavenly bodies would have imparted to his style of writing more of their calmness, dignity, and repose. Woe betide any unlucky mortal who may be in the wrong, and who may happen to assail Mr. Proctor; he is almost sure to be transfixed with an epithet. And then, again, the "Harmonious Blacksmith," who takes such liberties with orthography and grammar generally. Unfortunately he does this at our expense. A correspondent some months since said that he considered the space of the ENGLISH MECHANIC to be worth a guinea an inch. The "Harmonious Blacksmith" must look upon it as worth about a guinea a yard. He certainly says good things on a variety of subjects, but he uses such an extraordinary quantity of words that he deprives the information he is evidently capable of conveying of three-fourths of its value. The quickest way from one point to another is a straight line. The "Harmonious Blacksmith," instead of going from a point to a point in a straight line, is sure to walk in a circle, and sometimes he describes two or three circles before he gets to the point he aims at. This may be funny to him, but it is tantalizing to many of us who have very little time to spare. I wish, Sir, he would have a little consideration for our patience and your space.

I must take care or I shall subject myself to a similar reproach, so I will end by hoping that the *gentle hints* I have dropped may not be thrown away.

SUBURBAN.

ELASTIC BOILER AND TUBE SCRAPER.

[191] SIR,—The annexed cut illustrates a new boiler and tube scraper now being manufactured in New York by the Miller's Tool Manufacturing Company. On the iron rod or stem are pinned two conical cast-



iron caps. These caps serve as holders for the four scrapers, which are inserted so as to have half-an-inch bearing within each cap. At the back of each scraper is a steel spring, that allows the scrapers not only to be compressed and expanded but also to accommodate their shape to any unevenness that may happen to be in the tube. The peculiarity about these scrapers is that the scraping edges are chilled in casting, and then ground on emery wheels to a sharp edge. The point of one edge in each scraper projects past the other, so that the tube gets thoroughly scraped and cleaned throughout its entire internal surface. The thread on the stem allows piping to be screwed on to suit any length. The scrapers can be made to fit any tube, from 1¾in. to 4in. diameter, and the cost is about one-half of that generally charged for other scrapers. They are said to be durable, and for the purpose intended give entire satisfaction.

Kappa.

THE ELECTRIC LIGHT FOR PICTURES.

[192] Sir,—There are many things in this world that no "fella" can understand. Among those things I place my strangely erroneous statement that the evolution of light by electricity is unaccompanied by heat. Considering that before the year of grace 1820 I was familiar with and had repeated Davy's experiment of melting platinum within the luminous region between the two charcoal points, that I, of all "fellas," should have stated such nonsense, resembles my fellow correspondent's signature, "Pax Dei," in being past all understanding. When I read the falsehood and absurdity I had written, I felt strangely tempted to perform that act which has been said to indicate the utmost possible self-abasement, which act, Mr. Editor, I may, for the benefit of those, if any, who commit mistakes which make them feel as small as I did when I read mine, proceed to describe as the acrobatic feat of kicking your own seat of honour with your own foot. The force of self-abasement can no further go.

The advantages of seeing pictures by a light which hardly differs from that of day in its capability of shewing their true colours, and the absence of any objectionable chemical products of combustion, yet remain to induce my preference for the electric light over that derived from the burning of carbon.

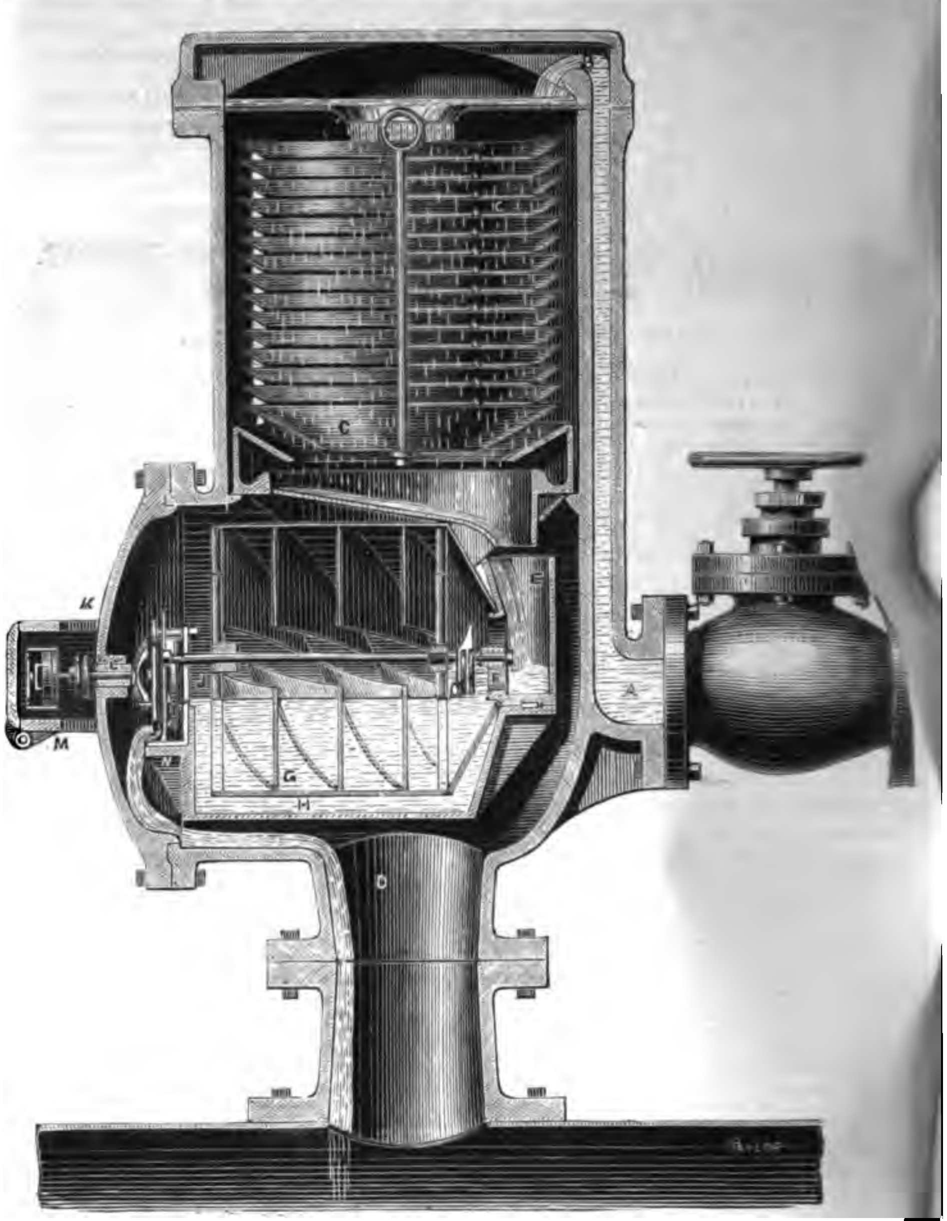
The Harmonious Blacksmith.

EMIGRATION.

[193] Sir,—I quite concur in all your correspondent "W. M." says upon this question, and there is no doubt that the country he indicates, Kansas, is a fine field for the industrious emigrant, more especially at this time, for such as are connected with agriculture or stock-raising. At the same time I would say that Texas has all the, advantages of Kansas with a most productive soil, and finer climate, except immediately contiguous to sea coast, only in some parts of that State. In the north-western parts it is eminently calculated for the growth of wheat; in the western for raising stock, on the vast rolling prairies; while Indian corn, oats, barley, vegetables, and fruit, are also raised in great abundance. Agricultural labour is in great demand throughout the State, single men earning from £2 to £3 per month, with board and lodging. These wages enable a man to save money, and at the same time he has an abundance of good food. You can suppose this when beef and mutton are not more than 1½d. per lb., and a bushel of wheat can be had for 8s., while as to butter, eggs, and poultry they are both plentiful and cheap. There is room in Texas for 20,000,000 of people. The Land Laws are very liberal. Land can be either purchased, or rented, at a cheap rate, and if a man goes there without capital he can have the loan of horses, implements, food for cattle, &c., without paying for same, other than the lender to have half of the crops, stock, &c., raised through the labour of the new comer. Of the eight million head of cattle supposed to be in all the United States, five millions are in Texas. They thrive on the rich natural grasses all the year round, and only require to be looked after from time to time to see that they are all right. I firmly believe that as this State becomes more generally known a vast tide of emigration will set in thither. It can be reached direct from English ports, and steamers from Liverpool run to Galveston in three weeks or thereabouts, or the emigrant may go to New York, and thence by rail at a cheap rate. I have several correspondents in Texas, all of whom give a highly satisfactory account of the country. In comparison with Canada, which being British territory is therefore urged upon the attention of the public as a good field for emigration, Texas is far, far superior, and a want of knowledge as to the advantages of the State is one of the chief reasons, why more do not emigrate thither. To the small farmer, or to the large one, Texas affords a certainty with care and industry, of realizing speedily an independency, and in many cases large fortunes. More especially will this be the case when the existing railways are extended further in, so as to form junctions with the Union Pacific Line and others, and when the Texas Lines are extended west into New Mexico, which as a silver mining district is vastly richer than any yet discovered in the Western States. Texas having a seaboard, though not with very good harbours, is an important feature in a new country for imports and exports, and the time is not, I believe, far distant when both Galveston, and more especially Saluria, in Matagorda Bay, will have a vast number of ships going forward and back to most parts of the world. From Texas may be imported to this country vast quantities of beef and mutton *fresh*, under an improved plan, and also the same plan as is now carried out with regard to Australian meat and its importation here may be adopted with large profits. I think it is the finest country in the world for English emigrants. I have no pecuniary interest in advocating the natural advantages of the State, either directly or indirectly. My only interest is to help in any way I can some of my poor hard-working countrymen here to go to a land of plenty, comfort, and security.

W. D. King.

[Our correspondent certainly gives a glowing account of Texas. Correspondents would do well to bear in mind that when they recommend so strongly any particular state or colony or part of a colony to intending emigrants they write under responsibility, and consequently should be careful in what they say; or, at all events, they should take especial care to well inform themselves before they write.—Ed. E. M.]



THE EVAPORATION METER FOR BOILERS. (*Described on page* 490.)

A SUGGESTION.—THE HARVEST, Etc.

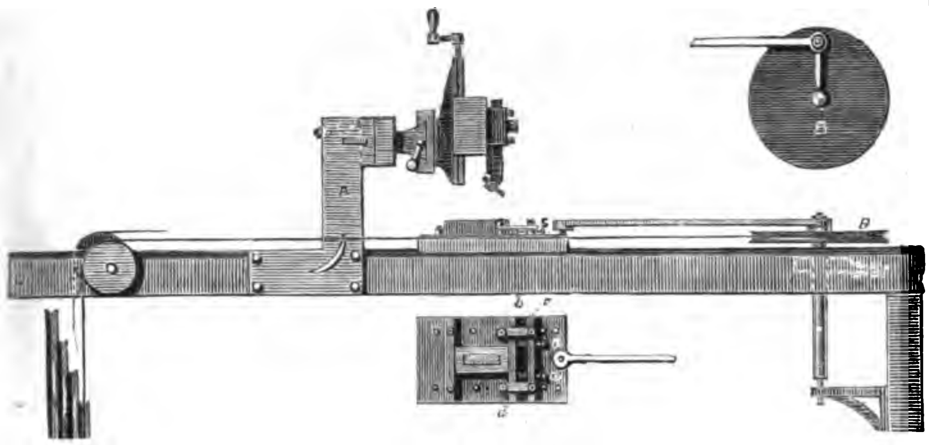
[194] Sir,—I have an uncontrollable passion for questioning. Sometimes such questions lead to pleasant surprises and valuable information. During a few days' ramble I have met with one or two incidents which may prove interesting to your readers. The 1st—Whilst at Kew Gardens Station my attention was drawn to a system of showing the times of the trains invented by the station-master. It is very simple, and saves many a minute of the porters' time. A board and a few strips of pasteboard are all that it requires. The time of the departure of every train during the day is printed on a slip of cardboard. These are placed in regular order, and directly a train has passed a slip of blank cardboard is placed over the slip indicating the time of that train, so that a passenger has only to glance at the table to know the time of arrival or departure of any train, and so on. I wish to goodness every station master would adopt this plan and place the board in a conspicuous part of the station.

2ndly—I don't believe in the alarmist cry of a bad harvest. As far as I can gather, grain will produce an average number of quarters. It is only upon light land that a failure occurs, and I opine that when the light land produces a good crop the heavy land fails, and *vice versa*. A fact I know is that here the wheat, beans, and barley are good—very good.

Lastly, your contributor, Mr. Underhill, would shout with delight to be encumbered with fossils, &c., as I am. I ask, "Do you meet with any fossils when digging?" "Yes, sir: I will show you some I saved." "Thank you: I am not much of a geologist?" "What is this, sir? and this, and this, &c., &c., &c. You can take what you please, sir." "Thank you." Such is a specimen of conversation held between your humble servant and those he questions. I declined taking specimens, thinking some one might prove more generous to the finder than I should, so they remain for the next wandering "English Mechanician" or geologian.

I have not seen your last issue, and may not see the next or the next. If, therefore, correspondents will take note of this, and querists content themselves by waiting, I will make up arrears as soon as I am near a library, and not so distant as three miles from a post-office.

C. H. W. B.



MOUNTING PLANING MACHINE.

[195] Sir,—Perhaps the accompanying rough sketch might prove of service to some of your correspondents desirous of mounting a planing machine on their lathe at a very small outlay. Should your space permit the insertion of the drawing I should feel much gratified.

A is a Z-shaped casting of iron, firmly bolted to the side of the lathe-bed by four bolts. To it is firmly bolted a compound slide rest. A gut band passes from the smallest pulley of the flywheel over two pulleys fixed to the bed of the lathe near the cone headstock; the gut passes along round a disc B having a radial slot, and bolt, which is adjustable, seen also from above. A rod passes from the bolt to the tail of the saddle S, which carries the object to be planed, between two jaws movable by screws or other means.

This machine works perfectly with light cuts for casting 10in. × 5in. and adjustable to 5in. in height. The edges of the lathe-bed are chamfered. The slotted disc was suggested by Munro's planer in South Kensington Museum.

Geo. Crowe.

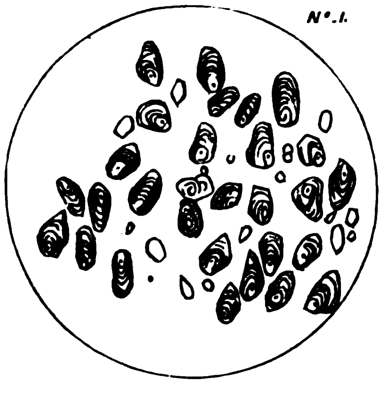
References in Plan of Saddle.

a. Screw to press removable bar *b* against casting.
d. Casting to be planed.
e. Iron bar which can be fitted to various holes in saddle in the same way as bar *c* carrying pressure screws.

MICROSCOPICAL JOTTINGS, CHEMISTRY, Etc.

[196] Sir,—It is not many months ago since I sent you some microscopical representations of starches of various kinds. If you think they are worth inserting I send some more. Fig. 1 is the genuine Maranta arrowroot, for which inferior varieties are often substituted. On p. 583, Vol. X., of the English Mechanic, I gave a figure of the Tacca arrowroot, referring to the Maranta, which I did not give; having now given it, your readers will be able to compare the two sorts.

N°. 1.



We often see in print that the starches are readily distinguished from each other under the microscope; certain kinds may indeed be thus distinguished, but to the "tyro" certain species are a source of infinite confusion. When potato starch is mixed with the Maranta arrowroot, and this is a case which often occurs in trade, it is not *easily* distinguished; the presence of the potato starch granules may be inferred by their size, but it must be remembered that there is no difference between a large Maranta and a small potato granule. There is, however, another mode of discrimination; the potato granule is *strongly* marked with concentric rings round the hilum—the Maranta granules exhibit this property in a much less marked manner; and again a few of the granules are too large to be classified as Maranta, and some of them are less regular in form.

On taking a sample of flour and magnifying it 200 diameters we find the granules *nearly* the same; in fact, to the tyro it would be the same, and the sample would be passed by as pure. But if they are only nearly the same, and not quite identical, there probably is a mixture of barley with the wheat. Fig. 2 shows a sample of barley meal; the outer husk has been separated from it as much as possible, and it is magnified 200 diameters. In barley flour we see more cellular tissue than in wheat flour, and the granules of starch are more often found enclosed in their cells. When a black or dark mass is seen, instead of using the needles and tearing it to pieces we may admit iodine water—this blackens the starch and only colours the cell tissue slightly yellow; on turning up a strong light, the object is clearly depicted. Portions of the husk and needle-shaped fragments are also seen in barley flour which are never seen in ordinary wheat flour. Exceedingly small granules are also seen in this flour as in wheat, and of the same form, with the exception that the hilum is more plainly seen.

N° 2

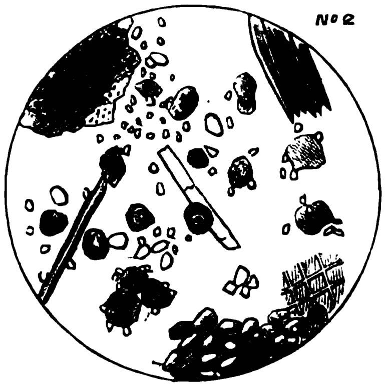
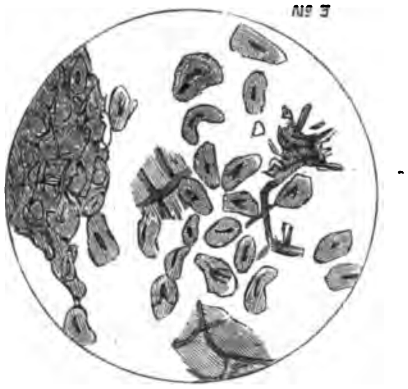


Fig. 3 is a sample of bean flour, which Dr. Hassall affirms was found in a sample of "cones."

N° 3



The granules themselves are very peculiar, being irregular in shape, and being marked with an elongated and deeply furrowed hilum. Cellular tissue is also seen, and there is a strange absence of the small granules which would answer to those of wheat and barley flour.

By the irregular form of the granule this kind of adulteration may be readily detected, but, strange to say, I have never had the opportunity of viewing it side by side with wheat flour in a commercial sample. The cut (Fig. 3) was made from a sample of beans, reduced to a fine powder by means of a file, which method answers exceedingly well for preparing samples of flours in the pure state for the purpose of practice in microscopical analysis.

"Sabbas" [4329] wishes to know what sort of a microscope to purchase. I should advise him to invest £5 in one of Crouch's instruments, with a ¼in. objective; this will show starches as the figures in this letter, and is nearly as good as one of Ross's instruments. If £5 is too much, get Field's "Society of Arts" Student's microscope, price £3 15s., with powers from 50 to 200 diameters; this is not nearly so good as Crouch's, but is a very good instrument.

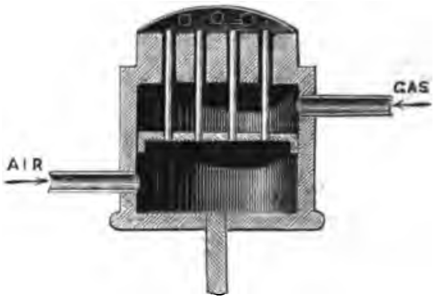
In answer to "C. R. H." [4328], he cannot expect to mount such an object as a cricket upon a glass slide; he can mount parts of it, that is all. Heat must be applied to the balsam to melt it, the object placed in it; air bubbles withdrawn by an air syringe; the thin glass cover put on and set aside for some hours. Very small insects, as the diamond beetle, may be mounted in a small box, so that the insect is exposed when a glass lid is withdrawn; but this is only done when the wing cases present a surface worth looking at. Seeds should be soaked in turpentine; petals may be mounted in water cells containing camphor. Zinc rings are the best for beginners to manage, the gold size takes easily to the surface. Glycerine is also very useful in mounting vegetable tissues.

Art Degrees, &c. [4355.]—"Beriro," if he is anxious to graduate, must do so at the London University. He must produce a certificate to show he is over sixteen years of age, pay a fee of £2, and go through a matriculation examination, held at the University of London, or at Owen's College, Manchester, Queen's College, Liverpool, or St. Patrick's College, Carlow.

The candidates for examination are examined in the following subjects:—Arithmetic, algebra, geometry (theoretical), the first four books of "Euclid," mechanics, hydrostatics, hydraulics, pneumatics, and optics, inorganic chemistry, Greek and Latin. The examination of Jan. 9, 1871, will be from the following books:—Xenophon, "Cyropædia," lib. ii.; Virgil, "Georgics," lib. iii.; "Æneid," lib. iv. June, 1871, Homer's "Iliad," lib. ix.; Cicero "Orat. II., in Catilinam." Besides the above, English language, English history, modern geography, and either the French or German language, at the option of the candidate. If "Beriro" passes the examination, after one years' study he is admitted to the higher grades, or examinations for B.A., M.A., D.Lit., B.Sc., D.Sc., LL.B., LL.D., M.B., M.D., &c. These are not given in the results of one examination; two examinations are required, except for the "Doctor" degrees, when three are requisite; and two years must elapse between the completion of "Bachelor" degree and the examination by which the Doctor's degree is obtained.

In query 4404, "J. M." asks for a sketch of Griffin's (Griffith's burner he says, but I suppose he means the well-known Griffin's furnace) burner, and wishes to know how the blast is arranged. Griffin's furnaces are arranged for heating either at the top or bottom.

The enclosed is a rough sketch of the burner. The air is supplied by a blowing machine, and a pressure of water upon the gas of ½in. is sufficient. The furnace for heating at the bottom is arranged thus:—A crucible jacket, crucible, and cover is placed upon a flat plate resting upon an iron stand. The lifter is then placed so that the crucible shall stand in the centre. A plumbago dome is then placed over the crucible, resting upon the lifter; the furnace is then built up with clay cylinders, and nearly filled with water-worn pebbles. When ready, the burner is connected with the gas on one side and the blowing machine on the other. The gas is lighted and pushed into its place in the flat plate whereon the crucible jacket rests. The blast of air is then sent in, and the progress of the operation can be watched by removing a plug in the lower cylinder.



For heating at the top—which arrangement, by the bye, is much the best—the perforated flat plate is placed as in the preceding, but instead of the lifter a cylinder is placed next. Over the perforation at the bottom is placed a hollow cylinder with holes in the sides and a solid top. Solid cylinders are now placed to the required height, and an outer clay cylinder placed in position. The annular space is then filled with pebbles, and a perforated flat plate placed on the top when the crucible and cover in its jacket has been arranged; the gas is then lighted, as in the former description, and allowed to play on the crucible before being thrust into its place, otherwise the cylinders will crack or the gas go out.

Possibly it may be unknown to "J. M." that Messrs. Griffin & Sons issue a guinea *oil lamp* blast furnace for melting metals. It will melt 1lb. of *cast iron* in twenty minutes, by the use of threepennyworth of oil at 8s. per gallon. The blowing machine is charged extra.

Chemical.—The reason "Prussian Blue" [4401] failed in attempting to make potassium ferricyanide was passing the gas into the solution too quickly, the solution was too concentrated, or he allowed the liquid to get hot. The grand secret, if there is any in the matter, is to *cool* the chlorine before it reaches the solution; to pass it in *slowly*; and, above all, do not add chlorine in excess. The end of the operation is determined by the solution giving no precipitate with a ferric salt. By acting on a dilute solution, and afterwards evaporating down to crystallizing strength, the potassium chloride is left with a little of the ferricyanide in the solution, while the greater part crystallizes out. This is the method I have always employed, and have found no difficulty in obtaining a pure salt. If, however, the temperature is allowed to rise, or chlorine passed in excess, hydrogen chloride is formed, and as this latter acid decomposes the salt at a high temperature, the operation is spoiled. I have seen students trying to prepare this salt when the solution has been actually boiling from the hot chlorine introduced. GEORGE E. DAVIS.

GALVANIC BATTERIES.—SLATER'S IRON CELL.

[197] SIR,—The clear and interesting description yougave the readers of your inestimable weekly by calling their attention to the subject-matter of a patent iron battery electro-magnetic engine, induced me to test their power in many ways, and compare the amount of work they would do, at what cost, taking the same number of cells of zinc and carbon (ordinary Bunsen battery), each having the same amount of surface exposed to the excitant. The result has far exceeded my expectation; and my great astonishment is that it has been so long kept from the public generally, or so very little notice or mention of iron as such a powerful element when used as a substitute for zinc.

I have read carefully most of the letters on electricity, &c., "given by that most worthy contributor to your pages"—"Sigma;" and although I cannot endorse all he says respecting this "Slater's iron cell," I have nevertheless to thank him for the careful and comprehensive method stated as the result of his experience. I will now proceed to explain the amount of absolute work done by the iron and carbon battery in 25 hours; ditto zinc and carbon (Bunsen), 25 hours; each a series of 24 connected to its voltameter and from thence to two gasometers.

At the end of an hour the zinc carbon had 42 cubic inches of the mixed gases (decomposed water) more than its rival; in 2 hours, 5¼ cubic inches only more than the iron; the 3rd hour the iron took the lead, and stood 34 inches ahead of the zinc; 4th hour, 76½; 5th, 115; 6th hour, 160¼; 7th hour, 214; 8th hour, 275 inches more than the zinc carbon. At this time I was compelled to leave them until the expiration of the 25th hour, when the iron carbon had the advantage by 1,762 inches.

There was considerable energy in the iron and zinc at this time, but the Bunsen was exceedingly feeble, as the galvanometer showed a deflection of only 14°, while the iron stood at 37°. I had previously weighed the metal before commencing. The zinc had lost 9 ounces more than the iron and required 5 plates to be re-amalgamated.

Experiment No. 2.—I resolved to try them another 25 hours, again to compare their work and comparative cost, which were as follows:—

BUNSEN.	s.	d.
Nitrous acid, 30lb. at 4d.	10	0
Sulphuric, 6lb., at 1½d...	0	9
Mercury for amalgam	0	6
Lad—attendance to ditto	1	9
	12	0

SLATER'S CELL.—The density of the fluid in porous cells had considerably weakened, and took 27lb. of the mixed nitrate of soda and sulphuric acid to get up its standard strength of 14·50. The cost of this, as I buy the material, amounts to about the same as sulphuric acid alone. The addition of water to dissolve the soda brings it within a fraction—namely:

	s.	d.
27lb. at 1½d.	3	4½
Attendance	0	6
	3	10½

or 3s. 10½d. against 12s.,—being an advantage of more than 8s. in favour of the iron cell, saying nothing of the extra work done by the iron. The result of the second day's trial was more in favour of the iron, more gas being liberated and much more zinc lost by local action. Indeed, some of the plates were used up, while the iron showed no sign of ill-usage beyond a uniform thinning. I find no use in making the solution in contact with the iron very strong, as there is a useless evolution of hydrogen with but little extra power; and when the porous pots have been used a few days I do not find that the solution rises in them as "Sigma" speaks of.

Sea-water is a uniform and excellent excitant for the iron. I am using this battery for an electric light with great satisfaction; and am sure that when its great power and the cheapness of the working cost is made known it must become a great favourite.

~~As~~ I must not trespass further now, I will, if agreeable to your readers, send the result of further experiments with a series of 36 cells. I wish you and your scientific contributors every success. OMEGA.

BICYCLE RIDING AND WALKING.

[198] SIR,—As various letters on the "Bicycle" have lately appeared in the ENGLISH MECHANIC, all very much in favour of this new machine, I think a few words from myself—I having been in continual practice for over twelve months—may be of some interest, and save much disappointment to those of your readers who are about to learn.

Some time back, at the first introduction of these machines, I, Herman Sloman, and others, while advocating the use of them for amusement and exercise, deprecated their utility for practical purposes or economising force. A correspondent at that time calculated theoretically the difference between bicycle riding and walking; he concluded an elaborate calculation proving that the force necessary for walking a distance, say five miles, if put into use on the machine, would only carry three miles, or little over two thirds. These calculations were based on the fact of the bicycle not taking the rider, but *vice versâ*, the rider pushing the machine, of which, by experience, I am painfully aware.

I have travelled most of the Surrey and Kent main roads, and find (with the bicycle), taking the roads as they come, and using force enough to thoroughly exhaust myself on a twenty mile journey, an average of about four miles an hour to be the outside speed, I can continue the journey—this being less than my walking pace. The machine I ride is a 38in. wheel; my height is 5ft. 10in.; weight 11 stone. On a walking tour I manage generally to do about 30 to 40 miles a day, which, up to the present I have not been able to do on the bicycle; although, had I trained twelve months for a walking expedition, I am satisfied 50 miles within the 24 hours would be rather under than over my power of endurance. My experience makes me believe that those of your correspondents who write of travelling 15 miles an hour on the bicycle must either be joking, or totally unacquainted with the subject. I will admit that on a level asphalte road, say a quarter of a mile round and perfectly level, a very high rate of speed may be obtained; and so it is with the locomotive, which on a plain road travels at 10 miles an hour, but on rails, where the friction is reduced to a minimum, 40 miles is done easily. I therefore consider the bicycle a toy, and only fit for exercise; although there are some men particularly fitted for these exercises, which perhaps may explain some of the astounding feats of which we read; but I find, on enquiry amongst my friends, that the majority join me in discarding the machine for all practical purposes.

If enthusiasts think it necessary to have a manual machine for utilizing force, I cannot recommend them anything better than a round wire cage similar to that of the squirrel; by imitating the movements of that industrious little animal, they may produce motive power to their hearts' content. A wheel-barrow, also, would do, but has the disadvantage (as some bicyclists say) of not utilizing the weight of the body. I can quite agree with your sensible, but facetious correspondent, "W.," who on a long journey thinks it better to carry the bicycle; and I am perfectly satisfied, joking aside, that on ordinary hilly and dusty roads it is much easier to walk behind and push the machine with the hands than to mount and force it forward by using both hands and feet. R. G. BENNETT.

POST-OFFICE ORDERS.

[199] SIR,—You will be as well able as any one to judge of the expediency of my proposition, and hence it should interest you to insert my letter. There are many of the readers and subscribers of your journal who are constantly wanting to send small sums to you, to their tradespeople, to their children at school, and to their correspondents at home and abroad; and the same applies to the world at large. Now, stamps are troublesome to all parties, and a temptation too strong for many postmen to resist, and a 3d. Post-office order is a heavy tax on 6d. to 2s. 6d. Hence, I would ask, could not a short and counterpart ticket system be adopted by the Post-office authorities, at ½d. or 1d. charge, to be more convenient and safer to the public. And again, as an old colonist, I have often to write for advice, and often to those who don't like to pay 6d. to oblige me; and which I quite as much object to their doing; but as our stamps are useless there I do not like paying 4d. or 6d. to send out 6d., and therefore do not sometimes get replies, of course. And I am but one of many tens of thousands, and I say the public servants ought to study the public convenience and interests in some suitable way; but by your inserting the above it may lead to a useful consideration of the same.

L. HEWETT, C. and M. Engineer.

MUSICAL.

[200] SIR,—In looking over the pages of our MECHANIC this week, my eye caught a letter headed "Musical," in which my name figured; and I naturally expected to find something interesting and instructive, at least for myself. I am sorry to have to say that I was disappointed. I do not wish to be harsh to any of our correspondents, but why should people write upon subjects about which they evidently know nothing? Nearly the whole of the letter is simply unintelligible to me. The part commencing "and why should signatures," and ending "flats or sharps," is particularly obscure; and after puzzling over it for half an hour, I am almost inclined to follow the example of our excellent "F.R.A.S.," and offer a small prize to any one who will discover what it means. "Music" seems to think that something "ought to be glaringly apparent" from his arguments (?). Perhaps it is all clear enough to him—I can only say that I do not understand it. Then there's the question:—"What remains of the seven, being flats or sharps." I'm sure I will not pretend to say; perhaps "Music" will kindly give your readers the interesting information. Will "Music" tell us something further about "the very effective mode of marking expression by joining the stems of the notes," as it is possible that some others of our readers, like myself, may never have heard before of such a mode of marking expression? "Music" first enquires what is the origin of the stave, and then immediately assumes that without doubt "it represents the strings of an instrument," &c., on which (wrong) assumption he proceeds to enquire:—"could any notation be [illegible] musical?" This appears to me a rather [illegible] establishing one's point. In conclusion, "Music" [illegible] himself pointed out the only means of gaining a [illegible] ledge of this subject, and I should advise him to [illegible] himself vigorously in the way he indicates, so that [illegible] next letter may be a little more intelligible.

I notice on page 431 a query upon tuning by [illegible] temperament. A proper reply to this would [illegible] good deal of space, and require a small sketch [illegible] musical type. If our editor is willing to make room [illegible] will give the information next week, as doubtless [illegible] would interest many readers besides the querist.

J. N. T[illegible]

[We will "make room."—ED. E. M.]

MR. RUDGE'S AIR PUMP.

[201] SIR,—Will your correspondent, Mr. R[illegible] have the goodness to give some description of [illegible] pump? At present, we are indebted only to [illegible] Mr. Taylor's engraving for a very good elevation [illegible] instrument, but this, for *practical men*, is comparatively worthless; and as the greater part of your readers [illegible] practical men, it is a great *desideratum* that [illegible] formation should be of that character in order [illegible] may be useful.

He says, "And as you will see, from the [illegible] brings the mercury down to the 30th part of an [illegible] Now if the pump *will* produce such a vacuum, I [illegible] do not see how the "photos" can show it, the [illegible] do what few pumps will do.

What does Mr. Rudge mean by "a metallic p[illegible] mechanically fitted?" I have not the faintest conception. I know what "metallic pistons" are in a general scientific use of the term, but they are, [illegible] inapplicable to the air pump. Again, how a "stuffing box" can be "composed of twelve collars of leather" I cannot comprehend; or in what way the "[illegible] chamber," "the piece of hollow brass," the "other pieces of leather," and the "end of the *gland*" are connected, I am quite at a loss to *discover*. Again, he speaks of the valves; but he *does not say what valves*, or where they are situated; and *there is no indication* in the drawings, admirable as *they are, to show where or* what they are.

From the position of the pipe leading to the cylinder I opine that it is on Tate's plan, but I should be glad if the maker would give a more special and accurate account of the pump *internally*, the external construction being sufficiently clear from the engravings. Will he also be good enough to state the kind of oil silk he uses and where procurable; what kind of oil he uses; and how the piston is oiled?

I shall be happy to answer any enquiries on the subject of my coil. INDUCTORIUM.

MR. PROCTOR AND MR. LOCKYER.

[202] SIR,—I thank "Luke the Labourer" for [illegible] "wishing to be hard" upon me. He is most [illegible] and considerate. Yet I should deserve no mercy [illegible] ever if I had really acted as he supposes. [illegible] with, I could not even plead ignorance, [illegible] read all Dr. Dick's charming works on astronomy [illegible] even if not, how could so obvious a fact as the [illegible]ment of the sun from certain parts of Saturn by [illegible] ring system—a fact which every one who has [illegible] the planet through a telescope can see for him[illegible] become the subject of a reclamation. The [illegible] preposterous, and had I made so ludicrous a [illegible] "Luke the Labourer" might have been hard upon [illegible] with a vengeance.

Premising that I charge Mr. Lockyer with no[illegible] worse than *forgetfulness*, I will now submit to [illegible] readers the passages from my "Saturn and its System" and from Mr. Lockyer's "Elementary Lessons [illegible] Astronomy." After referring to Table XI. (forming [illegible] octavo pages closely crowded with figures, which I [illegible] occupied seven weeks in calculating, *and every detail [illegible] which was absolutely new*), I proceed—"From this table it will be seen that . . . (for instance), in latitude 40° (Saturnian), the eclipses begin when nearly thr[illegible] years have elapsed from the time of the autumn[illegible] equinox. The morning and evening eclipses contin[illegible] for more than a year, gradually extending until the sun is eclipsed during the whole day. . . These tota[illegible] eclipses continue to the winter solstice, and for a corresponding period after the winter solstice; in all for 6 years 236·4 days, or 5543·0 Saturnian days. This period is followed by an interval of more than a year of morning and evening eclipses. The total period during which eclipses of one kind or another take place is no less than 8 years 292·8 days. If we remember that latitude 40° on Saturn corresponds with the latitude of Madrid on our earth, it will be seen how largely the rings must influence the conditions of habitability of Saturn's globe, considered with reference to the wants of beings constituted like the inhabitants of our earth."—"Saturn and its System," p. 181.

In the "Elementary Lessons of Astronomy," Art 276, Mr. Lockyer writes:—

"In latitude 40° we have morning and evening eclipses for more than a year, gradually extending until the sun is eclipsed during the whole day . . . and these total eclipses continue for nearly seven years; eclipses of one kind or another taking place for 8 years 292 days. This will give us an idea how largely the apparent phenomena of the heavens and the actual conditions as to climate and seasons are influenced by the presence of the rings."

And, as I said in the letter on which "Luke the Labourer" comments, there is nothing to show that these results (forming part of a series which I obtained by long and laborious calculations) were not obtained by Mr. Lockyer himself—not even inverted commas.

But I repeat, as respects this passage and three other far more noteworthy instances, I make no charge against Mr. Lockyer, save of having forgotten to duly indicate the source whence he had derived his information. Had the complete omission of my name from his book been intentional, the matter would have been different. As it is, I should not have referred to it at all but for the angry and discourteous note he appended to a paragraph in which I had paid him a high but not undeserved compliment.

The fact is, that Professor Pritchard and Mr. Lockyer combined their forces to attack me (apparently for no other reason than that, like them, I work in the field of popular astronomical literature). If in self-defence I have faced them, and dealt each a blow "straight from the shoulder," they have themselves only to thank. I am neither quarrelsome nor thin-skinned; but no one shall make unjust and ill-mannered attacks upon me with impunity. *Pacem amo, bellum non timeo.*

Richd. A. Proctor.

WINDMILLS.

[203] Sir,—In reply to "Derf Errac," page 450, letter 152, I should recommend him, before going to work upon models, to procure Smeaton's work on the "Theory and Construction of both Vertical and Horizontal Windmills." Smeaton was the engineer who built the famous lighthouse on the Eddystone rock, near Plymouth.

He should also know that the rustic form of horizontal mill was in use among the Tartar nations before the time of the Crusades. Vallani's plan for the same object may be frequently seen set up in the gardens of retired sailors, in the form of four full-rigged ships fixed at the extremities of four arms revolving upon a central pivot, a form that has been known ever since vessels at sea were found able to turn a complete circle with the same wind. All these forms are powerless for effectual work, unless constructed of colossal dimensions, and then their speed is so slow that formidable trains of wheels and pinions are required in order to perform any useful work

"Derf Errac" is astounded at the magnitude of the proportions of my horizontal mill, but the arms are only 18ft., whereas in the common vertical they are often 30ft. long. It is true that there is an addition of 12ft. to the radius, for the funnel openings are indispensable for concentration of the wind, without which no useful purpose can be obtained; and it may be observed that there being no movable parts, there is no wear and tear.

If "Derf Errac" would take the trouble to construct a model of my machine at the expense of a few sticks and some sheet zinc, he will find the immense advantage of concentration still greater on the large scale.

A horizontal windmill was to be seen at the beginning of the present century at the south end of Battersea Bridge, but being constructed on erroneous notions, it was soon done away with. It was in the form of a tower 80ft. high., with no provision for concentration, as may be seen in old views of Battersea Bridge. I was in that mill, however, before it was taken down, and found that it was only driving one pair of stones at a very feeble speed.

Henry W. Reveley.

ARTILLERY DISCHARGES AND RAIN.

[204] Sir,—I am not at all surprised that the Editor of the *Times* thought the letter of "R. P." (page 448) not worth publishing, for had your correspondent been as well informed upon the subject he writes upon as he professes to be, he would have known that the question has often been mooted, but no "right men" have ever thought it worth taking it up. By the way, what does "R. P." mean by "right men"? Does he mean Government officials, who might be induced by some "moonshiny" theory, to squander the public money in vague experiments? or does he mean private individuals? If the former, taxpayers would raise a very decided and rational objection. If the latter, I do not think any private individual could be found foolish enough to spend either time or money, for the benefit of a few, in making experiments, the theory of which is pure fiction.

I maintain that rain is *not* the inevitable result of a concussion of the air, for I have particularly observed the weather after artillery practice on more than one occasion, and as an instance of great concussion of the air which did not result in a fall of rain, I may mention the explosion of the *Lotty Sleigh*, in the Mersey, a few years ago. This explosion was so terrific that the noise was actually heard at Birmingham, a distance of about 60 miles. But, supposing for the sake of argument, that "R. P.'s" theory be correct, I would ask him of what utility would a continuous discharge of artillery, or a gunpowder explosion, be under a cloudless sky? In cloudy weather it would be mere labour in vain, or waste of labour, to cause a concussion of the air for the purpose of forcing rain, inasmuch as a voluntary shower is, in nine cases out of ten, inevitable. Again, allow me to ask "R. P." how many explosions of "Government powder-mills" or continuous "discharges of artillery" would be necessary to cause *one* shower of rain over the whole British area?

I am "quite at sea" as to the relevancy "a stone thrown into a pond" has to an explosion of gunpowder, but perhaps there is some deep philosophy in the allusion beyond my poor comprehension. I think the "mythical millions" that a want of rain has already cost might have been saved, and the "calamity" of a continued drought not only mitigated, but completely averted, if the "agriculturists of England" had exercised their common sense. It is pitiable to find that they do not give a wider meaning to their own proverb of "making hay whilst the sun shines;" if they did so, they would "catch water when it rained," and preserve it in *tanks* properly protected, which would be sufficient to supply all their wants during the drought.

In conclusion, allow me to ask "R. P." upon what authority does he assert that "clouds passing over us, unless drawn down by gunpowder, empty themselves into the German Ocean?" I feel inclined to think this is an original idea, and that your correspondent is his own author.

Lex.

[205] Sir,—During four years whilst I was at Woolwich, when the sky was very cloudy and overcast, whenever the artillery fired upon the Common rain generally ensued. I am inclined to think that a rapid succession of discharges from field guns would prove more efficacious than a few discharges at intervals from heavy guns.

Oliver Haldane Stokes, Captain (late) R.E.

HOW COD-LIVER OIL IS MADE, AND HOW IT SHOULD BE TAKEN.

[206] Sir,—As one of our subscribers has asked some questions about this important oil, I propose, with your permission, to lay before our readers a short account of the oil, and the best manner to administer it.

As its name denotes, cod-liver oil is made from the liver of the common cod-fish, and other species of Gadus frequenting the seas of Northern Europe and America. The following are the most important species of the oil-yielding fish, in a medical point of view:—*Gadus morrhua* or the common cod-fish; *Gadus callarias* or the dorse; *Gadus molva*, or the ling; *Gadus carbonarius*, or the coal-fish; and the *Gadus mulangus*, or the whiting. From this list it will be seen that cod-liver oil is the product of many other species of fish besides the common cod.

The oil may be extracted from the livers by three different methods:—By exposing them to the sun to undergo a process of fermentation; by boiling them in water for some time; or by dividing the livers and permitting the oil slowly to drain from them. This method is now employed in the preparation of the best English cod liver oil. The following is the way in which the oil is made at Messrs. Bell & Co.'s establishment:—The livers are collected daily, so that no trace of decomposition may have occurred, carefully examined, in order to remove all traces of blood and impurity, and to separate any inferior livers; they are then sliced and exposed to a temperature not exceeding 180° Fahr. till all the oil has drained from them. This is filtered; afterwards exposed to a temperature of about 50° Fahr., in order to congeal much of the solid fat (margarine), and again filtered and put into bottles well secured from the action of the air.

Three varieties of cod-liver oil occur in commerce, distinguished by their colour—the pale, prepared in England, or elsewhere; besides which are the light brown and dark oil from Norway. The difference in colour in the different oils depends upon the circumstances attending their preparation—as the amount of heat employed, the state of freshness or putridity of the livers, the quantity of decomposed matter present in the oil, and the length of exposure to the atmosphere. The following test is given in Dr. Garrod's "Materia Medica," from which also I have obtained some of the facts as to the preparation, &c., of the oil. When pure cod-liver oil, spread in a thin layer on a plate, has a drop of oil of vitriol added to it, a beautiful lake or crimson colour is produced, rising from the point of contact of the oil and acid, and rapidly spreading over the surface. This is probably due to the action of the acid on the biliary principles present in the oil. By this simple test the pure oil is at once detected; for when other oils not of hepatic origin are present, the sulphuric acid does not give the lake colour, or this becomes immediately mixed with and obscured by a dark brown substance from the charring of the oil. Such is the case with whale or seal oil, also with olive and other vegetable oils. Some of my readers may wish to know what cod-liver oil is composed of. It contains oleine, margarine, various biliary principles, also phosphoric and sulphuric acid, with salts of lime, magnesia, and iron, and a peculiar substance called gaduin—very insoluble in ordinary menstrua, but soluble in sulphuric acid, and giving a blood red colour to the solution; also traces of iodine and bromine; the proportion of iodine is not more than 0·5 per cent.

Cod-liver oil is a remedy which, at the present time, stands in very high estimation; nor does it appear probably that its reputation will be ephemeral. When taken by patients who have become emaciated from any cause, and whose blood is impoverished, it frequently restores the flesh, and, from Dr. Theophilus Thompson's statements, it appears also to improve the richness of the blood. Under its influence, patients often increase greatly in weight, the inscrease exceeding many times the amount of oil consumed during the period. It has been supposed that the iodine and bromine contained in it might produce the beneficial results, but this idea is not tenable, for the effects of these latter remedies are very different from that of the oil; it would seem probable that it acts simply as an oil, and that it is superior to other oils on account of its being more readily assimilated. If the statement of Winkler, prove correct—namely, that the oleine differs from ordinary oleine in not yielding glycerine—this may in part explain its value; but how it acts is still undetermined.

Some people find the oil unpalatable, from the manner in which they take it. Thus, some take it upon ale or porter, others upon milk or water. Can it be wondered at that such patients cannot "master" the oil? I have always found that the oil can be taken better upon some orange wine, or some mixture containing quinine and sulphuric acid. The acid covers the taste of the oil, and the quinine acts also as a tonic. Some patients cannot even take the oil when thus mixed with the acid mixture, and for the use of such I recommend the following:—Take of picked gum Tragacanth ¼oz., dissolve in 20oz. of boiling water, add sugar according to taste, now pour into this mucilage 10oz. of the best cod-liver oil, shake well; three drops of ess. lemons, and the same quantity of ess. almonds should now be added, and if you wish to keep the mixture for some time add 2oz. of brandy. In this compound the oil combines with the gum and forms an emulsion of a milky-white colour, which few will know from a well-made custard. The dose of this mixture is just double the quantity of the pure oil. The dose of the pure oil is from 1fl. drachm to 1oz., taken at the time of a meal or immediately after food. It is often advantageously administered at bed time; and my friend, "A Mechanic," will be able to take his at dinner-time, and so dispense with a pudding.

Patients often find that after they have been taking cod-liver oil for some time they turn from it with disgust. Why is this? I have already remarked that of all oils the cod liver oil is the most easily assimilated by the system. But after a time the intestines refuse to absorb it, and that being the case it passes through them, and is found in an unaltered state in the fæces; thus, by a wise provision of nature, directly the oil is of no more use, a dislike is felt for its employment. If, then, people find that after they have taken cod-liver oil, say for two weeks, it does not agree with them, they should leave it off for about a week or so, then take it again, and so on. By these means the full benefits of the oil will be derived. I trust that these remarks may be of some use to your readers.

C. J. H. W.

CARRIAGE WHEELS—THE PHANTOM AND OTHERS.

[207] Sir,—In the controversy on the relative merits of the spider and phantom wheels, which are but differently proportioned examples of Jones's suspension wheels, modified to render them suitable for light vehicles—modification which may be taken as representing the most modern forms of the principle of suspending the weight to be carried from the top of the wheel by rods or chains, instead of supporting it on legs or struts, which is just what wheel-spokes are—in the common way is carried out.

As it is well known that a very much greater weight can be safely supported by an iron or steel rod when that weight is suspended to it than it can safely bear if employed as a column in constant motion, like a wheel spoke, which must not only be incompressible, but also sufficiently rigid not to become bent in use, it follows that so long as it is not employed to communicate the driving forces from its nave to its periphery—in other words, so long as it is not required to act like a cogged or toothed wheel, or as part of what is termed "frictional gearing," but as a mere *trailing* wheel, and its axle is kept nearly horizontal—a wheel to carry with safety a given weight may be constructed on the suspension principle far lighter than in the ordinary manner.

Suspension wheels have the further advantage of being somewhat cheaper than those with spokes, for rod iron or steel is less costly than spokes, even when the latter are formed by automatic tools (not to mention costly hand labour), as in the case of artillery and waggon wheels constructed for Her Majesty's military service; but, as ordinarily made, they are very unfit—from their want of rigidity, in the direction that the driving force is communicated—to act as *driving* wheels either for locomotives or velocipedes. A driving wheel requires rigid arms or spokes, just as a cogged wheel does, and the only practical question is how the needful rigidity may best be obtained without needless increase of weight.

The usual method in the case of locomotive wheels is to construct the spokes of rigid iron, so that they may not sensibly bend when transmitting the driving force. When this plan is carried out in a velocipede it adds considerably to the weight of the driving wheels, which is a serious objection when it is considered the rider has to lift his carriage up-hill, which he must do when ascending inclines. The "Phantom" may be sufficiently rigid, especially if of moderate diameter; but, if I rightly understand, it has the same defect as the "Spider," viz., that each pair of suspending rods are attached to its nave in the *same* plane. Now if the rods be short, as in the case of a 36in. or 42in. wheel, they may, if unnecessarily thick, be rigid enough to perform the function of levers, and transmit the driving force from the axle to the periphery of the wheel, without the weight of the latter being made very great, but it is obvious that if the rods are only strong enough to (safely) suspend the weight of the carriage and its rider, they cannot, when each pair is in the same plane, also be *rigid* enough to act as levers for transmitting the driving force.

To enable a suspension wheel to become an efficient driving wheel, each pair of rods, instead of being in the same plane, should be attached to its nave at a distance apart equal to the nave's diameter; that is to say, in nautical language, attached *fore* and *aft*.

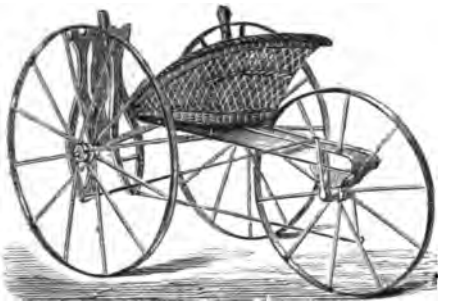
All the suspension wheels I have seen, until the principle was applied to our hobbies, *alias* velocipedes, have been *trailing* wheels. All cart, omnibus, cab, and railway carriage wheels—excepting the driving wheels of locomotive engines—come under this category; and for railway carriages whose axes are nearly horizontal—excepting when the wheels are so stupid as to run off the metals—I think suspension wheels are specially suited. I have a very strong opinion that when my respected friend Bridges Adams' notions of the advantage of reducing the dead weight to be hauled have come to be appreciated as they deserve, suspension wheels, with mild steel rods, of a quality resembling steel music wire, will come into use, not only on account of their much smaller weight but also because of the great facility of repairing them. Weight is of comparatively little importance on level railways; for a wheel, even if it were a solid disc of iron supports its own weight, and therefore that weight does not add to the force of traction required to haul it; but when we encounter gradients of one in twenty or more, all the weight of the train has to be lifted to the summit level, and this requires more coal than to make it follow its leader on a horizontal line.

It will be understood that I do not propose to make the driving wheels of a locomotive engine on the suspension principle. In them weight causes "bite," and so long as the wheel and rail have to be pressed together it can little matter whether comparatively light wheels are pressed to the rail by a load on their axles or by the weight of the wheels themselves. On the contrary, the heavier the wheel the greater the "bite," irrespective of the load on its axle; so if the driving wheels of a locomotive engine were solid castings, like a pair of iron-edge runners (which one of my men called cast-iron grindstones on the same principle that our Mary Ann says she "biles" unclean garments in her "iron" copper), it would be attended with the advantages of less wear (from diminished pressure in the axle-brasses) and cheapness of construction, for it costs less to cast a heavy disc than to forge a wrought-iron locomotive wheel.

If you think a suspension wheel on the principle I suggest worth engraving I shall be happy to send a drawing. THE HARMONIOUS BLACKSMITH.

TRICYCLE BY H. CHILDS.

[208] Sir,—According to my promise I send you a photograph of a tricycle I have just completed, and am pleased with. It will be seen that the driving wheel is behind; it is 30in. in diameter, and the two front wheels 36in. ditto; hind axle 7in. long, with 8in. cranks at opposite points. The connecting rods are only ¼in. diameter. The two front hanging levers and pedals, as well as the centre framing, is of wood. It steers easily with the two handles firmly fixed to the front axle. It needs no brake, as it is under perfect control by the feet. The muscular exertion is not at all fatiguing, as the muscles of the body are as well supported as if sitting in an arm-chair. There is a steel spring across the point-axle which takes off all concussion. I can get up any moderate incline with it, and think it would do ten miles in an hour. The distance from axle to axle is 31in.; ditto, between front wheels, 34in. I beg to congratulate you on the success of your journal. H. CHILDS.



ANSWERS TO QUESTIONS.

[209] Sir,—When last doing this I forgot to state that "W. T.," who has had very considerable experience in "bushing," *i.e.*, lining with cloth the holes in the butts of pianoforte hammers, has partly written an article on this subject, which I expect will let more light in on it than anything I can say, who on such mere practical details can only shine by reflected light, *i.e.*, mere moonshine compared to that of the original luminary. May I request that my fellow-enquirers will in future adopt the advice of Di Vernon to F. Osbaldiston, Esq., and ask all merely practical questions *at* him instead of *at* me. He has promised to answer all such arrears in one batch, and not only reply to Mr. Moffat, No. 2640, but "correct"—*a la* tutor—I hope not with a birch rod—Mr. Kemble's odd notions concerning the bushing of pianoforte centres.

I cannot call to mind where I saw the engraving of the foghorn which "E. A.," No. 3780, desires a copy of, or would have sent it. It is voiced exactly like the reed trumpet pipe of an organ, excepting the proportions of the reed to the pipe, the former being very unusually large in proportion to the length of the latter, and made stiff enough to bear an enormous pressure of wind.

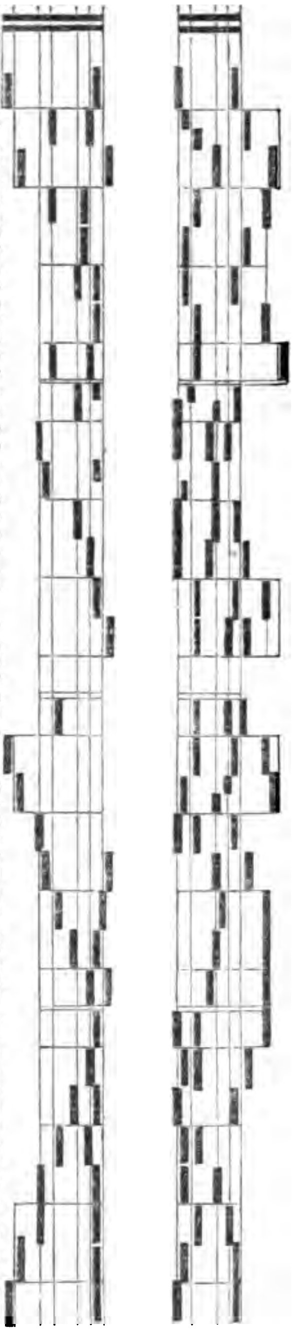
THE HARMONIOUS BLACKSMITH.

THE 100TH PSALM, ARRANGED FOR FOUR VOICES, BY GEO. COOPER, SEN., CONTRIBUTED BY THE "HARMONIOUS BLACKSMITH" FOR THE ESPECIAL BEHOOF OF THE TONIC SOL-FAISTS.

[210] Sir,—Rarely indeed do I fail to fulfil a promise, but mine to send a familiar tune in this notation, has remained so long unfulfilled that I am not surprised at an occasional gentle reminder. May I hope this will be received as reply to all demands.

In selecting "All people that on earth do dwell"—not even excepting those savage man-murdering races, the French and German, who have not only ceased to cultivate either social or musical harmonious relations with each other, but have also substituted for them that worst of discords, war—for the purpose of illustrating my old friend's system of musical notation, I have been induced to do so because all people know "All people," and because as almost all people possess "All people" in our ordinary complex notation, they will therefore be able to compare that with this, and, if wise enough, to admire its beautiful simplicity. If not all people, many people at the least among my fellow-readers, will also be able to compare this with the popular and much vaunted Tonic Sol-Fa system, which, to my crass ignorance, does not appear equally with this to possess the beauty of simplicity, however much of that same article some of the advocates of the Tonic Sol-Fa system may themselves have manifested.

As regards absolute originality, I fear I cannot justly claim for my old friend much more than most other inventors have exhibited. His notation, when examined by the light of the experience of those who are accustomed to music by *handle*, is resolved into a copy of the pins and staples of the barrel of that "horgan" made by the said handle to discourse the "sweet music" which drives Babbage to distraction, and compels quiet folk to pay for the privilege of silence, which we then—after this inflicton—do indeed recognize, in the words of the Chelsea philosopher, to be golden. This copy of these staples and pins, written on two staves of five lines each, is neither more nor less than the notation before the reader.



The idea of writing the notes or signs of the sounds uttered when the black keys are depressed on the lines, and those uttered when the white keys are struck in the spaces between the lines, for the purpose of avoiding the necessity of using signs for sharps, flats, and naturals in music, written for keyed instruments, with fixed intervals, is no novelty. If I am not much mistaken, it was done in the notation published by a reverend gentleman, whose name I forget—I think the same person who also anticipated Hawkins in the construction of apparatus which recorded musical performance on keyed instruments. About forty-five years ago I saw this notation engraved in an early vol. of the *Phil. Trans.*, date about 1680.

Anything simpler or more easily impressed on the mind of the intelligent tyro than that all the notes are of the same form, and the fact that the length of any one note in this system expresses its temporal value, it would be difficult to imagine; but this peculiarity, however valuable, cannot be properly termed an [illegible] —it is rather the observations of an existent [illegible] the lengths of the staples in the organ barrel [illegible] mine the time each of the pallets is kept open, [illegible] consequently the durations of the sounds of the [illegible] so a mere copy of these staples on paper show [illegible] relative lengths, and must have indicated the [illegible] each note to so appreciative a mind as Hawkins [illegible]

To those of my fellow readers who can [illegible] beautiful harmony I especially recommend this [illegible] ment or setting of the "Old Hundredth" [illegible] voices, in which the bass voice sings the [illegible] scale in contrary motion. For the manuscript [illegible] gem, which is by Geo. Cooper, sen., late [illegible] St. Paul's Cathedral and St. Sepulchre's [illegible] indebted to the kindness of my friend and [illegible] spondent "W. T.;" and I trust all my [illegible] readers, not excepting Dr. Ussher, from [illegible] heard but very little of late, to our [illegible] pleased with it.

THE HARMONIOUS [illegible]

FRUITLESS LETTERS.

[211] Sir,—Would you have the kindness [illegible] me through the Mechanic, or by letter, [illegible] can recommend that makes the best [illegible] adapted for dress making and general [illegible] you will greatly oblige me ?

Kearsley, Aug. 2nd, 1870.

[We frequently receive letters like the [illegible] we never on principle give the information [illegible] We think that a publication devoted to [illegible] cation, or, in fact, any other kind of [illegible] never recommend the goods of any [illegible] facturer. Weak journals may, and [illegible] things "for a consideration;" but [illegible] should be, like Cæsar's wife, "above [illegible] all events it is useless for any one to [illegible] letters as the one above.—Ed. E. M.]

MAMMOTH.

[212] Sir,—Only two skeletons of the [illegible] *Elephas primigenius*, are existing, I think [illegible]—the *mammoth of the Lena*, at St. Petersburg, and the [illegible] *of Lierre*, at the Museum of Natural History at Brussels. another specimen was discovered [illegible] near Tomsk in Siberia, and a commission [illegible] by the Academy for the purpose of [illegible] to St. Petersburg. I saw the magnificent [illegible] of the mammoth of Brussels some months ago, and [illegible] particulars of its discovery may prove interesting.

In the month of May, 1860, when [illegible] near Lierre (province of Antwerp), the [illegible] buried in the sands the skeleton of a [illegible] this skeleton was lying on the right [illegible] column very much bent; the head [illegible] was also a tusk of enormous dimensions; [illegible] ribs of the left side were missing, and [illegible] were broken, or rather discomposed. [illegible] military physician, recognized that it [illegible] of a mammoth. He had all the [illegible] they had lost their solidity; the head [illegible] weight, split and separated into [illegible] some other bones also suffered from [illegible] in the transport.

These ancient remains, deposited in [illegible] Brussels, deteriorated every year until [illegible] Dr. Dupont—so well known by his investigations [illegible] Belgian grottoes—undertook to restore them. [illegible] aided in this difficult task by Mr. Dapaun, [illegible] auxiliaries of the museum, who gave proofs [illegible] circumstances of great skill and perseverance. [illegible] months of laborious exertions the mammoth [illegible] was entirely restored in the action of walking.

The height at the nape is 3m. 60; the [illegible] Indian elephant, of which an adult skeleton [illegible] existing at the Museum of Brussels, is only [illegible] head weighs 250 kilogrammes, and the tusk [illegible] 2m. 90, following the curve.

The restoration presented great [illegible] well as the restoration of the missing [illegible] skull had been reduced into more than 200 [illegible] nearly a third part of the skeleton was [illegible] had to be carved in wood; the humerus, for [illegible] museum did not possess all the requisites, could [illegible] restored by the study of another humerus [illegible] the University of Ghent; one of the tusks is [illegible] one tibia and one rib do not belong to the same [illegible] but to an individual of the same species, [illegible] age.

The manner of putting together the [illegible] Lierre deserves special attention. In some [illegible] galleries the bones are perforated, and are [illegible] gether with iron wire, and so rendered motionless. [illegible] mammoth of Brussels has not a single bone [illegible] By means of some adjusting screws every bone [illegible] taken away and examined. The whole of this [illegible] skeleton can be taken to pieces in 20 minutes [illegible] up again in less than one hour.

For other particulars on mammoths, especially [illegible] that of the Lena, see *Intellectual Observer*, [illegible] 1867, page 70.

Bernard[illegible]

OUR SIZE AND PRICE.

[213] Sir,—When about to incorporate [illegible] Mechanic you invited suggestions. I, being [illegible] majesty's (self-appointed, if not self-named) [illegible] general, then did mine office. One of the said [illegible] tions was to extend the journal to eight pages [illegible] and charge 3d. for it. Considering you have to [illegible]

a good many communications, and have undertaken to report the doings of the scientific societies—not to mention reviews and extracts from new books—I cannot help thinking you could well occupy more space. It goes against the conscience to buy for 2d. what is honestly worth 3d.; but, commercially, it might be advantageous to enlarge both number of pages and the price at once. Your present capacity is hardly large enough for the journals and their contributors which you have absorbed, not to mention one or two others which may be absorbed. So I cannot help thinking that the sooner you relieve our TENDER consciences from the reproach of receiving more than an equivalent for our twopences the better.

The Harmonious Blacksmith.

[Though the "Harmonious Blacksmith" is not the only one who has made a similar suggestion, we think it right to say that we have no idea whatever of increasing the price of the English Mechanic. As to its size we do not know what it may grow to: much, however, will depend on the activity of our constituency, of readers and subscribers. It is possible to permanently increase it eight pages without any increase of price. Let us have three subscribers where we have now got two, and it shall be done.—Ed. E. M.]

CHEMICAL FLORICULTURE.

[214] Sir,—The three primary colours, red, blue, and yellow, are not to be found pure in any species of flower. We have red and blue in fuchsia, but no yellow; yellow and red in the rose, but no blue; blue and yellow in the heartsease, but no red, and so on. I mean, be it understood, decided primary colours, and not secondary. As this seems to be a law of nature that sets the art of man at defiance, we may expect blue dahlias, yellow geraniums, and scarlet pansies when the circle is squared, but not till then.

Dan Rosen.

TEMPERATURE OF JULY.

[215] Sir,—I send you my record of my 2ft. thermometer below the surface last year and this:—

1870.			1869.		
July	1— 2	57°	July	1— 5	54°
,,	3— 5	56°	,,	6— 7	55°
,,	6— 8	57°	,,	8—11	56°
,,	9—17	78°	,,	12—15	57°
,,	18—20	59°	,,	16—17	58°
,,	21—23	60°	,,	18—19	59°
,,	24—25	61°	,,	20—28	60°
,,	26—28	62°	,,	29—31	59°
,,	29	61°			
,,	30—31	60°			

On 1st July there was an earthquake at Santorin. Why did the temperature fall on the 3rd (or say the 2nd, these observations being at 8 a.m.) and then rise?

C. J. R.

THE SYMBOL π, CONIC SECTIONS, ETC.

[216] Sir,—"Gimel" should have told us he wrote "to argue," and not for information. "He knows all about the matter," he now says. Apparently, however, he does not know that a *ratio* is but an abstract quantity. Todhunter is quite right, of course. "Gimel" might as well say that the symbol 3 does not invariably represent the number three, because it also represents the number of angles in a triangle.

I should regard "the section produced by a plane passing through the vertex of a cone" as either two intersecting right lines, or one right line, or a point (according to the position of the plane), *not* as a hyperbola. One may, if one so chooses, speak of a circle as an ellipse, whose eccentricity is zero; of two intersecting lines as a hyperbola, whose axis is zero; of a right line (or rather two coincident right lines) as a parabola, whose *latus rectum* is zero, and so on: but I do not see the sense of it myself.

Richard A. Proctor.

P.S.—Todhunter and the Symbol π.—Todhunter is right, of course.

MOTIVE POWER FOR VELOCIPEDE.

[217] Sir,—I cordially join with Thos. Stanhope in hoping that some of your talented correspondents will be able to design a useful, safe, and moderately priced steam velocipede. I have read with the greatest attention and interest every new description of bicycle and velocipede which has appeared in your journal, each one professing to be the easiest and best ever invented; still I am as much at a loss as ever as to a selection of the most practically useful machine for a man who is too old to care either for the excitement of a little danger, or for too much physical labour, but who would gladly make use of some means of locomotion for his daily journey to business, rather swifter than his own feet, and rather less costly than a quadruped. Is it too much to look forward to the time when every road will be a tramway, and when steam carriages will run on them without any danger or inconvenience? and can we not "educate" the public in this direction by a "pioneer" steam velocipede?

R. M.

WALL DECORATION.—FRESCO AND STEREOCHROMY.

[218] Sir,—Your esteemed correspondent "Sabbas" has given a very good and short description of fresco painting; however, there is a more simple method not generally known. It is this: When the rough cast is dry, the second coat, "intonaco," is floated all over the wall, about 3-8in. thick, firmly pressed down with the trowel only; it is then left to dry. When perfectly dry the face of this last coat is rubbed down with sandstone to remove the thin skin which has formed on the surface; this thin skin removed will leave the wall quite porous, and now the painting may begin, by first saturating with soft water as much of the surface as can be painted in a day; it is also well to keep the edges wet for the next day, when the same is repeated until the whole wall is finished.

In this method the joins are avoided. But painting in fresco is now superseded by stereochromic painting, also sometimes called water-glass painting, a method which gives the artist perfect control and freedom over his material. One may work a painting over and over again until the desired effect is produced. An artist who is used to fresco, to body colour, or distemper painting, can master the details at once; besides the work is more durable than fresco; the two large pictures in the House of Lords are executed in water-glass medium.

The method is this: After the wall is covered with the second coat of mortar—one lime and two fine washed sand—the wall is left to dry perfectly. The colours are ground in pure water only, and applied with no other vehicle than water; the same colours are used as in fresco, no vegetable colour is admissible; when painting, the surface is first wetted to displace the air from the pores, the colours are worked into each other; when all is finished, the colours are only on the surface and will not bear to be touched; the whole painting is now fixed with water-glass solution in a diluted state, the solution is applied with a syringe for the first time, after it is done with the brush.

The above is only an outline of the method, but if required, and with permission of our kind Editor, a detailed account will follow.

The Welsh Shepherd.

CURIOUS SENTENCE.

[219] Sir,—I am attracted to this topic (p. 428, letter 92; and p. 469, letter 164), by my having a different reading. The central letter, as I always knew the passage, was not R, but N: Sator arepo tenet opera rotas. Meaning, (*sator*) the sower (*arepo*) of mischief (*tenet*) keeps (*opera*) his works (*rotas*) on wheels, or a-going. It was, in old times, the schoolboy tradition among my comrades that Arepo signified of mischief; the same word occurs in the (venerable!) nursery rhyme:

One-ery, two-ery, six-ery, seven,
Arepo, crackabo, ten and eleven;
Pin, pan, musky-dan,
Twiddledum, twaddledum, twenty-one.

Arepo is probably a bogie word; it is of Syriac cut, and of eastern origin. The Mohammedans have a grea deal about Araf, the partition between hell and paradise, see the Koran, heading of chapter vii.; Araf being much the same as Erebus; thus arepo might possibly mean deeds of darkness or mischief. We must not be too severe on the classical Latinity of the like; the passage affects to be an iambic trimeter verse, but it is merely a monkish amusement. The best known is: Roma tibi subito motibus ibit amor, *i.e.*, Rome, on thee suddenly with its emotions shall come love. This is by Sidonius Apollinaris, a Christian writer, a.d. 482. A mediæval toy of the kind was: Sacrum pingue dabo non macrum sacrificabo, which is an hexameter, meaning: I will give a fat victim, I will not offer a lean sacrifice—alluding to Abel. But the same read backwards by words is Cain's offering: I will sacrifice the lean, I will not give a fat victim; and this is a pentameter. Such a quaint conceit was called the Palindrome, or Sotadic verse. The latest play of the sort I know is that Mr. P. G. Hamerton writes capital letters from abroad to the *Globe* newspaper, and signs his name G. P. Notremah.

Gimel.

THE INDUCTORIUM.

[220] Sir,—I will, with your permission, make a few critical remarks on this subject, also with reference to the ingenious method of construction given by your correspondent "Inductorium." First, the tension of the electricity or length of spark depends on the number of windings of the secondary wires (*cæteris paribus*). In my opinion, if tension is required, the induction coil should be made longer, keeping the diameter constant. By this method, the number of windings and length of spark would be proportional to the length of wires. To obviate the inconveniences of spools of great length, large coils might be divided into sections, and combined in a compact form. As an instance of low tension, considering the length of wires used (viz., 150 miles), I may cite the coil at the Polytechnic Institution, which with full battery power gives only 25in. sparks. A spark 4in. in length, has been obtained from three miles of secondary wire; therefore, if the diameter of such a coil were kept constant, and 150 miles of wire used, sparks of 16ft. in length would be obtained. The following, I think, proves the correctness of the above reasoning. If two coils giving 4in. sparks be combined, and the current of the battery be kept constant, the combination will give 8in. sparks. If any of your readers detect a flaw in the above reasoning, I should be glad to have it pointed out, and also to have their opinion (perhaps I may include "Sigma") on the subject.

May I ask "Inductorium," whose method of construction I like, if he has tried the effect of 5 or 6 cells on his coil? which, I have no doubt, would give interesting results as to length of spark; also, did he succeed in winding the wire in regular layers in so confined a space as ¼in. between the discs.

S. T. Preston.

THE MICROSCOPIC INVESTIGATION OF MALARIA.

[221] Sir,—I need scarcely say that I have been very much interested in the articles on zymotics which have recently appeared in the English Mechanic, and, as a further contribution on the same subject, I send an account of a discussion at a recent meeting of the Polytechnic Club of the American Institute.

Dr. Vanderweyde introduced the subject by showing and explaining the device, as applied to his own microscope, for conducting the examination. Firstly, the liquid was placed in a cell, not such as is ordinarily used in microscopic investigations, but set in a perpendicular position, so that the light may be passed through it in a horizontal direction; the light from the cell is refracted and reflected by means of a prism up the tube of the microscope, and then, by another refraction and reflection, direct through the eye-piece in a horizontal line to the eye. This is very convenient, and saves many annoyances of former methods. Formerly, doctors had little faith in the revelations of the microscope, and scouted the idea that some diseases were originated by animalcula—as the itch and some others.

The researches of Hallier, the great microscopist of Jena, were referred to, and his conclusions with regard to the germs found in the bile of cattle dying of the Texan cattle disease stated at some length. This Texan cattle distemper answers to the yellow fever in the human system. In the bile taken from these cattle were found germs which not only lived, but grew and increased after the manner of those in yeast. The course of growth in the yeast plant was then traced, and the resemblance of the other germs pointed out. In regard to those found in the bile, it was stated, and illustrated by fine drawings, that their development was very largely influenced by the circumstances in which they were placed, one form being found when the growth was in carbonaceous substances, and another very different one when in substances containing nitrogen. Another interesting fact was then stated, showing a very close resemblance between the highest developed form of these plants or germs and those found in syphilitic diseases. Further developments resulting from close study of these germs may throw light upon the development theory, as well as the different relations of animals. All animals, during their development, go through the forms of all classes of animals below them—the impression of the parent alone deciding how far this development shall proceed.

The cell that causes the fever and ague has certain necessities of growth, as stillness of air and certain conditions of soil. This cell, or germ, when taken up with the breath, produces the fever. It does not rise any great distance from the ground, and hence the greater danger of sitting than standing in places where it abounds. The state of the body has much to do with the effect of the germ upon the system. When, after a full meal and in good health, exposure takes place, the danger is much less than when the stomach is empty and the system tired and exhausted. It will probably be proved that all contagious diseases have a common origin.

The use of the spectroscope has done much for science in the analysis of liquids. The two absorption lines of blood, in spectrum analysis, give us the means of distinguishing blood from any other substance, and showing the presence of any foreign body in the same, as they are never confounded with any others; no two bodies ever producing the same spectrum. In typhus fever the blood discs appear broken up, sometimes flattened and a disc half gone, as though cut in two. We find some poisons useful in disease, and their action may be attributed to their destroying these cells, or their arresting action, as, for instance, carbolic acid in small-pox, where, properly administered both externally and internally, it completely breaks up the disease. The effects of arsenic eating are possibly due to the destruction of organic growths in the system, rather than its arresting waste.

For small-pox Mr. Nash considered warmth, catmint tea, and Saratoga water about the best things; and Mr. Edwards said that one of the great errors of society is that people think that two sets of facts cannot be true at the same time, when both of them are true; for example, we are prone to think that either the chemical, the electrical, or the germ theory of disease is the true one, and the others false, yet they may all be correct. In the fearful epidemics of 1853, he found that at first the strong and healthy were attacked, and those that had been sick, or were just recovering, were the ones that escaped. As the disease extended, all were attacked, and finally the negroes, who had always braved malaria, both in Africa and in the South, fell victims to it. Those who recovered always had been under such treatment as would keep them from getting out of a perspiration; and it was the old nurses and negresses that understood this treatment, and were successful, while the faculty failed.

In the course of the discussion upon the several theories of disease, Mr. Root enunciated his theory of the circulation of the blood and the power of the muscles, which was, briefly, that they acted through the pressure of the blood within them dilating, and so shortening them. Dr. Vanderweyde considered that this was disproved by several well-known facts, as the elasticity of the arteries, which, by their expansion and contraction with the beating of the heart, prevented the transmission of power in this way; also the fact that the blood was only transmitted through the walls of the capillaries by endymosis, and not by pressure.

I enclose the account as it has reached me, believing that it will be interesting to our readers in general, and those interested in microscopical examinations in particular.

J. T. W.

GAS.

[222] SIR,—I had no intention of being discourteous to "C. D. C.," but when any one attacks other people, even though they are united in the form of a "Company"—which is too commonly regarded as a legitimate object of plunder and abuse—he must expect to get attacked in return; and when any one picks up a foolish and most unfounded charge, and supports it by instances equally unfounded, I, for one, scarcely think it is discourtesy to warn his readers that his knowledge of the subject is too scant to justify them in accepting his statements, for he invites this by setting forth these unsound remarks. For myself, I have not the least personal interest in the matter, as "C. D. C." supposes, but I do know what is the truth; and I do know, from years of acquaintance with gas engineers and gas directors, that as full a sense of right and as thorough a desire to do justice to their customers pervades that class as is to be found in any commercial body or individual; and having watched many of the squabbles got up by interested parties, I know that the cry against the companies is pure claptrap.

As to the manufacturing part of the question, I spent three years, not long ago, in one of the largest London works, with the intention of taking charge of a works; therefore, I am fully able to assure your readers that the notions set forth by "C. D. C." (taken up as they are from people who know remarkably little of the matter, though making much noise) are entirely erroneous. He says (p. 448), I am bound to prove this assertion, and I proceed to meet his desire. The point at issue is the alleged removal of illuminating hydrocarbons from the gas, because the companies "find it expedient"—a phrase which certainly implies that they do so for reasons not covered by the necessities of manufactories.

Now it is not even true that the illuminating power is reduced thereby, for the simple fact is, that the gas, as it leaves the retorts, is totally unfit for combustion as a light-giving agent. It burns with a lurid, smoky flame, and is heavily charged with sulphur and ammonia, both of which the companies are bound by law, under heavy penalties, to remove. There is no known process for removing these which does not also remove some of the light-giving materials; therefore, any reduction of the real illuminating power belonging to the gas, after the tar and condensible vapours are allowed to condense (which they must do, or they would choke all the pipes) is imposed on the companies by law to their great loss, for a little common sense will tell any one that it is their interest to keep in the gas all the power possible.

Following down "C. D. C.'s" letter, I do not class Letheby, Frankland, and the others named as "gas quacks;" nor do they join in the senseless gabble the real quacks utter. They watch and endeavour to keep down those irregularities of manufacture due to the inferiority of materials and carelessness of men met with in all manufactures, and which the gas managers themselves are as desirous as any one to diminish.

Next, as to the dividends, I must point out how "C. D. C." betrays his real unacquaintance with the subject and the source of his supposed facts. The companies are limited to dividends varying from 7 to 10 per cent. Will any one say this is too much for a trading profit when any day some new improvement might even supersede gas and destroy the capital invested? Remembering also that for very many years the companies scarcely had any dividend at all till improved manufacture—notably the use of clay retorts, and common-sense business arrangements limiting ruinous competition—were adopted. But "C. D. C." says, and "the *bonus* in addition, to avoid the letter of the law"—again an imputation of dishonesty. Now the simple fact is, no company can declare a bonus, and any one can stop their dividend by showing to a court of law that it is in excess; but the law permits them if in any years they do not make their full dividend in any subsequent year within six to make up that deficiency, and some of the companies have been able to do this, not as a bonus to evade the law, but openly and legally as *arrears given them by the law*.

As to carburetting, I have not the slightest intention of disputing about a matter which scores of patentees have tried at. By all means let any one try it who likes—as I have, and many others. The simple fact remains, as pointed out by another contributor, that after a great flourish of trumpets, and many statistics showing the great profit of the process as used in the city lamps, *it was abandoned*; and the general public steadily declines to patronize the many patented plans, and giving my opinion simply as my opinion, I consider it does so very wisely.

I find I have omitted one argument, which, as it is based on truth, must not pass. It is quite true that according to the mode of working a larger *quantity* may be obtained from the coals but of inferior *quality*. This is just one of the questions of manufacture and cost—the best way to obtain a gas of the power required by law. If the heat is very high or prolonged, more, but poorer, gas is obtained; and to compensate for this a certain proportion of rich and costly cannel coal must be used. What has this to do with the public, or how are they wronged? The company is bound to give them 12-candle gas, *making it how it pleases*. As a fact, the companies do supply 13 and 14-candle gas, as Messrs. Letheby and Frankland show by their reports; and this is the way the "public suffer."

SIGMA.

Filters filled with black oxide of iron are said to be very effectual in removing organic matter from impure water.

EXTRACTS FROM CORRESPONDENCE.

BRASS INSTRUMENTS.—J. Samuel says:—"In almost every public work in the United Kingdom there is a brass band, and there are generally some members who are mechanics, and most of them take in the ENGLISH MECHANIC. Now, I think it would be a great boon to them, as well as me, if some well-learned brother reader would write a treatise on all the different kinds of brass instruments and best makers; something similar to what Mr. Hermann Smith is writing about the harmonium."

GAS BY A NEW PROCESS (p. 474, l. 185).—"Gimel" says:—"Let me add my earnest trust that this may be described in a practical way, so that it may be tried. To say nothing of gas *light*, I can testify that one of the most delightful comforts is the gas fire, which you can have blazing, or low, or out, at pleasure; but it is very expensive."

SETTING OF VALVES.—"Paul Pry" says:—"Although the editor has not formally given Mr. Baskerville leave to contribute a series of papers on the setting of valves, I hope he (Mr. Baskerville) will do so, nevertheless. Such a contribution, especially from the pen of Mr. Baskerville, would greatly enhance the value of the ENGLISH MECHANIC to a very large section of its readers. In the mean time, I should be very glad to see a letter on the subject of the expansion valve as an auxiliary to the slide valve, explaining its action, and the method of setting it."

[A note offering space was appended by the editor to Mr. Baskerville's last letter, but was omitted in mistake by the printer. Mr. Baskerville has since been written to, and he will in all probability contribute the offered papers.—ED. E. M.]

SPEED OF CIRCULAR SAWS.—A correspondent of the *Scientific American* says:—"It is laid down in mechanics that the speed of a circular saw should be about two miles per minute—that is, the periphery of the saw should run 9,000, or a little over that number of feet per minute. Having had much experience in the building and the running of saw mills, I have found that a greater speed could be used with safety, of which I will give an example, a mill that I finished and put in operation about eight months ago. I was in nowise trammelled, and everything was left to my direction, which gave me an opportunity of testing a very high speed, together with a heavy feed on a large saw. The size of the building was 34ft. × 100ft., and two stories high. Size of engine, 15ft. × 30ft. × 82ft., with 83 revolutions per minute. Three cylinder boilers, 36in. diameter × 30ft. long. Flywheel, 20in. face × 12ft. diameter: weight, 8,000lb. From the flywheel, with a 20-in. belt, is driven a 4in. counter shaft, with a 4ft. pulley. A 6¼ft. pulley on counter shaft, with a 16in. belt to a 2ft. pulley on saw mandrel, drives the saw, which is 66in. diameter, running 800 revolutions per minute—14,000ft. per minute—which is about 5,000ft. per minute over the standard. With this very high speed the saw cuts 8in. to the revolution, making a 3in. feed, and in one day of twelve hours, 97 logs, producing over 34,000ft., were cut."

PREVENTING THE CLOGGING OF BOLTING CLOTHS.—"An Old Miller," writing from one of the agricultural states of America, says:—"A good method of preventing the clogging of bolting cloths consists in thoroughly cleaning them, inside and out, as well as the bolting chest, and then passing the flame of burning alcohol rapidly under the whole cloth. Extreme care should be taken to avoid damping the cloth."

THE RIGI RAILWAY.—A correspondent of the *Engineer*, writing from Fitznau, thus describes this novelty in railways:—"Immediately after leaving the station-yard the ascent is commenced, and in about 100 or 150 yards the incline of 1 in 4 begins, and will, I believe, terminate only at the summit. The rails, which are very light, are laid down to what appears the ordinary gauge; in the middle is a wrought-iron rack rail of about 4in. or 5in. pitch; the rails are laid on transverse sleepers, and outside the rails, longitudinal beams are bolted to the sleepers. The locomotive, "Stadt Luzern" by name, has (when on the incline of 1 in 4) a vertical boiler, the cylinders are 11¾in. diameter, and 16in. stroke; they are outside, and are parallel to the rails. The valve motion is of the straight link kind, the excentrics being outside the crank pin. As is very often seen on the Continent, the machine is supported on four wheels; their diameter is, I should think, about 2ft. 4in.; they are loose on their axles, the rack wheels are keyed on in the middle, and one axle is driven by the engine by spur gearing, the engine making three revolutions to one of the rack-wheels; the axle which is not worked by the engine has two friction wheels keyed on it for the brakes to press on, and the brake on the only truck I saw was of the same sort." The writer saw a truck containing about 4½ tons "pushed" up the incline at the rate of four or five miles an hour.

EYE-LOTIONS.—A correspondent of the *Lancet* calls attention to the dangerous practice of would-be philanthropists giving away eye-water to all applicants without reference to the real nature of the particular disease. He thinks, however, where it is confined to the sulphate of zinc lotion little harm is done. "The old family recipe for eye-water, if inefficient, is generally very inoffensive; it is strong of the water; and if it does no good it does no harm to any one, and produces little visible effect. It contains neither lead nor belladonna. In ninety-nine cases out of a hundred it is a very dilute solution of sulphate of zinc (white vitriol, so called). Water, alone, for the eyes is an excellent sanatory appliance, as frequently, perhaps, as it is for general purposes of health. But as simple conjunctivitis or catarrhal ophthalmia is the most frequent of eye complaints, a little sulphate of zinc is thrown in on speculation. It sometimes does good, it is very cheap, and it manifests its presence even in so great a quantity of water. We generally use too much water in our collyria. It was a valuable hint to me some time ago, when a distinguished foreigner observed that our strongest (he was speaking of sulphate of zinc—two grains to the ounce of water) was only the strength of their weakest lotion. But if one did not know when to prescribe or to omit sulphate of zinc, or sulphate of atropine, or other common lotions, one could only be safe by great dilution, and also perhaps by combinations of different remedies."

REPLIES TO QUERIES.

*** IN their answers, Correspondents are respec[illegible] requested to mention in each instance the [illegible] number of the query asked.

[2687.]—DUSTING BRASS MOULDS.—I beg t[illegible] mit the following:—For light work, face your [illegible] with the following: 3 parts new sand, and 1 par[illegible] mix it up as you would facing sand and face your [illegible] with pea-meal. For heavy castings mix 3 par[illegible] sand, 1 part old, and 1 part dried loam [illegible] your pattern with, and face your mould wi[illegible] meal. For dry-sand work use 3 parts dry [illegible] new sand; and for facing your dry-sand moulds [illegible] with, use lime; mix it in water the same [illegible] would black-wash. If "Ironfounder" will [illegible] instructions, he will find that "N. L.," who answ[illegible] query, is quite wrong. If "N. L.," has been [illegible] casting, he must know that coal dust is not [illegible] brass work. In the first place, brass is [illegible] searching nature that it would eat its way [illegible] casting would be what we call struck all [illegible] if he used black-wash for his cores and [illegible] brass would fetch it all off and leave it in [illegible] castings, as black-wash cannot withstand [illegible] brass on its surface. Lime is the only [illegible] withstand the action of brass; and lastly, [illegible] or blacking are used for brass work, it [illegible] look a nasty black colour, almost the sam[illegible] W. J. W.

[2756.]—LAMENESS IN HORSES.—Heav[illegible] lameness in horses I take to be no new [illegible] during 1868-9 I obtained from some extensive [illegible] that were making a few miles east of Lond[illegible] other things, a quantity of horse shoes, [illegible] solid and heavy, similar to the one figured in [illegible] CHANIC of July 29 (which from the depth the[illegible] found at must have lain there several hundred [illegible] which if used for lameness, then the one figured [illegible] be an invention, only a revival. I have about tw[illegible] of early horse-shoes, all very different from those [illegible] in use; also some old bits and spurs. To any [illegible] terested in these things I shall have much pleas[illegible] in showing them.—A CURIOSITY COLLECTOR.

[2756.]—LAMENESS IN HORSES.—"*Country Vet*[illegible] in reply to J. C. Duffryn, advises *bleeding in the act*[illegible] *stages of Laminitis* (fever in the *feet*). *In the majority* of cases the disease consists *of congestion of the entir*[illegible] venous circulation of the *foot*, and it *may remain in that* state for days without taking on inflammation. My treatment is to remove the ordinary shoes, and immediately apply the special ones, not seated or bevilled, but bearing the whole width on the sole as on the wall, unless the sole happens from being pared to be thin. Give a dose of from 3 to 6 drams (not ounces as stated) according to size of animal, which must be compelled to take exercise on soft or wet ground if available, sev[illegible] times daily. Should the case be a very acute one [illegible] water may be applied during the intervals of exerc[illegible] and also ten drops of Fleming's tincture of aconite [illegible] be given every hour until the animal is relieved. [illegible] aloes may be repeated in about three days, if nec[illegible] or any lameness remains. The majority of th[illegible] are relieved in two or three days. I never [illegible] stage of the disease.—T. D. BROAD.

[3766.]—TO CLEAN, AND FILL, [illegible] BAROMETERS.—Buy a glass tube clos[illegible] 34in. long, small or large bore as requi[illegible] with a fine rod with rag or the small [illegible] pipes (tobacco) to be had at any cigar shop. [illegible] mercury at any wholesale druggist's, price [illegible] crown per pound. Make a funnel of clean [illegible] and pour the mercury through repeated sheets [illegible] or vessel, until quite clean; then insert a clean [illegible] paper with a fine hole into the tube, pour in [illegible] quarter of an inch of the top; take a clean [illegible] and stop up with the finger, reverse and keep [illegible] the air bubble up and down till clear of speck[illegible] then fill up. Buy a boxwood cistern (or better [illegible] yourself), and fit it on the tube before with glue and [illegible] if too loose, unscrew the end with the sheepskin [illegible] and fill up, then screw on, and the tube is made [illegible] looking at the cistern of any mercurial baromete[illegible] idea is soon got hold of. Adjust by a good rule, and [illegible] good barometer of a friend or public institution. [illegible] work may be made to fancy. A screw at the bott[illegible] enable the mercury to rise to the top, so as to be c[illegible] about without risk. My advice to amateurs is, d[illegible] make many, as the fumes of mercury are very injur[illegible] —far better purchase.—GEORGE MACRAE.

[3815.]—EMERY WHEELS.—The expressed oil of [illegible] seed, like several other vegetable oils, but in a gre[illegible] degree, is capable by exposure of absorbing a l[illegible] amount of oxygen. It is this property of linseed [illegible] which renders it so valuable for mixing with pigment[illegible] as it is this gradual absorption of oxygen which [illegible] the oil, and produces the phemomenon of *drying* in th[illegible] paint. For this purpose linseed oil is put through [illegible] process of boiling with litherage and oxide of lead, [illegible] which it absorbs so much oxygen as to promote it[illegible] ing properties. In this condition it is styled "boiled [illegible] seed oil." This peculiar property of linseed oil rende[illegible] it very valuable in certain arts, as by continuing the ox[illegible] tion by prolonged exposure to the atmosphere it assum[illegible] the appearance and character of india rubber, be[illegible] very tenacious and durable, which any one can perce[illegible] in the durable qualities of ordinary wax-cloth. The [illegible] emery wheels are formed of clean emery compound[illegible] with just a sufficient amount of boiled linseed oil, [illegible] mixture being agitated for a sufficient period under [illegible] posure to a considerable temperature and a free acc[illegible] of atmospheric air, or some still more powerful oxid[illegible] ing agent, can be made to assume the necessary de[illegible] of tenacity, and whilst warm, being exposed to hydr[illegible] lic pressure in a suitable mould, and subsequent dry[illegible] in a stove, the emery wheel is complete.—MATRIX.

[3851.]—HARNESS.—"Saddler's" reply would h[illegible] been valuable some years back. I will give [illegible] advice and experience. If you use a "compositi[illegible] your harness will require constant applications of oil [illegible] dye, and scraping—the former to keep it supple [illegible] black, the latter to take away the cracky appearan[illegible] I find Clarke's harness blacking far preferable to an[illegible] ceipt I ever tried, and I am told it contains the right p[illegible] portions of oil, dye, and polish.—NOT A SADDLER.

[3949.]—GUYANA OR GUIANA.—These are three colonies, belonging to the British, Dutch, and French, of this name. They are situated between longitude 51° 30′ and 61° west, and latitudes 1° to 8° 30′ north. Venezuela lies between longitude 60° to 73° west, and latitude 2° to 11° north. Your correspondent "Bernardin" in mistaken in saying they are to north of Venezuela, such being impossible, since the Carribean Sea washes the shores of Venezuela on the north. The climate here is very unhealthy for Europeans. Demerara being the capital of British Guiana, the most westerly and adjoining Venezuela.—J. G.

[3952.]—LOAM PANS.—Having been troubled the same as "Inquirer," I discovered that there was too much clay in the loam, and after the mould was blackwashed and smoothed over, I came over it all with barm, or very stale beer, put on with a very fine brush; this has the double effect of staying it from veining, and the blackwash from scaling.—N. L.

[3982.]—SOAP-MAKING.—Some valuable information on this subject is to be found in Dr. Ure's "Dictionary of Arts and Manufactures."—Beta.

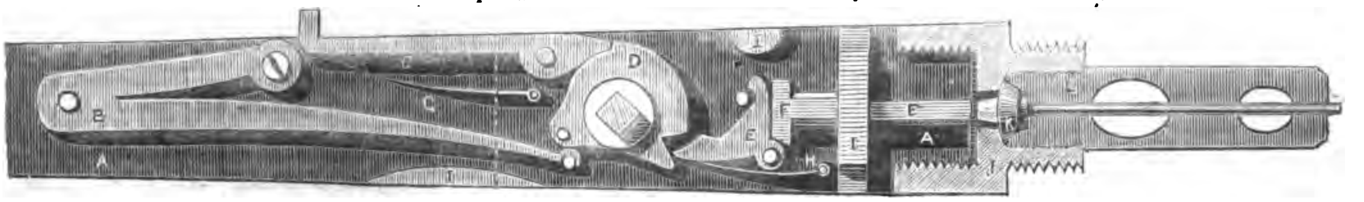
[3982.]—WORKS ON SOAP-MAKING.—"Campbell Merfitt on Soap and Candles," cost about £2; "Ott on Soap-making," cost about 10s. 6d.; "Kurten on Soap-making," cost unknown. All to be got through Trübner & Co. The two first are the highest authorities on the subject, and are exhaustive and well illustrated; the last is good and practical, but the translation (from the German) is faulty, many errors in substances, measures, and weights, which would puzzle a novice, though not difficult of correction by a practical hand at the trade.—D. G.

[4020.]—WOULFFE'S BOTTLE.—Let "M. P. C. S." chuck a piece of ordinary brass tube in a lathe (say) 2in. or 3in. long, and its external diameter slightly less than the internal diameter of the neck; now, whilst the tube is in rapid motion, press the part requiring to be cut out gently against the end, using emery and oil, or fine sand and water, as a cutting or abraiding medium. It will be found a great advantage if he can manage to apply the pressure through the medium of a piece of india-rubber held against the inside of the bottle; this will cut it out quite clean. The same plan is applicable to cutting the central hole in electric discs, &c. A very neat application of it is to cut openings opposite to the winding centres of shade-covered pine pieces; these openings can be protected by inserting a small brass *bush* or *ilet* with a little white lead, a great brass plug being used to keep out dust. Under those circumstances the shade never requires to be lifted, as the winding, &c., can be effected by the application of a suitable key.—Matrix.

[4022.]—TUNING BELLOWS FOR HARMONIUM.—See "Eleve's" letter, p. 186, *ante*.—Saul Rymea.

[4042.]—MAGNET.—Nos. 16 or 18 would answer.—Sigma.

[4044.]—AIR GUN.—The drawing represents the lock and breech screwed together. A A lock, B spring, C trigger, D tumbler, E sear, F F push pin, G trigger spring, H sear spring, I I I seats for the upper plate, removed to show the construction. The trigger and sear work on studs riveted into the plate, and prolonged through the upper plate, screwed down by a single screw, which also serves to check the motion of the sear. J section of breech, K valve, L brass tube. The valve rod within this tube has a spiral spring along its length to keep the valve to its seat; the valve is best made of bullock's hoof. The lock is represented ready to be discharged. The barrel—not shown—is on the other side of the plate A A; it is of brass, carefully bored and polished. In constructing an air cane, be sure the reservoir is sufficiently stout, and made of copper, that the brass collar into which the breech screws fits accurately, and is well soldered. The butt end should be brassed up, not tinned. Further details if requested.—T. A.



[4072.] — HARMONIUM QUERY.—As "Eleve" is doubtless too busy to answer queries just yet, I am sure he will pardon me for treading on his ground, especially as I shall merely tell "Valve" what I have been told by "Eleve." The reed holes for 8ft. tone should be 1¼in. by 5-16in. at base; and 9-16in. by 3-16in. at treble. The pallet holes should be 1in. by ¼in. at base, and ¼in. by 3-16in. at treble, of course graduated as regards length all the way; and the pallet holes should be ¼in. wide to all but the top octave—*i.e.*, thirteen notes.—Saul Rymea.

[4076.]—NATURAL SELECTION.—This doctrine, which is gaining general acceptance among the leading minds, is that the many varied species of plants and animals are gradually developed from a few simpler forms by natural processes; that the surrounding conditions of good climate, &c., produce modifications and those are perpetuated which suit the varied conditions. The idea really is that nature does just what man does when he produces new varieties. How far the process is to be considered to extend is doubtful; some people are terribly afraid of the doctrine, under the idea that it does away with creative action; whereas, it really means that the creative power is everywhere present, always active now and for ever, instead of acting once for all. When fully developed and rightly understood, it will be found to teach as the Great Teacher taught, that the sparrow falls not to the ground unheeded by its Father and ours; that each springing seed, each blade of waving grass, and the humblest insect, whose life is but a summer day, is part of a great whole pervaded by the universal life, of which these different forms are the actions and development.—Sigma.

[4093.]—THE ENGLISH CONCERTINA.—Since no one else replies to "Lost," allow me to say that the English concertina is really a good instrument. Its chief merits are—first, a complete scale; second, a single sound to each key, whether drawn out or compressed, thereby dispensing with the the thumb-bellows of German concertinas. I have heard very difficult music excellently performed on these instruments by Mr. W. H. Birch, of Reading, who is, I believe, musical editor for Boosey & Co., Holles-street.—J. Nash.

[4096.]—SODA WATER.—TO "F. C. S."—Tell me if two strong-hooped barrels would stand the pressure; and what material the bottling and corking apparatus should be made of; and what length of time it would take to impregnate the water with the gas; and what he means by a washing vessel between? Any information he can give will be thankfully received. I tried the unslacked lime, and it was quite a failure, which I knew it would be.—D. W. L.

[4102.]—GALVANISM.—Dr. Althaus's work is, perhaps the best on medical electricity, price 15s., obtainable through any bookseller. My next paper will deal with the galvanometer question.—Sigma.

[4121.]—BOTTLING FRUIT.—Take any quantity of fruit that is sound and fresh; fill your bottles; fill a copper nearly full with cold water, with a board at the bottom; put the bottles in, up to their necks in the water; put it on the fire, and let the heat get up to 150 degrees; let them stand at that heat for twenty minutes, then take them out, and fill the bottles with boiling water; then bung them, and tie with a bladder, and they will keep any length of time if kept air-tight.—D. W. L.

[4136.]—EGG-HATCHING MACHINE.—"P. G. M.," who asks for information in detail on this subject, will find an illustration of Pinchen's Incubator on p. 108, Vol. X., of our Mechanic. It has, I believe, been found successful. According to M. Réaumur, all that is required is a heat of 96° Fahr. Eggs kept at that temperature for the requisite number of days will produce chickens. Mr. Cantelo, however, who some years ago exhibited what he called a hydro-incubator, asserts that the proper temperature is 106° Fahr.; and if this heat is sustained chickens will sometimes appear on the eighteenth or nineteenth day. His machine was capable of hatching from 100 to 600 eggs; and its principle consisted in allowing warm water to flow along plates of glass placed over the eggs. The Egyptian and Chinese systems are much the simplest, as in these the eggs are merely placed in trays of sand or bran, and kept in ovens or on heated iron plates. It is very doubtful whether any system can be made profitable in this country.—Saul Rymea.

[4144.]—FIRECLAY BAKING.—The raw fireclay is usually mixed with one-third its weight of burnt fireclay termed "grog," or powder of old glass pots from which all the clinker, &c., has first been carefully removed. Sometimes a certain proportion of sand is added, or clays, other than Stourbridge, according to circumstances and the purposes to which the clay is to be applied. This mixture is moistened, kneaded, and let stand for some time; often a fortnight or three weeks, receiving occasional kneadings in the meantimey the longer you can let it stand and the more thoroughl. it is mixed the better the clay. When the articles are made they are allowed to dry gradually in a warm room; when they are very thick, three months are often allowed for this operation; they are then transferred to an oven and raised to redness. The more slowly this drying and baking takes place the less the liability to crack. In some cases fireclay crucibles are not previously burnt or baked before use. In the case of pots used for casting steel it is found that if the pots are burnt with the mouth downwards they do not crack, but if with the mouth upwards, they do The "grog" or burnt fireclay is added to form a sort of skeleton, as it were, and thus prevent the tendency to crack.—An Associate of the Royal School of Mines.

[4206.] — CHROMATIC FAIRY FOUNTAIN.—"Q. Q. R." evidently does not understand Prof. Tyndall's experiment. When a ray of light, passing from water into air, strikes the surface at an angle greater than what is called the "limiting angle of refraction"—viz., about 48° 27′, it is "totally reflected;" but this does not occur when the angle of incidence is less. In the falling stream the ray is continually reflected in this manner along the stream, thus (see Fig. 1); but, in the arrangement proposed by "Q. Q. R.," the ray would evidently very soon strike the surface at a much less angle, or, indeed, perpendicularly, and would accordingly pass through into the air without reflection: the falling water could not, therefore, be illumined.—Ignorant Irishman.

FIG. 1.

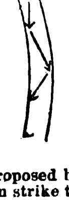
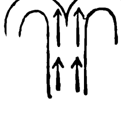
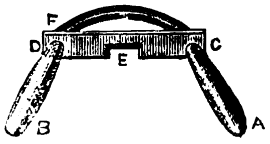


FIG. 2.



[4226.]—DOUBLE STOCKS.—In my humble opinion (although only an amateur) the best plan to get seed for double stocks is to pick off from the single ones every flower that has only four petals, saving only those with five and six petals, on what a florist would call semi-double, which will produce seed that will come nearly all double. I have now got some seed nearly ripe, saved from only semi-double flowers, and will forward "Saul Rymea" some if he will give me his address. It was saved from a few single that grew with some as fine double ones as any one could wish to see having spikes of flowers from 9in. to 12in. long, besides a mass of side branches; they are what we in Sussex call the Giant stock.—Norma.

[4273.]—SPLITTING WHALEBONE.—The blades previous to cutting are softened by boiling for a couple of hours in a long copper. They are then fastened edge upwards in an ordinary wooden bench vice, and planed by the subjoined tool. A B are two handles, C D is an iron plate, with a guide-notch E; F is a semicircular knife, screwed firmly at each end to the iron plate C D, having its cutting edge adjusted in a plane so much lower than the bottom of the notch E as the thickness of the whalebone is intended to be; for different thicknesses the knife may be set by the screws at different levels. The workman holding the tool by the handles applies the notch E at the end of the whalebone blade furthest from him, and pulls it gently along so as to shave off a slice in the direction of the fibres, care being taken not to cut across any of them. These slips are afterwards dried, and planed level, and are polished with ground pumice, felt, and water. I do not know where "Enquirer" can obtain whalebone; but it is brought from Greenland in pieces containing ten or twelve blades. The blades are sometimes separated and cleaned by the sailors of the whaling ships. The price varies from £50 to £150 per ton.—H. U.



[4279.]—GAS METERS.—As a maker both of wet and dry meters, I, with all due deference to Mr. H. Newton, prefer the former for exactitude and durability. Not to extend unnecessarily my letter, I will quote Clegg's work, (no mean authority):—"The opinions of gas engineers continue to be divided as to the relative merits of dry and wet meters; but for accuracy of registration, when the water is at the proper level, the wet meter is not surpassed, if it be equaled, by any other."—E. Wellard, Bordeaux.

[4314.]—RULE WANTED.—1lb. of cast iron contains 8·84 cubic inches; hence the cubic contents of any cast body in inches, divided by 3·84, will give its weight. Elucidation of example:—60 × 3·84 = 230·40 cubic inches in the block and 9 × 14·5 = 130·5; hence the cubic contents 230·40 ÷ 130·5 = 1·76551 + inches thick.—W. Driscoll.

[4316.]—A DIFFCULT QUESTION.—I do not see that there can be any doubt about there being first the inside tube 12″ diameter, gripped by a second tube, hoop, or ring, 18″ diameter, and this second one gripped, in its turn by a third, with an eight ton grip.—Unit.

[4323.]—SEWING MACHINES.—It is rather difficult to say exactly what the cause of "H. W.'s trouble is, as the effect he describes may be caused in one or two ways. There may not be sufficient tension on the top thread or the little brush is not properly adjusted against the hook.—Unit.

[4356.]—SOFTENING SKINS.—If flowers of sulphur be mixed in a little milk, and after standing an hour or two the milk (without disturbing the sulphur) be rubbed into the skin it will keep it soft. Care should be taken not to prepare it too long before using, as the milk is apt to become putrefied. Perhaps the above mixture may not answer "Country Vet.'s" purpose, as it is used to soften the skin (human) and improve the complexion. Yet he can give it a trial if he chooses, as its cost will be very small.—Kansas.

[4359.]—AMBER BEADS.—Amber beads may be repolished with whitening and water, or rottenstone and oil, finishing in either case with friction alone. Amber may be known from mellite (honey-stone) and copal, both of which are sometimes substituted for it, by the agreeable odour it emits when burning, and by the greater electrical power it possesses after friction; mellite is infusible by heat.—T. W. Boord.

[4361.]—METHYLATED SPIRIT.—"T. L. H." is in error when he says turpentine is added to spirit, to form methylated spirit.—An Associate of the Royal School of Mines.

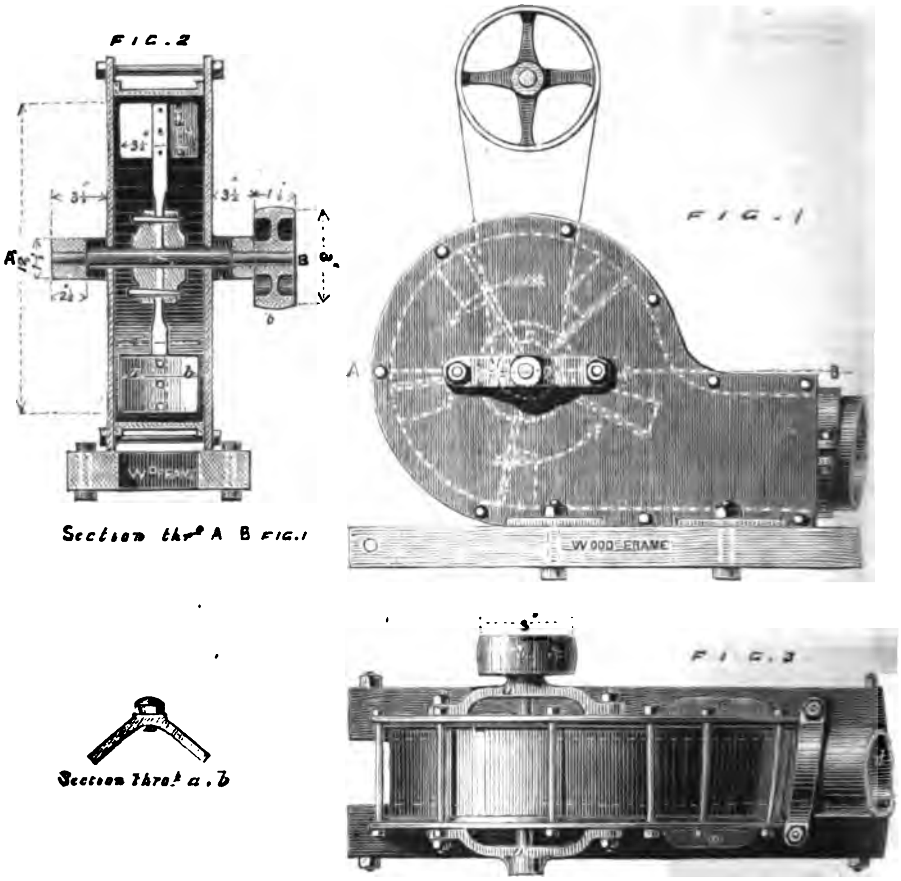
[4361.]—METHYLATED SPIRIT.—This is a mixture of 90 parts of spirit of wine (S.G. ·830), *duty free*, and 10 parts of wood spirit (methyl, alcohol, or carbinol). It cannot be used for medicinal purposes or beverages on account of its repulsive taste and odour; but for many of the purposes for which pure spirit of wine was formerly used, such as the preparation of varnishes, polishes, chemicals, the preservation of museum specimens, &c., it forms an efficient and cheap substitute.—Beta.

[4363.] — LIMEWASH ON MASONRY. — "Agent" should use a weak mixture of spirits of salts, or muriatic acid, and water.—Beta.

[4364.]—DRYING SMALL WHEELS.—A small room or cupboard heated by a gas stove would be the most economical, though I should imagine that any quick process would be apt to cause them to twist.—T. W. Boord.

[4365.]—INDICATOR DIAGRAMS.—"Fireman," in order to calculate indicator diagrams, must divide them into at least ten equal parts by lines drawn at right angles to the atmospheric line. Then, with the scale, which is attached to every instrument, he must read off the number of pounds indicated by each line. When this is done, the ten results must be added together, and the sum thus obtained divided by ten. It is not absolutely necessary that the diagram should be divided into ten parts; it may be divided into eleven, twelve, thirteen, or any other number of parts we wish. But the division into ten is that which is usually adopted, and for two reasons—first, because it is sufficiently accurate for all practical purposes, and secondly, on account of the division by ten being so easily and quickly accomplished, simply by removing the decimal point one place to the left.—THOMAS J. O'CONNOR.

[4324.]—FAN BLAST.—I enclose a sketch of blast fan, which I hope may meet with the requirements of G. Cook. Fig. 1 is a side elevation; Fig. 2, sectional elevation through A B; Fig. 3, ground plan. *a a* represents bearings for fan shaft; *b*, small pulley; *c*, aperture for admission of the atmosphere to fan; *d*, delivery pipe, which I propose making of gas pipe, said pipe to be reduced to about 1″ diameter at the nozzle, by diminishing socket or any suitable contrivance, and to be fastened into mouth of fan box by wedges of soft wood, well smeared with white lead or some similar substance; *e* is a pair of glands to ensure the wedges remaining in their place. In the sketch I have given the sizes I think necessary, and the driving pulley of course can be fixed in any convenient position; the sides of fan box to be of ⅛″ plate, periphery 1·16″ plate, slightly flanged for making joint; joint to be screwed up with ¼″ bolts and nuts, and to have a little white lead between to make it air tight.—ASSISTANCE.

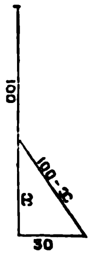


FAN BLAST. (*See No.* 4324).

[4370.]—PROBLEM.—Suppose a pole to be 100ft. in height and standing perpendicularly, what part of the pole will have to be cut off for it to touch the end of a base line 30ft. from the bottom of the pole, which is perpendicular to the base? Solution: (*vide* figure) we have the following equations:—

(Euc. I. 47.) $30^2 + x^2 = (100-x)^2 = 100^2 - 200\,x + x^2$;

hence $200\,x = 100^2 - 30^2 \quad x = 45{\cdot}5$.—BERNARDIN.



[4371.]—CHANGE WHEELS.—I have never seen a rule in any book for the wheels "Good Words" mentions that will act correctly; but the way I calculate them is in the following manner, which I find comes a great deal nearer the mark than any book rule that I have seen (and they are many books I mean): You find the wheel by proportion first, and then again by square root or evolution, then add the two answers together, and divide the product by two, and the answer will be the wheel to put on. Suppose the frame is making a 3 hank, with 30 wheel, and you wish to change to a 5 hank, square the 30, multiply by 3, divide by 5, and extract the root of the product, then proceed by proportion.

```
        30
         30
       ----
       900
         3
     5)2700
       ----
        540
          (23 root
        4
       ----
     43)140
        129
       ----
          11
3    :   30   ::   5
          3
     5)90
       ----
       18 answer by proportion
       23    „    „  evolution
     2)41
       ----
       20·5 or 2½.                B. H.
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P.S.—The above will do for lift and twist; multiply by 5 and divide by 3 for ratchet.

[4371.]—CHANGE WHEELS.—In answer to "Good Words," I beg to submit the following simple rules:—Multiply length by breadth by the weight of a cubic inch of the material required; then divide the required weight by this product, which will equal the thickness of pattern in inches. Weights of a cubic inch of different material: steel, 282; wrought iron, 28; cast iron, 26; brass, 3; copper 32. Example.—It is required to know the thickness of pattern for brass from the dimensions given by "Good Words"—9in. by 14½in., and to weigh 60lb. 9 × 14½ × ·3 = 39·15. Now, 60 divided by this = 1·5in. = thickness of pattern required.—C. N.

[4371.]—CHANGE WHEELS.—In answer to "Good Words," I beg to offer the following rule. Rule.—Multiply breadth by length and by the decimals ·268 for a divisor. Divide the weight required by this divisor, which will equal thickness of pattern for cast iron.

Ex. 9″ × 14½″ × ·268 = 34·32

∴ 60 ÷ 34·32 = 1¾″ thickness of pattern.

Then for wrought instead of cast iron × ·28

„ brass „ „ × ·3

„ copper „ „ × ·32

ASSISTANCE.

[4378.]—ELECTRIC ATTRACTION.—If "Electron" refers to vol. X., page 319, sec. 19, he will find an experiment very like his own as he was practically presenting his electric or proof-plane to the *stem*; his ball suspended by linen thread, which is a conductor, answers to the wired ball. The experiment appears to me to indicate clearly the fallacy of the "fluid and charge" notions of electricity, because the ball is continuously *attracted* by the electric if presented to it, but repelled when the electric is presented to the stem, because, according to my views, this interferes with the polarised circuit at first set up, and brings into operation the outer circuit formed by the electric through the operator to surrounding objects, as explained in my earlier papers. The glass carboys could be got of any wholesale druggist at about 5s., I think. "Electron" will please remember, however, that the advice to use them was not given by me. The job will be troublesome, and a muddle when done.—SIGMA.

[4376.]—COD-LIVER OIL.—"A Mechanic" will find an excellent substitute for cod-liver oil in linseed tea with syrup of iodide of iron. A chemist will proportion it.—ANON.

[4376.]—COD-LIVER OIL.—If "A Mechanic" should put a table-spoonful of strained orange-juice in a wine-glass, pour the oil into the centre of the juice, and then squeeze a few drops of lemon juice upon the top of the oil, he will find the nauseous taste of the oil greatly prevented; castor oil the same. Peppermint water almost removes the nauseous taste of Epsom salts; a strong solution of extract of licorice covers the disagreeable taste of aloes; milk that of cinchona bark, and cloves that of senna.—KANSAS.

[See "C. J. H. W.'s" letter in answer to this query.]

[4376.]—COD-LIVER OIL.—Squale oil seems more palatable and as efficient as cod-liver oil.—Address, Dr. Delattre & Co., Dieppe, France.—BERNARDIN.

[4376.]—COD-LIVER OIL.—There is no good substitute for cod-liver oil. If it is good it ought to be very nearly tasteless. But if "A Mechanic" tries this "dodge" I think he may take it without tasting the flavour; it is so with me. Having put some water in a wineglass pour in the oil; then to swallow it place your tongue right out on the outside of the glass, then throw your head back and the oil will glide down your throat without your tasting it in the least. If "Mechanic" fails at first let him try again.—C. J. H. C.

[4376.]—COD-LIVER OIL.—Take of cardamom seeds 1oz., gentian root 1 oz., soak these for a fortnight in a pint bottle of good rum. Dose—A tablespoonful to be taken three times a day in a wineglass of water. This, I should think, would answer the purpose of cod-liver oil, as it is both a tonic and a stomachic combined.—W. F. TRINDER.

[4376.]—COD-LIVER OIL.—Those who have a difficulty in taking cod-liver oil will find an excellent substitute in cod-liver pills. They are a French preparation, and a medicine far more palatable than the ordinary oil. I believe these pills are not generally known.—T. A. BURGE.

[4376.]—COD-LIVER OIL.—"Mechanic" should take an ounce of mutton suet chopped small, boiled in a gill of new milk as a daily diet. It is a thousand times superior to cod-liver oil. (From Dr. Skelton's "Family Adviser," page 218.)—J. LIGHT.

[4377.]—TEMPERING BRACE BITS.—Your correspondent, "G. W. A.," in answering query 4377, causes me to send this short reply, if you think it worthy of insertion. In the first place, cast steel and shear steel are both very different to temper. If the articles to be tempered are made of cast steel or old files, let them be first heated to about the colour of a biggareau cherry, and then plunge into cold water. Afterwards rub them with a bit of Turkey or grit stone—Turkey in preference; then hold on a bit of red hot iron about 2in. or 3in. from the cutting point or edge, and then various tints will show on the brightened surface. The proper temper for wood-cutting tools is a little less than gold colour; and for iron or steel, blue, to within ⅛ of the cutting part. The straw so much recommended, is too hard for cast steel, especially when it has been forged two or three times. For shear steel make very near white hot, and plunge in oil (vegetable oil), brighten, and let down to a pale straw colour, as that is not too hard for a shear steel tool. If the tool is under ⅛in. in flat or circumference, make cherry hot and plunge in a piece of soap.—W. REED.

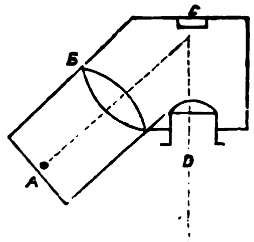
[4380.]—COLZA OIL is the same as rape-seed oil *vide* my note on "Vegetable Oils and Fats" in the ENGLISH MECHANIC of 24th of June, p. 331. For [illegible] particulars *vide Technologist*, vol. 4, p. 425, a note extracted from the *Mechanics' Magazine*.—BERNARDIN.

[4380.]—COLZA OIL.—Colza oil is an expressed oil made from the seeds of *Brassica campestris*; and rape oil is sometimes substituted for it.—T. W. [illegible]

[4381.]—COURT PLASTER.—Court plaster is made by applying several coats of a solution of [illegible] a little tincture of benzoin added, whilst [illegible] brush to a piece of silk stretched on a frame, each coat being allowed to dry before the next is put on. I suppose it is so called from having been used in [illegible] times by Court ladies for their patches.—T. W. BOORD.

[4385.]—BRAZING OR SOLDERING.—The edges of the brass to be united should be filed or scraped quite clean, covered with a mixture of hard solder and powdered borax, made into a paste with water, and then allowed to dry, being kept in position by iron binding wire, or otherwise; when dry they should be exposed to a clear heat, sufficient to melt the solder; for very light work perhaps soft solder, used in the ordinary way, would suit "Edinburgh."—T. W. BOORD.

[4386.]—OPTICAL ARRANGEMENT.—The instrument this correspondent wants is called an opaque lantern, and to do the work at all *well* he is not far wrong in hinting at an unknown number of guineas. A very powerful light is required to illuminate an opaque object in such a manner that its enlarged image may be thrown on a screen; nothing less than the oxyhydrogen light will answer, and after getting such a light it would obviously be foolish to use any but a good (and consequently, rather expensive) optical arrangement. The optical part is essentially the same as that of a magic lantern; the light is concentrated on the object at an angle of about 45° by a condenser, and a magnifying lens of short focus (as in the magic lantern, a photographic portrait lens will answer) throws an enlarged image on the screen. The accompanying diagram will explain the arrangement. The effects are very striking. The colours of natural objects, such as flowers, insects, and feathers, coloured drawings, cartes, and watchwork in motion, are shown. If only the light can be obtained the ordinary fittings of a magic lantern may, with a little ingenuity, be adapted to the purpose.—A, the light; B, condensing lens; C, object; D, object glass or photographic lens.—NORBITON.



[4387.]—SULPHATE OF COPPER BATTERY.—"W. G." can divide his trough into three equal parts with glass or slate partitions, and use flat porous cells to contain the zinc between two copper plates connected together. The sides of the trough should project beyond the ends, which may be tongued in and screwed together with two bolts at each end, and the bottom may be secured in similarly. Joints should be made with shellac varnish, the wood well soaked with melted paraffin, and the inside coated after making with a cement of resin, gutta percha, and a little linseed oil melted together. A look at p. 196, No. 269, may help "W. G." Either dilute sulphuric acid or a saturated solution of common salt will answer for the zinc cells; with the latter the zinc need not be amalgamated.—Sigma.

[4383.]—WEAK EYES.—If "Peregrine Pickle" will, on rising every morning, put his face into clean cold water, keeping his eyes open, and remain in as long as he can keep his breath, he will derive great benefit therefrom. Tried and approved.—A Chip.

[4388.]—WEAK EYES.—I would recommend "Peregrine Pickle" to lave his eyes copiously with cold water. It relieved me under like circumstances.—C. J. H. C.

[4388.]—COLLYRIA, OR EYE-WASH.—Alum: Dissolve half a drachm of alum in eight ounces of water. Use as an astringent. When the alum is doubled, and only half the quantity of water used, it acts as a discutient. 2. Sulphate of zinc: Dissolve ten grains of white vitriol in a pint of water or rose-water. Use for weak eyes.—Kansas.

[4388.]—WEAK EYES.—Take a teaspoonful of the best vinegar and put it into a pint of clean water; bathe the eyes while warm two or three times a day.—E. W. Barnett.

[4389.]—LATHE QUERY.—To make a set of draughtmen, turn a cylinder accurately to the diameter required, cut it into slices of the desired thickness with a thin parting-tool in the slide rest, turn out a boxwood spring chuck to the size of the discs, and face up the whole with a round-nosed tool in the slide-rest on one side first; then advance the tool slightly and face them on the other side. If desired they can then be ornamented with the excentric cutter or other tool in the same chuck. Grooves on the edge should be made with a point tool in the slide-rest before the cylinder is cut up.—T. W. Boord.

[4391.]—SCREW TAPS AND DIES.—"W. Reed" should bake his nipples and sockets in a retort well charged with powdered yellow prussiate of potash, and while red hot plunge them into urine; if they do not harden the fault is with the iron. He can make his taps and dies of *good* wrought iron and bake them in the same manner. If he is an old subscriber, and can refer to Vol. IV., p. 333, he will there find my *modus operandi* fully described. With good iron the process is a success; but with bad iron I think nothing can be done in the way of steeling or case hardening.—Ab Initio.

[4392.]—CALLIPERS.—You can see these in any tool maker's shop window. Sketch the shape and cut them out of sheet steel. Five shillings would buy them better made than you could make them at home probably.—T. W. Boord.

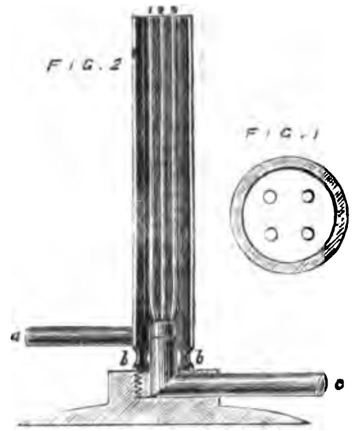
[4395.]—MITRAILLEUR.—See an article in this number.

[4396.]—ELECTROS.—A solution of one part phosphorus in fifteen of bisulphate of carbon is used, dipping the mould in for a minute, taking out and allowing the solvent to evaporate, and dipping in a weak solution of nitrate of silver. It is a nasty process and quite needless, as a little care will cause plumbago to spread over anything if it is good, and lightly rubbed over with a soft brush, breathing occasionally on the surface. The common housemaid's blacklead is rarely any use, but nothing is better than a piece of graphite carbon, as used for plates, very carefully ground up. Plaster of Paris ought to be dried and saturated with some melted fat before use, taking care not to use too much, so as to fill up fine lines and alter the contour.—Sigma.

[4401.]—FERRICYANIDE OF POTASS.—With reference to "Prussian Blue's" query, he had better dissolve 1,000 grains of ferrocyanide of potass in 4,000 grains of hot water (or 2oz. in 8oz. of water), and pass a current of chlorine through until only a slight precipitate is caused in a solution of ferric sulphate. Then boil down to 4oz., and filter while hot, evaporate down to 3oz., and again filter while hot, finally crystallizing out. It can be purified by crystallizing from hot water.—Urban.

[4403.]—MECHANICS.—Let "Alyssum" procure a lever of the first order, whose arms shall have a ratio to each other as 1 to 12, then by pressing any weight attached to the short arm down 1in., the weight placed on the extremity of the long one will be raised through a space equal to 12in. But "Alyssum" cannot expect an equilibrium in this case, since he states in his question, that the weight to be raised is 100 times greater than the weight to be depressed. In order to establish an equilibrium in this case, the weight on the extremity of the short arm should be twelve times heavier than the weight on the extremity of the long one (friction not taken into account.)—Thomas J. O'Connor.

[4404.]—BLAST GAS FURNACE.—Drawings and particulars of Griffin's blast gas furnace may be obtained from J. J. Griffin, 22, Garrick-street, Covent Garden. The blast burner I use is a modification of Griffin's, and consists of a large Bunsen's burner, with a ⅜ brass pipe projecting through the bottom, and branching into three or four brass tubes of ⅛th bore, which extend to the top of the burner, and through which a blast of air from strong bellows is set. The pressure of air must be at least six times the pressure of gas; length of burner, 9in.; inside bore, 1in. The difference between this and Griffin's is that mine will burn as an ordinary Bunsen's burner without blast (Griffin's will not), and is therefore useful for gradually heating up crucibles, which are liable to be cracked with the sudden heat of Griffin's burner. By building up a small fireclay furnace with this burner I can melt 5oz. or 6oz. of 18-carat gold in seven or eight minutes, and 10lb. zinc in fifteen or sixteen minutes. It has the advantage over Griffin's that I can do without blowing, except during the last few minutes, and I can leave it at any time. When the blast is put on, the flame drops instantly to about one-fifth the size, and has a pale ragged appearance, but the heat is most intense, being sufficient to fuse a fine platina wire held in it. I have also used it for making small steel forgings from ¼lb. to 1lb. weight. Fig. 1 is section of top of burner half size, showing position of blast tubes. Fig. 2, elevation. 1, 2, 3, blast tubes; *a*, gas pipe; *b b*, air holes; *c*, blast pipe.—Thos. Fletcher.



[4407.]—MAMMOTH.—I am doubtful if we have a perfect skeleton of *Elephas primigenius* in Great Britain, but "Naturalist" will find various bones and an interesting series of molar teeth of the great extinct elephant in the Museum of the Royal College of Surgeons, middle museum, ground floor, Nos. 566 to 661. Admission to Museum by written order from any M.R.C.S.—O-ce-o-la. (*See Bernardin's letter, page* 496).

[4409.]—TURNING SPHERES.—"J. W." will find a description of the lathe and rest he requires in No. 2, Vol. I. (April 7, 1865).—James Martin.

[4409.]—SECURING IRON CRAMPS.—"J. W." will find sulphur a good substitute for lead.—Old Dips.

[4410.]—TURNING SPHERES.—For a billiard ball the ivory should first be driven into a metal cup chuck; round off the projecting end first with the gouge so as to leave it a little larger than the size of the intended ball, then work towards the chuck and cut off with the parting tool, as it were *into* the chuck. Fix the rough ball so formed in a boxwood cup chuck, bound by a strong metal ring, with an opening *nearly* equal to the intended diameter of the finished ball. First smooth down the part where the ball was cut off, then chuck it at right angles to its first position, and carefully smooth over with a flat tool held horizontally, re-chuck at right angles to its last position, smooth again and continue the process until the tool meets with no remaining inequalities. Two semicircular templates may be used during the progress of the work, one about 1-16in. larger than the required size, for the preparatory shaping of the piece (this will be discarded with practice), and the second the exact size for finishing; both may be cut from a piece of sheet-brass or zinc. If the boxwood chuck cup be truly turned, and the inside edge chalked, the work may be fixed after each change of position by a light blow with the turning tool handle. The ball is then to be smoothed with fine glass paper, turning it in the chuck as before, and polished with whitening and water, mixed to the consistence of cream, on a piece of soft rag, the whitening being removed by a handful of fine ivory shavings held to the work while revolving in the lathe. A drop of sweet oil applied on a rag gives a brilliant finish. If "J. D. L." will practise for a short time on boxwood he will find making a billiard ball a comparatively easy matter, and will probably save himself the trouble of fitting up a spherical slide-rest.—T. W. Boord.

[4411.]—ISOMETRICAL DRAWING.—In reply to Mr. O'Connor I have not received the information I wished for, as he will see from a uery under the *nom de plume* of "Isometros" which I sent for insertion. I am also aware that the angle is constant, and I have not read Mr Bedford's papers. Finally, I shall be much obliged to Mr. O'Connor if he can assist me.—Carl J. H. Cotthesson.

[4412.]—WRITING INK.—Perhaps creosote would answer "J. G. M.'s" purpose. A *very* small quantity would be sufficient.—T. W. Boord.

[4412.]—WRITING INK.—I would suggest to "J. G. M." that he has ink of an inferior quality, or he would not have needed to send his present query. "J. G. M." may, however, improve what he has by adding a little tincture of cloves.—J. Nash.

[4415.]—CURIOUS PROBLEM.—If "Saul Rymea" had first defined "irresistible force" and "immovable body," he would, I think, have seen that his question is logically absurd. By the first, I can only suppose him to mean "matter moving with force so great that nothing in existence can stop it." As matter is supposed to be impenetrable, and therefore no two bodies can occupy the same space in the same time, an "immoveable" body must be one which will resist the impact and stop the motion of any other, no matter how great the force by which it is moved. Now, the definition of each of these bodies *presupposes the non-existence of the other*, and it is, I think, clear that the co-existence of both is absolutely impossible.—Ignorant Irishman.

[4419.]—WATER GLASS.—Dry carbonate of soda, 54 parts; dry carbonate of potash, 70 parts; silica, 192 parts; fuse together. Soluble in boiling water.—T. W. Boord.

[4421.]—MAKING FLANNEL ADHERE TO BRASS.—I should recommend "A Subscriber" to try a mixture of glue and rosin.—Ab Initio.

[4424.]—COFFEY'S STILL.—There is a description of this still in "Miller's Chemistry," Vol. I., p. 309 (3rd edition). See also "Ure's Dictionary of Mines and Manufactures," and "Watts's Dictionary of Chemistry." I should think it was totally unfitted for raising steam, seeing that it is specially designed for the condensation of vapours.—An Associate of the Royal School of Mines.

[4425.]—MALLEABLE CAST IRON.—Dr. Percy's "Iron and Steel" is out of print, and can only be purchased at an advance of two or three pounds upon the published price. Most public libraries possess a copy of it. Mudie's have two or more. Cumberland hematite pig iron should make good malleable castings without previous refining, but other impurer brands would require refining. Why not purchase old cast iron of good quality? It would be cheaper than to make it on a small scale. A good flux for a pretty good hematite, such as the Ulverstone, is as follows:—2 glass, free from lead or iron; 3 lime. Another:—2½ parts lime; 2 parts Kaolin or china clay; half part sand. Shale or fireclay may be substituted for the china clay, and thus have the advantage of being much cheaper. I have proved them many times in assaying. Fluor spar and lime would form a good flux with the addition of silica. I do not know the quantities, but they could be easily ascertained by trial. The slag produced should be nearly colourless, of a green tint, and well fused. If there be an excess of lime it will be porcelainous. You can purchase the abstracts of specifications.—An Associate of the Royal School of Mines.

[4425.]—MALLEABLE CAST IRON.—Percy's work is, I believe, out of print, and can only be obtained second hand at considerably more than the published price; Spons, of Charing Cross, would be a likely place. I know they had a copy lately. The patent specifications could be obtained by sending the price, or through a bookseller, but the numbers would have to be ascertained and given. Any good pig-iron will produce the so-called malleable castings. Limestone is used as a flux in cupolas principally to combine with the sand adhering to the pigs, and to act on the ashes where coke is used. Fluor spar is of very doubtful utility. Its principal action in furnaces is apparently to render the slag or cinder more freely fusible; but if lime or other base were deficient it would no doubt act on the silica itself, and in any case be apt to injure the lining.—Sigma.

[4427.]—CASE HARDENING.—Charred sheep shanks is the very best material for case hardening; if these are broken up and placed in a sheet-iron box, luted with clay, he will have no scaling of his work.—R. N.

[4437.]—FLUORIC ACID.—It is highly probable that fluoric acid is made in America, since fluor spar occurs at several places in America. According to Dana, the following are amongst the localities which provide it, none, I believe, very abundantly: at Muskelonge Lake, St. Lawrence Co., N.Y.; at Westmoreland, N.H.; Putney, St. Lockport, N.Y.; and Shawneetown, on the Ohio.—An Associate of the Royal School of Mines.

[4444.]—JELLY-FISH IN STONE.—The greenish-yellow veins and markings in the granite slabs are probably of Epidote—a mineral which often occurs in this way. It is a compound silicate of rather complex and varied composition. I need hardly say that no fossils at all have been found in granite, and it is utterly impossible that such an organism as a Meudsa could be. Granite is the most highly metamorphosed rock with which we are acquainted.—An Associate of the Royal School of Mines.

[4445.]—ASPHALTE FOR GARDEN PATHS.—"Sabbas" will find the following a very simple, cheap, and durable method:—Procure a sufficient quantity of stone broken rather fine; spread it out, basin fashion, and into the basin pour some heated tar; mix well. Then lay over your paths smoothly, sprinkle powdered quick lime over the top, and roll.—J. Nash.

[4449.]—RESTORING THE FRESHNESS TO FILTERED WATER.—Perhaps the flatness may be removed by aërating the water; this may be done by allowing it to fall from a height, say six or more feet, in a thin stream, or in a drop.—An Associate of the Royal School of Mines.

[4450.]—BATTERIES.—"A New Subscriber's" questions are scarcely fair to old readers or myself, as all the points he asks for have been recently fully examined by me. If he has not got them he had best send to your office for Nos. 267, 270, and 275, which will, I hope, give him all he wants in an answer like this. The arrangement of the plates is a mere matter of economy; in the Smee one silver plate is used, because it is clear; but the zinc is really best in the middle as in the bichromate. The Smee is the best for electrotyping; the bichromate for working a coil; so that each has advantages over the other. In the bichromate and in all batteries the zinc ought to be amalgamated.—Sigma.

[4451.]—MOULDS OF COINS.—I have found a mixture of equal parts of spermaceti, stearine, and wax, with a small quantity of rotten stone, to give good results. Fusible metal, gelatine, and sulphur may also be used.—T. W. Boord.

[4452.]—LIGHTNING CONDUCTOR.—"Iron" must get a pointed steel rod for the attractor, about 3ft. in length, and then must procure enough ⅜in. iron wire to come from the attractor to the ground. This must not be allowed to touch the wall of the house, but be passed through broken bottle necks, which are fastened to the wall by staples. The attractor must be fastened to the iron wire, and supported without metallic connection with the wall. The other end of the iron wire is fastened to a piece of iron plate, and buried about 1ft. deep in the earth. The conductor will now be complete. The lightning will pass down into the earth without touching the house, if care is taken not to allow any part of the conductor to touch the house, except through the bottle necks.—F. Walker.

[4452.]—LIGHTNING CONDUCTOR.—Of all materials copper is the best, and provided the conductor contains sufficient *surface*, it matters not how it is fastened to the house. It may be carried through the house or built into the walls, and will do its duty, so long as it is taken deep enough into the ground to insure its always being in a moist place. I use a copper band nearly 4in. wide; but the wire rope is very good, and can be had ready for fixing at Newall's, in the

Strand, at, I think, 1s. per foot, head and cramps included.—Q. Yorke.

[4456.]—PLUMBAGO BOTTLE BATTERY.—I rather wonder the querist was not subjected to the 6d. tax; however, his question being inserted, I suppose he will get my reply. Elliot Brothers, the instrument makers, Strand, near Charing Cross, are, I believe, the agents for Faures's battery; and the price 4s. or 4s. 6d.; but I do not know if this includes the zincs, &c.—Sigma.

QUERIES.

[4464.]—THE MANGANESE BATTERY.—If Dr. Stone is still a reader of our journal will he kindly state whether the manganese battery he described in these pages about two years ago is still at work, and whether he has found it satisfactory; likewise his experience in the matter?—M. D.

[4465.]—TRACING PAPER.—How can I make some tracing paper, and the carbonic papers that are used by "manifold" writers?—H. U.

[4466.]—CLEANING PRINTS.—Can anyone tell me how to clean prints that are soiled, such as steel engravings, &c.?—Rebaf.

[4467.]—IMPRESSIONS FROM PRINTS.—How can I take an "impression" from a print?—Sabbas.

[4468.]—MAGNETIC BATTERY.—"Ignorant Irishman" (p. 458), in reply to my query, mentions the magneto-electric battery. I would ask him to oblige by giving a further description, with sketch of the same, as most probably that will best suit my purpose; more so that the magnetic battery which he goes on to say will not produce a current, the especial object at which I am aiming.—Bebiro.

[4469.]—NEW DYE WOOD.—I read in a German review that Messrs. Walker & Co., Mansell-street, Aldgate, London, have introduced a new dye, extracted from a kind of wood very common in Africa and in the West Indies. This colour is said to be extremely fast, and equal in lustre, &c., to aniline colours. I wish a few more particulars, name of wood, &c.—Bernardin.

[4470.]—REMAK BATTERY.—Could any kind brother reader favour me with description of this battery?—Edmel.

[4471.]—INSULATING VARNISH.—I tried to cover copper wire, after having sulphurated it, with a coating of shellac, then with gutta percha dissolved in benzine, but my coating was never solid enough. Would any correspondent afford me assistance in improving my process?—Insulator.

[4472.]—BRITANNIA METAL TEAPOT.—Can any reader tell me how to solder a spout on a Britannia metal teapot without soldering-iron or blow-pipe? I have been told that where Britannia metal teapots are made no soldering-iron or blow-pipe is used.—J. B——h.

[4473.]—INTENSITY COIL.—I am making an intensity coil according to Dyer's instructions, 1" primary (16), $\frac{1}{2}$" secondary (39); but I find the winding on of the S. wire very tedious; is there a quicker mode of winding? Is there a possibility of overdoing the insulation? I give each layer a coat of shellac varnish, three layers of G. P. tissue, and one of tissue paper. Although I have only two layers on, it gives a shock not to be borne at all comfortable.—R. F. D.

[4474.]—HORSE POWER.—Will some brother mechanic kindly give me a simple formula for ascertaining the horse power of an engine by the diameter of a cylinder? or if he could recommend a good work on the subject I should feel obliged.—E. Wellard.

[4475.]—THE JERSEY TIGER.—Will some kind brother reader please to inform me whether the Jersey tiger, a species of moth, can be truly considered a British species?—J. J. M'Cartey.

[4476.]—TEMPERAMENT OF ENGLISH CONCERTINA.—I shall be obliged if a brother subscriber can tell me how to set the bearing (for tuning) the English concertina, it not being tuned to equal temperament, there being A flats and G sharps, and D sharps, and E flats.—Concertinist.

[4477.]—BOOKS.—Will some brother reader kindly inform me of a good and reliable book on the breeding of dogs, their diseases and cures; also a book on extension motions, as used in the army, stating publishers' name, and price of each? I shall feel very grateful.—A Chip.

[4478.]—BLUE WRITING INK OR FLUID.—Will any of your numerous practical readers kindly furnish me with a tried receipt for making good unchangeable blue writing ink, or fluid, which will dry quickly, and may be used either with quill or steel pens?—Lex.

[4479.]—COLLODION.—When I pour my collodion on the plate and return it into the bottle again it forms into ridges, and seems cracked. How can I remedy this?—W. Crawley.

[4480.]—COW-MILKING MACHINE.—Can any reader give me information respecting the above? It was exhibited in the 1862 Exhibition by Messrs. Sanborn & Co., of 99, Cheapside, who appear to have removed from that address since then. Does the machine answer its purpose, and where can it be obtained, either in England or the United States, and what is the price?—Kansas Emigrant.

[Experience proved the machine referred to by "Kansas Emigrant" to be a failure.—Ed. E. M.]

[4481.]—A DIFFICULTY.—Will some reader clear up a difficulty of mine respecting the use of the screw at the bottom of the barometer? I read the following passage to a friend, a maker of barometers:—"In other forms of the barometer, the mercury in the cistern is always maintained at the same level, for which purpose the cistern is formed partly of leather, so that, by means of a screw at the bottom, the surface of the mercury may always be adjusted to the neutral point before taking an observation"—("Cyclopædia of Useful Arts and Manufactures," edited by C. Tomlinson, Art. Barometer, page 103, Vol. I). My friend said he did not believe it. The use of the screw, he maintained, was merely for travelling purposes, to prevent the concussion of mercury and tube. Still, I hold to Tomlinson, but I have not the least idea of how to manage or adjust the screw. I should be very thankful for the least information on this point.—T. A. Burge.

[4482.]—OVAL.—Will any of your correspondents give me instructions for making an egg-shaped oval, and inform me why it is not given in works of geometry?—John Barton.

[4483.]—DEEP SEA SOUNDINGS.—Will some correspondent write a description of the most improved apparatus used in deep sea soundings, and what particular apparatus has been used in the late Admiralty Surveys. Also a brief account of the method adopted to discover the force and direction of under currents at sea? An early answer will oblige.—Psi.

[4484.]—BUNSEN'S BATTERY.—Will some friend tell me which is the best way to cut carbon blocks for a Bunsen battery? also what size of induction coil will do to show to a good effect all the vacuum tubes; what length of wire, &c?—An Old Subscriber.

[4485.]—OXYGEN HOLDER.—Will some one of our subscribers give me any information as to whether there is any other arrangement for storing oxygen gas for use of lantern than gas bag and pressure boards? If I remember right I read of something of the kind made by a Mr. S. Highley, of London. I believe it consists of a cylindrical box made of sheet iron. I hope to see a reply from some one.—Gasholder.

[4486.]—SHORTHAND.—Will one of your shorthand correspondents be kind enough to say which system of shorthand most resembles Gurney's system?—T. S. H.

[4487.]—BURNT CLAY.—Why does clay when burnt turn red?—Youngster.

[4488.]—MOURNING PAPER.—Will any brother reader oblige me with instructions for black bordering note paper and envelopes; and likewise inform me of the varnish used for relief stamping?—Stationer.

[4489.]—TURNING COPPER.—Can any of your correspondents inform me how to avoid the drag on the tool in turning copper with a tool of large cutting surface; *i. e.*, some better method than cooling by the dropping of water in the ordinary way?—Turner.

[4490.]—WELDING CAST STEEL.—Will some one oblige by stating the best process for welding cast-steel?—T. O. B.

[4491.]—THE TELESCOPE.—Can any reader, interested in the subject of the telescope, favour me with a method for clamping the draw-tube of a 3in. achromatic, so as to retain any particular focus?—Lancastrian.

[4492.]—RAISING WATER.—I should be very thankful if some practical man would give me information in the following matter:—A friend in the country has a well about 285ft. deep, from which he obtains water by cylindrical iron buckets hung on an endless chain, after the manner of a dredging machine. The motive power is a vertical tread-mill driven by a donkey. Owing to the tremendous wear and tear of the chain (which has caused it to elongate about 20ft. in five years) constant hitches and breakages occur; in such frequency, indeed, that my friend intends to abandon the present system and to adopt the old way of raising water by two alternately rising buckets. This will necessitate two cisterns, one each side, and other minor alterations; he is, however, most anxious to preserve the present motive power. Now, as the action requires to be reversed each time a bucket reaches the top, and as this constant reversal cannot be obtained by stopping the donkey and turning him round, what will be the simplest arrangement for obtaining the desired action of the horizontal spindle of the tread-mill? I should also be glad to hear whether a very stout vulcanized india rubber band (of course purposely made and with layers of linen) would prove strong enough to be substituted for the iron chain, which is a tremendous weight to fish up from the bottom in case of any fracture.—A. C. G.

[4493.]—COIL.—TO "SIGMA."—My best thanks to "Sigma" for noticing my query, and will he kindly describe how to construct the commutator for sending the secondary current in one direction only? The information I sought for was to enable me to graduate the tube that slides over the core, so that each division should be an equal increase in power, as I find that the power increases in a greater ratio than the tube is drawn out, and I do not know what that ratio is. Pigotts, of Piccadilly, has the tube of his atmospheric battery divided to do it, but I should like to know the rule by which it is done. Will "Sigma," at his earliest convenience, tell me how to construct a tangent galvanometer; also what a British unit is? I know the Varley unit.—R. N.

[4494.]—DISSOLVING RESIN.—Will any one inform me how I can dissolve resin without the use of spirits or oils? I want to mix it with paste, so as to make it very strong, as I use a great quantity of paste.—Thos. Grist.

[4495.]—IRIS DIAPHRAGM.—I should feel greatly obliged if "F.R.A.S.," Mr. Proctor, or any other of your talented correspondents would give me, through your columns (and with your kind permission) a sketch or description of the principle on which the above diaphragm is constructed for the application to telescopes, photographic lenses, &c.—Unit.

[4496.]—COPPER COIN.—Will some of your readers kindly inform me what the following copper coin is:—Obv.: "A F" in monogram, surmounted with a crown, a smaller crown at each side, and one below; rev: two arrows crossed, dividing "I. O R. S. M." a crown above; "1759" below.—E. A. Burnell.

[4497.]—ENGRAVING BALANCE METAL PLATES.—I should feel much obliged if you, or one of the readers of your magazine, can tell me how to get rid of the "burr" caused by the "graver" without *in the least* dulling the brightness of the plate. I have tried a scraper, but these plates show the least touch.—An Amateur.

[4498.]—EXHAUSTED ELECTRICAL TUBES.—I have seen several large glass tubes, 2in. or 3in. in diameter, and four of 5ft. long, which are used for showing the passage of a spark through rarefied air. They are closed at both ends by hemispher permanently exhausted, no cork. anyone tell me how they are [illegible] stand how the caps can be put [illegible] air, or how the tube is exhausted [illegible] only by the cap.—Ignorant Irish

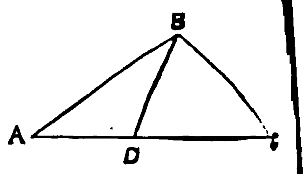
[4499.]—FOUL AIR.—What is [illegible] air" in wells and other places, and [illegible] —Jas. Symons.

[4500.]—SILVER THIMBLES.— silver thimbles that have been [illegible] have lost their whiteness?—A. T. N.

[4501.]—SEWING MACHINES "J. G." for his kind reply (4322). required, and therefore unable to posed to understand it was called in alterations and trials, arrived at th that the hole in the cotton reel was fore occasionally altered the tension was wound around the spill. It n anything stiff with plenty of dress of coarse silecia it is completely usel bad as before (see No. 278, July 22nd.: professor stitch it, and I consider his factory. What part would be most di correctly, supposing I took it to pie hook detached from the rest?—H. W.

[4502.]—ZOOPHYTES.—How can I pr for mounting, as some preparative them?—A. L. B.

[4503.]—MENSURATION OF SUPERF the three sides of a three-sided triangle.



A B = 9·2, B C = 7·5, and A C = 5·3. [illegible] your readers give me the working sum thro[illegible] cially how the square root is worked out [illegible] T. W. H.

[4504.]—ELLIPSES.—I should be much [illegible] of the correspondents of your excellent [illegible] tell me of any simple instrument for de[illegible] and how it could be made.—Nemo.

[4505.]—PENS.—I write a great deal [illegible] write very rapidly, I am always bothered [illegible] None suit me—quill, steel, bone, glass, &c. [illegible] the substitutes in pencil style: they [illegible] pencils. After all, are not pens and ink [illegible] process? Can nobody improve on it? [illegible] Mr. Needham, gunmaker, who introduced [illegible] gold pencil case, the inside being all [illegible] or so, but the ink caked at the point. [illegible] yet "not the thing." The black of the [illegible] &c., is too indistinct. Could there be [illegible] act chemically on the paper, without [illegible] marking-ink does not injure linen [illegible] solid not fluid affair. Still better [illegible] piano keys, letters and capitals, figures [illegible] away and print your "copy." Is [illegible] trivance among the fossil projects [illegible] Gimel.

[4506.]—WATER BAROMETER.—[illegible] condescend to say whether it would [illegible] to supply the like, at such and such a [illegible] is it to be got by one who has enough [illegible] not time for even such an interesting [illegible]

[4507.]—MUSHROOM CULTURE.—I [illegible] box 1ft. deep, 14in. long, and 10in. wide, [illegible] in which potatoes have been grown. If I [illegible] mould and put some mushroom spawn in [illegible] top of my boilers, will it grow mushrooms [illegible] dung? The boilers are at work daily, Sundays [illegible] —W. Reed.

[4508.]—TO "INDUCTORIUM."—My best for the description of what I have always c the best form of intensity coil; but, then, be the penalty of the Patent Law, as it is preci coil Mr. Apps, of the Strand, sells as his pate and the model of the one he made for the Polyte And all amateurs may not know that they cannot make a patented article even for themselves. "Inductorium" add to our obligations by stat size of his secondary wire and the best way of it; also size of soft iron wire for one or bund if some of the inductive power is not lost by $\frac{3}{8}$in. between the primary and secondary, *i.e.*, tube, $\frac{1}{8}$in. for ring?—R. N.

[4509.]—BRASS TUBES.—Will some reader how to brighten brass tubes when tarnished, and keep them bright? also the best means of s polished brass to polished brass.—Humility.

[4510.]—SARDINES.—How are sardines cure I can catch large quantities of river fish—roac perch, &c., I should be glad of some means of them; like sardines.—Oxonian.

[4511.]—WEIGHT OF BALL.—How can I obt weight of a cast-iron ball or wrought say, 7in. di and what length of $\frac{1}{4}$in. round wire can I obtai the same? Will the answerer kindly give his well as the answer? By inserting these in your n answering the former, if possible, you will greatly —Ralph Williams.

[4512.]—REVOLUTIONS OF BLAST FAN.—I impossible to count the number of revolutions of fan, will one of your many readers give me the r obtaining the same? There is one by the differe diameters of the two pulleys, but I have forgot and should be obliged to any friend who can infor through your columns.—Ralph.

[4513.]—HORSE-POWER.—1. The steam pres a given boiler being (as indicated by an *open* me gauge) 60lb. per square inch (*i.e.*, supporting a s umn of 128·6in. in height, and above base he boiler is cold), it is desired to know if the rer of a *non-condensing* steam engine in con- h, *i.e.*, worked by this boiler, is correctly by the following formula:—

$$n = \frac{f.s.v.}{33000}$$

is the theoretic R of th e area of piston in ies; *s*, the steam pressure, *as obtained above*; elocity of piston, in feet, per minute; or if it cessary to state and work the formula thus:—

$$n = \frac{f\,(s - p)\,v}{33000}$$

uct from the steam pressure, as indicated by ury gauge, still the atmospheric pressure (*p* in s) of 15lb. Does not the *open* mercury gauge give re already *as above the atmospheric resistance*, ender it incorrect to subtract *p*? 2. Under umstances, would it be correct in the case of engine to state the formula for theoretic R, :—

$$n = \frac{f\,(s + p)\,v}{33000}$$

s before, the pressure, as indicated by open mer- ge. 3. How is the *theoretic* R of a compound double (high or low pressure) condensing steam engine 1? Given boiler pressure, as before, = 60lb. er square inch (as indicated by an *open* mercurial respectively 15in. and 26in. diameter, stroke each) 3ft., revolutions 55, *i.e.*, speed of pistons, minute; steam used to full stroke in high cylinder, and, for simplicity sake, no account to of condenser back pressure. A clear and full the foregoing would much oblige one of your spectful of readers, who signs himself what he —A WORKING ENGINEER.

UNNOTICED QUERIES.

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ture, if any query remains unanswered for four , we shall insert the number and subject of the in this list, where it will remain for two weeks, if reviously replied to. We trust our readers will rver the list, and send what information they can e benefit of their fellow-contributors.

ce our last George Macrae has answered 3766; a," 3962; "D. G.," 3982; "T. A.," 4044; "Saul ," 4072; "J. G.," 3949; "Matrix," 3815, 4020; L.," 3922; "Sigma," 4042, 4076, 4102; J. Nash, ; "D. W. L.," 4121.

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DOMESTIC RECIPES.

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SYRUPS FOR SODA WATER.*

SIMPLE SYRUP.

TAKE of White sugar, 14 pounds (com.)
Water, 1 gallon.

Dissolve with the aid of a gentle heat, strain, and when cold add the white of two eggs, previously rubbed with a portion of the syrup, and mixed thoroughly by agitation.

The egg albumen is added to produce froth.

LEMON SYRUP.

Take of Oil of lemon, 25 drops.
Citric acid, 10 drachms.
Simple syrup, 1 gallon.

Rub the oil of lemon with the acid, add a small portion of syrup, and mix.

ORANGE SYRUP.

Take of Oil of orange, 30 drops.
Tartaric acid, 4 drachms.
Simple syrup, 1 gallon.

Mix as above.

VANILLA SYRUP.

Take of Fld. Ext. vanilla, 1 ounce.
Citric acid, ¼ „
Simple syrup, 1 gallon.

Rub the acid with a portion of syrup, add ext. vanilla, and mix.

GINGER SYRUP.

Take of Tinct. ginger, 4 ounces.
White sugar, 7 pounds (com.)
Water, ½ gallon.

Heat the sugar and water until the sugar is dissolved, raise to the boiling point, then gradually add the tinct. ginger, stirring briskly after each addition.

SYRUP SARSAPARILLA.

Take of Simple syrup, 1 gallon.
Comp. syr. sarsap. *ad. lib.*
Powd. Ext. licorice, 1 ounce.
Oil sassafras.
Oil wintergreen, aa, 15 drops.
Oil anise, 10 „

Rub the oils with powdered licorice, add a portion of syrup, rub smoothly, and mix the whole together by agitation.

ORGEAT SYRUP.

Take of Cream syrup, ½ pint.
Vanilla syrup, 1 „
Simple syrup, ½ „
Oil bitter almonds, 5 drops.

Mix.

COFFEE SYRUP.

Take of Ground roasted coffee, 4 ounces.
Boiling water, 2 pints.
Sugar, 4 pounds (com.)

Infuse the coffee in the water until cold, strain, add the sugar, and make a syrup.

STRAWBERRY SYRUP.

Take of Fresh, ripe strawberries, 10 quarts.
White sugar, 24 pounds.
Water, ½ gallon.

Spread a portion of the sugar over the fruit in layers, let it stand four or five hours, express the juice, strain, washing out the marc with water; add remainder of sugar and water, raise to the boiling point, and strain.

SYRUP OF RASPBERRY.

Proceed as for Strawberry syrup.

PINE-APPLE SYRUP.

Take of Ripe pine-apples, No. 2 or 3.
White sugar, 16 pounds.
Water, q.s.

Cut the fruit in thin slices, spread sugar over them, let stand twelve hours. Pour off juice and sugar, and set aside. Express the fruit, adding a little water. Then take water, q.s., to make, with the above liquid (juice and sugar), 1 gallon. Form a syrup with the sugar and water, and boil the pieces of the fruit already expressed. When the syrup is nearly completed add the fluid and boil a few minutes to clarify. Remove scum and strain. These three fruit syrups should be bottled when warm, corked tightly, and when wanted for use add equal parts of the fruit syrup and simple syrup. They will keep a year without a change.

NECTAR SYRUP.

Take of Vanilla syrup, 5 pints.
Pine-apple syrup, 1 pint.
Strawberry or raspberry, 2 pints.

Mix.

CREAM SYRUP.

Take of Fresh cream, ½ pint.
Fresh milk, ½ pint.
Powdered sugar, 1 pound.

Mix by shaking. Keep in a cool place. The addition of one-half drachm bicarb. soda to this syrup will prevent rapid change.

From the *Food Journal.*

GINGERBREAD PUDDING.—Take equal quantities of flour, bread crumbs, and suet, one or two eggs, four tablespoonfuls of treacle, and a tablespoonful of ground ginger; boil, in the shape of a plum pudding, and serve with custard around it, carefully beaten up in a glass of sherry.

COCOA-NUT TOFFY.—Chop a cocoa-nut into small pieces; mix one pint of milk and four tablespoonfuls of treacle; boil over a hot fire, adding ¼oz. of butter and the chopped cocoa-nut. When sufficiently boiled, pour into a soup-plate, and leave until perfectly hard.

BŒUF A LA MODE, FOR SUMMER TIME.—Brown a piece of beef (3lb.) and a calf's foot, with 1oz. of butter, in a covered saucepan, for an hour; then pour the grease off (the real gravy will adhere to the saucepan), and add six spring onions, some new carrots, a tablespoonful of vinegar, a pinch of flour, a dozen peppercorns, salt, a bay-leaf, a piece of thyme, and parsley. Simmer the whole on the side of the fire for three hours. The thyme, parsley, and bay-leaf ought to be tied together, so as to be taken out, as well as the calf's-foot, before serving.

GREEN PEAS.—An excellent method of preparing green peas, when small, is to cook them, without water, in butter alone. For this, 3oz. of butter are necessary for half a peck of peas, and they must remain for an hour and a half on a slow fire, in a copper, or, still better, an earthenware saucepan, well covered in either case. An onion, a piece of parsley, and a lettuce-leaf or two, cut small, must be stewed with the peas, and the saucepan must be carefully shaken every few minutes to prevent the peas from burning. It is better that the peas should not be washed beforehand. When peas are boiled in the water, the French cook also adds an onion and lettuce-leaves; then, ten minutes before serving, strains the water off; and, adding a piece of butter (the size of two large walnuts), and a lump of sugar, tosses them over the fire for the remainder of the time.

POTATO BREAD.—Grate your potatoes very fine, and proceed as in ordinary bread, using the potatoes instead of flour; sweeten to taste. This dish is much improved by grated cocoa-nut.

MOCK PATE DE FOIE GRAS.—*Pate de foie gras*, though universally admitted as a delicacy of the highest order, is rarely consumed by the modest middle-class families of England. Its very high price is the simple cause of this fact. We have thought, therefore, that it might prove useful, if we were to indicate how a very good substitute could be made at a moderate cost. It is impossible to dispense altogether with the fowls' liver; but two livers from either goose or turkey will suffice for a good sized terrine of what we will term "mock *pate de foie gras.*" A stuffing or *farce* must be made from 1lb. of suet or fat of pork, with an equal quantity of calf's liver, obtained as white as possible. The suet, cut into small pieces, is melted on the fire, and incorporated with the calf's liver, which has been skinned and cut up. Add pepper, salt, and spice, and place the dish on a very hot fire for five or six minutes, during which time the saucepan must be constantly shaken. When this has been allowed to cool, it should be forced through a sieve with holes of a moderate size. The *farce* thus made, a part of it should be spread in the terrine or gallipot which is to contain the *foie gras*. The livers of the goose or turkey are then added, accompanied with a good deal of seasoning, and the terrine is finally filled up with the remains of the *farce*. On the top should be placed two laurel-leaves, and the whole carefully covered with a layer of lard. The terrine may then be closed and placed in a saucepan only half filled with water, so that the ebullition should not enter into the pot. By boiling the water, the *foie gras* may thus be safely cooked.

TO PRESERVE PEACHES.—A correspondent, Mr. Smith, of Exton Park, has handed us (*Gardeners' Chronicle*) the following reply to an inquiry as to the best method of preserving peaches:—"The following is the recipe given to me by the *chef de cuisine* here: Split the peaches in halves; scald them in thin syrup to remove the skins; arrange the halves in clean pint tins filled up with rather thick syrup, made of 2lb. sugar and a pint cold water; boil for four minutes; have the tins covered; put them into a vessel; pour sufficient cold water on them to reach within half an inch of the top; submit them to twenty minutes' gentle boiling; keep in a cool place for use."

MACEDOINE DE FRUITS.—This is certainly the best way of eating uncooked fruit, and particularly when it is not of the finest. The method is simple enough. White and red currants, cherries, ripe gooseberries, and raspberries, are mixed together in a deep dish, after being picked; sufficient white sugar, according as the fruit is more or less acid, is placed in water enough to dissolve it, and poured, when melted, over the fruit, which must then stand for two hours before being put on table. Thus prepared, it acquires the rich taste of cooked fruit, and yet retains all its freshness. If the means of icing be available, the *macedoine* ought to be put into a mould and iced, when it makes a most *recherche* dish for dessert.

USEFUL AND SCIENTIFIC NOTES.

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WATERPROOF PACKING PAPER. — Waterproof packing paper is thus made by some manufacturers: The paper is covered with a resinous liquid, then painted over with a solution of glue and soot, as without this the paper will later show blotches. After this is dried, the actual waterproof coat is applied. This is prepared with two and a half ounces of powdered shellac, dissolved into two pints of water, which is gradually brought to boil, and stirred until the substance is perfectly dissolved and softened, when gradually one third ounce of powdered borax is added, until an intimate union of the substances takes place. The liquid is then left to cool, and while still hot any mineral colour may be added, such as lamp-black, yellow ochre, red ochre, iron blue, or burnt umber, whereupon it is left to get entirely cold. It is then ready for use. It is said the operation can be so quickly performed with a brush that two women can prepare 3,000 feet in ten hours.

OLIVE OIL.—The oil made in the district of Oneglia is better than that of Southern Italy, and large quantities are refined before being exported. The process of refining the oil is very simple. Large shallow tin boxes are made with small holes pierced in the bottom; this is then covered with a thin sheet of wadding. Four, five, or more of these boxes are placed on frames one over the other, and the oil being poured into the top box, is allowed to soak through the wadding and drop into the next box, and so on until it gets into the last, when it runs off into the tanks. The wadding absorbs all the thick particles contained in the oil when it comes from the mills, and leaves it perfectly clear and tasteless. The oil thus refined is almost exclusively exported to Nice, where it it is put in bottles, and sent all over the world as "Huile de Nice." Olive oil is all sold by weight. The total quantity exported from Oneglia in 1868 was 6,182,490 kilos. (121,822cwt.); of these, 257,610 kilos were shipped direct to England; 5,885,592 kilos. to France; 39,288 kilos to Genoa, to be there transhipped for America.

SPITTING OF IRON AND STEEL.—The carbonic oxide which causes the spitting of steel and cast iron is considered by Caron not to be absorbed from without, but to be formed in the metal itself by the oxidation of its carbon. Iron only spits in an atmosphere of hydrogen or carbonic oxide when it has been smelted with some material such as clay or earth, which can oxidise the carbon of the iron, or provided the hydrogen contained watery vapour, by means of which a portion of the metal can be oxidized by the water giving up its oxygen to the carbon of iron; cement iron, from which cast steel, with 1 per cent. of carbon has to be prepared, must therefore contain from 2 per cent. to 2½ per cent. of carbon. Carbonic oxide is evolved to a scarcely appreciable extent all the while iron is melted, and spitting is first noticed when the metal cools. Good quality iron oxidizes when melted just as steel does, but does not spit, because the oxide formed comes in contact with but little, if any, carbon. The scintillation is in no way connected with the spitting. Iron, like steel, burns with an evolution of sparks at a red heat in pure oxygen.

POLISHING WOOD CARVING.—Take a piece of wadding, soft and pliable, and drop a few drops of white or transparent polish or French polish, according to the colour of the wood. Now wrap the wetted wadding up in a piece of old linen, forming it into a pad; hold the pad by the surplus linen; tough the pad with one or two drops of linseed oil. Now pass the pad gently over the parts to be polished, working it round in small circles, occasionally re-wetting the wadding in polish, and the pad with a drop or so of oil. The object of the oil is merely to cause the pad to run over the wood easily without sticking, therefore as little as possible should be used, as it tends to deaden the polish to a certain extent. Where a carving is to be polished after having been varnished, the same process is necessary, but it can only be applied to the plainer portions of the work. Plane surfaces must be made perfectly smooth with glass paper before polishing, as every scratch or mark will show twice as badly after the operation. When the polish is first rubbed on the wood, it is called the "bodying in;" it will sink into the wood and not give much glaze. It must, when dry, have another body rubbed on, and a third generally finishes it; but if not, the operation must be repeated. Just before the task is completed, greasy smears will show themselves; these will disappear by continuing the gentle rubbing without oiling the pad. You should now be able to see your face in the wood, at least, so says the *Cabinet Maker*, from which we take the above directions.

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* From the *Pharmacist* (Chicago.)

NEW COATING FOR FIRE-ARMS.—For some time past the officers of the American Government have been successfully experimenting with a new metallic covering for fire-arms. The object (according to the *Mechanic's Magazine*) is to protect the steel of the weapon from oxidation, and from the discolouration produced by the burnt powder after discharge. Other governments have also been experimenting in the same direction, the covering generally attempted to be used being, we believe, nickel deposited in its pure state by a process known as that of Isaac Adams. This process, it appears, is being worked by the United States Nickel Company in America. It is a matter of fact that owners of favourite fire-arms often have them coated with a deposit of silver, which, however, tarnishes with the sulphurous gases produced on firing. It is also very expensive, which, of course, renders its application impracticable for the army. It was always known that the use of nickel would obviate both these disadvantages, being exceedingly hard and capable of taking a very high polish. The difficulty, however, has been that it could not be deposited by any known process, although partial success has been achieved by Becquerel, Kurts, and others. But the Adams' process of the American Nickel Company has overcome this difficulty, as has been clearly demonstrated by searching experiments. In one experiment two revolvers were taken, one of them being coated with nickel by the above-named process, and the other being carefully covered with oil. They were buried together for some time in wet sand, the result being that the nickelled weapon came out bright and and as free in movement as when buried, whilst the other was clogged and coated with rust. The introduction of this improvement will prove of great value both to the troops and to the country—saving the former much labour, and the latter much expense in preserving military arms.

AUDIBLE RAILWAY SIGNALS.—The necessity for some better means of communication with railway trains, especially within the metropolitan district, during foggy weather, when the signals at present in use are almost valueless, has induced Mr. Baines, of Smethwick, to invent an audible signal, which can be so arranged that communication from a station to an incoming train may be readily effected, thus permitting the traffic to go on as safely and regularly during the prevalence of fog as at other times. The inventor provides a treadle bar at the side of the line of rail, in such a position that a train in passing along the line will depress it or tread it down, and in doing so act on a bellows-like apparatus, and cause air to be forced through a whistle or other wind instrument. The apparatus can be thrown out of use when not required by means of a wire passing to the signalman at a distance.

NEW BUILDING MATERIAL.—The objection of want of novelty is sometimes raised against concrete as a building material, even by those who appreciate its advantages; but the same objection is not likely to be heard with regard to the new material proposed by Mr. Hillstream, of Lawrence, Kansas, who has discovered a means of preparing coal-tar in such a manner that it may be used not only for building, but for many other purposes, for which metal, clay, or other similar materials are at present regarded as essential.

DESTROYING BLIGHT ON PLANTS.—A useful composition for this purpose may be manufactured of:—Sulphur, 850 parts or grammes; soda salt, 250 parts or grammes; gas waste, 100 parts or grammes; ashes of vine cuttings and of oak twigs thoroughly baked, 180 parts or grammes; lime, 50 parts or grammes; animal charcoal, 20 parts or grammes; ochre, 50 parts or grammes. All these substances are placed together in an oven suitably heated, and are then ground and sifted.

DECOMPOSITION OF ALCOHOL BY CHLORINE.—Absolute alcohol can be decomposed by chlorine with artificial light as readily as in the direct rays of the sun. If we pass chlorine into the alcohol in the dark, and then burn a piece of magnesium wire, or employ electric light, the hydrogen of the alcohol immediately combines under a slight explosion with the chlorine. This is another confirmation of the analogy of magnesium light and electric light with the chemical rays of the sun.

MODELS FOR INVENTORS.—We have from time to time received requests from our subscribers, for the addresses of good and reliable model makers. One correspondent some time since proposed that some one should commence such a business, and notify the fact in our advertisement pages. This suggestion seems to have been adopted by Messrs. A. Davies and Co, of 14, Strand. They announce the adoption of a novel substance—leather—as the material for such models, which, on account of its cheapness, durability, and capability of manipulation, they consider well-fitted for the purpose. The great cost of models has hitherto prevented many inventors from ordering their construction—a mistake in one way, inasmuch as failure has thereby often resulted. Those of our readers who care to perfect their inventions before patenting, would do well to avail themselves of the facilities now offered.

VACCININE.—Vaccinine is a crystalline principle extracted from the leaves of the cowberry (*vaccinium vitisidæa, L.*) The amount of vaccinine in the shrub is about 1 per cent.; it forms long acicular crystals of somewhat bitter taste and devoid of smell. This substance is scarcely soluble in ether, better so in cold water and alcohol, but best of all in boiling water; a saturated solution of this substance in the latter yields, on cooling, a solid mass. When the crystalline substance is heated it melts to a clear liquid. It is not precipitated by either sub-acetate of lead or tannin, is neutral to test-paper, and contains no nitrogen.

THE USES OF PAPER.—Interesting articles might be written upon the raw material now used in the manufacture of paper. In Australia, the husks of corn are not only made into paper but into clothing, and a good article of food is also produced from them. Paper clothing is also made in China and Japan, where a good coat can be made for ten cents, and a suit of clothing for a quarter of a dollar. In Germany, paper napkins are now introduced, the cost of them is a trifle, and they can, after having been once used, be thrown into the common stock to be worked over again.

ANSWERS TO CORRESPONDENTS.

⁂ All communications should be addressed to the EDITOR of the ENGLISH MECHANIC, 31, Tavistock-street, Covent Garden, W.C.

ANOTHER TESTIMONY.

I have found your excellent publication unexcelled as an advertising medium.—J. ANDERSON, Blairgowrie N. B.

The following are the initials, &c., of letters to hand up to Tuesday morning, August 2, and unacknowledged, elsewhere:—

Sergt. W. C., J. B. Spicer, W. Hall, J. Elwell, J. F., W., T. W., Capt. J. H., Jas. Mills, An so forth, J. W., Rob. Billing, An Amateur, Jas. Gosling, J. R. W., J. H., J. S., A Learner, All Serene, J. H. W., W. W., Revd. R. F. G., J. M., A. D. & Co., E. Wood, Fred. Foster, S. Barrow, Rev. R. C., E. Potter, R. C. B., J. H., J. W. B., T. O'B., Colourman, S. Ibbotson, Semper Paratus, H. Harrold, Hermann Smith, W. H. Child, A. A., R. L., Rev. E. Kernan, D. G., E. L. G., S. A. R., E. H. T., R. A. Proctor, F.R.A.S., A. Tolhausen, J. K. P., T. S. H., J. S. Partridge, Veritas, J. P. Jackson, A Constant Subscriber, J. R. D., H. H., J. N. Thos. Pollard, Operator, Photo, J. Cooper, W. Hall, Virtumnus, Wreath, W. Bury, Anthony Grey, Soda Water, J. Bell, Nobody Knows Who, Hy. Mace, Wood Spoon, R. N., Raymond, J. Hastings, Velocipede, Hy. W. Henfrey, Rev. E. Kernan, Steel Pen, R. A. P., C. Draper, J. H. T., Omega, Col. S.

G. E. S.—Living in Winchester, why not order through a bookseller?

W. GRIFFITHS.—See "Inductorium's" letter in last number.

R. S. S.—We don't know the address.

ARTHUR UNDERHILL.—All right.

JOHN SHAW.—Can't promise; very likely.

AN AMATEUR.—Your first query is an advertisement.

DEWSBURY MUTUAL IMPROVEMENT SOCIETY.—John Tarnhill writes to say that there is no necessity for a new English Mechanic Society in this town, as there is a Mutual Improvement Society there already, but he admits it is mainly for those who have received little or no education. Possibly "F. S. H." (p. 448) wants something better or different.

J. J. M'CARTEY.—The accounts of "Tourists' Trips" were pressed out by other contributions more in keeping with the general scope of the ENGLISH MECHANIC. Besides, the accounts were not sufficiently compact and practical. Thanks for congratulations.

CHARLES E. MAY.—We have no room for illustrated *notions* for ocean railways. Yours is purely chimerical.

OLD HUMBUG.—The deserving and successful are generally abused, hated, or envied by the weak, the vicious, and consequently the unsuccessful.

RALPH WILLIAMS.—All are in print.

Q. YORKE.—Mr. Charsley's velocipede was illustrated in No. 282, on page 526.

THE SIXPENNY SALE COLUMN is the only place in which can appear queries sent by W. F. Trinder, T. Grist, A Subscriber, G. W. Tipton.

H. LEDGER.—No stamps in your letter.

D. SIBSON.—We do not remember your former letter The initials you refer to were not yours, exchanges not being acknowledged there.

T. J. O'CONNOR.—The value of your replies would be enhanced, and we should be saved much labour, if you would in each case prefix No. and title of the query.

OMNIGENIOUS.—See reply 3877 on p. 404.

W. BASSETT.—We cannot guarantee the truth of any statements made by advertisers, but we know the advertiser you inquire about to be a respectable tradesman, and do not think you would have reason to complain of him. With regard to the other advertisement we know nothing of the advertiser or the result.

R. N.—Should be glad to receive proffered drawing of Mordan's chuck.

FASHIONABLE FRED.—Have common sense and wait for your whiskers and moustachios to grow naturally.

GILES.—No. 3 is a Byzantine coin of the Roman Empire, struck at Byzantium (now Constantinople), after the removal of the seat of Government from Rome; there is a great similarity in those coins, and as the inscription on the obverse is indistinct, it is impossible to determine to which emperor it belongs. It is most probably a coin of Anastasius. No. 4 is an Indian rupee.

A BUFFER.—Advertise for the co-operation of some capitalist.

R. M'LOUGHLIN.—We know of no such journal. You should apply to the Commanding Officer of the London Corps of Commissionaires, 419A, Strand, London.

P. M., J. N., AND OTHERS.—See notice at the head of "Answers to Queries," referring to the numbering and titles of queries. Attention to those matters diminishes the editor's labour.

G. W. WHITAKER (Helmshore). — There were [illegible] stamps in your letter.

R. B.—The letters will be continued. You are mistaken if you think we "care little for the thanks" of our subscribers.

A FOREIGN ENGINEER.—Consult advertisement pages.

A. L. B.—Read the articles on mathematics by "C. H. W. B." which have appeared during the last few months in our pages. Your other query inserted.

A. B. (Portsea.)—Such queries are not inserted except in the Sixpenny Sale Column.

W. B. CUSTANCE (Ely).—Stamps sent are only sufficient for one insertion.

KANSAS EMIGRANT.—You can have the ENGLISH MECHANIC sent to you in Kansas, by subscribing, through the post. We have already a considerable circulation in the States. Messrs. Trübner's address is [illegible] noster-row.

H. A. C.—We imagine the last of the diviners was put to the rout by honest old Jonathan Oldbuck, in "The Antiquary." We certainly cannot give any information about any living members of that honourable [illegible] rather untrustworthy, profession.

ERRATUM.—In "Beta's" letter on "The Composition of the Human Body," in our number of July [illegible] should have been that "chloride of sodium exists in the blood *and* other secretions," instead of "[illegible] secretions;" and the quantity of potassium should have been 290 grains, and not 2oz. 290 grains.

POSTULATA. — "Benefit of Clergy" was a privilege granted to the clergy, and generally to all able to read, in the middle ages; by claiming which, when convicted of some greater crime, they either escaped punishment altogether or in part. The framers of later laws against certain crimes—such, for instance, as uttering of base coin—saw the evils attending such a course of procedure, and it became common to decree that the punishments mentioned therein should be incurred by all persons alike "without benefit of clergy."

HOBBY.—Replies on "*Warming Baths by Gas*, &c. have appeared in our last *volume*.

BERIRO.—We were obliged *to leave over many letters* on "Shorthand" from want of space.

ONE IN A FIX.—Find the number of cubic feet and reduce to gallons. A cubic foot contains 6·232105 imperial gallons.

A. B.—He would be liable to a penalty.

A WORKMAN.—From ten to five o'clock, 6d.; from seven to ten, 2d. We do not know how long the exhibition is to remain open.

T. O'BRIEN of North Wall, Dublin, writes:—"I have taken your MECHANIC weekly for the last two months, and am proud to acknowledge (in spite of the prejudice that exists here of supporting anything English) that it is one of the best and most useful journals I ever read." We beg leave to assure Mr. T. O'Brien that the prejudice he speaks of cannot be very general, as some thousands of copies of the ENGLISH MECHANIC go to Ireland weekly, and that many of our best correspondents hail from his country. We have every reason to believe that all such prejudices will pass away, under the influence of equal laws and their righteous administration. This journal is not a fitting place to discuss the causes of prejudices or the means of removing them. Its conductor, however, never fails, as many of Mr. O'Brien's countrymen know, to do what he can in another field towards the establishment of just legislation, which *must*, in the [illegible] of time, dissolve prejudices and weld us into a united and strong people.

H. COULSON.—Write him that you have communicated with us, and if he still takes no notice we will [illegible] him.

INSPECTOR COCKBURN.—Of course we did not impute any fraud to *you*. We said others might copy you for fraudulent purposes. We also think it is hardly fair to ourselves to ask what you ask.

G. F. S.—Thanks for your offer, but our satisfaction at seeing your discovery perfected would be quite sufficient without participating in the fortune you offer to share.

J. W. GRAY.—A title-page was issued with the first volume of the *British and Foreign Mechanic*, and may be obtained through any bookseller.

W. JOHNSON.—We cannot undertake to examine and report on inventions for obtaining perpetual motion.

OXONIAN.—One query inserted. The others have been answered in back numbers.

A. NOTTLE.—Our space is too valuable for the discussion of crude theories like yours.

G. E. D.—M.S. came to hand.

THE MICROSCOPE.—A. Allen says:—"It would afford me great pleasure to find a page of our very famous journal devoted weekly to the "Microscope," and if it could be possible to put all such information on that page I think it would be an acquisition. I sincerely hope our Hull correspondent will alter his mind, and not let his next paper be his last."

AMATEUR WATCHMAKER.—Our space must be occupied not for the benefit of a single individual, but of our readers generally.

VIATOR.—Your query is an advertisement.

LEMAS.—See answer to Viator.

J. H. BUFFHAM.—Both letters received. We fear that our other engagements will not permit us to do it.

ISAAC PITMAN'S letter next week.

F.R.A.S.—Article on Saturn next week.

THE *ENGLISH MECHANIC* LIFEBOAT FUND.

Subscriptions to be forwarded to the Editor, at the Office [illegible] Tavistock-street, Covent-garden, W.C.

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The English Mechanic
AND
MIRROR OF SCIENCE AND ART.

FRIDAY, AUGUST 19, 1870.

SATURN.

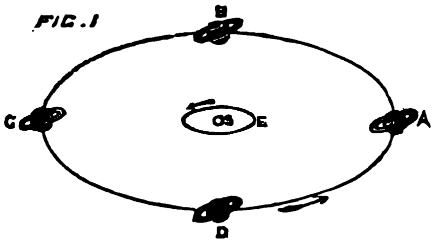
By a Fellow of the Royal Astronomical Society.

THERE can, we think, be very little question that amid all the wonders of the Solar System, the most wonderful in aspect, as in physical structure, is the planet whose name heads this article. In fact, we believe that no one ever contemplated Saturn for the first time in a telescope of adequate power without an exclamation of surprise at the extraordinary spectacle presented by a huge globe, suspended in space, belted like Jupiter, and surrounded by an (apparently) dense and solid ring or rings of light. We have purposely deferred any reference to this planet until his arrival at a position in the heavens which would enable the student to follow our description by a direct reference to the object described. Now, however, that he rises between five and six in the afternoon, is on the meridian between nine and ten, and sets an hour or two after midnight, we propose to give the same amount and description of detail with reference to him that we have previously done with regard to other visible planets; and we will say frankly, *in limine*, that it will be wholly our own fault, and not that of our subject, should this paper prove an uninteresting one. Premising, then, that Saturn has an equatorial diameter of 72,250 miles; that in addition to his rings eight moons circulate about him; and that he is situated at a mean distance of 874,321,000 miles from the sun, around which he performs one revolution in 10759·21971 days (or something like 29½ of our years), we proceed to the more immediate subject of our paper, the revelations made by the telescope as to the structure and condition of this most marvellous object.

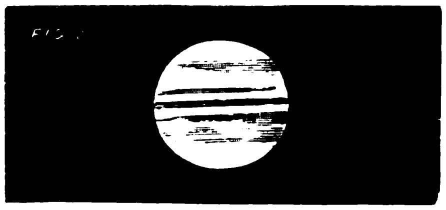
Passing over the connection of the Assyrian god Nisroch with the planet Saturn, and the altogether extraordinary circumstance that in many of the Assyrian sculptures this god is represented as *surrounded by a ring*, we may pretty confidently assert that Galileo was the first observer to whose gaze anything of the remarkable appendage of Saturn was revealed. It was in the year 1610 when he first seems to have made a telescopic examination of the planet. He employed, as is very well known, an instrument of a form invented by himself, and called even to this day the Galilean telescope, consisting merely of two lenses mounted in a tube—a convex one for the object glass and a concave one for the eye-glass. Turning this affair, which magnified, however, more than thirty times, upon Saturn, he was surprised to observe that it appeared *triple;* presenting to his eye the effect of a central globe with two smaller companions in contact with it. Two years afterwards, from a cause presently to be explained, the ring became invisible altogether, and Galileo saw the planet perfectly round. This so utterly puzzled him that he would appear to have persuaded himself that either his instrument, or, as he says, "some demon" had deceived him in his original observations; and, in seeming disgust, to have ceased to regard this particular planet at all. Whether it be so or not, one thing is quite certain, and that is, that Galileo makes no allusion of any sort to Saturn subsequently to the year 1612. Between forty and fifty years afterwards we find Hevelius observing Saturn with great attention. He seems to have got very little further than Galileo, either in what he could see or in his interpretation of it; at least, he finally came to the conclusion that the globe of the planet had two lunules or crescents of hyperbolic curvature, attached by their cusps to its body, the dark sky showing between the inner edges of these crescents and the ball of Saturn. He fancied that a movement of rotation sometimes carried one of these lunules in front of the planet's disc and the other behind it, and so imagined that he had explained the round phase which had proved so great a stumbling-block to Galileo. It was, however, Christian Huyghens, who, in 1659, first satisfactorily solved the mystery of the planet's aspect in his "Systema Saturnium," in which he showed how the appearances he had observed were produced by a thin flat ring surrounding Saturn's globe, and situated in the plane of his equator. On the night of the 13th October, 1665, Dr. Ball, and his brother, Mr. William Ball, of Minehead, in Devonshire, detected that this ring was divided into two by a black line, which has since been known as "Ball's division." This was re-discovered by Cassini, in 1675. It is worthy of notice that William Ball must have been a very assiduous observer of Saturn, as we have it on the authority of Huyghens that he saw the bands or belts upon the body as early as 1656. In 1662, Auzout seems to have seen the shadow of the planet upon the ring. Other discoveries we shall advert to in describing the various appearances presented by Saturn when viewed with the optical aid now at the command of astronomers.

We have referred to the appearance and disappearance of the ring (or rings) above; and it will perhaps make our subsequent observations rather more intelligible, if, prior to entering into a description of the physical features of Saturn revealed by the telescope, we try to give some notion of the reason of this, and of the very varying aspect of the rings themselves, presented at different epochs. Reference to the annexed figure will assist our explanation.

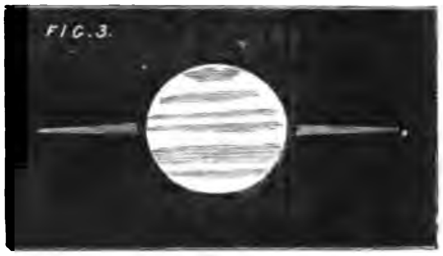
FIG. 1



In it, let S be the sun, the inner small ellipse be a perspective view of the orbit of the earth, and the outer large one of that of Saturn. Then, if for simplicity, we imagine these orbits to be in one plane, and remember that the axis of Saturn, like that of our earth, always travels through space (practically) parallel to a fixed line, we shall see that when Saturn is at A—the earth being (say) at E—we shall see the upper side of the ring and the north pole of Saturn—a condition of things which obtains at this moment. It will be equally evident that when, after an interval of some fifteen years, the planet arrives at C, his south pole and the under side of the ring will be seen. In both these cases it is pretty obvious that the ring will appear as a broad ellipse—in fact, at the time of greatest opening, the minor axis is about half the length of the major. A little study of the figure will show that, as the planet travels from A towards C, and from C towards A, the ring will gradually close up, as we shall be looking at it more and more edgeways; and that at intermediate points, such as B and D, we should (with a sufficiently powerful telescope, and the plane of the ring passing that of the sun) see only the illuminated edge of the ring as an excessively narrow hair-like line of light. It will also be noticed that when the plane of the ring passes through the earth, or when the sun is shining on the side turned away from us, the ring, save on a narrow dark line crossing the planet's equator, will utterly disappear. Furthermore, when we reflect how very slowly, relatively speaking, Saturn crawls along in his orbit, it will be easily perceived that our earth may—and, as a matter of fact, does—pass twice through the plane of the ring before it passes the plane of the ecliptic, so that ordinarily the ring disappears twice when it is in its ascending and descending nodes. Under the circumstances of such disappearance the effect presented is that seen below—



which is a *fac-simile* of a drawing copied from our Observatory book, under the date of January 25, 1862, and represents the planet at 12h. G.M.T., as viewed in a 4¼in. achromatic, with a power of 250. As an illustration of the return of the ring to visibility, we further append another sketch, made with the same instrument and power, on February 10 of the same year, at 11.50 G.M.T. The minute dot of light, apparently a detached part of the ring, was in reality a satellite. We may add that the ring disappeared again in the May following of the year in which these drawings were executed.



Assuming then that the student has acquired a clear conception of the reason why this remarkable appendage varies in appearance from a wide ellipse to a straight line, and ultimately disappears only to follow its cycle of changes in a reverse order, we may resume the thread of our description of the discoveries which have been made with regard to the structures of Saturn generally.

Reverting then to the duplicate character of the ring, it will be remembered that it was known to be double as early as 1665, and it is somewhat to the credit of Cassini (when we consider the nature of the optical means at his disposal) that he, ten years later, not only saw the division, but detected the difference of tint between the outer and the inner ring, the inner one being the brighter of the two. He compares this difference to that exhibited by burnished and tarnished silver. The next observation of any importance which we meet with in chronological order, is that of Short, the famous optician and reflector maker, who about the year 1760 would seem to have detected a division, or rather divisions, in the outer ring itself. In the month of December, 1823, M. Quetelet was trying a telescope by Cauchoix, in Paris, and thought he saw the outer ring to be double. On December 17, 1825, Captain Kater, employing a Newtonian reflector, by Watson, of 6in. aperture, saw three black streaks, the middle one being the strongest upon the outer ring. One friend with him could perceive *several;* another one only two. During the following January Kater repeated these observations with a Dollond telescope of the same construction, with which, under equally favourable circumstances, he could *sometimes see the lines and sometimes not.* He hence inferred that the divisions, whatever they might be, were not permanent. Since then this division of the rings has been seen by a considerable number of observers, including Encke, Padre de Vico, Lassell, Dawes, and many of less eminence. It may encourage incipient telescopists if we mention that during the year 1858 and part of 1859, we ourselves on several occasions saw this division fairly enough with the same instrument and power that we have employed in making the delineations of the planet which illustrate this paper. It was never equally visible on both sides simultaneously, though Sir William Herschel noticed that the inner ring became shaded off towards the interior edge; and the late Rev. W. R. Dawes, on a night of exceptionally fine definition, in the year 1851, saw this appearance resolved into a set of very narrow concentric bands, getting darker and darker as they approached the inner edge of the ring. He compared the appearance to that of steps leading down to the dark interval between the ring and the ball. In connection with the two principal bright rings of which we have been speaking, we may call attention to the remarkable fact, that if it be permissible to compare the measures (or estimations) of Huyghens with those of Sir William Herschel, and these again with the refined and accurate ones of the great Russian astronomer, Struve, there can be no possible doubt that a most extraordinary increase has taken place in the breadth of the system within the last 200 years, and that the inner edge of the ring is rapidly and perceptibly encroaching on the space by which it is now separated from the body of the planet. In fact, should this contraction go on at its present estimated rate, it has been calculated that by the year 1980 the dark ring of which we are immediately about to speak will be in actual contact with Saturn himself.

This interior dark ring, to which we have just referred, appears of a purple, or rather slate-coloured tint; it has been discovered within the last twenty years. We say "discovered," albeit there are plenty of indications that it, or at all events a part of it, must have been seen without its nature being detected a very long time since. The first record we have of it as an unmistakable appearance is that of the late lamented American Professor Bond, who observing at Cambridge, in the United States, on the night of November 11, 1850, with the gigantic refractor of 14·93in. aperture, then remarked that the inner edge of the inner ring seemed to have a kind of nebulous margin crossing the ball of the planet as a narrow belt. The actual shadow of the ring itself on the ball was seen below the ring. In total ignorance of what had been observed in America, the late Rev. W. R. Dawes, F.R.S., on the night of November 25th in the same year, while regarding Saturn with an achromatic of 6·4in. diameter, was struck with a similar appearance. He repeated the observation on the 29th of the same month, and again, in conjunction with the present President of the Royal Astronomical Society, Mr. W. Lassell, F.R.S., on December 3rd, on which night they both satisfied themselves of its existence. Oddly enough, news arrived on the very next day, December 4th, of its discovery in the United States by Mr. Bond. It may be somewhat instructive to add, as showing the imperative necessity which exists for recording any new or abnormal appearance, that in the year 1828 this ring must undoubtedly have been seen in a 6¼in. Cauchoix achromatic, in the observatory at Rome; but that nobody seems to have made any note of it, nor, in fact, to have troubled his head about it. It was, however, perceived by Dr. Galle, at Berlin, ten years later; though what has become of his observations, or rather of their record, we are wholly ignorant. Assuredly, so far as Bond and Dawes were concerned, the discovery was quite original. By far the most remarkable thing in connection with this obscure ring, however, is that—to say nothing of that painstaking old observer, Schröter, who expressly speaks of the space on each side of the ball being as dark, or darker, than the surrounding sky—neither Sir William nor Sir John Herschel, who zealously observed Saturn, nor Struve, who measured the whole of the dimensions of the planet and his appendages over and over again with the great 9·6in. Dorpat refractor, ever seem to have had the least suspicion of its existence; while, since 1850, it has been seen in one of Dallmeyer's 3⅜in. achromatic, and is unmistakable in any decent telescope of 4in. or upwards in aperture. It seems difficult to escape the inference that this strange object must have increased most remarkably in brightness within the last thirty years. Dawes, and after him Otto Struve, thought that the dark ring was itself divided into two; but this suspicion has not been confirmed, nor is it quite certain that there is a visible division between it and the inner bright ring. Before dismissing this part of our subject we may say that astronomers ordinarily designate the three rings, commencing with the outer one, as A, B, and C—B being, of course, the broader (and inner) bright ring, and C the crape ring.

(*To be concluded next week.*)

INORGANIC CHEMISTRY.

By George E. Davis,
Honours Certificated Teacher.

Introduction.

CHEMISTRY, or as it was first termed, alchemy, is a science which we may trace from remote antiquity; and, indeed, its course is more distinctly traced throughout the earlier ages by the fact that the alchemists were supposed to practise what was termed the "black art," and were, in general, supposed to be in league with demons.

In the pictures we have presented to us of these alchemists, their workshops seem to bear a mystic air; the alchemists themselves look grave and dull; whilst the bottles which are ranged upon the shelves are covered with symbols which add more and more to the mystification of the scene. These alchemists worked with salt and mercury, their aim being to produce some hypothetical compound, or to form by some yet unmade mixture the philosopher's stone. Thus alchemy went on: fortunes were dissipated and money spent upon experiments which, although set down by some as utterly worthless, often turned out successful in a different point of view: mixtures were made—they were heated, distilled, cooled, or brought into a state of solution by means of one or other of the several acids or solvents then known, and the result was not what was originally expected but some new compound, which was immediately designated by some fanciful name at the option of the discoverer.

In this manner several valuable products were discovered which added greatly to the advancement of the science. I may cite, as an instance, the discovery of vitriolic acid, made at the close of the 15th century by Basil Valentine, a monk of the Erfurt monastery.

These illustrations will serve to show that alchemy was that science which had for its object the formation of those substances which are now considered as having no existence. The mercurial earth of Becker, and the phlogiston of Stahl, which were then looked upon as separate entities, have now been distinctly proved erroneous theories — theories which showed an admirable amount of ingenuity in their construction, but which held no way against truth.

Instead of trying to make gold and the philosopher's stone, modern chemistry pursues its course in a different direction: it has for its object the study of those elements or particles of matter which come immediately under its notice—their properties and their combinations with one another. The chemist works, not as formerly, to isolate or determine the properties of phlogiston and other analogous bodies, but experiments with a view of classification, reducing his experiments to laws which may serve for the guidance of future generations.

A series on inorganic chemistry will not require much introduction to the readers of the English Mechanic. Since the journal first made its appearance ample provision has been made in its columns for notes and queries in the above science; many valuable letters have appeared, and extracts have been made from the various scientific periodicals whenever they have afforded articles likely to be of general interest.

The readers of the English Mechanic have had a series on "Modern Chemical Notation;" symbols have also been thoroughly explained (pp. 49 and 97, Vol. XI.); and as the chemical student should know the elementary facts about light and heat, magnetism and electricity, he cannot do better than follow "Sigma" through his course on electricity.

The present series, which these few remarks are intended to introduce, will be made of a thoroughly practical nature. Chemical technology will be studied in most of its branches—in all those at least which bear upon the subjects of the series; analysis, qualitative and quantitative, (the latter branch will be subdivided into volumetric and gravimetric), will be treated on; and also the blowpipe reactions of the various metals and elements will be inserted in their respective places.

Chapter I.

Chemistry is the science which treats of matter in its many forms; its decomposition into those bodies which are termed elements, and also of atoms; the probable ultimate particles of the elements as we know them, or as they have at present been studied: it treats of their properties and their combinations with one another, whereby we are able to form them into groups, the members of which exhibit a strong family likeness.

Chemistry is truly an experimental science; the laws which govern it are the result of exact and laborious experiments performed by those men who have devoted a whole life to its study. It is not to be looked upon as an isolated science, but a branch of one great whole—natural philosophy. The student may begin with chemistry, but he will soon find need of a good general knowledge of the cognate sciences—light, heat, magnetism, and electricity.

Matter, or the bulk of the material world, is at present known to consist of 64 *elements*, or 64 forms of matter which have not been proved compounds by the most powerful re-agents, or by the most powerful forces which have been brought to bear upon them. The elements are, then, of necessity, *simple matter*, whilst matter containing several elements is designated *compound*.

Matter presents itself to our notice in three forms or physical modifications—solid, liquid, and gaseous—which, however, are often not permanent, but dependent upon the forces by which they are influenced. As an instance of the first physical form we may take *ice*. The molecules in this form keep their relative position unless acted upon by an external force—such as that of heat; this latter force being kept away a piece of ice tends to retain the form given by nature or the hand of man.

In the liquid state, such as may be illustra by water, the molecules have a tendency to [illegible] over each other; in fact, they have no perm position, and by the application of heat they transformed into the third physical form gaseous state. By the application of he water this force overcomes the cohesion c particles, and also the force of adhesion to vessel in which it is contained. The res steam, and the only visible manifestation w of its presence is its condensation directly comes in contact with the atmosphere, s is itself an invisible gas.

The specimen given above of the [illegible] through the three states is not confined [illegible] pounds; by the application of intense [illegible] cury, which is a fluid at ordinary tempe becomes solid (at − 39·4° C.), and by the [illegible] tion of heat it is converted into vapour. [illegible] boils at 350° C., and emits a colourless [illegible] one hundred times heavier than hydrog

Elements, Atoms, and Molecules.—[illegible] seen that ordinary matter is not capable [illegible] tinuous subdivision; for taking water [illegible] ample, the theoretical division stops [illegible] reach a molecule. A molecule of the bod [illegible] smallest group which can take part in [illegible] mical action. But, although we have rea limit of divisibility as regards water, we ca split up that water—that molecule of water— simpler matter; its constituents, oxygen [illegible] hydrogen. By the action of the voltaic batt upon acidulated water it is decomposed, yield two gases named above. These gases have be submitted to the most energetic forces known the chemist, but without success; *at least*, in the direction to prove their *compound constitution*.

We have then divided *water and formed a* molecule; this molecule *or smallest portion of wate* which could exist in a free state has been *further* subdivided, and at last we have reached the ultimate atom. The existence of atoms has ofte been spoken of ambiguously, and as having relation to chemistry alone; but such ideas ar totally erroneous. If we believe in the combination in multiple proportion we must support th fact by the atomic theory. And, again, we [illegible] no chemistry to support the hypothesis—[illegible] electricity, and the cognate sciences [illegible] cient proof of its truth.

Radicles.—The elements, or simp [illegible] unite with each other to form compo [illegible] so doing they exhibit certain deg [illegible] each element in its uncombined [illegible] tially a *simple radicle*, having vario [illegible] force. A group of elements not bei [illegible] but possessing chemical force, is call [illegible] *pound radicle*; instances are to be [illegible] carbonyl $\mathrm{C\,O''}$ and sulphuryl $\mathrm{S\,O_2''}$; they [illegible] as elements, replacing them in many [illegible] compounds. (See also page 98, Vol. XI.)

Then, again, the elements may be divi [illegible] two great classes—chlorous (electro-neg [illegible] and basylous (electro-positive). When [illegible] pounds are decomposed by the voltaic batt [illegible] some (chlorous) make their appearance [illegible] positive pole, while the basylous appear [illegible] negative. The most stable compounds are for [illegible] by union of dissimilar elements, whilst si [illegible] combinations are characterized by their uns [illegible] nature; potassium (basylous) unites with [illegible] energy with chlorous oxygen, and the result very stable compound; but when chlorine [illegible] nitrogen enter into combination, these chlorous elements are so loosely united that [illegible] resulting compound cannot safely be touched w [illegible] out danger of causing a fearful explosion.

Symbols, Nomenclature and Formulæ.— the reader will turn to pp. 49, 97, he will see t a recapitulation on this heading is quite unne sary. The circles will be omitted in gra formulæ for the future.

Atomic and Molecular Weights.—A litr hydrogen weighs 0·0896 gramme, which w has been denominated a *crith*; a litre of ox weighs 1·4348 grammes—that is, 16 times he than hydrogen, or 16 *criths*. Now, as e volumes of the simple gases (with a few e tions) under the same pressure and temper contain an equal number of atoms, the ato oxygen must be 16 times heavier than th hydrogen.

But the reader will probably say, How ar atomic weights of those elements determ which, like carbon, have never been rend gaseous? It has been found by experiment 35·5 parts of chlorine unite with 1 of hydr and as 108 parts of silver unite with 35·5 of chlorine, 108 must be the weight of silver. For the determination of the atomic weight of carbon, diamond was burnt in a stream of oxygen; and from the experiments of Dumas, Erdmann, Liebig, and many others, the atomic weight of 12 has been adopted. If the metal be a dyad, the atomic weight is that quantity which unites with 16 parts of oxygen—calcium, for instance—the atomic weight being 40. This refers only to the normal oxides; the higher acid or basic oxides are of course exceptions. The *molecular weight* is dependent upon the *molecular* volume, which volume is that which is occupied by two atoms of hydrogen at the same temperature and pressure. The molecules of the monad and triad elements contain two atoms, with some of the pentads—therefore the molecular is twice that of the atomic weight. Most of the artiad elements have a molecular weight which is identical with the atomic; one atom, as in the case of mercury, occupying the same space as two of hydrogen. The molecule of phosphorus vapour occupies half the space of a molecule of hydrogen, if we take two atoms to equal a molecule; but in the above a litre weighs 62 criths, or 124 as the molecule weight, and as other experiments give 31 as the atomic weight, the molecule must enclose four such atoms and remain the normal size. Arsenic resembles phosphorus in this respect.

The molecular weight of compounds may be found by adding together the atomic weights of the constituent elements, and if the density is required the molecular weight must be divided by the molecular volume; nitric oxide ($N_2 O_2$) has a molecular weight of 60, but a density of 15, the volume being 4. As the elements unite with each other in definite parts by weights they also combine by definite volumes or parts by measure; two volumes of hydrogen unite with one of oxygen to form water; equal volumes of hydrogen and chlorine unite to form hydrogen chloride; whilst ammonia gas is composed of three volumes of hydrogen and one of nitrogen.

Acids, Bases, and Salts.—Acids are generally formed by the action of water upon the higher oxides; both are decomposed, and a new compound results, in which the atoms are very differently arranged. The characteristic of the acids proper is the ease with which they exchange their hydrogen for another basyl. By the action of one molecule of water upon an oxide molecule, either one or two acid molecules may be formed; when the latter takes place the acid is what is termed monobasic, that is, contains only one atom of hydrogen replaceable by metals. If, as in the former case, only one molecule of acid is formed by the mutual decomposition of the water and chlorous oxide, a dibasic acid is the result; an acid which contains two hydroxyl radicles, or two atoms of displaceable hydrogen.

(*To be continued.*)

RECENT IMPROVEMENTS IN THE MANUFACTURE OF GAS.

THE manufacture of gas is a subject of more than passing interest to many of our readers, and in giving the opinions of those best capable of deciding on the utility of the various suggested improvements, we ask the attention of those of our subscribers more particularly interested in the matter.

For some time past numerous gas engineers have been engaged in endeavours to convert the valuable fluids contained in tar into permanent gases. These attempts to utilize the rich hydrocarbons of the tar, however, have hitherto not been so successful as might be desired, principally on account of the naphthaline and solid deposits creating obstruction in the mains and pipes, and carbon in the retorts, without the anticipated increased quantity of gas. An improvement has, however, been introduced at Cork, by Messrs. Hill & Lane, which bids fair to overcome these obstacles. Their process, which is patented, consists in the thorough amalgamation of the tar, with a portion of the coal to be carbonized. From 30 to 40 gallons of tar are mixed and ground up with three quarters of a ton of coal and a quarter ton of breeze. The proportion used is 25 per cent. of the total quantity of coal to be carbonized. The advantages claimed for the process are a larger yield of gas, increased illuminating power, and the re-conversion of the breeze into coke, its particles being cemented together by the pitch of the tar. It is said that inferior Welsh coal, treated under this patent, can be made to yield 15-candle gas. The *rationale* of the process appears to be that, whilst in the former experiments the tar was merely distilled, in this it is in great measure decomposed, and the poorer gases coming from the coal combine, while in their nascent state, with the hydrocarbons of the tar, which are converted into permanent gases, instead of condensing and forming obstructions in the apparatus.

Of all the machinery in general use upon gas works, probably no portion is so uncertain and so unsatisfactory in its operation as that of the ordinary coke "scrubber." In order to extract the tar, the gas after leaving the condenser, was passed through vessels filled with coke or breeze. The transition from these breeze-boxes or tar-filters to "scrubbers" was accomplished merely by increasing the depth, and allowing water to trickle through; but only a small quantity of water being required, the difficulty was to distribute it equally. To meet this, Mr. Hill adapted the well-known "Barker's mill" to the purpose; but even this ingenious contrivance was not sufficient of itself; it distributed the water equally, but the quantity required to keep it going made the resulting liquor too weak to be profitable. Mr. Hills then introduced a "tumbler," a sort of double trough with a division across the centre, and so balanced over an open box that the small stream of water alternately fills first one division and then the other, the division into which the water runs remaining in position until it is filled, when it, so to speak, tumbles over, emptying its contents into the box, thus affording sufficient water to cause the mill to turn for a minute or two, but which stops when the supply is exhausted. Neither the Barker's mill, simple, nor the "tumbler" proved successful, and both have since been discarded. The most common method of filling scrubbers at the present time is with coke; and these seem to answer very fairly provided the gas is free from tar. However, the invention of Mr. Livesey is a decided improvement, and will, in all probability, be universally adopted. It consists in fitting the interior of the scrubber with a number of thin boards, disposed so as to present an enormous surface of liquor to the passing gas. In a scrubber 15ft. 6in. diameter by 28ft. high, are placed 22 tiers of boards about ¼-in. thick; and as there are 258 boards in a tier the whole surface is about 128,000 square feet. A layer of coarse cocoa-nut matting is placed on the top to spread the water. The gas is passed through these scrubbers, the first two being plentifully supplied with liquor, and the third with a small quantity of water. The greater part of the ammonia is absorbed by the liquor, which is increased in strength to 10oz. or 11oz.; the remainder is removed in the last scrubber by the use of from 5 gallons to 6 gallons of water to the ton of coal, or scarcely more than half a gallon to 1,000ft. of gas. The liquor so produced is of from 7oz. to 9oz. strength, while the same vessel filled with coke would require 3 gallons to 4 gallons more water to the ton, and would only produce liquor of 3oz. to 5oz. strength; therefore the arrangement of thin boards is about twice as profitable as the use of the ordinary coke scrubber.

In the matter of burners, Sugg's "steatite" and the slit fish-tail are recommended as preferable to the two-hole fishtail. The Brönner burner (a kind of split batswing) is reported as giving an illuminating power of 12 candles, with an hourly consumption of 5ft. Indeed, the batswing burner has beaten the ordinary fishtail completely out of the field, as it gives a much better light with about the same consumption of the gas.

Some method of completely removing the sulphur from the gas is still wanted, as although its amount has been reduced to a minimum, there is yet sufficient to make its presence felt.

SCIENCE FOR THE YOUNG.*

By the Rev. E. Kernan, Clongowes College.

Application X.

Inclined Plane.

(*Continued from page* 485.)

WERE the thread of the nut cut away all to a *small part*, and the nut-block still kept in position, the working of the screw would be the same (as far as the principles of the plane are concerned) as if the whole thread of the nut existed. It is obvious that this spreading out of the force has the great advantage of much less pressure on any *one* part of the screw. In practical use it is sometimes the nut, sometimes the screw that *may move*, and these motions correspond to the weight *forced up* the inclined plane, or the inclined plane *forced under* the weight. The apparatus in Fig. 87 may help to make more clear the elements of a screw. Standing on the base A is shown *one turn*, *s s*, of a screw. The flat strip of metal, *a a a*¹, wound in a spiral, is the *thread* of the screw. The cylinder on which *a a a'* should be rolled is omitted, and in its place a perpendicular plate, *b b*, supports the spiral. The upright B has two projecting pieces, in which slides the bar C, the lower end of which rests (by a small wheel) on the screw spiral. This bar C represents *one* portion of the nut, movable *perpendicularly*. The screw spiral *a a a'* can move horizontally, being joined to the disc D, which has a pivot *p*, and lies upon small rollers in the base. A cord *c c* in the groove of the disc, and fastened at some one point of it, is a convenient means of moving the screw spiral. Lastly, a sheet of paper (No. 2) is cut of the same size and shape as the support *b b*, and wrapped *round* the support. Now, to remove all doubt of the spiral *a a a'* being an inclined plane, it is only necessary to unroll the spiral or its support. The paper sheet being an exact model of the support, is taken off, and when drawn out straight shows an unmistakable inclined plane, which has suffered no change by being rolled *height to point*. To show the action of the screw upon the nut, turn the disc D in the direction of the arrow. The bar C is forced up. Here is seen by the effect *on one bit*, what is the effect on the *whole* nut. Turn the disc in the opposite direction, gravitation forces the bar (the nut) down, and thus besides showing a common action of the screw, represents what would occur if the bar were subject to the pressure of the *under side* of the screw. The bar would be drawn down *apparently*, but the real effect would be the *forcing under* of an inclined plane having *a* (not *a'*) for point; in fact, the reverse of what is seen in the figure, in which *a'* is the point of the plane.

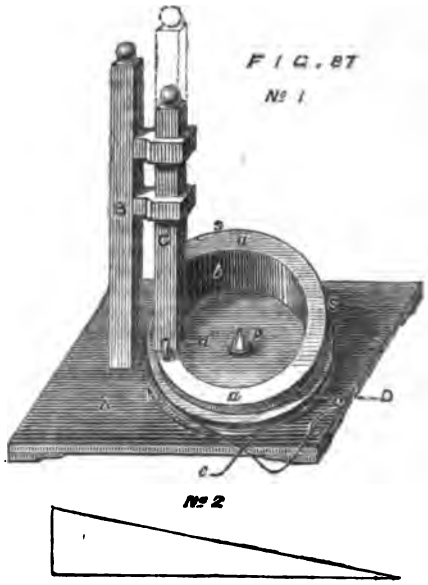


FIG. 87
No 1
No 2

This apparatus so far only shows one motion of screw (horizontal) and nut (perpendicular). But it is easy to imagine modifications, by which all the motions of both screw and nut could be represented. It would be too long to enter into these modifications, and the necessary minutiæ of detail in describing by diagram might produce confusion in the mind regarding this point (action of the machine), already perhaps too much extended.

III. Conditions of equilibrium. They are to be found in the 4th case of the inclined plane $\frac{P}{W} = \frac{H}{B}$; for in the screw the power is always applied horizontal to the base of the inclined plane which composes the screw. In the screw the "height" (H) is represented by the *pitch* or distance (d) between any two threads; and the "base" is replaced by the circumference $2 \pi r$; the formula then becomes

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* All rights reserved.

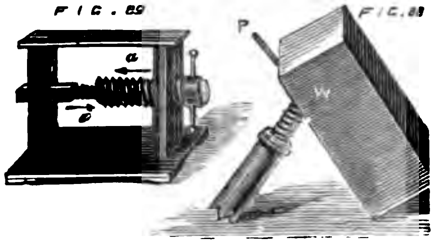
$\frac{P}{W} = \frac{d}{2 \pi r} \therefore P = \frac{d W}{2 \pi r}$. Should the divisor $2 \pi r$ not be understood, it will be quite sufficient for the present to know that it is the mathematical expression of any circumference; r is the radius, and 2π the relation of the diameter to the circumference, which not being an exact whole number is rendered by the decimal 3·141596. . . . . . From the formula can now be drawn all the conditions of better action, *i.e.*, how P may be as *small as possible*. It is therefore evident—1st, that the smaller d is the better—same principle as in the inclined plane; the less the height, the less is P. Hence *the closer the threads the more power is gained*. 2nd. The greater the radius of the cylinder r, the better—same again as in the plane—the longer &c. Hence *the larger the body of the screw the better*, the pitch remaining the same. 3rd. No gain if (r) be increased in such a way that (d) is proportionally greater. The reason is evident—the angle of the plane remains unchanged. 4th. What is *gained* by the reduction of d is *lost* in the motion produced. Before the change at each turn, the body could be moved a distance $= d$; after the change it will (it can) only be moved $= d - n$. Practically, therefore, *time* is lost in effecting the *same* work. 5th. What is *gained* by increase of r is *lost* in accomplishing the same perpendicular work. Recall the principle of "virtual velocities."

N.B.—In practical use, the power is always applied to the screw by means of a *handle* of some kind. The principles of this *handle* not having been as yet studied, it (the handle) cannot here be made enter into the formula of the screw; but it is necessary to remark that it may be found in books as represented by the letter r of the expression $2 \pi r$. For the present, it is enough to know that the change of r *must make a change* in the value of P, when r in $2 \pi r$ stands for the *handle* with which the screw is to be worked. This consequence, therefore, in no way clashes with the conclusions 2nd and 3rd from the formula where r is the radius of the cylinder (the body) of the screw.

IV. The uses of the screw, many though they are, can be all included under one head, "the exertion of power (force) of *any degree* from the smallest to the greatest which the strength of materials will allow." This extraordinary range is in *great part* effected by the "pitch" of the screw, which can be reduced indefinitely as long as the form of the thread can be maintained uninjured. The applications of the screw are all interesting, and many very important.

Screw App. I.—Weight Reaction.—In general use the "pitch" is so small that the weight (the force to be overcome) cannot react on the screw when the "power" is withdrawn. Thus, a heavy weight W, Fig. 88, lifted by a screw, cannot *push the screw back*, although the power P has ceased to act. The "pitch" (the H of the plane) is so little that the great force of W has but a small "component" *down along* the thread, which "component" is more than opposed by one of the "obstacles." The detailed examination of the various forces produced by W will afford an interesting study to any one who may wish *to see* fully the truth of the explanation just given.

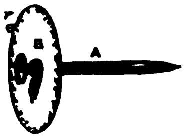
FIG. 89 FIG. 88



Screw App. II.—The Differential Screw.—After a certain point in various materials the thread cannot resist the pressure upon it—it breaks. There is then the limit of reducing the "pitch." To have a "working pitch" of less height, two screws of *different pitch* are made to work one *into* the other (Fig. 89), A, large screw moving as arrrow (a), B small screw moving as a'. On turning the handle P, the screw A advances as its "pitch" requires; but, in the mean time, B is *drawn into* A to the height of *its* "pitch;" the body W is only moved to a distance equal to the *difference between the pitch of* A *and the pitch of* B. This difference is the "working pitch." Now, as the difference may be made indefinitely small, a "working pitch" indefinitely fine can be produced. Great *power* is gained, but at the expense of *time*, in consequence of the diminution of space. There are instruments in which the contracting of the space is a gain, as it will be seen in the next application.

Screw App. III.—The Micrometer Screw.—In many optical and astronomical instruments it is necessary to estimate division of space much smaller than those of the most delicate vernier. For this purpose is used the "micrometer screw." The essentials of this instrument are (the frame, nuts, support of r, &c., are left out of the figure), a screw of very small "pitch," A (Fig. 90), and a circular plate B, very delicately divided. The plate is usually joined to the screw-shaft, and as it is moved round, passes under a graduated index r, which points to the number of divisions gone past, and, by its own graduation, indicates the number of turns which the screw has made. For measurement, it is only necessary to know the "pitch" of the screw; the plate will indicate the *fractions* of that pitch. Suppose then, the "pitch" to be 1 mm., and the plate large enough to be divided into 500 parts. Each *turn* of the screw moves the body, whatever it may be, to a distance of one mm.; each *division* of the plate shows 1-500th mm. The number of turns gives the number of mm., and the index r points to the number of 500ths to be added. The micrometer may be made so as to show 1-1000th of a mm.

FIG. 90



(*To be continued.*)

MICROSCOPICAL EXAMINATION OF ROCKS AND MINERALS.[*]

A MICROSCOPICAL examination of rocks shows that, as a rule, the igneous rocks may be distinguished at once from all others by their structure, which is that of a more or less perfect network of minute crystals: in many cases all the minerals are well crystallized; in others there is an amorphous or glassy base in which they are enclosed; there are, however, other rocks, such as the Felstones and the more recent volcanic Phonolites some of which do not present this crystallized arrangement of their constituents; and then there are the Porphyrites, which are characterized by the presence of crystals of felspar in a compact felspathic base. There is in fact a gradual passage from the compact Felstones to the Porphyrites; so that it appears probable that the amorphous base of all such rocks is simply the silicious magma or paste from which distinct minerals would have separated had the circumstances under which they were formed been favourable for crystallization to have taken place. As a typical example of a widely distributed class of rocks, I will take for description the well known basaltic rock of the Rowley Hills. An examination of thin sections shows that it contains a triclinic felspar, augite, magnetic oxide of iron, a little olivine, and a few crystals of apatite. The felspar is known to belong to the triclinic system, as it exhibits the characteristic striæ when examined by polarized light. Augite appears in minute black shining crystals, which appear bright brown, or occasionally green when in thin sections; it cannot be mistaken for any other mineral except hornblende, from which it is distinguished by a marked difference in the angles; it has also a clear glassy appearance, while hornblende is either distinctly fibrous in texture, or exhibits lines or cracks running parallel with the principal cleavage plane. Very frequently hornblende is green, while augite is yellowish brown, but this does not always hold good. The magnetite occurs in minute grains, or as thin laminæ, both being black and opaque. The apatite is seen in long acicular hexagonal crystals. The olivine occurs in crystals, and also in irregular grains, of a clear yellowish-green colour; it is, however, rare in this state, being nearly always altered to a dark green mineral. In addition to the above minerals, which must be regarded as the original constituents of the rock, there are also one or two zeolites, calcite, and a chloritic mineral, all of which are found filling cavities, and are secondary formations.

The use of the microscope is by no means confined to the discriminations of minerals; with its assistance we may learn many facts, as to the mode of formation of rocks, the order in which the various minerals crystallized, and the alterations which have been frequently caused by the removal of mineral matter, and its replacement by another of different chemical composition. In the Rowley rock, the minute crystals of apatite penetrate both the felspar and augite: the latter also encloses crystals of felspar and magnetite; the augite crystallized therefore after the others had been formed. The olivine contains grains of magnetite only, and was probably the second to crystallize.

Cases are not uncommon in which crystals have caught up portions of the surrounding mass while in the act of formation, and other facts indicate very clearly the actual condition of the mass at the moment of crystallization. For example, in a section of Pitchstone from Planitz, containing crystals of felspar, the minute opaque grains thickly scattered through the matrix are crowded together round the sides of the crystals, having been forced outwards as the latter increased in size; this clearly indicates that during the formation of the crystals, the matrix was in a [illegible] not in a *fluid* state, for had the particles been quite free to move, there would have been no crowding.

In a section of basalt from the Rhine, the olivine is in its usual fractured condition, and some of the larger cracks have been filled in with the fine crystallized matrix in which they are imbedded;—there is no crowding of the particles; in this case, therefore, the *olivine* was not only crystallized, but fractured, *before* the consolidation of the mass. In another *section* of basalt the crystals of augite *and olivine* are somewhat rounded, and the *cracks filled up*, so that they probably existed *as crystals or grains* before the ejection of *the lava*.

One of the most important aids in the examination of rocks and minerals is afforded by polarized light. In many cases it enables us at once to discriminate between different minerals, and not unfrequently affords clear evidence of changes which have taken place subsequently to the consolidation of the substance under examination. When a thin section of a crystal is placed on the stage of the microscope, and a beam of polarized light is passed through it, the beam is depolarized and generally exhibits colours due to interference; the intensity of colour varies according to the direction in which the crystal is cut, and consequently, in examining a section of rock, the various sections of any one mineral do not always give the same result; but as the crystals of igneous rocks lie at all angles, it is nearly always easy to obtain some which, being cut at an inclination to the optic axis, exhibit different degrees of intensity of action; therefore minerals which vary much from each other in this respect may be easily distinguished.

A most important point to be noted is, that the depolarizing action of a crystal is uniform over the whole surface of its section, if it consists of one simple crystalline structure; when, however, the light appears to break up into detached parts, each of which changes independently as the analyzer is rotated, we know that it is made up of a number of separate crystalline portions, either independent of each other, or sometimes related as twins.[*]

A knowledge of these facts enabled me to detect the presence of olivine and its pseudomorphs in the Rowley rock, as described in a former paper, and also in the *Geological Magazine*, vol. vi., p. 115. A pseudomorph is a mineral possessing a crystalline form, which does not belong to the substance of which it is composed; it is an altered mineral, or, in other words, an aggregate of mineral matter, which has been deposited simultaneously with the removal of that which possessed the original crystal form; it is easy, therefore, to see that the molecular arrangement of the particles must be entirely different from that of the original crystal. Now, by the aid of polarized light, such changes are at once rendered apparent, and we thus possess the means of obtaining most important information on the metamorphism of rocks and minerals, of which ordinary light would afford no indication whatever.

Serpentine has hitherto been a great puzzle to geologists, some having regarded it as an intrusive igneous rock, others as of metamorphic origin. As not unfrequently happens, both are, I believe, right; for every section I have made clearly proves it to be an altered rock, and one specimen from the Vosges mountains contains numerous grains of olivine, in which the change is only partially developed.

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[*] By S. Allport, from a paper in the Proceedings of the Birmingham Natural History and Microscopical Society.

[*] Sorby "On the Examination of Rocks and Minerals," in Dr. Beale's work on the Microscope.

These few facts will serve to indicate the importance of this hitherto neglected method of inquiry; for although the pseudomorphism of many minerals has been long studied, little attention has been directed to similar changes in rock masses.

A subject of interest to the microscopical observer, and one of considerable importance to the petrologist, is the occurrence of minute fluid cavities in the minerals of igneous and metamorphic rocks; they have been detected in several minerals ejected from active volcanoes; but so far as I have observed, they are far more abundant in quartz than in any other mineral. Those who wish to examine them may do so by making a section of almost any specimen of granite; they are very numerous in the granite and schorl rocks of Cornwall, the hornblendic granite of Mount Sorrel, in the syenite and gneissoid rocks of Malvern, and in the syenite of Croft Hill, and neighbouring bosses in Leicestershire. In these and similar rocks, the fluid cavities appear to be so entirely restricted to the quartz, that I have not yet detected any in the felspar or mica; they are certainly extremely rare in these minerals, if they occur at all; this, if established, would indicate a difference in the condition under which the minerals were formed, a point which I believe has not yet received attention.

For an account of the curious spontaneous movements of the fluid in some of these cavities, and for other interesting matter connected with the subject, I must refer you to Mr. Sorby's paper already quoted.

During the past summer and autumn (1869) I have collected specimens of the igneous rocks of the Midland coal-fields from the following localities:—Kinlet and Shatterford, west of Kidderminster; the Clee Hills; Little Wenlock, near the Wrekin, in Shropshire; Coalville, near Bardon Hill, in Laicestershire; and Matlock, in Derbyshire.

A microscopical examination of thin sections shows that all these rocks belong to the same type; they do not in fact differ more from each other than do different specimens of any one of them. The toadstone of Derbyshire is merely an amygdaloidal variety.

The rocks of the Warwickshire coal-field differ considerably from the foregoing; they contain hornblende instead of augite, and are therefore true greenstones or diorites; they may be readily examined in the railway cutting near Nuneaton, and also a little to the west of Atherstone. All the rocks just enumerated are clearly older than the surrounding Permians, which are never penetrated by them.

Having now made upwards of four hundred sections of rocks and minerals, I am inclined to believe that the following results of microscopical examination will stand the test of further study. 1. The mineral constituents of the melaphyres and other fine-grained igneous rocks may be determined with certainty—a result which has not been attained by any other method of examination. 2. The mineral constituents of the true volcanic rocks, and those of the old melaphyres, are generally the same. 3. The old rocks have almost invariably undergone a considerable amount of alteration, and this change alone constitutes the difference now existing between them and the more recent volcanic basalts.

The basaltic lavas of the Rhine and Central France are composed of a triclinic felspar, augite, magnetite, olivine, and frequently apatite, the same minerals as those constituting the old rocks above described. I have fine-grained specimens of the latter hardly distinguishable from recent basalts; and a section of Dolerite from the Puy de Barnère, in Auvergne, does not differ in any important particular from coarse-grained specimens from Rowley. It would be easy to extend the parallelism to other classes of rocks, but I will now only observe that we have here another proof of the doctrine long taught by Lyell—the uniformity and continuity of the laws of Nature.

Professer Favre, of Marseilles, has made some experiments with compounds of hydrogen and palladium. His results point to the conclusion that hydrogen should be classed with the metallic elements.

REVIEWS.

The Disposal of Town Sewage. By R. W. PEREGRINE BIRCH, C.E. London: Spon.

THIS is a pamphlet in which the various systems in use for the disposal of the sewage of towns are examined. Although no definite conclusion as to the best means of arriving at that end is adopted, the *brochure* contains a short *resume* of the various systems at present in force, and points out in a clear manner their advantages and defects. The author was at one time inclined to favour the A B C system as practised at Leamington, but since he examined the process at that town has seen reason to change his opinion. The author has visited most of the places at which attempts are made to utilize the sewage, and his conclusions are doubtless of value. But the fact remains, that no really unobjectionable method has hitherto been discovered, and we are no further advanced than we were some years back—save the negative information we have derived from the numerous experiments which have been carried out.

Building Societies and Borrowers; or, Suggestions for the Consideration of the Royal Commission on Friendly Societies. By C. D. ARNALDO FRIEDLEIN. London: Aug. Siegle.

THE author of this little pamphlet clearly exposes the enormous interest that is really paid by borrowers from Building Societies under the impression that they are borrowing money at about 4 per cent. Speaking of the system of fines, which he acknowledges are a necessity to the proper working of the business of these societies, the writer says:—"Under the existing system the societies derive the greatest profit when the borrower falls into difficulties. Certainly no 'friendly' society ought to consider such an occasion a legitimate source of profit." The fact that a borrower pays as much interest during the last month of his term as he did when he held the whole sum, is sufficient evidence of the necessity for a revision of the rules governing Building Societies, as well as a convincing proof of the enormous interest in reality paid by the customers of these institutions.

Public School Reforms. By M. A. B. London: L. Booth.

"M. A. B." has here gathered together the numerous letters which have appeared in the press on this subject contributed either by himself or others. The subject is one of considerable importance, and deserving the attention of all interested in the education of the country. Vast sums are annually spent by our public schools; but the amount of knowledge given for them does not seem to be of such a character as might be expected.

Biology versus *Theology; or, Life on the Basis of Hylozoism considered.* By JULIAN. Lewes: G. P. Bacon.

THIS is what might be called a *clever* attack on modern theology; but there is very little of the calm reasoning of science in it. The author expresses his opinions in too dogmatic a fashion to carry much weight, and his failure to see two sides to a question is ludicrous in the extreme. In his section on "Life—how produced in the first instance," after telling us that a dung-heap "actually swarms with living animals," he goes on, "Taking a dead dog, let us pound the carcase in a mill to destroy all life which can be crushed and ground out of it mechanically. Having so done, let us boil the pulp and raise it to such a heat as will destroy not only life, but even germ-life, the life of ova and of seeds, incipient or developed. We have now utterly stamped out every germ of life in the reduced carcase which was once a dog, and to prevent the conveyance of germs by the air, let us wrap the pulp in cotton wool, which, on the testimony of Professor Tyndall, will effectually exclude all germ-life from without. Here then we have an animal substance from which all life has been crushed out or boiled out, and to which no germ of life can penetrate; what will follow? The mass will putrefy in time, and the putrefying mass will teem with larvæ as before. There cannot be a doubt of it, if the oxygen of the air or water can percolate the cotton wrap." In the first place, how is it possible to wrap this pulp in cotton wool without allowing the germs floating in the air to settle on it during the operation? And in the second, how is it proved that *all* germs *are* destroyed by the crushing and boiling? The arguments of this gentleman are so radically weak that we can afford to grant him his premises and then be free to reject his conclusions.

RELATIVE MATERIAL STRENGTH OE FRANCE AND PRUSSIA.

THE *Tablet*, in an article on this subject, says:—In most of the conditions of national strength we find a parity between Germany and France. It is curious that in population the two countries are precisely equal. The North German Confederation, and its trusty allies, the South German States, count together about 38 millions of souls, which happens to be the exact figure of the aggregate population of France, as shown by the census of 1866. The several proportions are as follows:—The Confederation has 30 millions, Baden about a million and a half, Wurtemberg nearly 2 millions, and Bavaria something under five.

Passing from population to an estimate of economical advantages, there is as little difference between the two countries. Both are two-thirds agricultural; Germany has most ships, and foreign trade, and manufactures; but, as a set-off, French agriculture is most productive. Thirdly, as to revenue from taxation, the total of the Confederation is 40 millions, while that of the States is 12; in all 52 millions. The revenue of France is much larger, but then her national debt is also much larger; so that practically she has but little more than Germany available for all the purposes of her administration. The annual expenditure of both countries on their respective armies, so far as we know it, is about the same, Prussia spends between 12 and 13 millions, France a million more.

There can be little doubt that this war will be enormously expensive beyond all experience of European wars. Not so expensive, probably, as the conflict between the Federals and Confederates of America, in which a million of men were kept in the field at an outlay of 200 millions sterling per annum. The present outlay will be less; partly because by the conscription a vast saving is effected in bounties and pay as compared with the American system; and partly because the area of the campaign will probably be much narrower. Wars become, in fact, every year more costly as civilization advances. The Italian war of 1859, which lasted only six weeks, cost France at least 20 millions: Bismarck's three weeks' campaign of 1866 cost Prussia nearly as much: the present outlay will certainly not be less lavish; so that from those figures we may estimate roughly, and quite within the mark, the probable cost of the present war.

The interesting question, of course, is (if it could be answered,) what advantage, if any, may be supposed to be possessed by either of the belligerents over the other? On the side of Prussia it may be said that she commences the war with a lighter load of national debt. Her total debt is put down as less than one-third of that of France. Hence her borrowing power is greater. At the same time, as regards this war, the borrowing power of France may, we suppose, be regarded as practically unlimited. The advantage of a small debt is, however, felt in the lightness of taxation; and this advantage is very decidedly on the side of Prussia. The Germans are less burthened, and, therefore, comparatively at least, better able to bear additional imposts.

THE LEAF AS A WORKER.

(*Concluded from page* 391.)

BUT if we regard the leaf only as a drawer of water, a lifter of earthy matter, a carrier of lightning, a gatherer of nourishing gases, a defence against zymotic diseases, we give it an inferior place—it is only a humble, common labourer. Man might invent and apply machinery to pump the water and evaporate it; he can enrich the soil, can put on his roof metallic conductors, and can escape epidemic diseases if he will breath *pure air.* "Ah! there's the rub!" for he can get pure air only as the leaf prepares it for him. Man can, in a measure, do the work of the leaf, but science has failed to demonstrate a way to do the chemical work that the leaf does.

The leaf is not a common labourer, then; for, though it deigns to do this drudgery, its great field of labour is elsewhere. It is an analytical chemist of the noblest order, and, as such, performs labour that Liebig, and Fresenius, and Regnault attempted in vain, and such as no chemist can ever perform. Here it is that the leaf asserts its superiority as a worker—becomes a right royal labourer. Here it uses the same re-agents that man is permitted to use, but with which he cannot succeed. And so the leaf looks down upon the great and learned chemist, and regards him as a bungler. Every exhaled breath of man, and of every animal on the face of the globe, is loaded with poisen. The product of combustion, whether arising from the cheerful home fire, from the fire-box of the locomotive, from the furnace of the factory, or belching forth in terrible profusion from the yawning crater of the volcano, is pregnant with the same life-destroying agent. Millions of cubic feet of this dread destroyer, one foot of which is sufficient to produce death, is being set free every second of time. It is escaping from your lungs every four seconds. But be not frightened—no harm can come to you; for God has ordained the leaf as his agent to care for you—to disarm this deadly foe of its terrors—to seize upon it, anatomise it, take to itself a part, and give up the remainder as the life-giving air of heaven!

And what is the measure of its force—what is the sum of its acting energies? I can only tell you what is its *equivalent*. I can give you the exact measure of its strength, and at your *longest leisure* you can reduce it to the ordinary standard of mechanical force, and determine the measure in horse-power. How much mechanical labour, can all the men, women and children, all the animals of the earth, and all the locomotives and engines on sea and land perform? The leaf does just as much as all those combined.

We have said nothing of the æsthetics of leaves—of their beauty and variety (we must not forget that all flowers are leaves). There is not a leaf in the whole vegetable kingdom that does not excite emotions of the beautiful, either by its form, colour, or odour. There is beauty in the leaves of the solitary palm, and beauty in those of the dense forest, crowded so thick that beneath them the "shadow hardly moves." Beauty in the microscopic moss-cup, as well as in the palm whose leaves expand to 30ft. in circumference—beauty and glory in them all.

Not only, then, does the leaf supply all the material wants of man, but it also ministers to his spiritual nature—reveals the character of God, blesses man, makes him nobler, wiser and better. In autumn, when the cold winds blow and the leaves turn yellow and red, it is the popular belief that the *frost* has coloured and killed the leaves, and caused them to fall away. Not so. We mistake here a coincidence for a cause. The time for frost and for falling leaves is the same—one has no relation to the other. There has been no work of violence wrought—no destruction. The leaf has finished its allotted task, it has built up its appointed cycle, stored up the food for its successors, and now its work is done—Ah! well done. No duty has been neglected; it has finished its course; and now it arrays itself in its most gorgeous hues, for its hour of glory has come, and it rests upon the bosom of its mother earth. May it not teach us here a lesson—a marvellous lesson—how to live and how to die; how a true life is crowned by a triumphant death?

WHAT IS ENERGY?*

Part IV.

THE DISSIPATION OF ENERGY

(*Concluded from page* 416.)

At this point we can imagine some champion of perpetual motion coming forward and proposing conditions of truce. "I acknowledge," he will say, "that perpetual motion, as you have defined it, is quite impossible, for no machine can *create* energy, but yet I do not see from your own stand-point that a machine might not be constructed that would produce work for ever. You tell me, and I believe you, that heat is a species of molecular motion, and hence that the walls of the room in which we now sit are full of a kind of invisible energy, all the particles being in rapid motion. Now, may we not suppose a machine to exist which converts this molecular motion into ordinary work, drawing first of all the heat from the walls, then from the adjacent air; cooling down, in fact, the surrounding universe, and transforming the energy of heat so abstracted into good substantial work? There is no doubt work can be converted into heat—as, for instance, by the blow of a hammer on an anvil—why, therefore, cannot this heat be converted back again into work?"

We reply by quoting the laws discovered by Carnot, Clausius, Thomson, and Rankine, who have all from different points of view been led to the same conclusion, which, alas! is fatal to all hopes of perpetual motion. We may, they tell us, with the greatest ease convert mechanical work into heat, but we cannot by any means convert all the energy of heat back again into mechanical work. In the steam-engine we do what can be done in this way; but it is a very small proportion of the whole energy of the heat that is there converted into work, for a large portion is dissipated, and will continue to be dissipated, however perfect our engine may become. Let the greatest care be taken in the construction and working of a steam-engine, yet shall we not succeed in converting one-fourth of the whole energy of the heat of the coals into mechanical effect.

In fact, the process by which work can be converted into heat is not a completely reversible process, and Sir. W. Thomson has worked out the consequences of this fact in his beautiful theory of the dissipation of energy.

As far as human convenience is concerned, the different kinds of energy do not stand on the same footing, for we can make great use of a head of water, or of the wind, or of mechanical motion of any kind, but we can make no use whatever of the energy represented by equally diffused heat. If one body is hotter than another, as the boiler of a steam-engine is hotter than its condenser, then we can make use of this difference of temperature to convert some of the heat into work, but if two substances are equally hot, even although their particles contain an enormous amount af molecular energy, they will not yield us a single foot-pound of work.

Energy is thus of different *qualities*, mechanical energy being the best, and universal heat the worst; in fact, this latter description of energy may be likened to the dreary waste heap of the universe, in which the effete forms of energy are suffered to accumulate; and, alas! this desolate waste heap is always continuing to increase. But before attempting to discuss the probable effect of this process of deterioration upon the present system of things, let us look around us and endeavour to estimate the various sources of energy that have been placed at our disposal.

To begin with our own frames, we all of us possess a certain amount of energy in our systems, a certain capacity for doing work. By an effort of his muscles the blacksmith imparts a formidable velocity to the massive hammer which he wields: now what is consumed in order to produce this? We reply, the tissues of his body are consumed. If he continues working for a long time he will wear out these tissues and nature will call for food and rest; for the former in order to procure the materials out of which new and energetic tissues may be constructed; for the latter, in order to furnish time and leisure for repairing the waste. Ultimately, therefore, the energy of the man is derived from the food which he eats, and if he works much, that is to say, spends a great deal of energy, he will require to eat more than if he hardly works at all. Hence it is well understood that the diet of a man sentenced to imprisonment with hard labour must be more generous than that of one who is merely imprisoned, and that the allowance of food to a soldier in the time of war must be greater than in time of peace.

In fact, food is to the animal what fuel is to the engine; only an animal is a much more economical producer of work than an engine. Rumford justly observed that we shall get more work out of a ton of hay if we give it as food to a horse than if we burn it as fuel in an engine. It is in truth the combustion of our food that furnishes our frames with energy, and there is no food capable of nourishing our bodies which, if well dried, is not also capable of being burned in the fire. Having thus traced the energy of our frames to the food which we eat, we next ask whence does this food derive its energy, If we are vegetarians we need not trouble ourselves to go further back, but if we have eaten animal food and have transferred part of the energy of an ox or of a sheep into our own systems, we ask whence has the ox or the sheep derived its energy, and answer, undoubtedly, from the food which it consumes, this food being a vegetable. Ultimately, then, we are led to look to the vegetable kingdom as the source of that great energy which our frames possess in common with those of the inferior animals, and we have now only to go back one more step and ask whence vegetables derive the energy which they possess.

In answering this question, let us endeavour to ascertain what really takes place in the leaves of vegetables. A leaf is, in fact, a laboratory in which the active agent is the sun's rays. A certain species of the solar ray enters this laboratory, and immediately commences to decompose carbonic acid into its constituents oxygen and carbon, allowing the oxygen to escape into the air while the carbon is, in some shape, worked up and assimilated. First of all, then, in this wonderful laboratory of Nature, we have a quantity of carbonic acid drawn in from the air; this is the raw material. Next, we have the source of energy, the active agent: this is light. Thirdly, we have the useful product: that is, the assimilated carbon. Fourthly, we have the product dismissed into the air, and that is oxygen.

We thus perceive that the action which takes place in a leaf is the very reverse of that which takes place in an ordinary fire. In a fire, we burn carbon, and make it unite with oxygen in order to form carbonic acid, and in so doing we change the energy of position derived from the separation of two substances having so great an attraction for each other as oxygen and carbon, into the energy of heat. In a leaf, on the other hand, these two strongly attractive substances are forced asunder, the powerful agent which accomplishes this being the sun's rays, so that it is the energy of these rays which is transformed into the potential energy or energy of position represented by the chemical separation of this oxygen and carbon. The carbon, or rather the woody fibre into which the carbon enters, is thus a source of potential energy, and when made to combine again with oxygen, either by direct combustion or otherwise, it will in the process give out a deal of energy. When we burn wood in our fires we convert this energy into heat, and when we eat vegetables we assimilate this energy into our systems, where it ultimately produces both heat and work. We are thus enabled to trace the energy of the sun's rays through every step of this most wonderful process: first of all building up vegetable food, in the next place feeding the ox or sheep, and lastly through the shape of the very prosaic but essential joint of beef or mutton entering into and sustaining these frames of ours.

We are not, however, quite done yet with vegetable fibre, for that part of it which does not enter into our frames may, notwithstanding, serve as fuel for our engines, and by this means be converted into useful work. And has not Nature, as if anticipating the wants of our age, provided an almost limitless store of such fuel in the vast deposits of coal by means of which so large a portion of the useful work of the world is done? In geological ages this coal was the fibre of a species of plant, and it has been stored up as if for the benefit of generations like the present.

But there are other products of the sun's rays besides food and fuel. The miller who makes use of water-power or of wind-power to grind his corn, the navigator who spreads his sail to catch the wind, are indebted to our luminary equally with the man who eats meat or who drives an engine. For it is owing to the sun's rays that water is carried up into the atmosphere to be again precipitated so as to form what is called a head of water, and it is also owing to the sun's heat that winds agitate the air. With the trivial exception of tidal energy all the work done in the world is due to the sun, so that we may look to our luminary as the great source of all our energy.

Intimately linked as we are to the sun, it is natural to ask the question, Will the sun last for ever, or will he also die out? There is no apparent reason why the sun should form an exception to the fate of all fires, the only difference being one of size and time. It is larger and hotter, and will last longer than the lamp of an hour, but it is nevertheless a lamp. The principle of degradation would appear to hold throughout, and if we regard not mere matter but useful energy, we are driven to contemplate the death of the universe. Who would live for ever even if he had the elixir of life? or who would purchase, if he might, the dreary privilege to preside at the end of all things—to be "twins in death" with the sun, and to fill up in his own experience the melancholy dream of the poet,—

> The sun's eye had a sickly glare
> The stars with age were wan,
> The skeletons of nature were
> Around that lonely man.
> Some died in war, the iron brands
> Lay rusting in their bony hands;
> In peace and famine some.
> Earth's cities had no sound nor tread,
> And ships lay drifting with their dead
> To shores where all were dumb.

NEW ELECTRO-TYPOGRAPHIC MACHINE.

The *Academy* gives the following interesting account of the new electro-typographic machine:—

"The French have been more speedy than ourselves in putting into operation the modern inventions in telegraphy. Hughe's American machine, which delivers the message in long printed strips like a tailor's measure, is employed on all the great railway lines in France; and the delicate apparatus of M. Meyer, which faithfully transmits autographs, drawings, Oriental characters, or whatever the sender may fancy to trace on the metallic paper, is now used on the Lyons railway.

"A new electro-typographic machine, the invention of M. Henri Fontaine, a French barrister, is now at work in one of the public offices in Paris. The object of this machine is to print off with economy and rapidity the quantity of short papers required in law courts, public and private offices, or commercial houses, now executed by the longer and more expensive processes of printing or authography. The machine of M. Fontaine, like the electric telegraph, is on the principle of substituting fixed for movable types, one type only being employed for the same letter; thus dispensing with the ponderous and bulky movable types of the printer. Steel types, representing the different characters used in printing (capitals, small letters, italics, &c.), are ranged around two horizontal discs, placed one over the other. Above these is another metallic circle divided into notches corresponding with the type below. By a very simple machine, as the handle or bar in the centre presses against the notch representing the letter required, an electric shock lowers the type upon a sheet of paper rolled around a cylinder placed beneath, prints the letter, and again returns to its place. The operation is so rapidly performed that a hundred letters may be easily printed in a minute. When completed, the paper is transferred to the lithographic stone to be worked off. The great recommendation of M. Fontaine's machine is its great simplicity, the ease and rapidity with which it is worked, its convenient

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*By Balfour Stewart in *Nature*.

size (about 3ft. by 2ft.), and its moderate cost. The typography is remarkably clear and distinct, from the employment of finely engraved steel types."

ON THE USE OF PHOSPHATES IN DYEING.

MR. COLLAS, of Paris, has recently succeeded in using phosphates as a mordant in dyeing and calico printing. To this end, he passes the yarn or the cloth through a weak solution of a phosphate in an acid, and afterwards though a dye bath or an alkaline bath, by means of which the phosphate is fixed upon the fibre; the stuff, after being prepared in this manner, is ready to be dyed or printed with aniline, or with vegetable, or animal colours. The stuff thus prepared may be passed through a solution of tannin before being printed or dyed. Thus, for instance, in order to dye in dark colours, the yarn or cloth is immersed in a warm and clear decoction of one kilogramme of sumac in four and a half litres of water, of from 30° to 40° C., after which, the stuff is wrung out. It is then immersed for twenty or thirty minutes in an acid solution of phosphate of lime of 50° Baumé, and when wrung out and washed it is ready to be dyed. Purple, especially, yields fine hues. In order to dye with insoluble colours, the cloth is immersed in a mixture of gelatinous phosphate of lime with a solution of gelatine in water, having a temperature of 25° or 30° C. Cochineal-lake may be prepared in this manner by stirring gelatinous phosphate of lime-hydrate into a filtered decoction of cochineal. M. Alfraise, according to the *Moniteur Scientifique*, believes this gelatineus phosphate to be of great importance. He thinks that it may replace the cream of tartar, because it becomes insoluble at 100° C., or that, perhaps, in some instances, it may prove a substitute for albumen, especially for cheap goods. For the preparation of dye-lakes, this substance is also worthy of notice as it furnishes many decoctions of dye-woods and lake, different from the alumina-lake. It also affords very fine blue lakes with the oxides of copper and cobalt. Cochineal carmine may also, perhaps, be prepared by mixing a solution of the gelatinous phosphate with a solution of cochineal.

LUNAR ACTIVITY.

WE have been favoured with the following extract, bearing on change on the moon's surface, from the letter-press accompanying the portion of the lunar map about to be issued by W. R. Birt to the subscribers.

"Change.—The subject of physical change on the moon's surface is one of considerable interest, and continues to receive from observers an increased degree of attention which is calculated to elucidate many intricate points. In the Report of the British Association, 1868, p. 30, the necessity of determining the normal character of a spot before any physical change that it had undergone could be ascertained was suggested; this had reference to *brightness*. In connection with this was a quotation from the Rev. T. W. Webb, relative to certain changes of *colour*, which he suspected had taken place in the crater *Eratosthenes*. The reader will find an article on "Scales of Lunar Tints" in the *Mare Serenitatis*, its Craterology, &c., pp. 13, 14. Darker and lighter surfaces are of importance in the inquiry; for the tint of an object may vary as seen from the earth in consequence of a physical change supervening which leaves its form unaltered. The study of physical change may be pursued in connection with the following points, viz. *Alteration of form*, as when some portion of an object previously well-known has been destroyed; *Obliteration of an object*, as a conspicuous crater, for èxample, ceasing to exist as such; *Variation of brightness* not connected with changes of visual and illuminating angles, as when a bright spot at a given place is no longer recognizable, and the converse, *i.e.*, a bright spot appearing where none was seen before; *Alteration of colour* from darker to lighter, and the reverse. It is quite possible that change may be taking place in each of these departments, although at present we have no conclusive evidence of the fact. In some cases, as regards *form*, a change may occur suddenly, as when a quiescent volcano breaks out into actual eruption, or when a portion of a ring-mountain gives way and a land-slip is the result. To detect such changes, as well as instances of *obliteration*, a very extensive acquaintance with the minutiæ of lunar detail is indispensable, and to assist in the inquiry the following suggestions are offered:—

"1. To examine every part of an enclosed surface, for example, in order to detect the existence of craterlets, spots, streaks, or other signs indicative of volcanic and seismotic (or earthquake) action.

"2. To survey by alignment, and also by micrometrical measurement, the interior and border of the surface under examination in order to make a drawing to scale of sufficient size to insert on it every object detected.

"3. To observe under every variation of illuminating and visual angles the interior and exterior of the border, and to record every appearance of upheaval, depression, separation in the nature of faults, fissures, or cracks, and to determine the order of sequence of the phenomena thus brought to light as illustrative of the *past* history of the formation.

"4. To examine at intervals of 59, 443, and 1,447 days respectively* the objects the appearance of which have been previously recorded, and to keep a record of these examinations with a view to illustrate the *present* history of the formation.

"5. To transmit a record of all observations, whether in accordance with the above suggestions or otherwise, to a central point for examination and discussion.

The possible instances of change alluded to under the heads of *form* and *obliteration* may occur suddenly, but a physical variation of brightness may be gradual. Two methods may be suggested by which such changes may be detected:—*first*, a very careful series of observations of spots suspected of change, such as *Plato*, the observations being continued over a long period; *second*, a systematic registration of the brightness of spots whenever they are observed. The same remarks apply to variation of colour or tint. It is in this direction that a persevering course of observation and study may meet with marked success; and if registers of such observations, and the consequent determination of brightness and colour be preserved, they become exceedingly valuable for comparison with later observations."

THOMSON'S ROAD STEAMER.

AT the present moment, when so much anxiety has been expressed on account of the exportation of horses, a Parliamentary paper just issued will be read with interest, as showing that the time approaches when we shall no longer require the services of that noble animal. It appears, by the reports on Thomson's "road steamer," made to the War Department, that this engine, unless, perhaps, for hunting purposes, is far more useful than any horse. Mr. Anderson, the Superintendent of Machinery, says he has "come to the conclusion that the question of steam traction on common roads is now completely solved;" that the application of the india-rubber tire is a perfect success; that it opens up an entirely new field, and that he looks upon this application as a discovery rather than an invention. The wheel and its tire may be described as consisting of a broad iron tire with narrow flanges, upon which is placed a ring of soft vulcanized india-rubber; this ring is about 12in. in width and 5in. in thickness, which thus surrounds the iron tire, and is kept in its place by the flanges; then over the india-rubber there is placed an endless chain of steel plates, which is the portion of the wheel that comes into actual contact with the rough road, the reticulated chain being connected by a sort of vertebra at each side of the wheel. The india-rubber tire and this ring of steel plates have no rigid connection, but are at perfect liberty to move round as they please without consulting each other, or even without the concurrence of the inner ring of the wheel which they both enclose. Mr. Anderson states that the reason why this wheel is so efficient is because the soft india-rubber allows it to flatten upon the road, whether rough or smooth. The wheel being a circle, if it is a rigid structure, presents but a small surface, but this wheel conforms to every irregularity for a space of nearly 2ft. by the veight of the engine causing the india-rubber to collapse, and so producing a change of form. In the construction of the road steamer the greater portion of the weight, including the boiler, rests upon the driving wheels; the third wheel in front is for guiding the direction of movement, and is perfectly under control. In the course of experiments witnessed by Mr. Anderson, the engine went up a zigzag labyrinth of courts, and it can describe any figure almost in a space of twice its length. The boiler employed is an independent invention adapted to the carriage. Its chief peculiarity is the copper pot for holding water within the furnace, and it is so contrived that if the boiler contain any water the pot will have a full supply. This arrangement keeps the centre of gravity low, and allows the engine to run up hills of one in ten, or go along an angle of 35°. On the first day Mr. Anderson saw it in Leith the streets were very wet and adhesive. A train of waggons containing ten tons of flour, besides their own weight, were standing at the bottom of a slippery street with a gradient of about 1 in 17; to this train the little engine was attached, and away it marched as if it had no load, went up to the top of the hill, and then down on the other side, no brakes being required. After depositing its load somewhere in Leith it ran down to the Portobello seashore at the rate of ten miles an hour. On surveying the sands, Mr. Anderson says, it seemed an impossibility that it could walk on such soft sinking ground, but on it rushed through all, over some quicksands, ran into the sea and along its edge in every direction in the most wonderful manner. It then, after returning from the seaside, removed an old boiler from the docks to a yard at some distance. The boiler and waggon with the fastening chains weighed upwards of twenty-two tons, and the boiler on the waggon stood some 25ft. high. Up to this the engine backed, then marched off with its load along the quay, over a rising swing bridge, and along other quays, until it reached its destination. The charm of the performance, Mr. Anderson remarks, was the way in which it was done. No shouting, no refractory or desultory pulling of horses, but by the expenditure of a few pounds of coals and water the whole was accomplished with ease and celerity: and so accustomed are the people in Leith to its performance that no notice was taken of it except by the country horses, for the town horses seem to know that it is their friend rather than their enemy.

THE MITRAILLEUR AT SHOEBURYNESS.

THE mitrailleur which has been selected for trial by the English Government is an improvement by Major Fosbery, V.C., on the Belgian model. Its first trial took place on Thursday week at Shoeburyness, and we extract from the *Times* the following report of the results:—Major Fosbery adopted the Metford barrel and bullet and the Boxer cartridge. The former have been superseded by the Henry rifling and projectile. The Boxer compound cartridge, though excellent for small arms, was proved yesterday to be not so fit for these machine guns as the American form of cartridge made from one piece of metal.

There can be no doubt that the Fosbery mitrailleur, as it ought to be called, is superior in all respects to the Belgian arm, but it is equally certain that the experience of English experimentalists can suggest further improvements which can certainly be carried out by English mechanists. As usual we are late in adopting a new weapon, but, having adopted it, we shall carry it out to greater perfection than has been done by any foreign nation.

We have often expressed our opinion regarding it. We believe that it will hold a worthy place in battles and sieges, and that place is between the fire of infantry and field artillery. The experiments have confirmed us in that opinion, but it would be unwise to sit down and dogmatize after one day's trial. It is better to await further proof before actually declaring its value as a thing established. So far as we can see, it may be very important if attached to cavalry, especially to break squares, to tear lines to pieces, and to harass a retreating enemy. In fortresses it must be of great use. It gives the fire of perhaps a dozen infantry soldiers armed with the best known weapons. Mounted infantry, "dragoons," in short, would perhaps do as well, but it is impossible to prevent their changing themselves into cavalry. The mitrailleur is extremely light, eats nothing, and its use can be easily learnt by artillerymen. It has no nerves to unsteady its aim, and if lost cannot be used by an enemy unless he has the same small arm ammunition, which ought always to be that of the infantry rifle in use.

With these few words of preface we will simply relate the experiments carried out yesterday by the committee appointed to try it.

The first discharge was from the mitrailleur, at a range of 800 yards—too far for anything like steady shooting from infantry in battle. All preparations having been made, and the telegraph having been duly worked to ensure safety to everybody concerned, the small detachment assembled round the piece. An officer stood with a timekeeper in his hand, and when the hand came round to an easily marked place on the dial, cried "Load!" Instantly the axletree boxes, close on each side of the barrels, were opened, and a breech-plate with its 37 cartridges was seized quickly and placed in the hollow breech while the laying of the piece was in progress. One momentary pressure on the lever pushed up the plate and its cartridges to their place and cocked all the locks; then the word "Fire" was given by Captain Alderson, who superintended the working of the machine throughout the trials; a gunner beside the piece pressed rapidly down the side lever, and in an instant the locks were set free and 37 bullets sent flying through the air. The sound was exactly like that of a volley of musketry, but the target was too distant to allow of hearing the sharp taps of the bullets upon its wooden face, so different from the dull thud made when a small missile finds its rest in human flesh. No sooner was the crash of the volley heard than an upward thrust of the lever freed the breech-plate again and left it loose, to be instantly lifted out by the gunner on the right of the piece.

The same process was repeated a second and a third time without a hitch, and very rapidly, but when the fourth breech-plate was about to be inserted it became manifest that the whole of the cartridges could not enter their barrels, because two out of the 37 last discharged had adhered too tightly to their barrels, so tightly that their bases had been torn off, leaving the rest of each of the two cartridge cases in the barrels.

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* These and their multiples are periods of "similar phase" when the terminator lies near the same spots, the position of the terminator varies with regard to the spots in accordance with variations of the luni-solar seasons dependent upon the value of ⊙ — ☊.—See Report Brit. Assoc., 1868, p. 9.

It is clear that fresh cartridges could not be forced in, and an inexperienced hand would have taken it for granted that the mitrailleuse must cease firing, but not so Captain Alderson. Quick as lightning, his eye detected the blocked barrels, and, with hardly less speed, he seized the bases of the two cartridges corresponding with them, and about to be introduced. They were rapidly extracted, and then the breech-plate was dropped into its place, pushed home by the lever, and fired as before, but only 35 bullets this time left the barrels. The fifth round was fired like the fourth, two cartridges being extracted as before, but the fifth breech-plate left behind it two more cartridge cases, blocking two additional barrels, so that this time four cartridges had to be extracted. These mishaps, which were solely due to the compound form of the cartridge case, caused a certain amount of delay, and the two minutes expired before a seventh round could be fired.

It is not necessary to say how great was the interest, nor how anxious were all present to rush to the target and see the results. No one would have grudged the run of 800 yards, but means of transport were at hand in the shape of a truck or lorry, drawn by a horse and running along a railway laid down along the range. It was soon crowded and even heaped up by a mass of gentlemen, all eager to see for themselves what had happened. As they neared the long black target the range party were seen spread all along its face busily counting the bullet holes and marking them with daubs of white paint lest they should be counted in favour of another discharge. The total number of bullets fired ought to have been 222, but eight cartridges had been withdrawn because of the blocked barrels. There remained, therefore, to be accounted for 214 bullets.

No slight hits such as could be made by missiles rebounding from the earth, but there were found 110 fair hard strokes upon the target. They were to be counted as "through" or "lodged." So far as we could see, they were all through. Some of them had not actually struck the painted figures, but were to be found perhaps within an inch, or even closer, of the men's heads or the horses' legs. Now a rear rank, whether of cavalry or infantry, never covers its front rank so accurately that bullets missing their comrades in front must fail to strike them also. Again, in some cases more than two bullets had lodged in the same man or horse. Targets cannot be made to represent accurately the effect of artillery or infantry fire upon flesh and blood by any method of appropriating the value of the hits. Yet it does seem a little too much under the mark to set down that the 110 bullet holes in the target would only have placed *hors de combat* 38 cavalry or 45 infantry. All that can be said is that, generally speaking, in a competitive trial of this sort the same method of marking is equally fair to each of the rival weapons. That it would be so in this first round we have no doubt, because all the barrels were fired so nearly at the same moment during each discharge that the stricken soldiers would have no time to fall, or at least that their places could not have been supplied by others in time to catch the next bullets on the same spot.

But this is not the manner in which the mitrailleur is intended to be fired against lines of horse or foot. On the left of the carriage, just below the breech of the weapon, is a small wheel with a handle, which, being turned, gives a horizontal motion to the piece, and we have more than once explained that the thirty-seven cartridges of the mitrailleur can be fired either all at once, as in this first series, or one after another at whatever speed may be required. In all future firing throughout the day the latter method was adopted, and the horizontal motion given. Thus is disposed of that most curious of objections that the mitrailleur shoots too well, and throws its bullets too closely together. And how great an advantage would this close volley of bullets be in cases where a bridge or a road, or a narrow pass, is to be defended! Who has not been stirred by that episode of the battle of Meeanee, when Sir Charles Napier placed a small group of infantry soldiers in the gap of a wall, and told them that they might die there, but that the enemy must not enter it. They did die there nearly all of them, but they kept the pass. Two or three mitrailleurs would have done it better, and with no loss of life.

When the officials and visitors had feasted their eyes sufficiently on the targets and marked how one man must have been shot in the heart, another in the head, and another in a limb only, the lorry was put in requisition again, and a group once more assembled round the mitrailleur. Two minutes were again given as the limit of time, but now the discharges resembled file firing, the horizontal motion being given so as to distribute the bullets. The Metford bullet is hard and heavy, and there can be no doubt that it will pass through one man and kill another behind him; many of the hits, therefore, that were counted as only disposing of one soldier and many of those that were not counted at all would very likely have killed two, and during this round time enough would have been given to the dead to fall and to the living to hear the steady voice of their officers crying "Close up, men"—a sound which as it becomes more frequent tells that the business of death is being swiftly accomplished. The advantage of the file firing from the mitrailleur was shown by this, that, though mishaps again occurred through the sticking of cartridges in the barrels, and five platefuls of bullets only could be fired, there were 154 hits, and, according to the reckoning of the committee, 59 cavalry or 49 infantry would have been slain or grievously wounded. Four minutes' work with the mitrailleur had given 264 hits on a target representing a front of 150 infantry or 90 cavalry soldiers, at 800 yards distance.

It was now the turn of the field guns, and the new 9-pounder Indian bronze gun was placed in position.

Let it not be for a moment supposed that the mitrailleur can be set up as a rival to rifled field artillery for general service. Where the power of the mitrailleur ceases that of the rifled field piece may be said to be in its highest perfection. If, therefore, at the short ranges of to-day the new weapon appears to advantage, further experiments will show that the limit of its powers will soon be reached, and no wonder. The 9-pounder Indian field gun weighs 8 cwt. The mitrailleur only 3 cwt. and 20lb. The 9-pounder, with its carriage and ammunition carried with the gun, but without waggon, weighs 33¼ cwt., and requires six horses. The mitrailleur, mounted on a carriage suitable to it, with lumber and ammunition complete, would weigh 12 cwt., and could be drawn by two horses. So that weight for weight and horses for horses, three mitrailleurs could be taken into the field for one 9-pounder rifled bronze gun.

The mitrailleur requires but one non-commissioned officer and five men to work it luxuriously, and three men could manage it comfortably at a pinch. The 9-pounder requires a non-commissioned officer and ten men, yet the practice of yesterday seems to show that there are occasions when, within certain definite limits, the mitrailleur may even surpass the 9-pounder gun.

At the range of 800 yards firing shrapnel with time fuzes the 9-pounder muzzle-loading gun was fired five times in its first two minutes, and eight times in its second two minutes. The first time it, like the mitrailleur, had its mishaps in loading. Its effect was 118 hits on the target, counted as 24 cavalry or 27 infantry killed or disabled. The eight rounds fired in the second two minutes gave 115 hits and 45 cavalry or 51 infantry placed *hors de combat*.

Next was brought up the 12-pounder breech-loading rifled field gun of the service. Segment shells were fired from it with concussion fuzes. Six times in two minutes did it send forth a projectile intended to burst and envelope the target in a shower of iron fragments. At the end of its firing the account given was—hits 38, cavalry disabled 15, or 18 infantry. The same gun was then fired with shrapnel carrying time fuzes. The result was even less, 15 hits, eight cavalry or five infantry killed or disabled. This closed the practice at 800 yards.

The mitrailleur was brought up 200 yards nearer the target. At a range of 600 yards it fired six rounds and gave 127 hits, killing or wounding, often with several bullets, 61 cavalry or 51 infantry. But now it was in its turn surpassed by the muzzle-loading rifled bronze gun, firing shrapnel, with time fuzes, for at 600 yards it was fired seven times in two minutes, and gave 283 hits. Its slaughter was counted at 68 cavalry or 88 infantry.

The ninth group of rounds was from the 12-pounder breechloader, with shrapnel and time fuzes, at 600 yards. Result—142 hits; 48 cavalry or 58 infantry disabled.

The time required for numbering all the hits upon the target, and calculating men and horses killed, had so delayed the firing that by this time it was late in the afternoon, and there was only time for two more groups of shots. The mitrailleur was quickly brought up to within 300 yards of the target. Only five rounds were fired from it in its two minutes, 171 bullets penetrated the target, and, by the calculation of the committee, would have killed 60 cavalry and 129 infantry soldiers.

BLOOD PICTURES.—Dr. Day, of Geelong, Australia, the improver of the guaiacum-tests for blood and other animal fluids, confirms the discovery of Neumann, that the picture or network formed by human blood can be distinguished under the microscope from that which is formed by the blood of other animals. He says he has repeated the experiment, which is "wonderfully simple," almost every day for the last two months with invariable success. A small drop, not a mere speck, of blood, is to be placed on a microscope slide, and carefully watched, at a temperature of 10° or 12° Reaumer (= 54·2° to 59° Fahr.), until the picture or network formed by its coagulation is developed. Human blood speedily breaks up into a "small pattern" network; the blood of other animals (calves, pigs, &c.) takes a longer time, and makes a larger pattern; but the blood of every animal seems to form a characteristic "picture." Dr. Day has examined the blood of calves, pigs, sheep, rabbits, ducks, hens, several kinds of fishes, &c., as well as that of man, and has found the results to be trustworthy and constant.

MICROSCOPICAL NOTES.

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A SIMPLE AIR-SIEVE.—The apparatus made use of consists of a small deal box, about 12in. square, having an opening to the front with sloping sides, so as to direct the current of air directly upon the surface of a glass plate, which slopes (at an angle of about 22°) from a vessel containing distilled water at the upper part of the box, to a trough placed at its base. The water is caused to trickle slowly over the glass plate by means of a cloth siphon from the upper vessel. In its course it comes in contact with the air, which is conveyed in a current through an open window into a room whose temperature is greater than that of the outer air, thus causing a traversing of the air of "out-o'-doors" to the inner chamber. The box contains a smaller opening into the chamber, through which the current can be detected. The water which trickles over the plate is then collected in the trough at the bottom, and, when examined microscopically, shows the presence of Monas Lens upon its surface, and when tested by solutions of potassic permanganate, by means of a volumetric analysis burette, shows varying proportions of organic matter present. One new fact is that the presence of monads is always, in these experiments, best discovered by examining the surface of the liquid. By the use of water in the apparatus described, the particles floating in the air are seized in a way which produces no injury, and the surface brought into contact with the air is larger than in Prof. Angus Smith and Dancer's experiments.—*Monthly Microscopical Journal.*

NEW MODE OF SUB-STAGE ILLUMINATION.—Dr. J. Matthews has devised a plan for this purpose which has been very favourably spoken of. It consists in the employment of a low-power object-glass, so fitted that the pencils proceeding from it may be thrown at any angle on the object. Dr. Matthews has solved the *difficulty of sub-stage* illumination by adopting *one of the objectives* themselves, of lower power, *as an illuminator in* place of a condenser, but *not axially. It must be* so mounted as to send the whole of its *bundle of* rays at angles varying with the requirements of any given case, and in this consists the value of the methods. Any of the powers may be used, bearing in mind that the higher the examining, the lower, within convenient limits, should be the illuminating power, in order to secure a proportionate amount of light. The only use of condensers of short foci and wide angle is to get the more oblique rays of the cone by stopping out some part of the rest. Dr. Matthews' best results have been procured by a ⅔rds or 1¼in. object glass, which gives in all cases quite sufficient light. There is no limit to the angle at which the illuminator may be used in relation to the axis of the instrument short of 90°, supposing both the covering and the mounting glass as well as the stage to be of no thickness; but as they all have a very sensible one, and it is found that rays of a greater angle than about 83° do not penetrate the slide to the object, but are reflected and lost, he has found it better to work at angles varying from 25° to 65°.

ACTION OF LIGHT ON FERTILE FROG'S OVA.—Herr Auerbach recently contributed to certain numbers of the "Centralblatt" the results of his observations. He states that during the spring (April 13th to 20th) of the present year he had frequent opportunities of observing the spawn of the frog, and was particularly struck by the circumstance that even the diffused light of day, but especially the direct light of the sun, constituted a powerful excitant of the contractions of the protoplasm of the egg. If the amount of light falling upon an egg, or, more correctly speaking on the primary segmentation spheres and the secondary results of fission, be increased, alterations of form may be seen to occur even under the eye of the observer. If the egg be so placed that the white pole is directed towards the light, the contractions excited have a tendency to push the black pigment in part over the white area, or even to completely cover it, whilst the opposite pole becomes whiter. When the first meridianal furrow has been completed, this pigmentation of the clear area occurs to a less extent. This alteration in the distribution of the pigment must not be confounded with the well-known rotation of the yelk, which depends on the centre of gravity being near the white pole.

HOW TO PREPARE YOUNG OYSTERS FOR THE MICROSCOPE.—Having found a "black-sick" oyster (to use the dredgermen's term), the spawn of which is quite mature and ready for extrusion, pour off from the shell the dark slate-coloured fluid into a long narrow two-ounce phial; fill up the bottle with *distilled* water; shake it up gently; allow the deposit to settle, and change the water two or three times, repeating the agitation to get rid of the salt. Then substitute for the water *liquor potassæ*, diluted with an equal quantity of distilled water. Allow the young oysters to remain in this for two days, agitating occasionally; and, as often as the solution becomes discoloured, pour it off, and renew the same until no colour is given off and the shells are seen to be thoroughly cleansed from all animal matter, by their sinking freely and rapidly to the bottom. When this stage is arrived at, stop the process, that the two valves of the shells may not be separated by the destruction of the hinge. Wash *repeatedly* in distilled water, to remove all trace of the alkali, and finally wash and preserve the shells in a little rectified spirit of wine (not methylated spirit). When they are to be mounted for the microscope, shake them up with the small quantity of spirit; and, before they settle, dip in a fine camel-hair brush, and deposit its contents on the slide. If too much spirit has not been added to them, there will be just enough of the shells in the brush to make a nice object. They show better when not huddled together too thickly. If undistilled water or methylated spirit be used, instead of being brilliant and clean, the shells will probably have the milky and semi-opaque appearance which is so objectionable. As each oyster produces on an average 800,000 young ones, the spawn of one parent will be sufficient for almost any number of slides. It is worthy of notice that, in its early condition, the oyster has both valves equally convex. This process is equally applicable to the bleaching and preparation of starfishes.—*Science Gossip.*

WASHING CHALK FORAMINIFERA.—Take about one ounce of chalk—that which lies in powder at the base of a chalk cutting is preferable,—place it in a quart bottle with about a pint of water, shake it, and after a few moments pour off the milky fluid down to about one-fourth; add more fresh water and continue the shaking and pouring off, waiting longer each time for the *debris* to settle. If this washing is continued through ten or twelve times in one day, and afterwards repeated two or three times a day for a day or two, the final result will be a sediment entirely composed of Foraminifera. By this means nothing can be detected as mixed with the Foraminifera. If small fragments of chalk remain mixed with the Foraminifera, that will give evidence of insufficient shaking. Plenty of water and plenty of shaking is sure to produce satisfactory results.—*Science Gossip.*

CIRCULATION OF THE LATEX IN THE LATICIFEROUS VESSELS.—Some experiments have recently been made upon the circulation of the latex in the laticiferous vessels of the leaf of *Chelidonium majus*. According to some authorities there is no visible motion except such as is the result of injury, while Schleider says, "that in the uninjured vessels, the motion of the latex can very seldom be successfully shown." Now by potting a young plant of *Chelidonium majus*, and placing any one of the young leaves between two strips of glass (upon which a drop of glycerine has been put), in such a manner as to bring the under side of the leaf uppermost on the stage of the microscope, so as to throw the strong-reflected sunlight upon it from the mirror below, it appears that—1st, there is occasionally either a nearly total want of motion, or only a slow one, of the coloured granules, or at times a very rapid motion of the particles to be seen; 2nd, that while watching the circulation as seen through the lenses, if the diaphragm be moved from left to right, so as to cause the shadow to enter upon the right of the field of view, a brisk circulation is instantly witnessed, which appears to be changed in direction as the diaphragm is moved back again, so that the direction of the circulation can be changed at will by the interception of the sunlight. The same result is seen when clouds pass between the sun and the mirror. The direction of the circulation is *from* the apex of the leaf in sunlight, and *towards* it in the shade. Prof. Balfour says, that in plants with milky and coloured juices evident movements have been perceived, and mentions the calyx leaves of *Chelidonium majus*, as also the india-rubber plant, the guttapercha tree, and the Euphorbia, as examples. The *Leontodon taraxacum* also exhibits a similar phenomenon.

SCIENTIFIC SOCIETIES.

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NORWICH GEOLOGICAL SOCIETY.

AT the monthly meeting of this society, held on the 2nd inst., at the museum, Mr. J. King in the chair, numerous specimens of the bones of *Elephas* and *Bos primigenius*, were exhibited by the Rev. J. Crompton, having been picked up by him during a recent stroll on the coast near Baston. An interesting discussion took place on the origin of the stony bed lying between the crag and the chalk. Mr. J. E. Taylor stated the hypothesis that from the secondary period to the Glacial-epoch Norfolk was a land surface, and that the chalk had been gradually worn away by pluvial and atmospheric action, so as to leave the flints, which are naturally distributed through the chalk, in a mass, thus forming the stony bed. The finding of the bones of *Hipparion*, or three-toed horse, in this stony bed tended to show that there was a land surface. The finding of an enormous flint embedded naturally in the chalk, and a portion of it exposed in an upward direction, showed that the chalk had been worn away by the agencies he had mentioned. Mr. Bayfield concurred with Mr. Taylor, and mentioned a fact he had observed in support of the theory. It was agreed to make some useful additions to the scientific literature of the institution for the benefit of the members.

FRICTION.—X.

BY C. DRAPER, A.B., L.C.E.

(*Continued from page* 468.)

Friction Wheels.—When one body *slides* on another the surface of contact of one of the bodies remains the same while the sliding continues; but when one body *rolls* on another, or when two bodies roll on each other, the surface of contact of each is continually changing as long as the rolling continues.

If one body roll on another the resistance is very much less than if the motion had been that of sliding. This resistance to rolling motion has been termed "rolling friction," but evidently erroneously so, as friction, properly so called, can only take place when a body *slides* or *rubs* on another; the word friction itself being derived from the Latin word *fricare*, to rub. Hence it is a principle in the construction of all machines to substitute rolling for sliding motion where possible. For example, let us take the case of a railway carriage, and suppose it to traverse the rails upon runners like a sledge. Now we have in both cases that of sliding and rolling, the same materials in contact, viz., iron and iron. In the former case, the resistance to motion would amount to about 224lb. per ton; in the latter, we know from the results of a great many experiments that it rarely exceeds 9lb. per ton. In the latter case also the resistance is made up of two parts—resistance to rolling, and the resistance to friction of the axles turning in their boxes; neglecting the former as being very small, let us find an approximation to the resistance of the axle friction. Let P be the resistance in pounds, D and d the diameters of the wheel and axle in feet, and W the weight resting on the axle. Now during one revolution of the wheel the carriage will move through a space of π D feet, therefore the work expended on it is equal to P × π D foot pounds, the work expended on axle friction during the same time is $\mu W \times \pi d$ (see last paper); and, supposing this to be the only resistance, we must have

$$P \times \pi D = \mu W \times \pi d \text{ or } P = \frac{\mu W d}{D} \text{ lb.}$$

Let μ = 1·20, W = one ton, D = 36in., and d = 3in., then $P = \frac{2240 \times 3}{20 \times 36} = 9\frac{1}{3}$lb.

The great advantage therefore of wheels applied to carriages of all kinds arises from the friction being transferred to the axle, and being then reduced in the proportion of the diameter of the wheel to that of the axle; hence, the larger the wheel and the smaller the axle the less work is lost in overcoming friction. Considerations of a practical nature of course set limits to the sizes of wheels and axles. Thus, if the axle be very small it will also be very weak, and if the wheel be very high the level of the axle will be above that of the point of attachment of the traces to the horse, etc., and therefore a portion of the effort of the horse will be lost in urging the wheel against the ground.

An extension of the same principle explains the advantage of "friction wheels" and "friction rollers." When these are employed, the journal of a shaft, instead of turning in a pedestal, as is usually the case, rolls on the circumference of a wheel or roller, as in Fig. 24. Frequently each end of the shaft is supported by two rollers, as in Fig. 25. Let δ be the diameter of the journal A, which supports a weight W; D the diameter of the friction roller B; and d the diameter of *its* axis C, which turns in a cylindrical bearing. Suppose now that A were turning in a bearing like C, with the same coefficient of friction μ, then the work which would be expended on A in one revolution would be $\mu W \times \pi \delta$, when it is supported on the roller B; however, when it has made one revolution, B, and therefore C, has made a fraction of a revolution represented by $\frac{\delta}{D}$, supposing the motion of A and B to be that of pure rolling; the work expended in friction in this case is therefore only $\mu W \times \frac{\delta}{D} \times \pi d$, neglecting the weight of the friction rollers. The work lost in the former case bears therefore to that lost in the latter the proportion of $\mu W \times \pi \delta : \pi W \times \frac{\delta}{D} \times \pi d$, that is of D to d, or the diameter of the wheel B to that of its axis C.

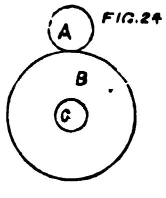


FIG.24

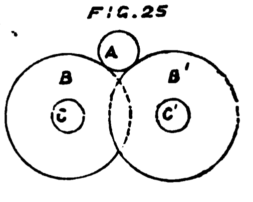


FIG.25

When there are two rollers under each journal, as in Fig. 25, the only difference is that the load on the journal A is equally divided between the two rollers B B', the friction on each axis C C' is consequently halved; but as there are two of them, the total amount remains the same. If we support the axes of the friction rollers again on other rollers we shall still further diminish the friction, although at the same time increasing the weight on the last axis. Practical considerations such as this, set limits to the reduction of the friction; thus we might reduce it to any extent by increasing D or reducing d in the same proportion; but if D be very great, the weight on C will also be very great; and if d be very small C will be very weak.

The Anti-Friction Cam-Press.—The name of this press is derived from its peculiarity of having nearly all its motions rolling motions. Now, although this reduces the friction to a minimum, we must not lose sight of the fact that without friction we could have no rolling motion whatever; for if friction did not exist, the application of the slightest force would cause one body to *slide* on another, provided, of course, the direction of the force was other than normal to the surface of contact.

The anti-friction press (Figs. 26, 27 and 28), consist of two cams C C', of spiral form, turning respectively on the axles A A'. These axles again roll on the sectors S S', the apices of which turn on knife edges K K' bearing against the foot and top of the press, K being fixed and K' movable upwards and downwards in a vertical line. Between the cams is a roller, R, which is turned by a winch either directly or by the intervention of toothed gearing. The mode of action of this press is perhaps best understood by reference to Fig. 28, which represents the frame of the press, the cams and sectors being shown behind. Fig. 26 shows the initial, and Fig. 27 the final position, when K' is at the extremity of its travel. By referring to Fig. 26, it will be seen that as we turn the roller R in the direction of the arrow, the cams will revolve in the directions shown by the arrows next them; so that in the final position, the roller R will have itself been raised a height equal to the difference of Aa and Ab; that is, the excentricity of the cam C. In like manner, if the peripheries of the cams be the same, the cam C' will be raised to a height relatively to R, equal to the difference of A'a' and A'b'; therefore the total travel of K' will be equal to the sum of the excentricities of C and C'.

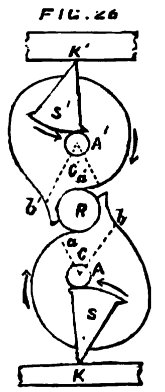
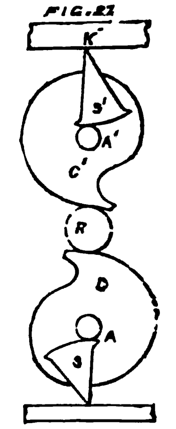
FIG.26


FIG.27


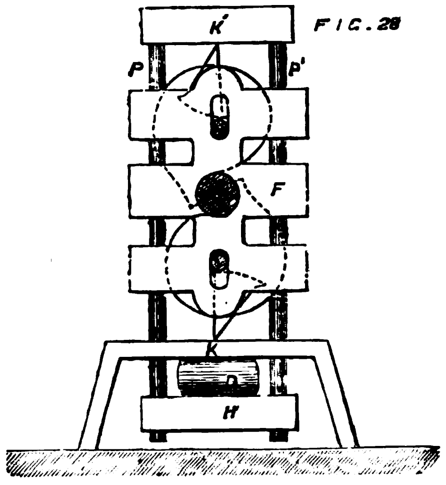


FIG.28

In Fig. 28 it will be seen that the frame F is attached to the vertical columns P P', so that when the press is worked, the columns rise upwards, independently of the frame, carrying with them the follower H, thus compressing the substance D between the fixed piece K and H. To calculate the efficacy of this powerful machine, let us assume the following dimensions:—

Example 20.—Let the length of the periphery of the cam C or C' be 3ft. 4⅜in., the diameter of the roller R be 2⅛in., the excentricity of each cam be 2in., and let the winch give motion to R by means of a wheel and pinion having respectively 52 and 8 teeth. Let the diameter of the circle described by the winch be 2ft. 7⅛in., and let it be turned by two men exerting each a force of 20lb. Find the force with which a substance will be compressed by the machine, neglecting the small amount of friction which exists.

Here the resistance is urged through a space of 4in. We must then find the length of the path described by the power of 40lb., while the follower makes its travel of 4in. Now, by measurement, it is found that 19-20ths of the periphery of the cam is passed over by the roller, while the follower makes its travel of 2in. Since 19-20ths of 3ft. 4¾in. is 38·7in., nearly $\frac{38\cdot7}{\pi \times 2\cdot5}$ must be the number of turns of the roller R, and since the circumference of the wheel is to that of the pinion as 52 : 8, $\frac{38\cdot7}{\pi \times 2\cdot5} \times \frac{52}{8}$ must be the number of turns of the winch. Now the length of the path of the winch in one turn is $\pi \times 31\cdot5$in., therefore the path in the above number of turns must be $\frac{38\cdot7}{\pi \times 2\cdot5} \times \frac{52}{8} \times 31\cdot5 \times \pi$ or 3169·5in., and the work applied must be equal to $\frac{3169\cdot5 \times 40}{12} = 10565$ foot-pounds; and if the required pressure = P, we must have $\frac{P \times 4}{12} = 10565$, or P = 31695lb., or over 14 tons.

(To be continued.)

LETTERS TO THE EDITOR.

[We do not hold ourselves responsible for the opinions of our correspondents. The EDITOR respectfully requests that all communications should be drawn up as briefly as possible.]

*** All communications should be addressed to the EDITOR of the ENGLISH MECHANIC, 31, Tavistock-street, Covent Garden, W.C.

All Cheques and Post Office Orders to be made payable to J. PASSMORE EDWARDS.

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"I would have every one write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks: a vice from whence great inconveniences derive their original."—*Montaigne's Essays.*

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*** IN order to facilitate reference, correspondents when speaking of any Letter previously inserted will oblige by mentioning the number of the Letter, as well as the page on which it appears.

SPRING VELOCIPEDES.

[223] SIR,—The vitality of Fallacy is really something surprising, although certainly not extraordinary; in both senses it is "ordinary"—if not confined to Newgate. On the contrary, I fear it is not Fallacy but Truth which is becoming *extra*ordinary; but perhaps the latter is so very unacceptable in the nude that it requires to be "draped" by the former to enable ordinary mortals to bear it.

One fallacy which has exhibited great vitality in the pages of the ENGLISH MECHANIC is the proposal to propel velocipedes by coiled or other springs, which, in the language of a reverend correspondent (by the way, reverends can hardly be expected to be familiar with such merely mundane things as coiled springs), you *may* "wind up" just as you do your watch. May I suggest that, although an analogous operation, it is no more "just" as you wind your watch than is the winding of the church turret clock, whose maintaining weights are from a quarter to half a ton? Doubtless both are treated like a limited liability company, and "wound up;" but I think if my reverend fellow-correspondent was accustomed to that peculiar kind of "church service" yclept turret clock winding, he would hardly have treated velocipede spring winding so lightly as to say "just like you wind your watch;" on the contrary, the injunction to "watch and pray" must have been involuntarily carried out by him, for he would most certainly have *watched* anxiously for the reappearance of the heavy maintaining weight and *prayed* fervently to be relieved from the labour.

This not very new subject has cropped up repeatedly in the pages of the ENGLISH MECHANIC, and even before that journal came into existence, for perhaps forty years. Certainly it was not invariably "just as you wind up your watch," for an engineer whose experience was probably greater (even if his faith in the art of removing mountains with small expenditure of muscular energy was less) than that of your clerical correspondent long ago proposed to propel carriages, from railway locomotives to velocipedes, by compressed air, which is, however inconvenient, rather more practical than employing coiled steel springs. It would require iron air-holders like the gas-holders of the long-since defunct portable gas company, or, perhaps, something resembling an egg-ended steam boiler. Perhaps, however, they would not weigh much more than the steel spring, or rather, the scores of steel springs which would be required. In both cases, a person so utterly ignorant of the laws of dynamics as a mere blacksmith must necessarily be might very unreasonably object that all this additional weight had to be carried on the wheels of the carriage and *lifted* up the inclines, which certainly requires force to effect (at least in England). After all, the same may just as truly be said of the boiler of the locomotive, which contains water, a yet heavier fluid than compressed air, not to mention the water tank and its contents, with coke or coal to boot. So a compressed air-carriage may not be quite so absurd a thing as it has been pronounced to be, and a compressed air velocipede will certainly soon be *un fait accompli*—that is, as soon as we can import and naturalize from the "green" isle (not its similarly coloured natives—they are imported in quite sufficient numbers already) certain natives' "green ideas," especially that which had the honour of being figured in the ENGLISH MECHANIC some months ago: I mean the celebrated fly-wheel velocipede which *ascended* (?) hills easily *in consequence* of the heavy fly-wheel with which it was provided. Having achieved this Hibernian reversal of dynamical laws, it follows that we may do without springs altogether, for we have only to make the fly-wheel large enough and heavy enough to compel it to take up hill the carriage, the air vessel, if we yet prefer carrying one, and the heavy-sterned Christian rider together; but being, in the matter of mechanical contrivance—if not in the employment of language—an advocate for using the fewest possible parts (I do not mean parts of speech), I would humbly suggest that the principle might be carried out in a less complex form by removing the *boiler*—I mean the air-vessel—and also the carriage, and *suspending* the Christian from the axle of the fly-wheel. Should this be found in practice to put this unique one-wheeled velocipede out of balance (which might be the case if all mechanical laws were not treated like the Christian, re-suspended), that balance might be restored by *suspending* another Christian of similar conformation on the opposite side. May I further suggest that our Chancellor of the Exchequer and Chief Commissioner of Public Works be selected for the first experiment? for should anything unpleasant occur, the spectators could not possibly have their feelings shocked by their employment of objectionable words, because the two gentlemen I have proposed are both so remarkable for dignified courtesy and polite speech.

Not having a very lively faith in the immediate realization of that pleasant political prospect in "Irish affairs" and ministerial "resignation" which I have suggested, I now return from the Tower Hamlets and her Majesty's Exchequer to the more prosaic subject of coiled steel springs, and, in all seriousness, ask how the something the velocipedist is to "wind up" (unless as in the case of certain city companies he also stops progress and don't "go on") when he "goes ahead" at anything like the rate Mr. Reveley proposes he is to impel himself and his "veels?" When driving (needs must when *something* drives) his vehicle twenty or thirty miles per hour, I have a shrewd suspicion that the most muscular of Christians would have but little muscular force, and yet less "vind," to wind up these, to him, anything but "springs of health." The only *waters* such "springs" would produce would not be quite animal—not mineral; in other words, the waters of fatigue and profuse perspiration.

When the Frenchman who lately took *out* a patent, I trust that patent will not return evil for good and *take him in*, and Mr. Cunningham (who is a clever mechanic) proposed the use of springs, for the 100th time at least, I fear they lost sight of this small difficulty. I can aver that I have never yet seen a bicycle, tricycle, or any other kind of cycle, not even excepting the far-famed Yankee Rantoon (Qy., What can its very odd name be derived from?—I am quite curious concerning its etymology), which did not completely use up the whole muscular energy of the most muscular of muscular Christians when he changed his *locus standi*—(or rather *locus treadi*; excuse the curious Latin, Mr. Editor—please don't *bark* at it) at a much slower rate than Mr. Reveley proposes he shall do. I am quite willing to admit that if you make a "Machine" (in the coachmaker's sense of the word, as well as in the engineers') to carry six or eight men, all of whom can assist its propulsion, that it becomes a six or eight oared cutter, and "cuts" along a good road at a tremendous rate—by the way, another proof of the advantages of co-operative labour; indeed, few trotting horses can keep pace with it. Small need for any springs there, excepting india-rubber tires; but except he be going "down-hill" (which I am sorry to say I am very fast), a single (I don't mean unmarried) velocipedist has little power to spare. No doubt when he is going the same way as myself his gravity—if he has any left after laughing at the writer—might be employed to wind up, instead of wasting that force—so far as its use for propulsion is concerned, by absorbing in friction by means of a brake. Having wound up, *un*winding would help him up-hill; but, to suppose that when propelling his hobby on level ground or ascending hills of very slight gradients, he can "wind up" without stopping, is equivalent to supposing him an enormously muscular Christian; indeed, quite as much so as that muscular Christian of the last century, the late lamented Mr. Topham, *alias* "ye strong man," if not a lineal descendant without any degeneration of that great Greek heathen fellow, who (to judge by some of his recorded doings) was, however muscular, no more a Christian than some of my contemporaries, rivalled our stout Quaker President of the Board of Trade in physical power, rejoiced (according to Grote) in the euphonious appellation of "Herakles," and seems, in common with the immortal Sam Weller, jun., and the late Lord George Bentinck, to have been (in two, or even three, senses of the words), a man of (Augean) stable mind, even if he very reasonably objected to assist lazy waggoners who neglected to put their own shoulders to their own "veels."

About a year ago a prudent correspondent enquired—it was very prudent in him to do so before "commencing to manufacture on the large scale"—what the dimensions of a spring would be that would take him up Highgate-hill. As he did not specify the rate at which he desired to ascend it, the condition of the road, [illegible] gradient, the kind of carriage, and its weight, that he intended riding on, nor yet the measure in pounds avoirdupoise of the body in which his enquiring mind was located (in fact, by hiding his own gravity he quite upset mine), I was not mathematician enough to "kalkalate" the problem in the absence of those data. He might have been a "light character" (I mean no offence), or he might have had that peculiar Christian conformation which renders assistance [illegible] necessary to progression; but by way of helping the seeker after knowledge your very practical correspondent "W. T.," in No. 244, Vol. X., favoured [illegible] with a description of the spring—or rather the springs—required to drive the barrel of a [illegible] acting pianoforte round about 12 or 14 times, [illegible] which he might be able to arrive at some vague [illegible] of the dimensions of the spring, or perhaps the century of springs required to elevate himself [illegible] region of "horned" cattle, the "Horns" at Hig[illegible] If some of the enquirers were to take the trouble [illegible] reading "W. T.'s" communication instead of [illegible] you, Mr. Editor, with theirs, I fancy it would [illegible] them up" evermore.

The only thing about the matter which seems feasible is, as I have before said, to store up [illegible] the force of gravity which runs to waste [illegible] down hill, instead of absorbing and causing [illegible] changed into heat by the brake. This is no doubt desirable, but not very easy to do without adding [illegible] siderably to the weight and greatly increasing the [illegible] of a velocipede; but, perhaps, I ought to say [illegible] about its cost; for when we want not only to ride [illegible] also to construct our hobbies, fifty or one hundred pounds worth of springs is of course no consideration whatever to ye English mechanic, who is invariably such a go-ahead fellow, and proceeds so utterly regardless of expense. For myself, being, in the physical sense, a very *broad* churchman, *i.e.*, a heavy Christian, I prefer walking on my own feet to "valking on veels"—riding in a carriage propelled either by steam or horses. I do feel it would be great presumption in me, at my time of life, being a mere *biped*, to attempt to compete with that noble *quadruped* the horse. *Ne sutor, &c.* Instead of feeling that *I had* the inestimable privilege of being gifted with reason, *I should esteem* myself no wiser or better than *Plato's man, who, if* not a goose, doubtless was at least first cousin to a gander (although reported in ancient story to have been a Frenchman—I mean a gallinaceous fowl stripped of its feathers); but I think the male goose would have "ansered" better as a representative of humanity, especially as it more nearly approaches to the ordinary intellectual condition of mankind, so I infer [illegible] must have been either a male goose or a female gander, it little matters which. "Arcades Ambo," quote Byron—may I perpetrate another specimen of canine Latin and say of man and his "plucked" representative, "Ansari duos."

THE HARMONIOUS BLACKSMITH.

THE HARMONIUM.—REPLY TO "ALEXANDRA."

[224] SIR,—At the risk of increasing that "deluge" of my correspondence, which according to "Alexandra" has flooded our journal since her enquiry appeared in No. 260, of March 18th, I feel [illegible] to reply to her. I have only had two contributions [illegible] up to August 5th. The first related almost entirely to improving the treble of the piano, and the [illegible] chiefly to her own design for an upright instrument, and in it I stated the honest truth, that I am not a harmonium but a pianoforte maker, and that I do not pretend to anything like that practical acquaintance with the construction of harmoniums which distinguishes Mr. Hermann Smith, Mark Ellor, Eleve, &c. In fact, that as regards great variety in the power and quality of the sounds of different ranks of reeds, I am a mere suggestor. Did it never strike "Alexandra," as a most significant fact, how little she is indebted to [illegible] trade for the information she required, through the columns of the ENGLISH MECHANIC?

If "Alexandra" will refer to her letter of enquiry [illegible] specting Myers's reeds (I quote from memory, [illegible] having the number at the moment before me), she [illegible] that my letter bore the peculiar "ring" of another [illegible] very valued correspondent of the ENGLISH MECHAN[illegible] alluding, of course, to the "Harmonious Blacksmith." For this reason, also because he was born with a silve[illegible] spoon in his mouth, while I have to meet the exigencie[illegible] of life as best I may,—also because I had seen but [illegible] of Myers's instruments, but my friend, the "Harmonio[illegible] Blacksmith," had not only seen and *examined* some of them, but enjoyed the personal acquaintance [illegible] Myers—for these reasons, I repeat, I thought better [illegible] turn "Alexandra" over to him, knowing well he co[illegible] give her twice the amount of information I possess[illegible] that he would refer her to the number and date [illegible] Myers's patents, and could spend the whole of his tim[illegible] if he pleased, in the investigation or elucidation of a[illegible] subject to which he chose to direct his attention for t[illegible] time being. I certainly think he gave "Alexandr[illegible] all necessary information. More she could ha[illegible] obtained by purchasing the patents themselves, whi[illegible] cost but a few pence. But the height of my offendi[illegible] seems to be that "Harmonious Blacksmith's" let[illegible] was not signed "W. T."

The "Harmonious Blacksmith," whose abundance [illegible] utterance is rather apt to overflow, not to say "deluge" the ENGLISH MECHANIC (I leave him to fight his o[illegible] battle with you, Mr. Editor, and her Royal Highness, [illegible] specting the insertion of so many of his effusions) h described Myers's patent reeds more than once—see No. 262. The Physharmonica "reed with a swell," has also been described in the English Mechanic to be a free reed combined with a pipe.

I believe the Germans put a 2ft. pipe to a tenor C reed, but it is obvious the pipe may be shortened to half, to a quarter, to an eighth, or even to a sixteenth of that length, which would approximate to the length of the wind channels for such a reed in the harmonium. We have Mr. Hermann Smith's authority for regarding all these wind channels as veritable pipes. I infer the shorter the pipe the greater the influence of the reed on the short column of air within it, and of course the less the influence of that column of air on the sound of the reed in the way of improving its timbre.

"Alexandra" asks for a trumpet stop in the harmonium worthy that title. I can't help her, unless she can find room in the instrument for more pipe tone (along with the reed tone) than any short wind channel can be expected to afford. In such case, we at once introduce a rank, whose wind channels are so long as to take it quite out of the harmonium family. It may be said there is no natural line of demarcation between wind channels and pipes—but a double C reed, with a wind channel or pipe 4ft., or even 2ft. long, would rather come under the category of an organ rank, than an harmonium stop. "Alexandra" would cheaply obtain much information by reading; the patents mentioned in "Harmonious Blacksmith's" reply (also intended for her) to "J. C. P.;" in No. 277.

Referring again to the significant fact that none of the harmonium makers have offered the least assistance to "Alexandra" for contrast and variety of tone, it may be that those who have mastered the details of mere ordinary construction fear absence of adequate pecuniary reward, for spending time, money, and brains in the construction of an instrument very much out of the common way. Who can blame them while they can sell their productions? They have their living to get, and this takes a great deal of the poetic feeling out of us.

W. T., Pianoforte Tuner and Repairer.

MICROSCOPE.

[225] Sir,—Your correspondent "C. C. S.," in his reply to "Sabbas," refers to a new student's microscope exhibited in the Workmen's International Exhibition as being suitable for his requirements. I have much pleasure in corroborating "C. C. S.'s" statement. Having worked with the instrument I am fully convinced that it is the cheapest microscope in the English market. The stand is made of one solid piece of brass, whereby great firmness is secured; it has a spring object-holder, a good object-glass, the eyepiece is excellent, the rack work and fine adjustment smooth and easy. In fact, it forms the basis of a very capital instrument. Wishing your greatly improved journal increased success.

F. B., F.R.M.S.

["F. B." stated the price of the above microscope, which we omit for reasons given elsewhere.—Ed.]

OUR SIZE AND FORM.

[226] Sir,—Though I agree with the "Harmonious Blacksmith" (letter 213, p. 496), about enlarging the size and increasing the price of the English Mechanic, I think the plan suggested by you is by far the best, if it can be carried out. You know best. At all events the offer is both a generous and courageous one. Our facetious friend, the "Harmonious Blacksmith," suggests that the English Mechanic should be increased eight pages in size and one penny in price. You, sir, say you do not know what the ultimate size of the English Mechanic may be; and judging from the manner in which it has incorporated other periodicals of late, it would not be an easy thing to foretell. But you say distinctly that you have no idea of increasing the price, though you will increase the size *eight pages* if you could get three subscribers where you have but got two. Here then is, as I take it, a *bona fide* offer, and one that reflects great credit on the management. It is in fact a challenge, and I beg to suggest that we, the subscribers, take it up at once and heartily. I believe that our subscribers may be increased one-third with comparative ease. Not one-half, I may say one-third, of the people interested in such a publication as ours, take it in at the present time. I am just returned from a short holiday trip, and I was surprised in several instances to find persons, and just the ones to become subscribers, who knew little or nothing about the English Mechanic; and I have reason to believe that two or three of them, on their return home, will become subscribers. I know no better way to widen the area of our readers, than for those who are subscribers to introduce the journal to strangers during their holiday trips this time of the year. In more than one instance I left my copy at the hotel, in the smoking-room; and I was interested to see how it was looked into and enquired after. I beg to suggest that others do likewise.

Our ever obliging adviser, "F.R.A.S.," said (page 312):—"I assure you I personally recommend the English Mechanic right and left to every scientific friend I have, and to others, who, without claiming any title to that appellation, yet wish to know what is going on in the way of physical and mechanical discovery." If "F.R.A.S.," who takes so much trouble to enlighten us, also recommends our journal "right and left," certainly we, the mass of the readers, may imitate him in one way at all events, by recommending our friends "right and left" to become subscribers.

I, for one, sir, will take up the challenge, which you have so courageously made, and as I have made one suggestion in the way of increasing the circulation, I hope that others, who may feel inclined, will make other suggestions, so that we may all unite together to increase the prosperity of the English Mechanic.

Hopeful.

[Other correspondents have expressed themselves similarly to "Hopeful." Mr. Grierson, who has so valiantly defended the Lewis system of shorthand, says:—"I always leave my English Mechanic on our office table for some time, for the benefit of my fellow students. One of them has just become a subscriber, and a second states that he intends to become one." Q. Sea says in a letter:—"I take every opportunity of introducing to the notice of my friends as the most friendly act I can do them."—Ed.]

REPLY TO "SUBURBAN."

[227] Sir,—"Suburban" rebukes me (in all good faith I know), for what I do as a duty, and not a pleasing one. The readers of the English Mechanic have a right to claim that those correspondents who are familiar with a subject should not suffer erroneous statements respecting that subject to remain uncontradicted. Personally I should care nothing though "A. Z." chose to assert that the earth is corkscrew-shaped, or though "B. Y." said that Jupiter is a pancake; but if they assert the theories in the English Mechanic I should not hesitate to point out that on the whole accepted views are preferable. It is not the shortcomings of "A. Z.," or "B. Y.," or "C. X.," that I regard, but the injury their mistakes may do to our journal. But is "Suburban" serious? He speaks of "unlucky mortals" who are "in the wrong," and who "happen to assail" people, almost as if he loved them, and he will not have them "transfixed with an epithet" at any price. Are they worthy of "Suburban's" championship?

Has not our own "F.R.A.S." lashed some of these offenders, and stingingly, too? I once called in his aid for such a purpose, and I remember it was very effectual indeed.

R. A. Proctor.

THE FLUTE AND FLUTE PLAYING.

[228] Sir,—I am an old man—a musician—and in my youth used to play the flute. I have heard Drouet, Nicholson (in his prime), Richardson (an old friend), Pratten, (ditto), and most of the later performers; and am also an amateur mechanic, and consequently an admirer of your publication; but little did I imagine that I should live to see any arguments in favour of that detestable instrument (the flute)—fit only for mild curates and similar-minded individuals. I know all about the abortion, have seen overtures arranged for *four* flutes, and have had to accompany solos performed on an instrument with eight, and heaven knows how many more keys. Also, I once heard Boehm, and after that, nothing that I have heard, or ever shall hear, will convince me that the flute is a desirable instrument for any one to waste his time in learning to play. I once gave an engagement to Richardson to play at a concert, being anxious to do him a service. On the night he sent me a notice, saying that a *boil* in his cheek made it impossible for him to appear. Fancy the situation—poor fellow! Read in any old novel the description of a curate's abode—"Over the mantelpiece, on two books was placed *his flute*, &c." But, with all my prejudice, I will say, that for the true poetic "flute-like" tone, nothing surpasses the *old German flute;* and I shall be much surprised if our facetious and learned friend, the "H. B.," does not agree with me, at all events, in this particular.

F. F. C.

TO WHAT HEIGHT MAY CLOUDS OR EXHALATIONS ASCEND?

[229] Sir,—Searching through Shaw's "Boyle" for information relative to an experiment conducted by Boyle, I happened upon a paragraph (Vol. ii., p. 454) containing a statement so incredible—at least so it appears to me, although founded on the observations of two eminent men—that I venture to claim the assistance of your readers in an endeavour to arrive at the truth. I will now proceed to quote, so far as is material, the paragraph in question. After stating that, perhaps, the atmosphere may rise to the height of some hundreds of miles, Boyle says: "Nay, exhalations may ascend much higher, if there was no mistake in that strange observation made at Toulouse, in a clear night in August, by the diligent Emanuel Magnan, who, as Ricciolus tells us, 'saw from 11 o'clock at night till 12, while the moon was under the horizon, a little lucid cloud, near the meridian, and almost in the zenith, which could be illuminated by nothing but the sun; and, therefore, must have been higher than the whole shadow of the earth. And,' says Ricciolus, 'the like phenomenon was observed by the great mathematician Riccius.'"

Now, beyond the short explanation contained in the paragraph above quoted, I am unable to ascertain what were the observations made by either Emanuel Magnan or Riccius; yet, I cannot but think that the observations in question must have been founded on error; since, if we suppose the cloud to have been higher than the whole shadow of the earth, then its distance from the observers considerably exceeded half a million of miles; and if, as we may suppose, the cloud was at that distance of visible sensible breadth, then it must have had an actual linear surface of thousands of square miles. That such should have been the actual case appears to me improbable in the extreme.

However, it is probable that the enormous circle of readers of the English Mechanic embraces more than one student of science familiar with the labours of Magnan and Riccius; and, I doubt not, their kind assistance will soon remove my difficulty. Should information as to the above-mentioned phenomenon, however, be not forthcoming, then, sir, you or your readers will, perhaps, favour with an answer to the query forming the heading to this letter.

Glaisher has, I think, stated that when at the greatest altitudes, the cirrus clouds, commonly called "mare's-tail," appeared to him to be distant as ever. But what I wish to know is, whether or not exhalations ascend beyond the earth's atmosphere.

S . . . . . r.

HOW LL.D.'S AND PH.D.'S ARE MADE.

[230] Sir,—I have been an interested reader of our valuable Mechanic during the last twelve months, and as this is the first time I have addressed you, I cannot but congratulate you on having such an array of talented contributors on an almost endless variety of subjects. Truly there is a national education for the working man at twopence a week! If you think a few lines of mine worthy of admission into your columns, I would reply to an "Ambitious One" who is desirous of knowing how LL.D.'s are made.

An LL.D., or indeed, any degree obtained in a British university, undoubtedly confers honourable distinction on its possessor, and I would add that a foreign degree is not inferior if obtained in a fair and legitimate way (*i.e.* not through mere money considerations).

For some years past, however, foreign universities, particularly German ones, have for a pecuniary consideration granted LL.D., Ph.D., and other degrees for sums varying from £15 to £25, and we frequently see a plain Mr. on one day emerge a full-blown Doctor on the next. I am personally acquainted with more than one who have thus obtained diplomas. It must surely be a standing *disgrace* alike to both university and candidate, when the latter obtains his diploma *merely through purchase.*

The subject of these *German Yeast* degrees has lately been fully exposed in the *Scholastic Register.* The number for July last, contains the following remarks:—"The University Degree Trade has not been thriving lately; a result that is mainly due to the exposures which have appeared in our columns. Some of the agents have entirely abandoned the occupation; but there are still two or three in the field. The facilities offered by these gentlemen are, however, now of a somewhat restricted character, as nearly every European university is closed to every person who is unable to pass a somewhat strict examination."

If the above remarks are true, and an "Ambitious One" is desirous of becoming a *learned* Doctor in so *degrading* a manner, he had better set about his business at once, ere he be too late. The authorities are apparently beginning to see that their degrees, otherwise valuable, are likely to become valueless, since it is impossible to distinguish between those *purchased* and those earned by laborious study.

Steel Pen.

HANDWRITING.

[231] Sir,—Your correspondent "W. S. A." (p. 469) appears to forget that we live in an age of railways and telegraphs, and the old fashioned stage coaches and their living prototypes have grown out of date.

As steam superseded manual labour, so quick writing supersedes slow writing. The "true, correct, and beautiful form of the letters," as "W. S. A." in a burst of poetic feeling expresses it, belonged to the days of the "sleepy Charlies." In these modern days of "tarnation hurry," it is neither necessary nor desirable for business men to write as exquisitely and carefully as schoolmasters or professors of writing. It is not *style* but *rapidity* that is aimed at this rapidity unavoidably results very often in illegibility.

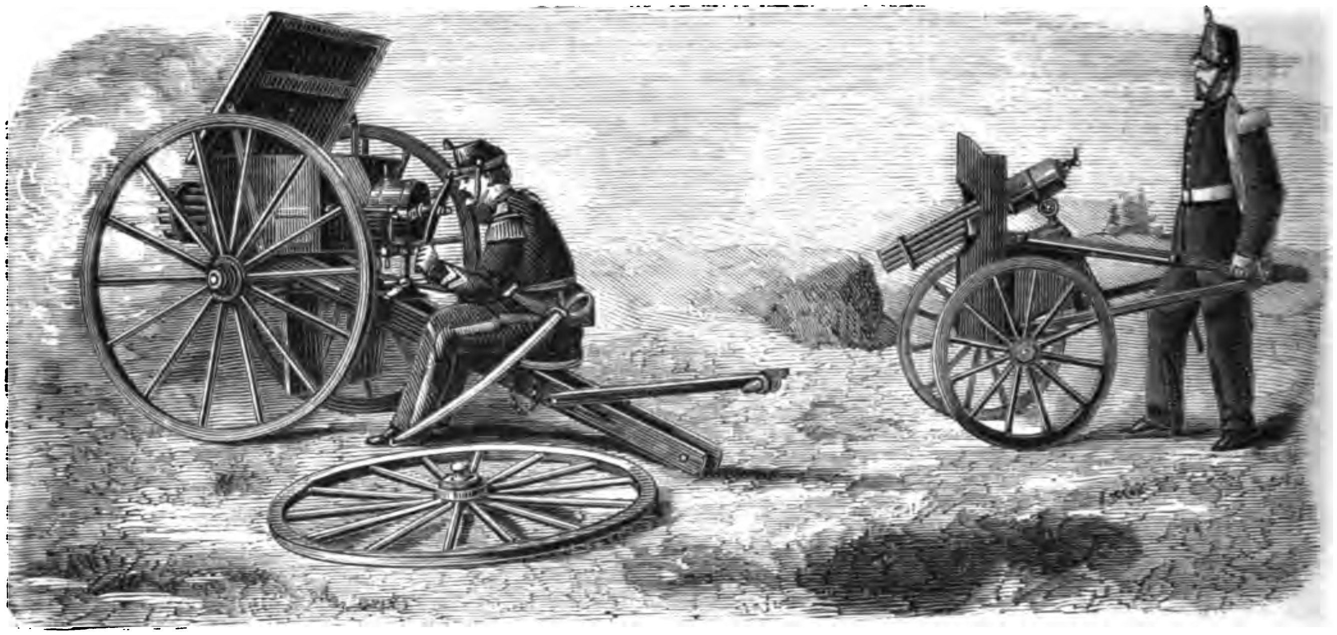
"W. S. A." alludes to writing as an "art." Now to the great majority, who use it merely as a means of conveying their thoughts to others, it is *not* an art. Schoolmasters and a few others have made it an art for the purpose of *teaching* writing, but after quitting school it is not necessary for those who do not intend to earn their bread by forming their letters in a "true, correct and beautiful style" to write like schoolboys. There is no departure from truth, and therefore there can be no ignorance or vulgarity, in not forming the letters correctly. Modern excellence is to be able to write three letters in the time formerly occupied by one. Time flies and man walks. We should not consume time unnecessarily, lest time should consume us before we are aware of having wasted our allotment.

Lex.

THE FRENCH MITRAILLEUSE.

[232] Sir,—The Franco-Prussian War and the part being played therein by the mitrailleuse will probably cause brother readers to welcome the annexed illustrations and description of this deadly weapon. The mitrailleuse is the patented invention of M. Francois Jules Manceaux, of Paris, a gentleman well known for his various improvements in firearms in general, the English patent having been secured through Messrs. Robertson, Brooman, & Co., patent agents, Fleet-street. A mitrailleuse was patented by M. Manceaux in 1867; the present invention, however, is a great improvement upon the former weapon. The first part of the present improvement consists in fitting the barrels between plates which stretch across from one side to the other, and are connected to side plates or straps, which are carried on

THE FRENCH MITRAILLEUSE IN ACTION.



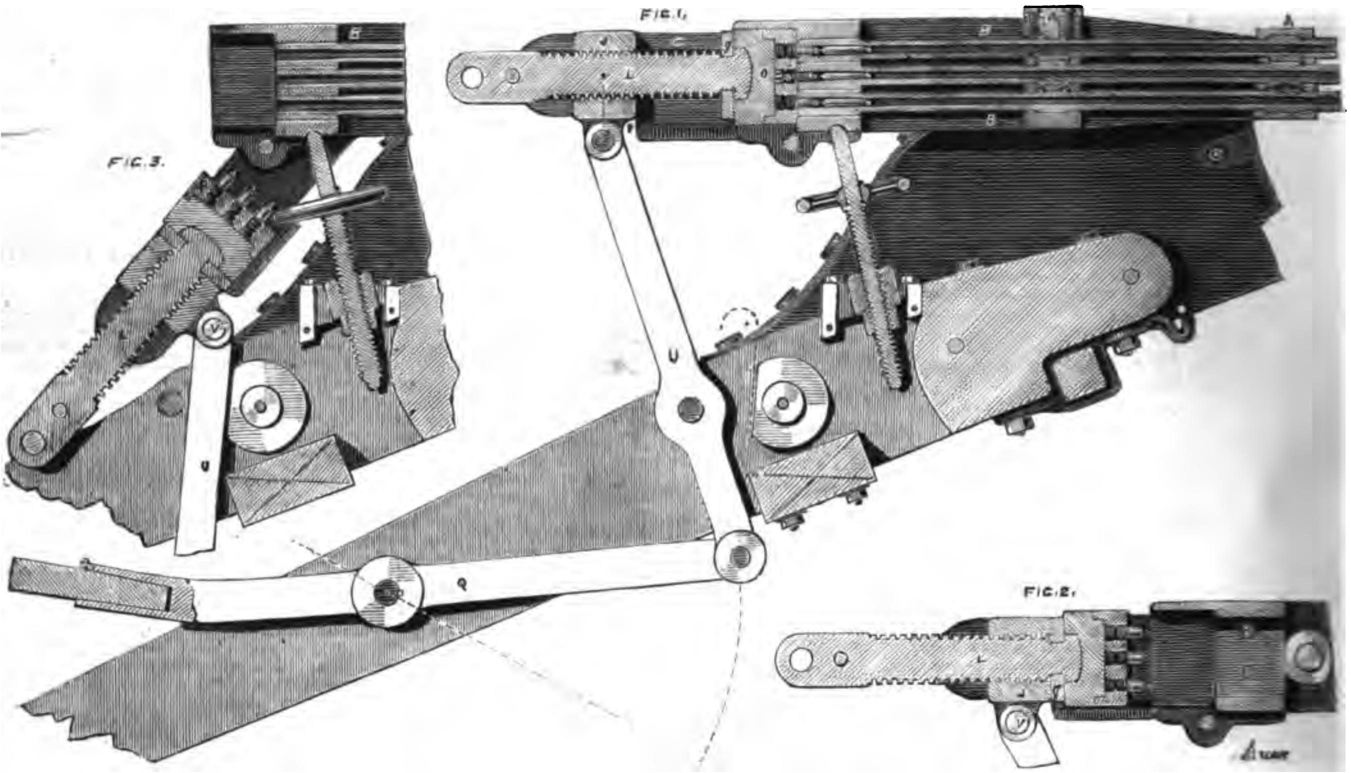
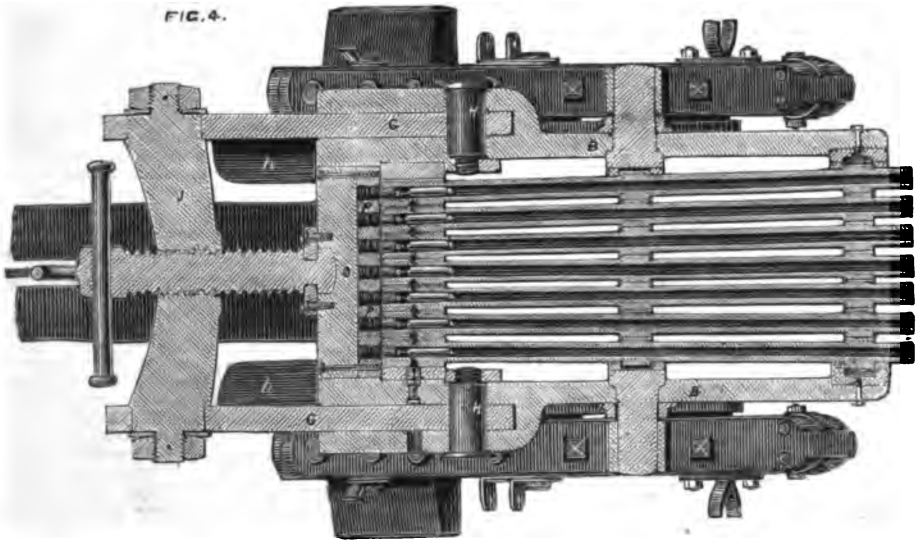


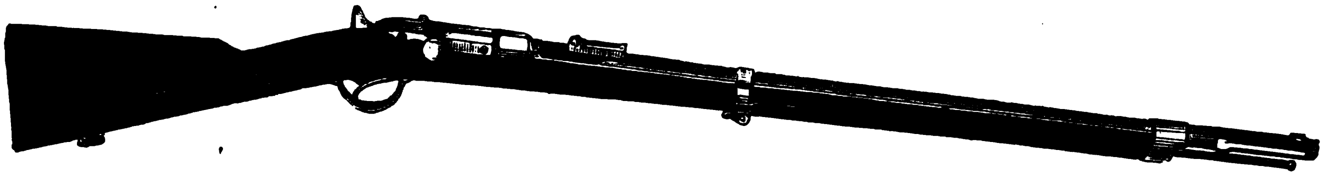
FIG. 4.



trunnions. The trunnions enable the apparatus to be mounted upon a carriage, so that it can be used in field operations.

The principle of the French mitrailleuse will be seen from the accompanying engravings, fig. 1 of which is a sectional elevation of the weapon and carriage; fig. 2 is a section of the breech end; fig. 3 is a section of the breech end, with the block or closer drawn down, leaving the barrels free to be loaded; and fig. 4 is a sectional plan, with the cartridges in the barrels and the closer screwed home. This compound gun is composed of a series of barrels, which are fitted between plates A A, which stretch across from one side to the other so as to firmly unite the two side plates B B, upon which the trunnions are formed for supporting the mitrailleuse upon a carriage, so that it can be moved from place to place and employed in field operations. The rear ends of the side plates B B are of greater thickness than the other portions, and are slotted so that the guide plates of the closer can work therein. These plates are centred upon pins, which are kept in position without working loose by means of tappets acting upon the nuts on their ends. The breech-closer plates G extend a distance beyond the rear end of the barrels, and have near their ends long holes, which serve to hold secure a transverse bar J. The central portion of the transverse bar is of larger diameter, or is thicker than the other parts, so that the threaded rod L, which passes through it, may be turned so as to bring the breech-closer nearer to or further from the rear of the barrels. The front of the threaded rod L is

THE CHASSEPOT RIFLE.

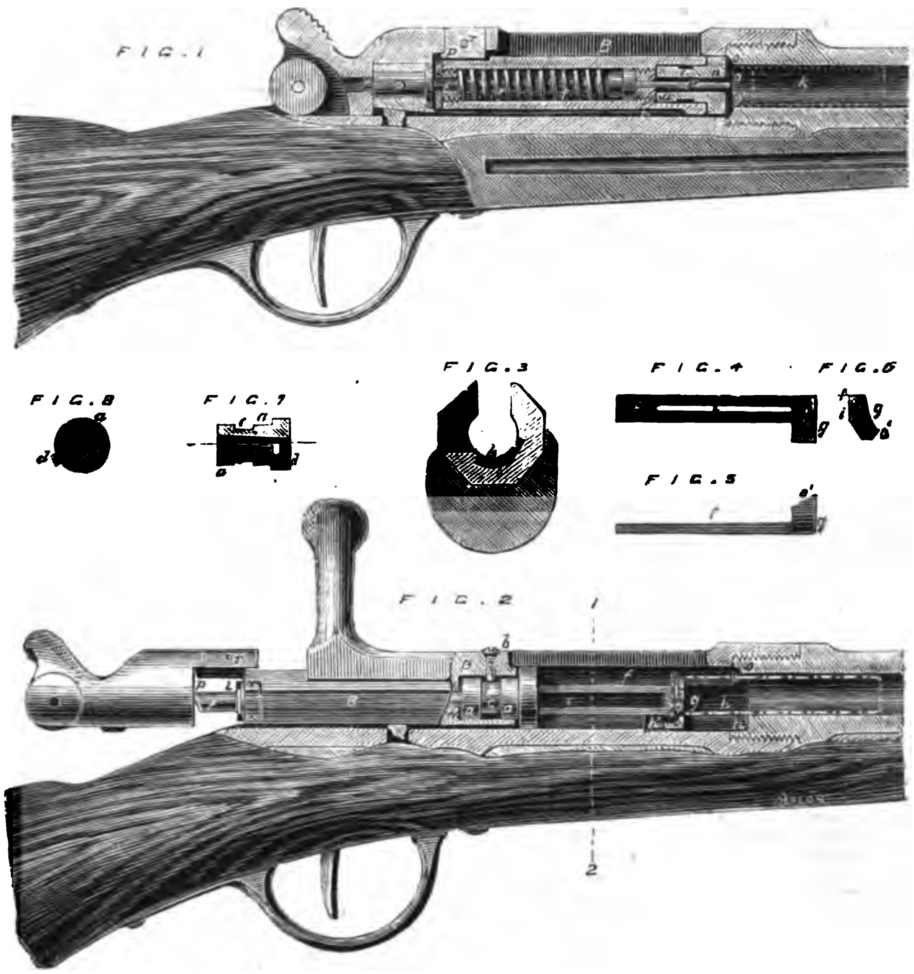


rounded, the rounded portion being fitted between two half plates *q q*.

The under side of the closer plate has lugs *v v* for carrying a pin V, to which the upper end of a link or lever bar U is jointed. The lower end of the link is pinned to a lever Q, so that the closer, when released from the barrels, can be raised and lowered upon their joint pins H H, which are fitted in the side plates B B. The under side of the rear of the side plates has projections for the closer to slide upon as it is being moved, and when it has travelled such a distance as to be tilted, it rests upon a plate *h*, which forms part of the closer frame G G. The front of the closer or breech block O has a face plate P secured thereto. This plate is provided with a series of holes corresponding to the number of barrels filled in the frames upon the carriage. The holes are threaded for the reception of screw plugs or nipples, through which pins are fitted. The inner ends of these pins rest upon a disc of horn or other yielding material, so that when the explosion takes place the force of the recoil is diminished. The distance the pins may project is regulated by a washer or plug screwed into the back of the plate P. Under the rear of the breech end of the barrels is attached one end of an elevating screw, by which the depression or elevation of the barrels is governed. The lower end of the screw works in a block or socket on the carriage.

The drawing back of the breech-closer is regulated by a hand lever, and it can be retained at the required point by means of a pawl working in the teeth of a ratchet wheel fitted on the side of the frame. When the barrels are filled or loaded with cartridges, and the breech-closer brought in contact with the rear of the barrels by means of the lever handle, the fire can be communicated by means of a percussion cap, or fuze, or quickfire at one side of the barrel framing, which fire is instantly forced through a hole, and impinges against the cartridge case with sufficient impulse to break it and explode the powder therein. The explosion in the barrel causes fire to be driven through another hole, which leads from the first barrel to the second, and this causes the second charge to be fired in the same manner as the first, and from the second to the third barrel in succession until the whole of the barrels on that level have been discharged. The fire then passes up to a second series of barrels, placed above the lower series in succession, and in a similar manner to a third series of barrels.

WIL. K. HIBBET.



THE CHASSEPOT RIFLE.

[233] SIR,—The annexed illustration of this celebrated weapon, showing M. Chassepot's latest improvements, will probably interest the readers of our MECHANIC.

In its original form failures occurred in practice with the rifle traceable to the form of cartridge used. It became, therefore, the object of M. Chassepot's later improvements to adapt the gun for the employment of flanged cartridges, and to provide the arm with an automatic arrangement for extracting the cartridge cases. Fig. 1 is a longitudinal section of a fire-arm constructed according to these improvements. Fig. 2 is a section showing the extractor in the act of withdrawing the cartridge case. Fig. 3 is a transverse section through the line 1, 2 of Fig. 2. Figs. 4, 5, and 6 are separate views of the extractor. The movable head shown in the engravings of the first gun is dispensed with, and the caoutchouc obturator is replaced by a metallic piston *a*. Through the centre of this piston a channel of truncated conical form is formed by the passage of the striker or needle R (which it shortened), when impelled by the spring T. The metallic piston *a* is lodged in a chamber in the front end of the breech-bolt B, and is held by a screw *b* passing through the side of the bolt and entering a circular groove *c* on the outside of the piston. A square tooth or projection *d* is formed on the periphery of the piston near its head. This tooth serves to operate the extractor. The rear or tail *f* of the extractor is in the form of a flat ruler terminated at the front by the extractor proper *g*, which is a curved piece having the form of a portion of the inner circumference of the barrel, and having a recess to receive the flange *o* of the cartridge. The cartridge is shown in two positions; in Fig. 1 it is seen in the charge chamber, and in Fig. 2 as withdrawn from this chamber. A longitudinal groove or slot *i* is formed in the rear flat portion of the extractor, into which the tooth *d* of the piston takes. The extractor slides in a recess *h* in the bottom of the breech chamber.

The employment of flanged cartridges modifies the form of the charge chamber, and dispenses with the combustion chamber in the old rifle. The rear of the charge chamber, that is, the rear end of the barrel, has a circular groove o^{11} to receive the flange *o* of the cartridge. A cavity h^1 is formed to receive the extractor proper *g*, which completes the annular portion at the entrance of the charge chamber. In withdrawing the breech-bolt, the tooth *d* of the piston *a*, reaching the end of the groove *i* of the extractor, draws back the extractor, and with it the cartridge case, which is then thrown out. When a fresh cartridge is inserted its flange enters the recess o^1 of the extractor, which pushes it into place when the bolt is pushed forward. Thus, the extractor is operated by the bolt both to push the cartridge into place and to extract the case from the barrel.

The screw (which formerly passed through the main or top piece to enter the slots in the bolt) is now replaced by a plate *p* (Figs. 1 and 2), passed through this main piece and held by a pin *r*; this piece serves as a tenon to slide in the groove of the bolt B. The tenon on the spring carrying rod f^2 is dispensed with, as well as the corresponding mortise in the button at the hind part of the bolt. The whole is replaced by a button or stopper L screwed into the rear end of the bolt. The sight rises on a hinge towards the front of a barrel to facilitate operating it.

F. G. R., late H.M.R.A.

THE PHILOSOPHY OF THE *ENGLISH MECHANIC.*

[234] SIR,—It seems to me I might speak of the philosophy of subscribing to, and reading carefully such a publication as the ENGLISH MECHANIC. There may be a valuable principle involved: something that reacts on one's own whole temperament. To read and study such a paper will have the same effect on the mind as a good broom in a housemaid's hands upon the cobwebs. The whirr of science clears the crannies and calls thought into action. The perusal of such bustling pages is most suggestive. How can one be idle, lazy, or inactive? One must set to work at something. Just as when I go to church, I fancy I get more good by the trains of my own thoughts aroused than by anything actually said in the sermon (though the trains would not have arisen elsewhere); so also a clever scientific paper sets its readers a-thinking, a-thinking, and not only a-thinking, but also a-doing. Say that I read an article on astronomy, or perhaps on making one's own telescopes. Very well, then there are those bookshelves. Just so. But what have bookshelves to do with telescopes? Not much, in one way. But think of the philosophy of the thing! The bookshelves ought to have been done "yesterday," and were to have been put off to "to-morrow." But now—*Now's* the ticket. Thanks to the telescope article, now, however hot it may be, off goes the coat, the shirt-sleeves are tucked up artistically *above the elbow*, out come saws, planes, hammer, nails, screws, sand-paper, and everything, and the overdue job is done; and it is the telescope artist who has done it, or set it a-going; and who knows but on top of the shelves, when varnished, will be a telescope, as a tripod symbol of success? Thus, in like manner, if you tell a man how to make his own gas, or to construct his own barometer, he may do one or the other, or neither; but in any case you have given him an impulse of energy, a push of progress, quite as accelerating and much more pleasant than a whack over the back with a stick, and a shout of "Go on, stupid!" The man *must* address himself to something useful; there is a ring or rattle of machinery in his ears, a gurgle of cogs and *drums* and *bands* (of genial industry, not of horrid war). The like is good, whether as work or as play, whether as bearing on livelihood, or as mere hobby and holiday, and every man ought to have his pastime, and be choice about it, because if he has not a good one, he will have a bad one. Even as amusement, mechanical occupation is beneficial, to body and to mind, to health and to comfort. I even imagine it promotes morality, sobriety, and so forth; at least it ought to do so, and might do so. For example, suppose I have to do with a goodly steam-engine. There it is, the Titanic motor, with bones of iron and marrow of steam. I don't neglect *it*; and why should I neglect myself? Its polished parts are shining, its brass parts are brilliant; there is no rust on it; and why should there be any on *me*? I can at least be clean. And, mind you, it is not necessary for the hardest-working stoker or poker to be dirty: grease will get off tar; oil will wash off oil or paint; wash your hands in a spoonful of turpentine; a jug of hot water is easily got: get a wife to get it for you: go in for a lump of soap, and a pinch of soda, nailbrush

even, and bath; make the bath yourself, at the worst. At any rate, be clean and tidy, like your steam-engine. Nor do you abuse it or misapply it; it has its oil, its proper amount of drink; and, strange to say, that drink is water. Would water do for me? Suppose I try? I never heard of a steam-engine getting drunk, unless the man in charge of it did, or went mad, like the Yankee regatta of two rival steamers among the snags, where the captain sits on the safety valve, and sings out, "Go ahead!" No, my model steam-engine is very sobering; it would get grimy if I let it, but I don't; nor will I treat myself worse. I'll be clean, neat, hard-working, clean again, hard-working again, always sober, never muddled or puddled, always measured, aye, and merry too; as jolly old Juvenal saith, with a sound mind in a sound body. So I beg to enounce that the philosophy of the English Mechanic is the spirit of utility; it sets you on to be serviceable to yourself and to others; not only in great public "patents" and improvements, but also in natty tidy home contrivances. And all the while the whole thing in its very essence is a witness for self-respect, for decency, for personal cleanliness, for sobriety, for home happiness, and all that makes life worth living for.

Gimel.

CURIOUS QUESTION.

[235] Sir,—As a constant reader of the English Mechanic, I have been interested, almost amused, at the amount of disturbance cerebral, literary, and philosophical, which seems to have grown up out of a very simple question, put honestly and singly with a view of attaining information upon a subject of mechanical forces.

That an "F.R.A.S." should have descended into so humble an arena was more than I had presumed to think of. But now whatever may be the tenuity of my own cerevisia, or of Messrs. A, B, or C (a point I am not anxious to settle), the thing *I do* wish to have understood, and which I probably failed to put with sufficient clearness before, is this:—Suppose a piece of ordnance at any point on the equator, and fired point-blank (or with such elevation as to give the longest range) first to the east, then to the west, in each case with the same charge, will any and what difference be found in the distances to which the shot will have been propelled in this one case or in the other, either from the atmospheric resistance arising from the earth's rotation on its axis, or from any other cause.

As the earth in its *orbital* motion carries its own atmosphere with it, it is presumed no difference would arise from that source.

R. T. Gould.

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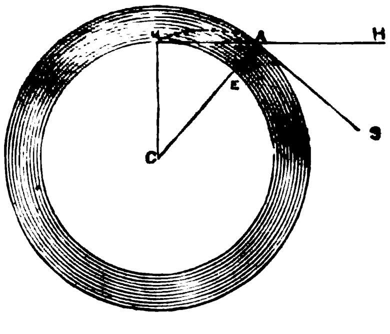
[236] Sir,—In reference to No. 36, p. 378, I would feel grateful to Mr. Proctor if he would favour your readers with his view of this question, taking into account the small quantity D E in his paper on the earth's motion, p. 372, col. 3, of No. 249, 31st Dec., 1869. I observe that when the question is confined to due east and west, as is done by Mr. Gould, and no elevation stated, and if we take the elevation to be = 0, then D E = 0; but the ball must in its easterly motion be retarded by the trade wind, whereas in its westerly motion it must be accelerated by the same cause. I do not suppose, however, that this cause of disturbance is intended by the proposer to be taken into account, and therefore the difference between the east and west motions will = 0, as stated by "F.R.A.S.," p. 395. When the ball is thrown *vertically*, a condition introduced by Mr. Usborne, No. 148, p. 450, then D E becomes a maximum; and if the height be considerable, say 3,970 miles = earth's radius, the ball would require 2,075 seconds to ascend, and the same time to descend, which would give for D E a very considerable magnitude.

M. L.

READINGS FROM THE GLOBES.

[237] Sir,—Not the least of the numerous and important contrivances made by Providence for the comfort of his creatures is the twilight or crepusculum, by which we are gradually introduced into the rays of the morning sun, and as gradually transferred from the reign of one mighty potentate to the dominion of his great rival night. Twilight commences with the setting of the sun, and lasts (so astronomers say) until the sun gets 18° below the horizon, when the atmosphere ceases to reflect his rays, and it commences again with the early dawn, when the sun comes again within 18° of his rising point. Since twilight begins at this distance below the horizon, we can from hence calculate at what height the atmosphere has the capability of reflecting the sun's rays. Its actual height we are unable to ascertain, because, being an elastic fluid, it expands with considerable distention the higher it reaches from the earth, and becomes of such rarity that, as far as we know, it exerts no influence upon the appearance of the sun. If it were of the same density throughout, its height could be ascertained with great accuracy from the weight with which it presses upon everything around us; but this is not the case, as every aeronaut has experienced, and as others may learn from their description. The causes of twilight are usually ascribed to the refractive and reflective powers of the atmosphere. By means of refraction we have twilight sooner than we otherwise should; and by reflection it is diffused over all the expanse of the atmosphere. Refraction acts with much greater power in a dense atmosphere than in one of much tenuity, and is more considerable near the horizon than at great altitudes, gradually decreasing until the zenith is reached, when no refraction takes place. By refraction, a ray of light proceeding from any celestial object is bent, and in consequence, that object appears to our view sooner than it otherwise would. From the same cause, the sun and the stars have a greater altitude apparently than the reality. As a proof of this it is recorded that some Hollanders who wintered in Nova Zembla, some time ago, saw the sun 17 days sooner than they expected, which would not have been the case had not the refractive power of the atmosphere raised that object (particularly as being near the horizon) to a greater altitude than computation made it. It is an admitted fact, then, that refraction makes a celestial object appear higher than it actually is. Thus, in figure let S represent the sun; when, then, the ray S A strikes the atmosphere, it is refracted, and as it is unequally refracted by the atmosphere, the refraction being greater in the lower and denser parts than in the upper, the line A M will assume a curved shape, and become, I suppose, what astronomers call the crepuscular curve, and the object S will be seen by a man at M. If, however, instead of being the ray itself, it were a reflected ray, refraction would of course act upon this ray, too, which would have its share in illuminating the atmosphere. Suppose then an innumerable number of reflected rays were in existence; all of them would be affected by refraction, and hence would throw their light, though in a diminished degree, upon the earth; for if refraction takes place upon every celestial object, it must also act upon the rays surrounding that object, and the consequence of this will be that, although we shall not be able to see the sun or heavenly body itself, we shall see the harbinger of that body's appearance in the dawn of the early morn. Refraction, therefore, has its share in the composition of the twilight, and it co-operates with reflection in gradually intensifying the dawn until it breaks forth into the perfect day. When reflection acts upon the ray S A, it will throw the ray in an exactly opposite direction, and the angle S A C being the angle of incidence, will be equal to the angle C A M, or the angle of reflection; and hence we shall be able to compute the height of the atmosphere. This, however, will be one ray only; but when millions upon millions of reflected rays pervade the superincumbent atmosphere, light is diffused all around, and animals and men are roused to their occupations, and nature displays her attire to the gaze of all. Suppose, then, that when the sun is 18° below the horizon the twilight begins, then the angle M A S is equal to 162°, the supplement of 18°; and since the angle of incidence is equal to the angle of reflection, therefore S A C = C A M, or 81°; then having two angles and a side, we can find the hypothenuse A C, which is equal to 4,031 miles, from which subtract C E, the earth's radius, and we have E A the height of the atmosphere, or 49 miles. And we not only can find the height of the atmosphere by knowing that the sun begins to illumine it at 18° below the horizon, but we can ascertain how long the twilight will last at any particular place. If, for the sake of illustration, we take London on June 21, and wish to know the time twilight will continue, we must elevate the globe for the sun's declination—namely, 23½°, and having made a mark upon London with prepared chalk, we shall find that it will only descend 15° below the horizon, and the consequence is that there is twilight at that time all night, and the twilight all night will continue until London, in the revolution of the earth round the sun, and in the rotation of the earth upon her axis, reaches 18° below the horizon, or until the declination of the sun is again 20½°, which will not happen until July 20. We infer, then, that twilight lasts all night from May 23, when the sun's declination is 20½°, and whilst he is travelling to his greatest declination and back again to 20½°, which makes 58 days. And if we wish to find the duration of astronomical twilight at any place on the globe, we must elevate for the sun's declination, and notice how long the given place will be before it reaches 18° below the horizon.

T. S. H.



SUMMARY OF OBSERVATIONS.—SPOTS ON PLATO, JUNE AND JULY, 1870.

[238] Sir,—The weather during the lunations of June and July, 1870, has been very unfavourable for prosecuting the interesting series of observations on these objects which were commenced in April, 1869. While as many as 242 observations in 37 series were recorded in April and May, 1870, June and July have afforded only 80 in 18 series. The observers in April and May were Messrs. Elger, Prato, Gledhill, Neison, and Whitley; in June and July, Messrs. Gledhill, Elger, Neison, and Ingall. The observations in April and May gave a little under *seven* as the average number of spots seen on any one evening; those in June and July a little above *four*. There can be no doubt [illegible] deteriorated state of our atmosphere has contributed mainly to produce this result; and if we take the number of separate observations as an approximate measure of this deterioration, the good state is to the bad as 3 to 1, nearly. It must, however, be borne in mind that the number of observers in April and May was greater than in June and July, and this [illegible] must be modified accordingly. If we enquire [illegible] spots observed (13) have been affected during [illegible] unfavourable lunations, the following table, containing the degrees of visibility for the two sets of two lunations each, with the differences, also the differences for the two corresponding sets in 1869, may tend to elucidate the question:—

Obs.	Spot	Visibility		Differences		Remarks
J & Ju		A & M	J & Ju	1870	1869	
17	1	1·000	1·000			
10	4	·973	·588	−·385	+·055	
15	17	·838	·882	+·044	+·221	
16	8	·812	·941	+·129	−·334	
6	5	·514	·353	−·161	+·353	
2	14	·432	·118	−·314	+·168	frequent [illegible]
8	16	·379	·176	−·203	+·111	
2	25	·243	·118	−·125		?
1	9	·216	·059	−·157		frequent [illegible]
5	30	·162	·294	+·132		companion of [illegible]
1	11	·081	·059	−·022		[illegible]
1	12	·027	·059	+·032		[illegible]
1	31	·027	·059	+·032		companion [illegible]

The variations of visibility have been, as on former occasions, *irregular*; and this irregularity is apparent on comparing the differences of 1870 with those of 1869. It is true that in some cases the course of the annual curve is reversed, as shown in Nos. [illegible] 14, and 16, and this is to be expected with a deteriorated atmosphere; still the greater decrease of visibility of spots Nos. 4 and 14 is irreconcilable upon this view with the increase of visibility of No. 30, Dawes's companion of No. 8, a small craterlet requiring generally a fine state of our atmosphere to see it. No. 8 has also increased in visibility during the last two lunations. Of the spots which were sufficiently observed during the first year to afford curves of visibility, the following were not seen during the two lunations of June and July—*viz.*, *Nos. 2, 6, 7, 10,* 18, 19, and 22; of those which are *common to the first* year, and the two lunations *June and July* of the second, Nos. 8 and 17 maintain a high degree of visibility, while Nos. 4, 14, 16, and 5 have fallen considerably. Tho only spots which have exhibited a high degree of vesibility under all states of our own atmosphere are Nos. 1 and 17, and these, with the increase of such a small spot as No. 30, lead to more than a suspicion that the variations of visibility at all seasons are in a great measure independent of variations of our own atmosphere.

Mr. Elger has pointed out that the markings and spots are so closely connected as to be regarded as cognate phenomena. The greatest number of spots observed on any evening was 8 by Mr. Elger on *June* 10, and by Mr. Ingall on July 14. Nos. 14 and 16 were seen by both observers on both occasions, and the rarely visible spots, Nos. 12 and 31, were seen by Mr. Ingall on July 14. At the same time he noticed the markings, and describes them as appearing with at least ordinary distinctness. He adds, "The whole of the floor at times of fine definition, was covered with spots of light." This is very remarkable, as he appears to have failed in picking up some of those spots which were frequently visible in 1869, as Nos. 22, 13, and 19, and is strikingly in contrast with those stones of the floor described as "very dark." Can it be that on such occasions there is a superficial covering of some kind interfering with the ordinary reflection from the floor? or are the white spots themselves smaller superficial masses reflecting a greater quantity of light?

I will forward another extract bearing upon brightness and colour in a few days.

W. R. Birt.

FREE-REED ORGANS *v.* HARMONIUMS.

[239] Sir,—When Debain, of Paris, first invented the harmonium (or, one might more correctly say, first brought into the notice of civilized Europe an invention long previously known to the Chinese under a ruder form), all those of us who happen to be musical as well as mechanical, went into ecstasies about the new instrument. It had long been a want to provide some keyed instrument for private use, cheaper and less cumbrous than the organ, which would give us sustained tones capable of interpreting organ music. And we thought we had found it. At first the novelty made us blind (deaf rather) to its important defects. But gradually one came to discover that the very best harmoniums have necessarily, from their construction, these very sad defects—1, the tone is of the reed, utterly and irretrievably reedy; 2, the bass overpowers the treble; 3, the intonation is so sluggish that it is only adapted for the slowest of music. And even when Kaufmann, of Dresden, introduced the percussion action to remedy this last defect, although a palliative, it was by no means a cure.

For these reasons I, for my part, and I am sure I may say the same for all my musical friends, had long given over the harmonium as a musical instrument, and relegated it to the country chapel and the schoolroom as an accompaniment for hymn tunes—better, certainly, than the discordant flute, and fiddle, and clarionet, which it very often displaced—but still, very bad, both from the impossibility of distinguishing the air and the impurity of the tone which causes it to out through the voices and drown them with its buzz instead of supporting them.

And in enumerating these defects I do not refer to bad harmoniums, but to the best. The faults are as inherent to a 36 stop Debain, or a 24 stop Alexandre, or [illegible] of Schiedmayer's best instruments (and I have tried [illegible]se) as to a common six-guinea harmonium.

[illegible]ntirely given up reeds for musical purposes, as played out. Last March I wrote Messrs. Breavington & Sons, for a Mason & Hamlin organ No. 46, an 8 stop cabinet with vox humana and two rows of keys. I had grave doubts about it at the time. I confess I read Messrs. Mason & Hamlin's certainly very glowing prospectus of their organs with some suspicion, knowing that folks in New York are not incapable of very tall talk. In due course my organ arrived, and I am not sure I can give much greater praise than by saying that every word of the prospectus I found literally and scrupulously true. It is the ideal of what musicians have longed for in a harmonium. The tone is round and pure, as different to the reediness of the best harmonium as can be. It is resonant, the chords ringing again through the hollow-chambered case after they are struck. The bass does *not* overpower the treble, but by a particular system of voicing the reeds, every note in the register is of equal power. The intonation is so perfect that the touch is as rapid and delicate as a pianoforte, without any trick of percussion action. It is consequently adapted for any style of music, from the lightest dance *morceaux* to the heaviest mass music. Best of all, so pure and true is the tone that even used at full power with four sets of reeds, it will not drown a solo voice.

Now the great difference in principle of construction between the Mason & Hamlin organ and the harmonium is so simple that it is strange it should not have occurred to English builders. Take a violin string and stretch it on a bit of board, and try with a bow to get tone out of it, and we might have come to the conclusion that there was no tone to be got from a string, did we not know that by stretching it over a hollow case instead an Amati violin is made. Messrs. Mason & Hamlin do the same thing with reeds. Each reed is placed in a separate chamber over a delicately resonant sounding box, and the result is perfect organ tone. I would not be misunderstood in using this expression. I employ it in exactly the same way as we say an 8ft. stopped pedal pipe gives a 16ft. tone. The *tone* is the same though the volume and the depth are wanting. Just so closely does the American free-reed organ approach the pipe organ in tone. As the builders very honestly say, "If you can afford £300 to buy a pipe-organ get one in preference to one of ours, but if you cannot, we can supply you for one-third of the cost an instrument of better tone and capacity than any cheaper pipe-organ." This is undeniably true, as I can bear ready and willing testimony. And as regards even the cheapest American organs with one set of reeds, the tone is as pure, although, of course, the capacity for variety, afforded by a greater number of stops, is wanting.

Amongst other differences in construction is the employment of very powerful exhaust bellows, whereby the air is drawn through the reeds instead of being blown into them. Any one who has used a "mouth-harmonicon" must have observed how much better tone is obtained from it by drawing in the breath than by blowing through it. The reeds are moreover heavier in make, and the tongues of a different pattern to those of the harmonium.

The vox humana is an ingeniously simple piece of mechanism, which produces a delicate effect for solo playing, only comparable to the articulation of the voice, or the vibration of a violin string beneath the bow. So far from being a monotonous and vulgar effect, like the wretched "hubble-bubble" of the old tremolo stop, it is so dainty as only to be noticed when one listens for it. It is contrived simply by a rotating fan at the top of the instrument, which vibrates the air *after* it has left the reeds, instead of before. The automatic swell is the most perfect I have ever seen, enabling a performer to command the power of the instrument from a whisper, soft and crisp as a musical box, to its full capacity, without any difficulty such as is experienced in "keeping the wind in" when playing on a harmonium with the "expression" stop out.

No one who has ever tried an American organ will think of going back to a harmonium—indeed, when one of them is placed side by side with a much more expensive harmonium the difference is so painful to any one with a musical ear, that the buzz and reediness of the harmonium is simply intolerable.

EUSTACE HINTON JONES.

THE CRATER FONTENELLE AND LUNAR COSMOLOGY.

[240] SIR,—The cross westward of Fontenelle, figured by "Foreigner," appears to be nearer to the crater than that mentioned by Beer and Mädler, and in the position of their *delta*. If I interpret the general figure of "Foreigner" rightly, the mountain range S.W. of Fontenelle, not shown by B. and M., but very plain on Rutherford's photogram of March 6, 1865, would lie parallel with the S.W. side of B. and M.'s lozenge, which side, according to them, is a broad light streak not shown by "Foreigner." It is the N.W. side of the lozenge which contains B. and M.'s cross in the position of their *zeta*, some distance W. of "Foreigner's" cross. These crosses I have no doubt are formed by intersecting fissures in the mountain ranges. There are two intersecting fissures of the same kind in a depression north of *Plato*, which may be seen under a suitable illumination, with a comparatively small aperture. It would be well to study these features in connection with surrounding objects, as they evidently point to seismotic or earthquake action. By the way, this will introduce a few remarks on the letter of "Littus Habet Conchas," who alludes to a continued series of critical observations of the moon's surface as *not* tending to establish any corresponding physical resemblance between the earth and moon. May I be allowed to ask your correspondent if he will kindly inform me in what work I can meet with such a series of *observations?* The latest series of seleno-topographical *notices* that I am acquainted with is by the Rev. T. W. Webb, published in the *Intellectual Observer*. This series includes numerous very valuable observations of his own, but they hardly possess the character of a continued critical series which can be used in finally disposing of the question as to the similarity of the moon and earth, or the opposite, although there are many observations that bear upon it.

For myself, I may say that after eleven years of close observation of the moon, with telescopes varying from 2·75 to 10in. aperture, my own impression is that the moon is more earth-like than it is generally imagined to be. If the reader will kindly turn to page 436 of the ENGLISH MECHANIC, for July 29, he will find mention made of a line of cliffs, part of which form the S.W. border of *Hipparchus*. These cliffs I have most attentively studied, and I know of none of the features of the moon, and they are numerous, which are more earthlike in appearance. The line of cliffs is exceedingly analogous to a terrestrial coast-line. Whether the "fluid masses," occupying the interior of the "hollow spheres" of your correspondent, sufficed to produce the appearance of *erosion* on the faces of the cliffs towards *Hipparchus* is a question that may or may not be settled by future observations; at all events, all the "hollow spheres" N.E. of the cliffs could hardly have ejected sufficient "fluid material" to have affected them, and it is difficult to understand how the "fluid masses," once occupying the interiors of *Halley* and *Hind*, could have *eroded* the cliffs below them. Let us look at this matter for a few moments in the light that a most careful examination of the whole region will afford. Referring to the article already quoted, south of *Halley* and *Hind* will be found a tract of *high land*, certainly the highest in this part of the moon, and probably the earliest formation hereabout. This high land appears to have been dislocated by a "fault" which is traced to *Tycho*, on one of the lines of the *last distributions and settlements of the typical lava of the burst shells of the spheres*. Of the precise nature of the surface at the time when the dislocation took place we are ignorant, especially as to whether the "hollow sphere" *Hind* was then included in the mass of high land, and it is difficult to obtain a *true* ideal section, but we have good evidence to show that the dislocation took place *before* the bursting of the "shell," for in its neighbourhood the "fault" is certainly interfered with by the grooves, which are apparent on the sides of the "crater" *Hind*. After this the evidence is strongly conclusive, either that the cliffs before referred to were *raised*, or that the surface N.E. of them *subsided*, for they cut off abruptly the slopes from the "crater" *Hind*. And here we may institute a comparison between the apparently more ancient craters *Hind* and *Halley* (premising that the "hollow sphere" *Halley* burst after the cliffs were formed), and the more recent one *Aristillus* on the *Palus Putredinis*. The result of such a comparison I leave with the intelligent observer, who is acquainted with the agencies producing and affecting *our* geological phenomena. Do not these *successions* point to such slowly operating agencies as we are familiar with in the earth's crust, and cannot we find terrestrial analogues to lunar craters, such as *Hind* and *Halley*, on the earth's surface? for example, *Santorin*, and such as those partly filled and broken craters on the borders of the *Maria*, on our sea coast—*Torbay*, for instance. May not so close a scrutiny as the lunar *Hipparchus* has undergone, when extended to the whole moon, contribute to the detection of an increasing number of terrestrial analogues?

In conclusion, I would just remind the reader that the article "Telescopic Work, &c.," on page 418, contains a description of the formation adjoining that sketched by "Foreigner."

W. R. BIRT.

ON THE LINK MOTION.—LETTER I.

[241] SIR,—Mr. James Harrison has written a letter on the subject of the "Link Motion" in No. 275 (July 1st), in which he reiterates with amusing earnestness his erroneous opinions concerning it.

He says, if I (J. B.) "was well versed in link motion, I never would have said that the whole amount of vibration must be communicated to the centre of the link." I did not say anything of the sort, as any person can see by reading over my letter in No. 273, June 17th. What I did say is this:—"That the amount of vibration that the middle of the link should have is found by adding the lap and lead of the valve together, and multiplying the sum by two, and it must have that amount, and impart it to the valve-spindle too, or it is all wrong;" and I hope to be able to make Mr. Harrison understand the truth of that proposition, and the practical necessity of carrying it out in the steam engine, before I have done with him.

In the letter alluded to, I gave an instance to illustrate this rule, in which the valve has 1½in. of lap, and ¼in. of lead, which together make 1¾in., and multiplied by 2 give 3½in. as the proper amount of vibration for the middle part of the link; but in that instance I said nothing at all about the throw of the excentrics or the *full motion of the end of the link*, because I was then merely proving, in a rough way, the necessity for motion at the centre, and giving the rule for finding its amount. The motion at the end of the link, or the "full amount of vibration," is another thing altogether, and is of course always much greater than the centre motion, but is never any particular measure of it, as the amount of end motion depends upon the greatest length of stroke the designer wishes to give the valve; and the centre motion is fixed, as I have just said, by being made equal to twice the sum of the lap and lead, or twice the "lineal advance" of the excentrics, and this is what we might call the normal vibration of the link centre, *which is increased by the crossing of the rods in one arrangement of the gearing, is decreased by the same cause in another arrangement, and is neither increased nor decreased by a third arrangement;* but all this will be explained further on.

Mr. Harrison still "emphatically denies" the existence of *any* motion at the centre of the link "when that centre is in a line with the valve spindle and crank shaft, and the diametrical centres are in opposition to each other." He also says that, "both excentrics have the one throw" (*right*), "and travel one distance" (*right*), "and at the same speed" (*wrong*), "but in opposite directions" (*wrong*). The excentrics, and of course the ends of the link, move for a considerable portion of each revolution *in the same direction*, and the reason of that is, the centres of the excentrics are never set in diametrical opposition to each other, as Mr. Harrison supposes, but in practice are always placed more or less on one side of the diameter line.

A line connecting the centres of the two excentrics will not pass through the centre of the shaft, but is always some distance from it, and that distance is known amongst engineers as the "lineal advance" of the excentrics, and its amount is determined by the amount of the lap and lead of the valve. I have no doubt, from Mr. Harrison's writing, that this is the first time he has heard of the "lineal advance," for if he knew anything about it, or its objects or effects, he could not have perpetrated so many blunders in so small a space as he has done; but if he has patience and humility, and aptitude to learn, he may acquire some knowledge of the subject before I have done with it.

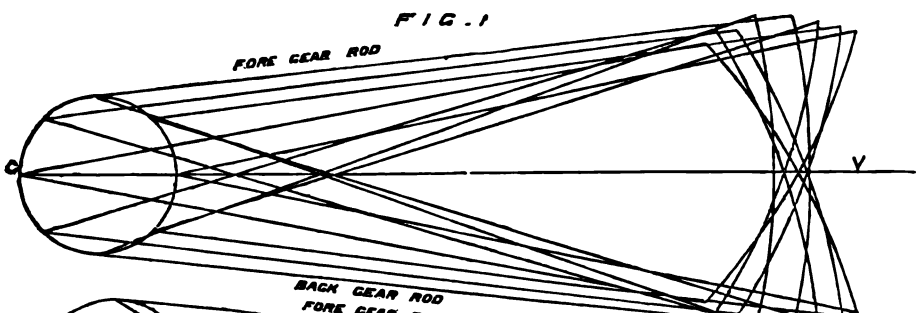
But even if the excentrics were set without any "lineal advance," and with their centres in "diametrical opposition," Mr. Harrison would be no nearer right than ever, for the centre of the link would still have some vibration due to the crossing of the excentric rods, as I explained and illustrated in my last letter; and the exact amount of this vibration would depend upon the length of those rods, the length of the link itself, and the throw of the excentrics; and this centre vibration can never entirely disappear till Mr. Harrison, or some other person, makes a link motion in which the excentric rods will have infinite length, the link itself no length at all, and in which the circle described by the centres of the excentrics shall be no larger in diameter than a mathematical point; or till he produces a link motion in which there shall be no crossing of the rods; and that, I may as well tell him, is quite practicable, and at the same time quite useless, *for a motionless centred link would not do for working a slide-valve at all.*

I will now proceed to place before Mr. Harrison and "our readers" the link motion as it really is in practice, and I will explain and illustrate the principles of that very simple, beautiful, and *imperfect* contrivance in the plainest language I can command, so that even Mr. Harrison, and other gentlemen like him, who have yet to learn the very A B C of the business, may be enabled to understand it.

Fig. 1 is intended to show the mechanical impossibility of constructing the ordinary link motion so that the centre of the link shall have no vibration. The centres of the excentrics are set in diametrical opposition or without lineal advance—that being the position in which they impart the least motion possible to the centre of the link; and whatever the amount of centre motion in this case may be, it is caused entirely by the crossing of the excentric rods, which crossing is an unavoidable necessity of the case, therefore, motion—more or less—at the centre of the link is unavoidable; but we always want a great deal more motion at the centre than is imposed upon it by the crossing of the rods, and this additional motion is got by placing the excentrics so that a line connecting their centres shall be at the required distance from the centre of the shaft—and this is the lineal advance as explained above. In all these figures the excentrics themselves are omitted, the centres only being retained as all that is necessary to the explanation.

In Fig. 1 there are eight different positions of the gearing shown for one revolution. This figure is drawn from an actual half-size model which I have had constructed especially for the purpose, and the amount of vibration at the ends and centre of the link is faithfully shown; the excentric rods are 3ft. long, the link is 16in. from centre to centre of excentric rod ends, and the circle described by the centres of the excentrics is 8in. diameter, consequently the ends of the link have 8in. of vibration in all positions of the motion; the link is suspended by the centre, and the length of the suspending bar is 21in. The amount of motion at the centre of the link is 1⅞in. In my former letter I said it was 2in. for a similar valve-motion. I took that from an inch scale drawing, hence the slight error; but 1⅞in. is the exact thing, and is what the model shows. C V is the main centre line of the crank shaft and valve-spindle. The link is shown in "middle-gear"—as it is called—with its centre opposite the valve-spindle, or in the position in which Mr. Harrison "emphatically denies that the centre of the link vibrates," as if its position with regard to the valve-spindle could in any way affect its motion. How could it? The motion of

FIG. 1



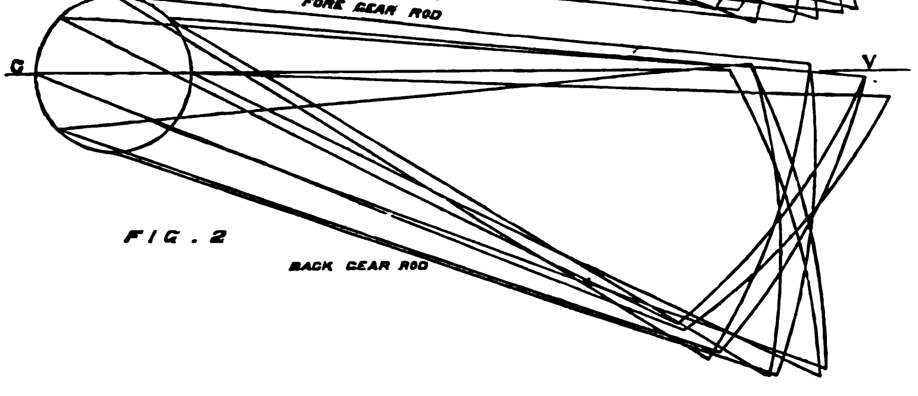


FIG. 2

the link is derived from the excentrics through the rods, and from them alone; and no matter what part of the link, be it the end or be it the middle, is in gear with the valve-spindle, the nature and amount of its vibration is ever the same; and its position with regard to the valve-spindle has about as much to do with modifying that motion as the handle of the stoker's shovel has.

Fig. 2 shows the forward gear end of the link in gear with the valve-spindle, and the reversing lever (not shown) in the end notch of the rack. In this position all the movements, and attitudes, and angles made by the link during a revolution are of course identical with the middle gear position; it is impossible they could differ in the slightest degree; and all that Mr. Harrison says about the centre of motion being 2in. higher up or lower down, and about the disengaged rod receiving all the angles, and about "that end of the link having almost double the vibration," is pure unmitigated nonsense, without a shadow of foundation in reality or fact, and his three diagrams are on a par with the text they are intended to illustrate.

I have already said that in Figs. 1 and 2 the centres of the excentrics are placed diametrically opposite each other, and without lineal advance, and the object of placing them so has been explained—viz., to illustrate the impossibility of constructing the ordinary link motion with a motionless centre; but excentrics set in this way are not suitable for working a slide-valve, because all slide-valves have more or less of lap and lead, and, therefore, require the excentrics to be set with more or less of lineal advance. I have also to remark that the excentric rods shown in Figs. 1 and 2 are unusually short as compared with the length of the link and the throw of the excentrics; and I have purposely made them so in order to exhibit in a conspicuous manner and on a large scale the influence which the crossing of the rods has upon the movements of the link, for short rods are more influential in that way than long ones, other dimensions remaining unaltered.

JAMES BASKERVILLE.

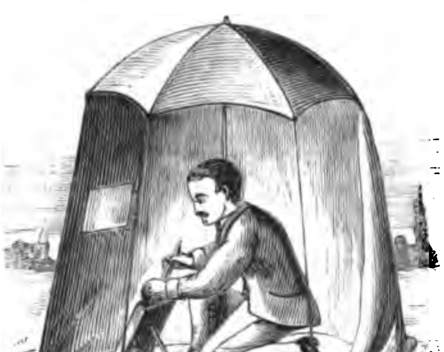
[242] SIR,—Mr. Harrison commences his letter very well, by apologizing to Mr. Wheatley for his unpolite reply to that gentleman's letter. He also confesses that he knows very little about the link motion. Such a confession on his part I think quite unnecessary. But he spoils all by the "would-be satirical way" in which he alludes to my letter. Allow me to correct his assertion that my diagram (Fig. 2, page 425) is a copy of Mr. Baskerville's; the dimensions are taken from the working drawings of an engine now running on one of the chief railways in Ireland.

Now, sir, if Mr. Harrison will not agree with either Mr. Baskerville or myself that the link does not swing on a centre, I hope he will accept the authority of D. K. Clarke's "Railway Machinery." In that work he will find a series of diagrams showing the curve described by the working point of the link, in full, backward, middle, or full forward gear, whether hung from the centre or bottom end. Now, one of the defects of the curved link is, that if the motion is set to work with ⅛in. lead in mid-gear, it will become 3-16ths or more when working in full back or forward gear; this difference in lead increases as the rods are shortened, so that the general practice is, in designing motions for tank engines or locomotives in which the motion must be short, to substitute for the lifting link the stationary reversed link with the reversing gear attached to the pulling rod, which works up and down in the link: a constant lead is claimed for this motion. Now, as discussions in your valuable journal should be conducted in all good nature, allow me to say that if Mr. H. would wish for a set of diagrams I would be most happy to send him a set showing the position of the link in all parts of the stroke. If he will not accept my authority, all I can do is to refer him to the work above. In the mean time, I think if Mr. H. will examine the diagram (Fig. 1, page 425), he will come to the conclusion that the link moves to a small extent along the motion line, on account of the rods drawing the link, top and bottom, towards the excentrics where they cross. This occurs even when the excentrics are placed diametrically opposite. But engineers require the link to open the ports even when in middle gear, and for that purpose they give the excentrics an advance of 1-16in. which with 1in. lap on valve, 5¼in. travel of excentric, and, of course, all other dimensions suitable, would open the ports ⅛in. on each side. As for the letter of "R. H. M.," in which he states that with the excentrics in the position shown on page 425 the rods ought to be crossed, I really do not know what to say about it. Either I know nothing at all about the link motion, or else "R. H. M." has ideas about it totally at variance with all known theories.

JAMES F. RYAN.

A HANDY TENT FOR PHOTOGRAPHIC PURPOSES.

[243] SIR,—I send you a sketch of a handy tent for the benefit of any of your photographical readers who may be contemplating the practice of their art during the holidays. It is taken from the *Philadelphia Photographer*. Drive a stake in the ground so that it will be about 3ft. high; now take a common umbrella, tie the handle firmly to the stake, then place a double sheet of black and yellow calico over it, leaving a small hole in the centre for the point of the umbrella to pass through. The entrance may be at either side. The bottom of the cloth reaches the ground, and upon it stones can be laid, or it can be pinned down. A square cut out of the black cloth leaves a yellow square for proper light to enter. The sketch of the arrangement will make all plain.



E. T. WHELBIK.

ANCIENT BRITISH GOLD COIN.

[ ] SIR,—The following is a description of an uninscribed ancient British gold coin, found on the Downs near Brighton, August 17, 1869:—*Obverse*, plain and convex. *Reverse*, a disjointed, tailless horse to the right; a pellet below; above, the arms of Victory; pellets, &c. A pellet in a ring at the head [illegible] the horse. The device is partly surrounded by a beaded circle. In very fine preservation. Gold, size, ⅝in. by ⅝in.; weight, 95 grains. On the rim of the obverse are marks, looking [illegible] like a legend. The type of this coin is [illegible] the first class of Evans ("Coins of the Ancient Britons," plate B, No. 8), and is very like those in [illegible] ("Annals of the Coinage, &c.," plate I., [illegible] and 4.)

This is the first ancient British coin that is known to have been found at Brighton; a copper one of a different type is *said* to have been found there [illegible] Evans, p. 206, plate IV., No. 12), but Mr. Evans is not satisfied of the fact. I purchased my coin of the man who found it, and myself know the exact spot.

HENRY W. HENFREY, M.N.S., &c.

EMIGRATION: WHERE TO GO—WHO SHOULD GO—HOW TO GO—WHEN TO GO.

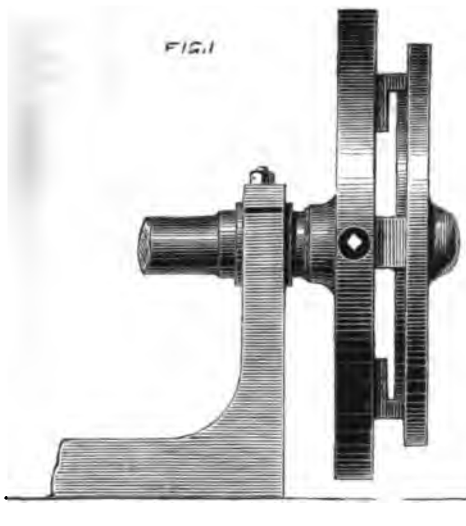
[244] SIR,—If Emigration is still entitled to any space for discussion in your columns, I should like to say a few practical words on the subject. I would divide my observations into four parts.

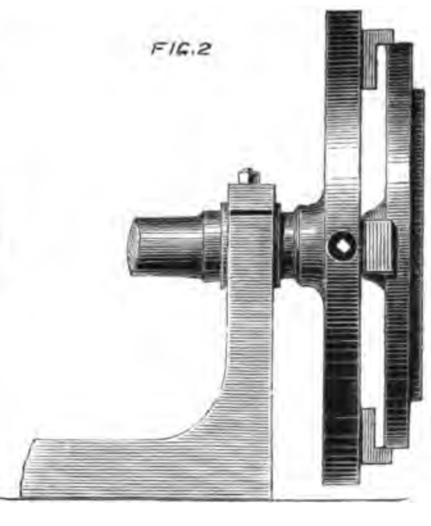
1st. *Who should go.*—I would advise [illegible] have not had some experience as practical farmers, or who cannot form a society in which the clearing of *the land* shall be the principal object, and [illegible] individual shall bring an experience in some way useful on a farm; this would in no way exclude such mechanics as smiths, carpenters, wheelwrights, &c. I am of opinion that a practical farmer, a smith, and a carpenter emigrating together (with their families, and if they have grown-up sons and daughters so much the better) would be sure to succeed if they go to the [illegible] place.

2nd. *Where to go.*—To a British colony, or to the United States, for practically I think the choice is thus limited, as emigration to *foreign* countries—that is to say, to non-English speaking countries—*for the ordinary* British emigrant is the height of *folly*. The British colonies may be divided into the Australian, South African, and British North American. The first and second division are difficult of access on account of the distance and consequent *expense of passage*, and so for the present I will pass *them over*, and take Canada as the colony to be *compared with the States*. It has great advantages. It *is prosperous, fertile, rich*, well-settled; and, moreover, *English*, Irish, and above all, Scotch, will find themselves "*at home*" there. Land is to be had cheap, and the intending purchaser or tenant may rely upon being *justly* dealt with, both by the Dominion Government and the Canada Company, in whatever engagements they may mutually enter into. They may also be certain that when *cleared* and cropped, the land will *ultimately* amply repay their labour and outlay; *but*, oh! the weary work of clearing a Canadian "concession" (I write under the supposition that the emigrant has not the capital to purchase or rent a cleared or partially cleared farm, but that he simply brings his labour and [illegible] money with him). The felling of the forest and the grubbing up and splitting the stumps is [illegible] heartening work to those who look upon a farm as only so much land to be tilled; whereas, all Canadian uncleared land is a forest to be reclaimed; add to this, the farmer has to make and maintain his own road as far as his concession extends; and, lastly, all the unallotted (Government) lands are far in the backwoods—far from towns, villages, or railroads. In this description I exaggerate nothing, nor do I suppress anything that could brighten the picture. The climate is extreme—in summer dreadfully hot, and in winter severely cold—but, in justice to the winter climate, it must be admitted it is not disagreeable or unhealthy. It is dry, bracing, and cheering, so that to sum up I would not advise emigration to Canada for the class of persons I am advising to leave England; but I do most strongly advise such to go to the Western and North Western States of America, and there settle on the prairie lands, offered now on most favourable terms by most of the great railroad companies. Of these States and of their advantages and capabilities, enough has been published for every one to have an idea of what they are; but I know how suspicious all English— British emigrants, are of all American land prospectuses, no matter by whom issued. Now I am not going to select *any* of the many railroad companies who offer land to settlers, but I know that with hardly an exception they are all genuine, and it would be hard to advise intending settlers in their selection.

3rd. *How to prepare for going, and how to go.*—I would advise (always supposing a society formed) that the *farmer* should go first and select the land; this on most of the railways he can do by going to the agency of the company at New York, and there seeing *on the map* the disposable lands, and then before laying out one penny, or rendering himself liable in any way for anything, he can see the lands himself and make his bargain; then, if he is satisfied, let him send passage tickets from America to his friends at home by one of the great steam lines from Liverpool, London, or the Clyde. He will find this the best way; as if he has English gold or bank notes, he will enjoy the advantage of the premium on gold which exists now in America, and is likely to continue. I do not specify any particular line of *steamers*, but I most emphatically warn every one against any *sailing vessel* whatever.

4th. *When to go.*—Preferably the early spring (say April, and I should say on no account go after the end of May, as later the heat is terrific, and makes a steerage passage, even on the best appointed steamer, a perfect misery. *At any time* th passage is a discomfort, but in an always crowded steerage, with the thermometer at 80° to 90°, and too little ventilation, the state of things is dreadful. I have had official experience of it. D. G.





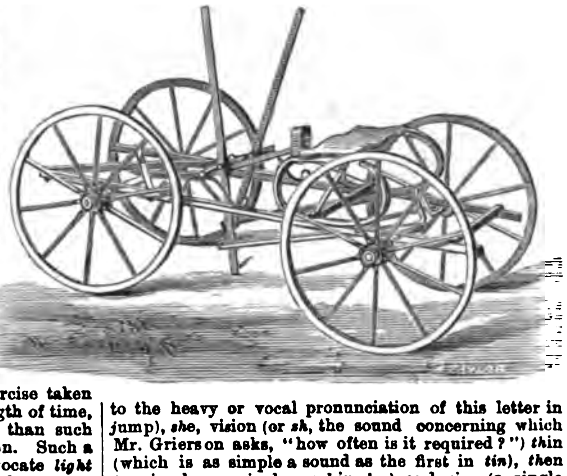
TURNING BOTTOMS OF CYLINDER COVERS.

[245] Sir,—According to promise I send a sketch showing how the bottoms of cylinder covers are turned off without having any hole through them. The cylinder cover is fixed in a dog-chuck, that is a chuck with four movable jaws in it, worked in and out by four screws so as to suit any size article that would want to be turned. I have shown the cover fixed in this kind of chuck with the cover reversed from one side to the other. Fig. 1 shows the cover fixed for turning the outside, fig. 2 for turning the inside. Fig. 2 is the best way to commence turning the cover first, for this reason: By turning off the rim so as to fit the bore of cylinder first, when reversed it can be fixed as shown in fig. 1 by the rim, and then the outside, likewise the face of cover, can be turned off and finished, but if fixed as in fig. 1 first, when reversed as shown in fig. 2 in tightening the jaws, it would be apt to make a mark where the jaws come, so that fig. 2 would be the best position to hold it first, fig. 1 next. J. C. Molton.

A FOUR-WHEELED VELOCIPEDE.

[246] Sir,—I inclose photograph and description of a light four-wheeled velocipede which I have had in use for twelve months, and from which, during that time, I have derived much pleasure and benefit. I may state that I had it constructed by a friend in the business, therefore if any credit is due I do not at all claim it. The material used in its construction is chiefly good ash; with the exception of the crank axle, very little iron is used. The wheels are all 30in. in diameter, with bent ash rims, and hooped with leather instead of iron. I give preference to the leather on account of its being lighter and almost noiseless. The hind wheels are the drivers, the front ones being used to steer by. The crank axle is made of ¾in. round iron. The cranks are 4½in. throw, and placed at quarter centre. There is a ratchet on the nave of each driver, so that the working parts remain at rest in going down hill. The ratchets are made in the form of hoops with the teeth inside, and put on the naves like ordinary rims. The catches work inside those ratchets and fall into the teeth by their own weight—no spring being required, and consequently no ricking noise. The material of frame is 1¼in. by 1in. Bent ash elliptical springs are used, 1¼in. by ¾in. The ellipse is 19in. by 10in.; one side is secured to the frame, and the other side has the ends left about 10in. apart; across this space is secured a strong leather strap, upon which is laid the seat. These springs are by far the best and lightest which I have ever used. The propelling is done by ordinary hand and foot levers. The whole weight a little under 57lb. With respect to speed, though the drivers are small, I can easily run a mile in six minutes, though for a long journey I find that six miles an hour is ample, if health and comfort are to be attended to. I look upon the velocipede as giving a most pleasant and valuable means of exercise, and I think it will be acknowledged that any exercise taken in due moderation, and continued for a length of time, is far more beneficial to the human system than such exercise taken severely and of short duration. Such a consideration as this compels me to advocate *light* velocipedes, *small* drivers, and *moderate* speeds.

J. Hastings.



BICYCLE RIDING.

[247] Sir,—Now the dark evenings are approaching, will you, through your valuable paper, allow me to impress upon my brother bicycle riders the necessity for wearing a white or brown Holland coat when out for evening exercise? I have tried several kinds of lamps, both fitted to the velocipede and fastened to the rider; the latter may be made to burn, but is a great annoyance to some horses in passing; but the Holland coat is almost a guarantee of perfect safety to all. These remarks apply especially to those gentlemen who possess bicycles with rubber-tired wheels. I have, for the last two months, been using the "Phantom Wheel" with rubber tire. It is very comfortable to ride. Its merits are faithfully represented in the pamphlet published by the manufacturers.

I cannot agree with a remark made by one of your correspondents, "That it is better to sit well back." To ride a velocipede properly you must sit upright; if the saddle is put far back on the spring it compels the rider to lean forward, which looks very ugly, and if persevered in will prove injurious. I know a youth who walks quite in the present Grecian Bend fashion, and his deformity (I call it) was produced by constant bicycle riding with the saddle too far back on the spring; but I trust to see him, and many others, shift their saddles and avoid this bad habit. R. L.

SHORTHAND.

[248] Sir,—Except to the few readers of the English Mechanic who are shorthand writers, the discussion which you have printed on Pitman's and Lewis's systems of shorthand must be unintelligible. Only those who have a knowledge of the alphabets of the two systems can understand the rules for writing which Mr. Grierson has quoted from them. I think it is possible to give, in few words, an impartial description of the *alphabets* of the two systems. I will try. If I succeed to your satisfaction, Mr. Editor, I shall be obliged if you will allow your readers also to see my attempt.

Writing is, professedly, a representation of the *sounds* of the words we speak. Thus, we begin the word *paper* with the letter *p*; the first letter in *sound* is *s*, etc., because the letters *p* and *s* are appropriated as the representatives of the sounds we make at the commencement of these words. In the use of the consonants we are tolerably consistent. We do not write *s* when we speak *t*, nor *p* when we speak *f*, though we do, in some words, use *ph* for *f*. We want six more consonants to complete the English alphabet, namely, types for the italicized letters in *ch*ump (corresponding to the heavy or vocal pronunciation of this letter in *j*ump), *sh*e, vision (or *sh*, the sound concerning which Mr. Grierson asks, "how often is it required?") *th*in (which is as simple a sound as the first in *tin*), *th*en (as simple, or single, as *d* in *den*), and si*ng* (a single sound of the nasal class, made at the throat).

But when we come to examine the vowel sounds, and the letters we employ to represent them, all is confusion, arising from the inefficiency of the alphabet of vowels—*a*, *e*, *i*, *o*, *u*. Everyone will give the same sound to the letters *p a p* in the word *pap*, but let the syllable *er* be added, and the sound of *a* is altered from *pap er*, to *pa* (*pay*) *per*. Every single vowel type changes its sound many times in different words; as *mate*, *mat*, *fall*, *want*, *father*; *me*, *met*. I need not carry the reader through all the changes which may be rung upon the five vowels. The same thing occurs with the double vowels. The diphthong *ou* has different sounds in *sound* and *journey*; so in *people* and *George*.

Now, the difference in the alphabets of the two systems is this: Pitman's, or "Phonography," gives a shorthand character for each of the useful consonants in the English alphabet, that is, for *b*, *d*, *f*, *g* (as in *go*, never used for the first letter in *gender*), *h*, *j*, *k*, *l*, *m*, *n*, *p*, *r*, *s*, *t*, *v*, *w*, *y*, *z*, (18); for the six consonants enumerated above; a distinct sign for each long and short vowel (12), as in *rather*, *lather*; *mate*, *met*, &c., and for the four dipthongs *i*, *u*, *ou*, *oi*, as in *bind*, (in which *i* represents a sound different from that in *bin*), *tune*, (different from *tun*), *bound*, *boil*.

We have thus in Phonography an alphabet of forty letters, which, when written, represent, without defect or mistake, the very sounds we utter in speaking English. If anyone should complain of the number—that it is a large unwieldy alphabet—his complaint lies against our language for being so rich in sounds. It will be observed that the letters *c*, *q*, *x* are not included in the phonographic alphabet. They are omitted because they are not wanted. *C* is represented by *k* in *cat*, by *s* in *city*, and by *sh* in *social*. *Q*, with its following *u*, is represented by *kw*; and *x* is either *ks*, as in *extant*, or *kz*, as in *exact*.

In Lewis's system there is no such alphabet of sounds, and I must deny the correctness of the term "phonetic," as applied to it. He gives a shorthand character for each of the twenty-six letters of the common alphabet, with additional signs for *th* in *them*, *sh* in *she*, and *ch* in *cheap*; and leaves unprovided with signs the sounds in pleasure, brea*th*, wro*ng*. His alphabet thus contains but twenty-six useful letters to represent forty sounds. These consist of the twenty-three useful letters of the common alphabet (*c*, *q*, and *x* being unnecessary) and the three consonants just enumerated.

As for the numerous sounds which the five vowels, *a*, *e*, *i*, *o*, *u*, represent, he leaves the writer to employ them as they are used in the common spelling, or omit them altogether.

Hence, the reading of Phonography is so easy that it is impossible to make a mistake when it is correctly written; and the reading of Lewis's, and all the other common systems of shorthand, is so difficult that the deciphering of them has passed into a proverb to express uncertainty and confusion. Isaac Pitman.

IGNITION BY ELECTRICITY.

[249] Sir,—I saw an enquiry a short time since in our paper about igniting gas by electricity. Perhaps the enclosed cutting from the American *Technologist* will afford some of the information "W. H. B." asked for:—The idea of using electricity to ignite inflammable substances or explosive compounds is not new. Lightning, which is nothing but an electric discharge on a large scale, produced in nature's laboratory, has effected this from time immemorial. The ignition of alcohol, ether, gunpowder, &c., by the electric spark, is one of the oldest experiments in this branch of physics, and during the last one hundred years has formed one of the standard experiments in the philosophical lecture-room.

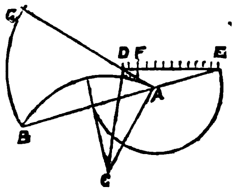
Electricity produced by friction was proposed and practically applied to the lighting of gas; the small amount developed when the feet are rubbed on the carpet in a very dry room is often sufficient to charge the person, so that by touching the gas jet a small spark will appear, which will ignite the gas readily if the latter be turned on to a proper degree. Many devices have been contrived for the development of this frictional electricity. Thirty years ago machines were made in Groningen, Holland, with a glass disc, the whole being enclosed in a glass case, nearly hermetically closed, and provided with chloride of calcium or other hydroscopic substance, which would absorb all moisture, and thus keep it dry, so as to ensure the obtaining of a spark in all states of the weather. Batchelder, of New York, patented a small friction machine, which was hidden in the ornamental globe attached to the lower central part of a chandelier. When the gas was turned on, and a knob which rotated in an inside disc or vulcanite three inches in diameter was turned, a spark was conducted to the burners and the gas was ignited. Vance, of New York, invented a gas lighter in which a similar machine was placed above the handle, and turned by means of a small handle. The insulated metallic rod attached to the lighter was thus charged, and when brought against the gas burner it emitted a spark, thus lighting the gas. Cornelius, of Philadelphia, patented a small cup, lined inside with silk, and closed with a stopper of vulcanite, the whole being attached to the gas bracket. When the gas was turned on and the vulcanite stopper lifted out of the cup, friction enough was produced to develope an electric spark, which was conducted to the tip of the burner by means of a small insulated metallic chain. In 1860 Van der Weyde, of New York, presented to the Smithsonian Institution, at Washington, a simple syringe of vulcanite, which, by sliding the piston along the interior of its cylinder, produces electricity enough to do the same thing. It was, in fact, a small and very convenient instrument for developing small amounts of electricity for experimental purposes.

In 1863 Wesolewski patented a very neat and very small frictional machine of vulcanite, in which a lamp containing bisulphide of carbon was lit by a spark, the latter substance having been found to be more easily ignited in this way than any other liquid. The blue, non-luminous flame of the bisulphide served to light a candle or lamp. But the odour of this compound is so offensive to most persons that the apparatus had a very limited sale, although it was pushed most vigorously. The inherent uncertainty of all methods of obtaining electricity by friction caused this agent to be abandoned by the knowing ones, and the voltaic battery, induction sparks, or magneto-electricity was substituted for it. Lately, however, there has been produced a small frictional machine, made entirely of vulcanised india-rubber, and hermetically enclosed in a casing, which also contains a condenser of the same material. By giving the handle half a dozen turns, a strong, snapping spark appears between two conducting wires which project from the apparatus. The machine may be had of different sizes, the smallest size not being larger than a common paper-collar box, and of about the same shape. The large size has the same general form, a slice of a cylinder, and is one foot in diameter, and three or four inches thick. It is now extensively used for igniting gunpowder, nitro-glycerine, &c., in blasting and mining operations.

W. R.

RECTIFYING THE CIRCLE APPROXIMATELY.

[250] SIR,—There must be many ways, equally simple and much more exact than any lately described, for obtaining with ruler and compasses alone the approximate length of a given entire circumference, or aliquot parts thereof. Thus, Hutton erects at the ends of a diameter two perpendiculars, one = 3 radii, the other = tan. 30°, and the line joining their tops is within a hundred-thousandth part nearly = the semi-circumference. But I conceive that the real problem, to be usefully solved, must apply to every arc, whether commensurable with the circumference or not; and comprises three cases. 1. To rectify particularly any given arc. 2. To lay off on a given circle an arc practically of a given length; and 3, to construct an arc subtending a given angle, and practically of a given length. For the first of these I venture to doubt if the following has been, or will soon be surpassed. It is probably new, being derived, but considerably improved, from two invented and published as new by Professor Rankine in 1867.



Given the arc A B, whose centre is at C. To lay off on the tangent A G its approximate length. Bisect the arc, and bisect again the half next A, by the secant C D, meeting the tangent at D. Draw the chord, B A, and produce it to E, so that A E = half of B A. Join E D, and make D F = two elevenths of D E. (This division is only necessary in the case of very large arcs, approaching a semicircle, or at least a quadrant. For any under an octant there will be no sensible difference if D F be as little as an eighth, or as great as a quarter of D E). From F, with radius F B strike an arc B G, which will cut from A G the required length.

The error is positive, or A G longer than the arc, when this is a quadrant or anything less; but at some arc I have not determined, between 90° and 180°, the error vanishes; and for arcs approaching a semicircle this is reversed, or the line A G too short, the defect, however, barely reaching a ten-thousandth in the extreme case of rectifying a whole semicircle by one operation. By distinct calculations I find

The error in 19° = + about $\frac{1}{3,800,000}$ of the arc.

,, ,, in 30° = ,, + $\frac{1}{650,000}$,,

,, ,, in 45° = ,, + $\frac{1}{127,000}$,,

,, ,, in 60° = ,, + $\frac{1}{41,000}$,,

,, ,, in 90° = ,, + $\frac{1}{160,000}$,,

,, ,, in 180° = ,, — $\frac{1}{9,400}$,,

The beauty of the method is, that whereas in other rectifications, as far as I know, however small the error for arcs of small curvature, it constantly increases with their angle, and at length so rapidly as to make the rule applicable only by dividing them and taking their half or quarter; it here ceases to increase, reaches a maximum for some arc between 45° and 90°, probably never reaching $\frac{1}{30,000}$; and then so decreases with further increase of curve that the quadrant is rectified more truly than an octant. In still more curved arcs it decreases to nothing, passes to the opposite side, and thus barely reaches a sensible amount for any arc, even up to a semicircle. For arcs below 60° the errors would be even less if we made D F = $\frac{1}{5}$ D E, and the positive maximum be less; but as it would occur at a lower arc the change of sign would be at a point below 90°, and the negative error increase longer and quicker, becoming at least, $\frac{1}{320}$. Hence—I choose the fraction $\frac{2}{11}$ of D E, to reduce error on the whole throughout all possible arcs.

Mr. Drach's very curious discoveries were not proposed, I conceive, as geometrical approximations, but as arithmetical abreviations of the process of multiplying or dividing by 3·14159265, &c., for which they are surely most remarkable, and up to these first nine or twelve figures, very useful. In fact, he represents the above nine by a combination of factors that contain but five significant figures; thus (3 — ·3008007) × 1·05. Pushing the principle further, he shows how the effect of these twelve, 3·14159265359, may be got from the same 5, and two more, namely, adding (3 – ·008007) × ·00000000012. This is perhaps the limit of utility; but if exactness to 16 decimals (that is, to a thousandth of a hairbreadth in the circumference of the earth) should ever be needed, he obtains it by one figure more, subtracting from the last factor ·000000000002. The extensions he has contrived beyond this, to 18 and to 31 decimals, are wonderfully curious, and that is all; but we must remember the arithmetical processes are abridged in exact proportion to this reduction of the number of significant figures, or rather of figures above unity.

E. L. G.

P. S.—As far as the above number is quoted at all, it should be correctly 3·1415926535897932384. Though the 17th and 18th places might be 01 without greatly affecting society, the sixth must not be a 1, as twice printed in Mr. Proctor's letter.

THE SATELLITES OF URANUS.

[251] SIR,—I have endeavoured to comprehend the movements of these bodies as described in astronomical books, but I cannot succeed in making the data given by Sir W. Herschel agree with certain statements of other excellent observers of these distant bodies.

Sir W. Herschel in 1798—the epoch of the ascending node in long. 165°—found the plane of their orbits to lie 81° south preceding, and 79° north following. These, in our modern method, would be Pos. = 189° and 11°; this would make the inclination to the ecliptic about 80° on the W., and 100° on the E. side respectively. He had previously found the motions to be retrograde. Now when half a revolution of Uranus had been performed—say in 1840—the ecliptic would be similarly inclined to the circle of declination on the other side, so that near the descending node the plane of the orbits would be inclined about 10° to the meridian, in Pos. = 170° and 350°. In figs. 1 and 2 the apparent orbits are shown as projected on the meridian, the strong lines denoting the plane of the orbits, the thin lines the meridian and circle of declination, and the dotted lines the ecliptic. The arrows indicate the direction of the motion of the satellites (as I suppose) in the half of their orbits nearest the earth at the nodes. A telescopic view is, of course, obtained by an upside-down view of the figures.

FIG. 1

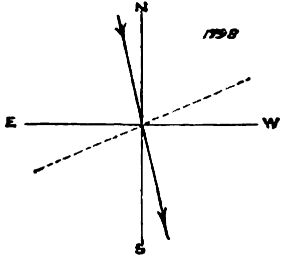
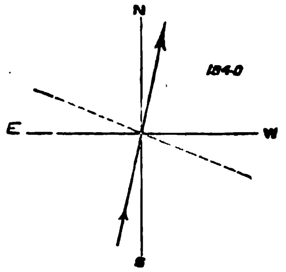


FIG. 2



Now, in 1851-2—when the apparent inclination was on the same side of the meridian, as in fig. 2—Mr. Lassell observed the satellites at their greatest elongations to be in Pos. = 82½° south preceding, and north following, say 187½° and 7½°. How does this agree with their discoverer's conclusions?

Mr. Hind, in "Solar System," p. 121, says that Mädler found the axis of the planet inclined at an angle of 15° 26′ to the circle of declination, 1843, Sept. 28; but whether the N. pole was N. of this circle, or between it and the ecliptic is not stated.

I should feel greatly indebted to Mr. Proctor, "F.R.A.S.," "Omicron," or any other competent astronomer, who would kindly help me to understand these matters.

ETUDIANT.

MICROSCOPIC EXAMINATION OF ALE.

[252] SIR,—It may interest "John Barleycorn" to hear that I devoted a few spare minutes the other evening to the careful examination of some "bitter [illegible] I found no trace of acetic acid by optical [illegible] saw some isolated cells of *Torula* and, horrible [illegible] late, a goodly number of bacteria and vibriones, [illegible] appeared to be in the liveliest condition. Under [illegible] ¼th, &c., the spectacle was most edifying and [illegible]

[illegible]

CALLAUD GALVANIC BATTERY.

[253] SIR,—There would seem to be afloat [illegible] your readers an error as to the name of the [illegible] of the so-called "gravitation" galvanic battery.

"What is in a name?" will not hold in this [illegible], for the mistake has already caused a misconception [illegible] the mind of at least one correspondent. The [illegible] should be Callaud not Calland. In the year [illegible] laud, of Nantes, called the attention of the [illegible] Academy to his new battery, in which the [illegible] was absent, and the liquids were kept from [illegible] "superposition." Verité, of Beauvais, the [illegible] the wonderful astronomical clock of Beauvais [illegible] dral, hit upon the same idea some time later.

Both these inventors requiring electricity [illegible] clock-work motion, had not to trouble themselves [illegible] the great objection to this battery—*that it must not be shaken*; otherwise, it is stronger, [illegible] and uses less sulphate of copper than Daniell.

E. [illegible]

MAMMOTH.

[254] SIR,—Your correspondents "Bernardin" and "Oceola" are, I think, in error in regard to their statements about the non-existence of a mammoth [illegible] in Great Britain. There is a *perfect skeleton* of a mammoth in the Natural History Department of the British Museum, and several parts of another skeleton together with a specimen of the *hair*, which was found embedded *in ice*. I would advise "Bernardin" to visit the British Museum (if he has not already done so), and I have no doubt he will be as much pleased with our English specimen as with any to be seen on the Continent.

AN ASSOCIATE OF KING'S COLLEGE, LONDON.

THE FIELD BOILER.

[255] SIR,—Permit me to correct a statement in your last issue regarding the "Field" boiler, which is likely to mislead. After having stated that upwards of 60,000 "Field" tubes are now at work in this country, you say:—"They are not likely, however, to be generally adopted for factory and other uses, where more liability and neglect exists." In answer to this statement, will you allow me to state that upwards of 870 "Field" boilers have been made up to date in this country, and with few exceptions are all employed for factory purposes? The number of tubes and boilers mentioned above do not include those made by Messrs. Merryweather & Sons for their well-known steam fire engines, as they have the sole right of employing these boilers for that particular purpose. In addition to this I may mention that a very large number of "Field" boilers are made on the Continent, amounting to about ten times the number made here in England, one firm alone having turned out as many as 150 boilers a year during the last few years.

I trust that this statement may satisfy you and your numerous readers that the "Field" boiler is as safe and reliable for all stationary and [illegible] purposes as any other boiler.

LEWIS [illegible]

THE INDUCTORIUM.—IRON IN BATTERIES.

[256] SIR,—Your readers owe thanks to "Inductorium" for his description, p. 472, even though the mode of construction described be well known. I think he would find it less trouble to pass the wire through the melted paraffin while winding. It is very easily done by fitting a cover to the vessel, in which pulley-shaped holes or rollers are provided at extreme opposite sides; and also a frame carrying a roller, which goes to the bottom of the vessel, which is then placed as far away as is convenient over a regulated gas burner. He would find it an improvement, also, to increase the diameter of his discs gradually from the ends, the shape of the coil being brought to that of the curves of the magnetic force generated by the primary.

In reply to his question, I have not particularly measured the vacuum my Tate's pump gives; I only know that it has answered the purposes I have used it for better than other forms.

In reply to Mr. Preston, p. 497, I think he is correct, as I have no doubt that the inner turns of the secondary are by far the most effective; as the outer ones increase in length, their resistance is increased, and the force is used up in overcoming it, and as the force itself diminishes, also, the useful effect is much lowered; the real objection to great length is, of course, the increased primary and resistance to the battery, and, therefore, greater battery power is required.

Will Mr. Jarman, p. 447, say wherever he got iron from containing 65 per cent. carbon, as it would be a great curiosity, as it is about ten times the usual proportion?

The figures of cost given by "Omega," p. 494, as comparing the Bunsen and Slater's iron cell, differ considerably from my results, but I am unable to compare them, because the conditions are unknown in his case, and so much depends on the actual strength of the acid, and accurate results can only be obtained by working from the equivalents of the materials. I rather suspect "Omega's" nitric acid was weak, as this alone can explain the difference in the amount of work if the measure capacity of the cells was the same. Of course, independent of local action, zinc will consume faster than iron, as its equivalent is 32·6 against 28.

Another matter is that the comparison is not a fair one for another reason—viz., that equal numbers of the cells are used; now 24 cells are very greatly in excess of the number which can be advantageously used to decompose water, or, more correctly, dilute acid; and as the electro-motive force of the Bunsen is the highest, this tells most against that battery.

With "Omega's" other remarks I entirely agree; and I may add that the electro-magnetic engine for use with which the battery was mainly devised is a very excellent and powerful form. SIGMA.

EXTRACTS FROM CORRESPONDENCE.

AN "ENGLISH MECHANIC" SOCIETY FOR LONDON.—"Tometer" says:—"I am much surprised and grieved to find that there are so little hopes of a Mechanics' Mutual Improvement Society being established here in London. I should have thought there must be subscribers enough to form a hundred societies such as that proposed by a correspondent a few months ago. I believe if a meeting were held there would be plenty of attendants, but very few care to write, as they seem all to think 'there will be plenty of others write without me,' and, therefore, none write; so the thing drops. I really do hope something will be done in reference to this important subject, and, I should say, the sooner the better."

ASTRONOMICAL NOTES.—I trust the "Fellow of the Royal Astronomical Society" will not be moved by Mr. Frith, or any one else, to falter in giving us his kind and valued "Notes." Let him be assured that there are lots of quiet-going fellows like myself, who, *though they may not express it* as I do now, enjoy those "Notes" particularly, and scan them always with keen appreciation.—GIMEL.

MECHANICAL MOVEMENTS.—This part of our paper is very interesting, and I have no doubt when it is completed, it will go into the form of a book. True, the ENGLISH MECHANIC itself is a convenient "book," size (not too big), but still the "Mechanical Movements" would form a nice neat volume; and some of the more attractive items could be expanded by a system of notes, copious and explanatory, and a full index would (as ever) make the book complete.—GIMEL.

MIRAGE.—Mr. W. L. Carpenter, writing to *Nature*, mentions a mirage which occurred on the coast of Portugal, on the same day as the remarkable one seen in the Firth of Forth, July 22:—"A reference to my journal shows me that on the same day we were dredging on the Portuguese coast, within sight of the Ferilhoe and Berlinga Islands, about forty miles north of Lisbon. The bearings of these islands and their exact distance, calculated by the aid of the known height of the lighthouse, gave us, of course, an exact position, which our 'dead reckoning' also confirmed. Several solar observations, both for latitude and longitude, were taken by two of the officers during the day, both of whom always arrived at the same result, but this was so widely different from our position as previously determined by two other methods, that we were forced to the conclusion that there was a very false horizon. It was the only instance of the kind during the month I was at sea."

AN IMPROVEMENT IN GALVANIC BATTERIES.—Mr. W. Poole Levison, of Cambridge, Mass., in a letter to the *Journal of the Franklin Institute*, says:—"In the spring of 1869, while making use of a small bichromate of potash battery, I discovered that the addition of nitric acid to the mixture of potassic bichromate and sulphuric acid, contained in its porous cups, conferred upon it the virtue of *steadiness*, without involving the evolution of annoying fumes. For over two months, during last summer, I had in almost constant action a combination of twenty-three large Bunsen cells charged with dilute sulphuric acid and the triple mixture mentioned, and 'set up' openly upon the floor of my room. Not only did I work about it with perfect comfort, but left choice brass instruments in its immediate neighbourhood with impunity. Its energy never fluctuated, and after remaining for some time steady, declined, precisely as if the electro-negative plates were bathed in nitric acid only. To a cooled mixture of potassic bichromate solution and sulphuric acid (perhaps preferably in atomic proportions) add *nitric* acid. The proportion of nitric acid may be greatly varied, as its office is merely to transfer oxygen."

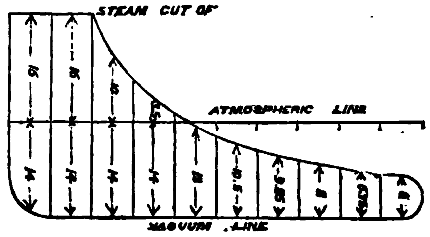
FIXING PHOTOGRAPHIC PRINTS.—A correspondent of the *British Journal of Photography* gives the following method for fixing prints:—"Allow the prints to get saturated in a solution of hyposulphite of soda, three ounces to the pint, and then well squeeze them. This two or three times repeated is quite sufficient. The prints, after the first pressing, on being separated, immediately absorb a fresh supply of hypo. solution, as a sponge would do, which in its turn is eliminated by pressure, carrying with it all the salts of silver; and, as the pictures are such a short time (five or six minutes) in the fixing solution, the tone is not lowered in the least. The prints at this stage have rather a curious washed-out appearance, caused by the paper being semi-transparent; but they resume their brilliancy on drying, and are in the best possible condition for effectual washing. The advantages of this method are—a great saving of time, ditto of material, and an approximation to, if not perfect fixation."

COAL FORMATION OF THE LOFODEN ISLANDS NORWAY).—It appears that in the Island of Ando, one of the Lofoden group, a seam of coal has been discovered, which, in physical and other properties, bears strong resemblance to the well-known boghead, but the thickness of the layer is irregular, and does not, as far as has been ascertained, exceed 20in. The diameter of this coal basin is about 2,800 metres.

REPLIES TO QUERIES.

*** IN their answers, Correspondents are respectfully requested to mention in each instance the title and number of the query asked.

[3988.]—ENGINE INDICATING.—As nobody else appears to answer this query I will try, though only a learner myself. Before you begin to adjust the indicator, see that it is perfectly clean, free from grit, and well oiled with the best oil. Next fix your indicator to the taps in the ends of the cylinder if possible, as the sides are objectionable; next gear your band to some convenient part of the engine to get the required stroke for the indicator. If a beam engine, the radius bar; if a horizontal, you must gear a lever from the crosshead to the roof of the engine-house; then fix your band towards the tap, so as to get about a 5in. stroke, more or less, to suit your indicator; then carry your band towards the cylinder on small pulleys, over the indicator; then couple your band, but be confident your band is long enough at first, as you can shorten it with a running loop at pleasure. You must be careful and see that your stroke is not too long, so as to cause the indicator barrel to stop at each end, in which case it would produce a defective figure. This done, wrap your paper round the barrel, sharpen your pencil to a very fine point and let it touch the paper as lightly as possible, but before you take the figure see that your indicator is in working order by letting it work a few strokes.



Should the diagram, when taken, resemble the above, it will be a very good one, there not being much room for improvement, as it approaches very near the true expansion curve. Then to proceed to measure it up, you must divide the length of the figure into ten equal parts, then measure through the centre of each division from the vacuum line towards the atmospheric line, then from the atmospheric line to the steam line. Should it be a Richards indicator, it will be 16lb. to the inch, the same as the above. Then add each side up, and divide by ten, the number of divisions in the figure; then add the quotients together, and the product is the mean pressure per square inch throughout the stroke; in the above case it is nearly 15½lb. To find the horse-power, multiply the square inches on the piston by the mean pressure per square, then by the number of feet the piston travels per minute; then divide the product by 33,000, the equivalent of one-horse power, which will give you the number of horse-power the engine is turning. "Hopkinson on the Indicator" is a very good book for explaining the action of the slide-valve. "The Discussion as to whether High or Low Pressure Steam is preferable in point of Economy," with an appendix, by Edward Ingam, of Bancroft Mills, Oldham, and Bourne's "Catechism of the Steam Engine," likewise his handbook, are very good books.—W. W. H.

[4011.]—PRICKING ORGAN BARRELS.—"C. W. A." gives what seems a funny process for doing this. Now without pretending to know how it is done in practice, I remember seeing a description of the process in the *Magazine of Science*, of which I think only three or four volumes ever appeared, nearly thirty years ago. It is there stated that the barrel is mounted in its own frame, with a division plate attached, and is moved forward for each successive note, and a tap with a small hammer administered to the corresponding lever (or whatever it is called), which, having a sharpish spike underneath, leaves a mark on the barrel. If the note is a long one, then a mark is made at the beginning and another at the end of the note, and the two dots joined with a pencil mark. The barrel is afterwards taken out and a peg or a staple, long or short, as necessary, driven into every mark. I do not know how musical-box barrels are done, and believe that they are never, or at most, only rarely done in this country.—J. K. P.

[4131.]—SUN-DIAL.—Whatever serves as a gnomon (let the dial face how it may) must have an edge or edges parallel with the earth's axis, that is, in this hemisphere leaning from south to north, and in London 38½° from the vertical; moreover to be available throughout some hours, it must have its chief planes or sides facing due east and west. What "W. H. C." means, therefore, by "supposing it to be placed exactly opposite the point in the horizon where the sun first appears on June 21st," namely, something like 40° north of east, I cannot tell. Any object will cast no shadow on the longest day at noon, if its north side reclines (in London) 28° from the vertical, and its east and west do not overhang. The difference between "mean noon" (or twelve o'clock) and apparent noon (or twelve o' sun) being on that day only seventy seconds, will not affect the question, because there are always two full minutes during which neither the east nor west face casts a shadow, this time being taken in their turning through the half degree of the sun's diameter. It is not generally known that dials (and those of elegant forms) may easily be made to show clock time, exact to a quarter minute, throughout the year; and even to a second (except in a few days of midwinter and fewer at midsummer) by having two gnomons, used alternately for nearly half a year each. I propose this problem to the ingenuity of some of your readers.—E. L. G.

[4174.]—GEOLOGY.—Fossil plants from the coal measures grew at some period between half a million and three hundred million years ago, but which of these dates may be the nearer the truth no means exist of guessing. As the Cumberland strata dip in leaving that county, and are overlaid by others, these again by others, and those by others in succession, till, by the time we reach London (not to say Ipswich), the aggregate thicknesses have summed up to about *ten miles*, and as the most rapidly shoaling parts of present sea-bottoms, the Gulf of Venice, or the mouths of great tropical rivers, are not receiving *a foot* of sediment *per annum*, "Veritas" may reckon a minimum of time for the deposition of these ten miles, but only a minimum. The fished-up cable showed that the Atlantic is not depositing *half an inch* of its chalky mud per annum. Certain sandstones, that there is much reason to believe are the quickest deposited strata, show laminations about forty in an inch, that were most probably each the effect of a twelve hours' tide. These are about all the data that geo-chronology has to theorize on.—E. L. G.

[4288.]—WARPED CABINET LID.—I *fear* that "J.B." (the second) will find that even if he succeeds in straightening his warped cabinet lid by "Cabinet Maker's" method it will warp again. Because as the part which he *swells* by damp in the manner proposed gets dry it will naturally shrink as before, and so twist as before. In order to prevent this, therefore, I would advise him if and when he gets it straight by the mode prescribed, which would be *helped* by a few weights, to have grooves made *across the grain* of the *back* of the lid to the depth of half its thickness, and in width and number in proportion to the size of the lid, and if into these he fits with glue and screws, slips of perfectly dry wood, I think he will find his work likely to *stand*, which otherwise I doubt.—J. B.

[4361.]—METHYLATED SPIRIT.—This composition is *not* allowed to be used in the preparation of any medicine to be taken internally—*i. e.* to be drunk; and several parties have been heavily fined for selling it flavoured with various essential oils so as to render it potable. It is prepared by mixing nine parts grain spirits, generally from 60 to 65 o.p., with one part wood naphtha. Both its preparation and sale are hampered with stringent fiscal regulations. "T. L. H." has misinformed the querist in this case. I have had less or more to do with methylated spirit ever since the act came in force—now thirteen years since.—A REVENUE OFFICER.

[4380.]—COLZA OIL.—"Bernardin" is mistaken when he says that colza oil is the same as rape oil. Colza is extracted from the seeds of *Brassica oleracea* or *B. campestris oleifera*, which yield from 36 to 40 per cent. of oil. Rape is obtained from the seeds of several kinds of *Brassica*, but principally of *B. napus*, which yields about 33 per cent. (sp. gr. ·9128), and *B. rapa*, which yields a smaller quantity, but of a specific gravity of ·9167. The specific gravity of the true colza is ·9136; but as might be expected, it is extensively adulterated. The mistake seems to have arisen from the Customs' returns classing all seed oils under the one head of "rape oil."—REBAF.

[4381.]—COURT PLASTER.—The following is the method described by Dr. Paris:—Black silk is to be strained and brushed over ten or twelve times with the following preparation:—Dissolve ½oz. of balsam of benzoin in 6oz. of rectified spirits of wine, and in a separate vessel dissolve 1oz. of isinglass in as little water as possible. Strain each solution, pour together, and let the mixture rest, so that any undissolved parts may subside. When the liquid is cold, it forms a jelly, which is warmed and applied to the silk. When the silk coated with this mixture is quite dry, it should receive a coat of a solution of 6oz. of tincture of benzoin and 4oz. of chian turpentine, to prevent its cracking.—H. U.

[4382.] COPPER COINS.—The first coin named by "Hastings," (query 4382, page 454), is one of Faustina junr., empress of Rome; if the hair is put up something after the way of the present chignon; if not so, one of Faustima sen. The second coin is one of Hadrian or of Vespasian, emperor of Rome; if the head on the coin is very large it is one of the latter emperor, if not so, one of the former. They are called first or large brass.—W. J. EGGLESTON, Dewsbury.

[4383.] THREE COINS.—The first of the three coins described by S. S. Wright is a shilling of Elizabeth; the other two are 17th century tokens, struck in Antrim and London, by R. Young and J. Evin, during scarcity of copper coins in the reign of Charles the First; none of them are worth much above sixpence over their intrinsic value.—W. J. EGGLESTON, Dewsbury.

[4384.] COPPER COIN.—The copper coin of "W. B." engraved in query 4384, is probably a very early British or Gaulish coin, too early to be assigned to any ruler.—W. J. EGGLESTON, Dewsbury.

[4396.]—ELECTROS.—I am sorry "Faber" does not find my composition suit. I think he is sparing of the rotten stone, but remember I had failures in casting off metal of large diameter, as the stuff stuck in deep places. I do not remember having over much trouble in blackleading. I suppose there is blacklead and blacklead at the shops. The recipe was given me by a relative M.D., F.R.S., who got it from a professional, but so long ago (1842), that I do not remember quite all about its success or otherwise. I do recollect that I soon gave up electrotyping, and that some of my early casts were very good. I think the stuff is all the worse for remelting repeatedly, at least my impression is that I was more successful at first than afterwards.—J. K. P.

[4397.]—SCREW TOOLS.—I am sorry not quite to understand the last words of "Faber's" query (p. 455). The words "and in top," appear a misprint. I suppose the only way to make an inside screw tool from a screw plate is to screw in a piece of steel, as in making a tap, and then filing it thin by removing half the material from the top side and one-quarter more from underside, and all the thread, and more than that, say half the breadth, from the back, to form an ordinary screw tool. I have made an inside screw tool—viz., for a nut 1⅜in. diameter and ⅛in. pitch, by flattening the end of a steel bar ⅝in. square, and drawing it out on one side just like the "bit" of a key, and then centering it at both ends, and treating it as if it was a bar, with an outside screw to be cut on it in the ordinary way, and it acted *perfectly*; really could not have been wished to be better. I may as well mention here, as many a workman (so-called) is not aware of it, that inside screw tools *should* be cut on a left-handed *hob*, and I have seen many from first-rate shops that were not done so. Also, I cannot see what "Faber" can want with screw tools so small as ¼in., as the internal screws are so much more easily tapped, and I think any pitch whatever, up to about 80 or 85 to an inch, is kept in stock at Buck's, besides some finer ones, so that he can hardly be obliged to make his own. I do always make mine, having formerly been to the trouble (and very great, too) of making a set of hobs, and think nothing of making more if requisite, as I want them, but in those days aliquot pitches were not to be had at the shops.—J. K. P.

[4399.]—INTERNAL GEARING.—I do not much approve of this plan in a general way, but to anyone intending to use it I would remark that the pinions should be as large as can be got in. Also, that internally geared wheels *are* commonly cut with a circular cutter in a frame specially made for the purpose, and are attached afterwards to the plate or rim of wheel that they belong to; of course it is difficult to make small ones this way. "G. W. A." has very nearly hit upon the best plan of making an internal wheel, when he says, "drill a series of sixty holes, &c.," but the chipping "away neatly" is the difficult part. The way to get over this is to have a driller similar to mine figured November 12, last year, (and which you must have in order to slot drill any part of the teeth any way), mounted on a plate attached to the slide-rest, so as to be itself on the radius of the work, and slot drill the teeth by traversing to and fro, not on the line of the radius of work, as "G. W. A." proposes, but parallel to axis of lathe mandrel and lengthwise of the teeth. The tool referred to will work comfortably inside a wheel of 8¼in. diameter, and another I have intended for a different purpose would go inside a 4½in. wheel. Of course a drill or "grinder" made to the right shape is required. All this is not easy to describe without a drawing, and I cannot stop to make one now, but will give more particulars if called on to do so.—J. K. P.

[4402.]—TELESCOPES.—Most telescopes have the screw parts *cut* so as to act as springs upon and retain the sliding tubes in any position. If "G. F.'s" telescope is so made a few slight blows with a hammer on the beak of an anvil, properly applied, will set these springs in and make them act more strongly; if, however, there are no such springs, and there are no means of cutting or making them, a ring of thin kid, fastened with shellac, and oiled, will give the required stiffness of draw.—J. B.

[4409.]—FIXING IRON CRAMPS.—"J. W." will readily fix his cramps or other ironwork in stone by the use of Roman cement and bits of scrap-iron driven tightly with punches into the hole to jam the cramp. When the cement is set it is quite as strong as lead.—J. B.

[4410.]—TURNING SPHERES.—Q. Yorke advocates boxwood for chucks. I do not. Maple is much better wood for the purpose. Nearly all our chucks are made of the bottom ends of maple poles, and last for years. If "Young Amateur" finishes one side of his backgammon men before he cuts it off the cylinder he will have to chuck once instead of twice. "J. D. L." had better get a practical workman to turn his billiard balls, as I can assure him it is no easy job to turn a perfect sphere. He will only spoil his ivory.—Wood Spoon.

[4412.]—WRITING INK.—Let "J. G. M." put two or three drops of carbolic acid into his inkstand, or about thirty to the pint of ink. The ink cannot then go mouldy, nor will this addition spoil the ink.—Spero.

[4412.]—WRITING INK.—"J. G. M." will probably find that a small piece of camphor placed in his ink bottle will prevent the growth of the "mould" fungus.—H. P.

[4412.]—WRITING INK.—A few cloves (say two or three) put into an ordinary-sized inkstand will prevent it from going mouldy and also preserve its liquidity.—Wahsrof.

[4414.]—HEIGHT OF OBJECT.—If "Enquirer" will take two tubes and connect them in such a fashion as shall enable him to case them to form L or any angle, he will provide himself with an instrument which will enable him to get approximately the height of any object, or width of any river. He may use it thus:—Suppose he stands on the brink of a river, the width of which he wishes to know, let him measure on his side a given distance in paces right and left of some tree or building on the opposite bank. From each end of his measured base-line let him view the tree, keeping one tube parallel with his base line. This will necessitate his adjusting the other tube to a certain angle with regard to the other one. He must register these—easily done by a piece of string fastened midway between the ends of each tube; then turning his face landwards, let him describe a precisely similar triangle, which will be pretty nearly an equilateral one—if the process be accurately gone through, it will be quite—and measure the distance from its apex to base. This will give the width of the river. Or he may measure the angle in *degrees*, and reproduce the triangle on paper to scale, and work the problem out at home. Some years since, I interested some school-boys much by putting them up to the dodge. I hope it may be useful to "Enquirer."—H. P.

[4415.]—CURIOUS PROBLEM.—"Saul Rymea" asks us, in page 478, What would be the result if an irresistible force came in contact with an immovable body? In the first place, I should like to know how this gentleman proposes to define the expression, an "irresistible force;" at what point does anything obtain the property of being "irresistible?" Secondly, What is an immovable body? All bodies with which we are at present acquainted are both movable and moving.—S. A. R.

[4415.]—CURIOUS PROBLEM.—Very! An "irresistible" force comes into contact with an "immovable" body—well. Why, sir, it would be a case of the Kilkenny cats—only there would be no tale to tell.—H. P.

[4415.]—CURIOUS PROBLEM.—If, as I presume, "Saul Rymea" supposes his "immovable body" to be also "perfectly hard," the force with which the "irresistible," by which I understand "perfectly hard" body would impinge upon it would be *infinite*, and therefore impossible *in nature* and inconceivable to the human mind; under such circumstances, therefore, his question is unanswerable. But if either of the two bodies be capable in the slightest degree of alteration of form by impact the "energy" is expended in *producing such alteration*.—J. B.

[4416.]—PHOTOGRAPHICAL.—Test your bath with litmus paper, if acid, add a few drops of ammonia until it is neutral; then test the strength and make it up to 50 or 60 grains per ounce. Take care that you do not float the paper too long; one minute is quite long enough for the present warm weather. I do not float longer than 30 seconds in summer with the sample of paper I use. I should recommend "John" to change the paper, as it is a very bad sample if it discolours the bath to the extent he says. "John" must also take care that the paper is perfectly *dry* before printing it. By attention to the above points he ought to succeed; if not write again and give particulars of make of paper, strength of bath, description of toning bath, &c. Regarding brown negatives he must give more particulars before I can recommend a cure, but I fancy he has been *messing* his bath until it is useless.—Operator.

[4416.]—PHOTOGRAPHICAL.—"John" may find advantage in adding a little, or perhaps a good deal of fresh silver to his solution; 60 grains to the ounce of water is the thing, and with this strength three minutes will sensitize the paper. Also make a new toning bath as follows:—2 grains bicarbonate of soda (common bread soda), 2 grains gold, 8oz. water. This will give a good and rapid tone. When the exciting bath becomes brown, the remedy is kaolin. Blend a very small quantity, just what will muddy the bath, and filter. The quantity of albumenized paper has a good deal to do with brown baths. Try some other house for paper. Are you buying cheap chemicals or dealing in a second-rate house? Don't do either.—Paddy.

[4418.]—SILVER COIN.—In answer to "A Young Beginner," I beg to inform him that his coin is a Roman denarius of the family of Antonia. It is one of a series struck by Mark Antony in honour of his legions. They bear: *Obverse*, a galley and rowers. ANT. AVG. III. VIR. R. P. C. (for Antonius Augur Triumvir Rei Publicae Constituendae; Antony Augur Triumvir, for the re-establishing of the Republic). *Reverse*, three military standards, the centre one surmounted by the Roman eagle. LEG. (for Legio, Legion), and the number. The first legion has LEG. PRI. (very rare); the 2nd, LEG. II.; the 3rd, III.; the 4th, IIII. or IV.; the 5th, V.; the 6th, VI.; the 7th, VII.; the 8th, VIII.; the 9th, VIIII. or IX.; the 10th, X.; the 11th, XI.; the 12th, LEG. XII., or LEG. XII. ANTIQVAE; the 13th, XIII.; the 14th, XIIII., or XIV.; the 15th, XV.; the 16th, XVI.; the 17th, LEG. XVII. or LEG. XVII. CLASSICAE; the 18th, XVIII. or XIIX. or LEG. XVIII. LIBVCAE; the 19th, XVIIII. or XIX.; the 20th, XX.; the 21st, XXI.; the 22nd, XXII.; the 23rd, XXIII.; the 24th, XXIV.; the 25th, XXV.; and the last, the 26th, XXVI. One has CHORTIVM PRAETORIARVM, and another has CHORTIS SPECVLATORVM. Legions II. to XXIII., are common, and worth 2s. or 3s. each.—Henry W. Henfrey, M. N. S., &c., &c.

"π" also answers this.

[4423.]—PHOTOGRAPHY.—"John" and "J. B." both complain of bad tone to their photos. "J. B." should not try to get his tones too black, or they become cold and raw. I like a nice purple tint and always get it with my formula, which they will find in some of the back numbers of the English Mechanic, and to which I dare say many of our readers can testify. The reasons of the brown, leathery appearance may be many. There may not be enough silver in the paper, or gold in the toning bath, or too much sodium, or a badly salted paper, or under-exposed print. Old nitrate of silver baths are better than new if treated as follows:—Pour the bath into a large-mouthed bottle, then take about 1gr. of pure permanganate of potash in 1oz. of water, and pour in (a drop at a time) every three or four minutes. The reason for not pouring it all in at once is, because then it would turn nearly all the silver in your bath into permanganate of silver. Now shake this well and let settle. When you see the bath has a slight pinkish tone you may be sure that all organic matter is expelled the bath; place it in strong sunlight for about a week or in diffused light for a fortnight. There will be a precipitate; decant or filter (always keeping the bottle steady). This done, add fresh bath to make up for loss, at the rate of 60grs. per ounce for positive, and 50grs. per ounce for negative. Now test your bath for sensitiveness; if not sufficiently sensitive add more silver, always weighing. In fact, weigh everything. "John" need not be at all surprised at the bath discolouring after a dozen sheets, when I tell him that the same thing has occurred to me after two sheets. All that has to be done is to filter the bath through kaolin and add silver to make up for loss. What does "John" want with *black* negatives? Nothing can be finer than a good *brown* negative, always providing, of course, the shadows are clear. And now let me once more advise them to look at my descriptions of formula in back numbers, and success to them and all other fellow-workers in the "black art." If they have not enough, let them "ask for more," like Oliver Twist.—Mus.

[4424.]—COFFEY'S APPARATUS FOR DISTILLATION.—This apparatus differs in construction from all ordinary forms of still, for by its use a pure marketable spirit can be produced from the fermented wash by one distillation. It consists of a number of rectangular frames of wood about a foot each in depth, and of an area proportionate to the quantity of wash to be distilled in a given time. These are superimposed horizontally upon each other, each being furnished with a diaphragm of copper plate pierced with numerous small holes, and the apparatus, for the sake of convenience, is usually arranged in two columns:—1, the *analyser* 2, the *rectifier*. It is worked by steam at a pressure of 5lb. or 6lb. to the square inch and produced [illegible] ordinary boiler. When the analyzer is under full pressure the wash is introduced at the top through a pipe, to be afterwards referred to, and flows in a continuous stream through the holes in the diaphragm, meeting in its passage with the steam, which gradually raises it to the boiling point and causes it to part with the spirit which it contains. The steam, carrying with it the impure spirit, is next conveyed by means of a close pipe to the bottom of the rectifier. This vessel is traversed by another pipe whose convolutions are arranged horizontally throughout its entire length, one end being connected with the wash reservoir and the other with the top of the analyzer. The wash, in the first instance, runs through this pipe to the analyzer, and, being cold, causes the watery particles of the mixed steam and spirit to condense upon the [illegible] of the pipe, whilst the vapour, richer in alcohol, rises from one compartment to the other, gradually parting with the water until it reaches the "spirit plate;" here it is collected, and contains about 95 per cent. [illegible] alcohol.—A Revenue Officer.

[4427.]—CASE HARDENING.—If "W. H." [illegible] his cylinder red hot and then plunge it [illegible] with powdered prussiate of potash, he will [illegible] enough to resist filing.—Semper Paratus.

[4427.]—CASE HARDENING.—I do not [illegible] case harden with prussiate of potash, in [illegible] your work would scale in the fire. But it must [illegible] smooth afterwards, and what will a little scale [illegible] then? If it is of iron a little hardening won't hurt perhaps, but it should be of steel, and *cast* [illegible] *shear*. I once made one of the latter, and will [illegible] another. If of cast steel, as it should be, and well [illegible] it need not be hardened at all. It is not like a mandrel that is everlasting by running with heavy pressure on it. It never does *move* with any stress on it except when drilling, and very little then, and at all other times [illegible] held fast by its set-screw. I would rather fit the double-bearing mandrels than one *hardened* back centre cylinder.—J. K. P.

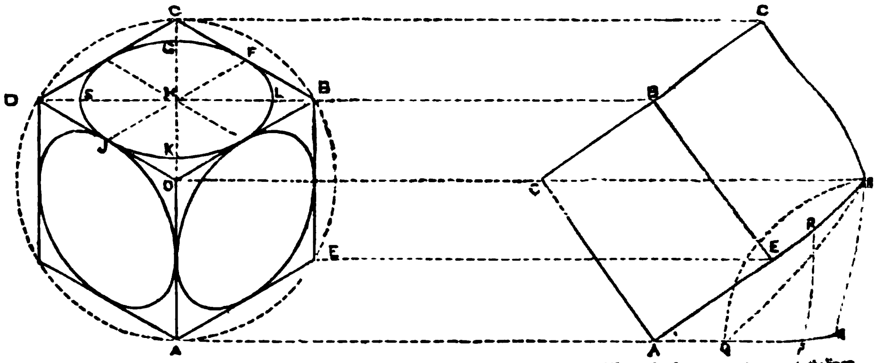
[4432.]—ISOMETRICAL.—This is returning to first principles. Fig. 1 represents a cube of 1in. in isometrical perspective with a circle on each face. As the lines OD, OB, OA, are equal and equally inclined to the paper and to each other they are contained by a circle (dotted). Fig. 2 is the side elevation of the cube. The way to get the angle of inclination of AX to the horizontal is to construct a triangle A N M, whose sides are in the proportion of 1, $\sqrt{2}$, $\sqrt{3}$, respectively, as that is the ratio of the lines, A D, A N, and D N; and the way to do this is as follows:—take M N = 1in. and make M Q = M N; then join Q N and make M A = Q N, and join A N,

$$\text{then, } ON = \sqrt{MN^2 + MO^2} = \sqrt{2},$$

$$\text{and, } AN = \sqrt{AM^2 + MN^2} = \sqrt{3},$$

and, therefore, $\triangle AMN$ is similar to $\triangle OAN$, and the angle N A M = angle O N A. Now to find the proportions of the projected circles. As every circle may be supposed surrounded by a square, the side of square obviously equals the diameter of the circle, or J F = O B, or, that is to say, J F is the measured diameter of the circle to be projected. Measure off A P = J F, and draw P R perpendicular, then G K = P R and S L = A R, and this holds good for any sized circle, as they are all exactly in the same proportion. Of course a isometrical drawing comes out larger than a perspective one, as the vanishing lines are not foreshortened, but exhibited of their full length, and the amount of this increase is $\frac{\sqrt{3}}{\sqrt{2}} = \frac{1{\cdot}732}{1{\cdot}414} = 1{\cdot}225$, or 22½ per cent. larger in lineal dimension. I do not give the proof of the last two sentences, as any one may easily make it out for himself, with a slight knowledge of geometry and of the principles of projection.—J. K. P.

FIG. 1 FIG. 2



[4433.]—MARKING COTTON CLOTH.—If "B. D. F." will get some ordinary, but clean, gas tar, and put it into an iron pan, and slowly drive off by heat the gas remaining, he may then apply it to marking goods of any sort by a stamp or otherwise, and it will resist all attempts at discharge by acid or alkali, but it will not show white. (This is used by all bleachers and dyers in Lancashire.)—Wahsrof.

[4434.]—TAPS AND DIES.—TO W. REED.—A left-handed male screw may be made from a right-handed tap, with a specially made screw-stock or equivalent contrivance in which the blank to be screwed is steadied on one side by a blank die, and has the teeth of a right-handed tap forced against it on the other. It is not worth doing, as it cannot be done well, and there are other and cheaper ways of getting a screw made if it requires doing decently. Workmen are, or used to be supposed clever, if they knew this trick. I accidentally struck a triple thread with ordinary dies a short time since, but then I was using them only for the purpose o their making scratches on the thicker parts of some small shafts that I was turning. I could, however, have followed up these scratches with the screw tool and have produced the wonder of a triple thread from single dies.—J. K. P.

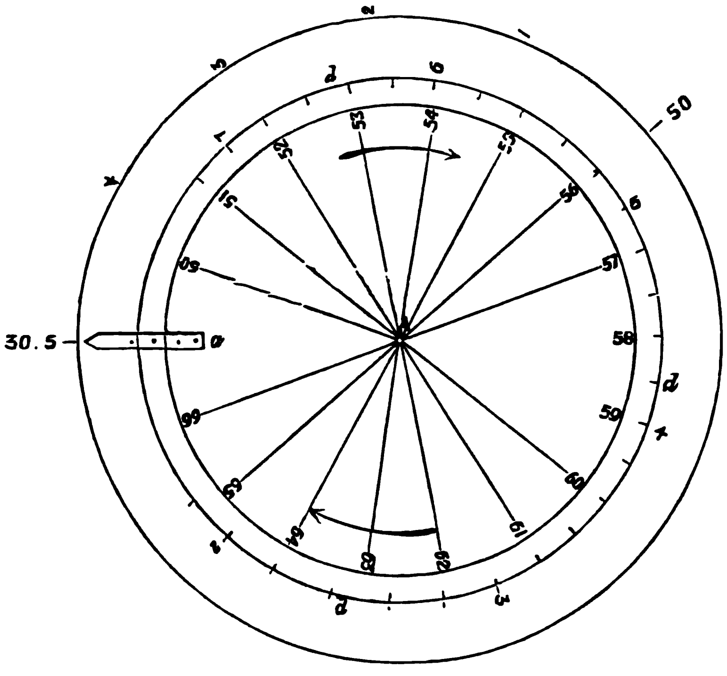
[4434.]—TAPS AND DIES.—W. Reed can make left-handed taps and dies very easily: he has only to work them the other way or backwards.—SEMPER PARATUS.

[4439.]—MATHER & PLATT'S PATENT PISTON.—"C. S. A." should write to Mather & Platt for the spring clip (I presume it is Barker's patent), and they will send him one, no doubt, and also the necessary information with it. The address of Mather & Platt, engineers, is Salford, Lancashire.—WAHSROF.

[4441.]—BAROMETER.—I must ask "Junius" to examine the index closely, and he will find that the degrees of temperature increase in a direction *opposite* to the tube graduations on circle *d d d*, so that as the temperature rises the liquid *falls* and the ratio in my glass is ·4in. for 1° Fahr. more or less, thus: *e.g.*

54° Fahr. = 6 inches
55° „ = 5·6 „
56° „ = 5·2 „
62° „ = 2·8 „
} Barometer steady at 30·5

This must be found by experiment for each glass, and it is only necessary to select a day when pressure is *steady*. Having inscribed your circle *d d d* as directed, place a blank circular card therein, and mark on the margin the temperature at that time. This figure must of course coincide with the liquid level on *d d d*. An hour after the temperature will have probably altered 1° Fahr. more or less. Set down this new number opposite its reading on *d d d*. A certain interval of tenths will be found for 1°; with a compass mark off the rest around the card. Supposing the interval = 5in., then there will be 2° Fahr. for each inch rise or fall. Any work on "Pneumatics" explains the law of expansion of air, &c., but such a calculation would be difficult and probably inaccurate compared to the plan suggested. In case of barometer falling I can only repeat what appears with illustration (53): with, however, a correction in 6th line from bottom, the words "*pointer a*" should be "54° *on card*." As the position of pointer is confusing where now placed it will be better to fix it in the blank space between 50° and 66°. A larger index is forwarded as desired, but I fear space is too valuable for its insertion. If "Junius" fails now I will draw out an index for him.—CORNUBIA.



[4442.]—CROQUET.—"Woodman" can buy a book of croquet instructions at almost any bookseller's for 6d., which will give him all the information he asks for. He will find crabtree or maple as good as anything for his mallet heads and balls, and quartered ash for mallet handles and starting posts.—WOOD SPOON.

[4445.]—ASPHALTE FOR GARDEN PATHS.—I had some done by my own man, and if "Sabbas" will get it from the gasworks prepared he can easily lay it down. Mixing the what is called asphalte—*i.e.*, the crushed cinders saturated, or nearly so, with the gas tar, with old lime, broken bricks, bits of limestone rock, Derbyshire spar, &c., to taste, and then well rollered several times.—WAHSROF.

[4446.]—MOUNTING MICROSCOPIC OBJECTS.—I don't think "H. U." will derive much advantage from mounting rotifers, as any medium in which they are mounted will cause so great an alteration in them as to render them useless; besides which, these creatures have an awkward habit of going to smash. Their natural end seems to be diffusion. If, however, "H. U." wishes to try the experiment of mounting them, he had better use Thwaite's liquid, or glycerine and camphor water. Pumphrey's vulcanite cells are so cheap (1s. per 100) that no excuse exists for trying rubberings. The latter are a plague to use, but will answer their purpose, *when* used, most admirably.—H. P.

[4446.]—MOUNTING MICROSCOPIC OBJECTS.—I fear it will be difficult to mount a rotifer so as to keep well, without causing a great alteration in its appearance. Try one in Dean's medium, but mounted in a cell, will be most likely to succeed. Try by soaking the rotifers in water saturated with creosote, and mount in the same fluid. Or chloride of zinc, 10 grains; distilled water, 1oz. I fancy you will find one of the above solutions to answer. I have never mounted rotifers, but have used them successfully for a great number of animal tissues, and dissections of insects. The vulcanite rings answer extremely well; in fact, they are the most useful cell made.—OPERATOR.

[4449.]—RESTORING FRESHNESS TO FILTERED WATER.—The flatness of the filtered water, and of that which has been boiled, proceeds from the same cause—viz., the absence of air. If, therefore, "F. P. S." will aërate his water after filtering by pouring it from a watering can with a fine rose held at a height of about 3ft. or 4ft. (if necessary repeating the process) he will find it as fresh and palatable as before. The same effect will be produced on boiled water.—VERTUMNUS.

[4449.]—FRESHNESS TO WATER.—Pour sharply from one vessel to another; or, better, pass carbonic acid gas (easily made from chalk and sulphuric acid) through it.—H. P.

[4451.]—MOULDS OF COINS.—Fusible metal makes very fine moulds of coins, and avoids the trouble of blackleading. Gutta-percha softened in *hot* water also answers well if it is placed on the coin, and the two put on a piece of plate glass in a *press*. An ordinary copying press will answer well. Sulphur and white wax are also used; and for small coins, ordinary sealing wax will answer for a rough experiment.—OPERATOR.

[4451.]—MOULDS OF COINS.—They can be made of gutta-percha, or wax, or plaster of Paris. I recommend wax, which I should use as follows:—Grease the coin and fix a cardboard ring round the coin, and then pour in the wax, melted; when it has set, take it off and repeat the process on the other side; next stick them back to back, and brush it well with plumbago (a fine quality black lead), it is then ready for electrotyping.—SEMPER PARATUS.

[4451.]—MOULDS OF COINS.—White wax, with flake white added, gives very good impressions of coins, &c., which should have a narrow slip of paper gummed round their edges, to hold the wax when poured in a melted state on them. These should, when cold, be coated with plumbago, applied in powder by a camel's hair pencil till the whole surface of the wax assumes a polished appearance.—J. B.

[4451.]—MOULDS OF COINS.—I take impressions on moulds of coins in this way. I use them for medallion cutting by Lowe's machine (the cheapest, neatest, quickest, and best out):—I first get some gutta-percha of a thickness to suit the coin or medal to be copied and steep it in warm water until it becomes soft, and then warm the medal and lay it on the gutta-percha, and simply place a 14lb. weight upon it. This does one side only—the same is required for the other. I then rub the gutta-percha impression with the finest plumbago (prepared for electrotyping) and submit it to the sulphate of copper bath, using the finest sulphate of copper and the carbon battery, and have got some very good impressions.—WAHSROF.

[4451.]—MOULDS OF COINS.—If it be required to produce *moulds* of coins so as to obtain facsimiles in electrotype copper, the best plan is to make impressions in sealing wax on note paper, then, to avoid warping, attach them to a heated copper wire, and then thoroughly blacklead the surface. I have a considerable collection of Grecian, Roman, and English coins made in this way when electrotyping was in its infancy. The mould of each side was taken close together on the same piece of paper, and a smooth connection between them made with soft white wax, enabling them to be trimmed up so as to show the obverse and reverse side by side, attached by a band, as shown in engravings. They may be silvered or gilt to represent the original; when larger than a florin gutta-percha will be found to be the best material, as both this and sealing wax have the merit of not injuring the surface, which can hardly be said for stearine and spermacetti, &c.—W. K. B.

[4452.]—LIGHTNING CONDUCTORS.—Rod iron is generally used for them. A good size is ⅝in. They should reach above the highest part of the building, and be pointed at the top. The points of contact with the supports on the side of the house, are preferably of glass; but that precaution is mostly ignored, and the rod must be inserted in the earth to the depth of about a foot or so.—SEMPER PARATUS.

[4453.]—BACKGROUNDS.—I do not recommend backgrounds to be rolled up. If the stretcher be made with wedges, like the stretchers used for painters' canvas, a tap with a hammer now and then will keep it tight. To paint a background, use a coat of size and whiting, with a little glycerine for first coat; and after that is dry, lead-coloured paint, containing a large proportion of turps, will give a perfect *dead* surface without gloss that will not crack if used with care.—OPERATOR.

[4457.]—STEAM BOILER.—It often happens a bleaching and printing works that, though they use the steam for boiling, &c., after the great pressure has been taken out of it by the engine, they require more steam at a reduced pressure to that in the boiler—and there are many makers. But Messrs. Musgrave & Son, or Messrs. Hick, Hargreaves, & Co., of Bolton, make what are considered very capital reducing valves.—WAHSROF.

[4456.]—BLACKING FOR HARNESS.—The following recipe is given by good authority:—Treacle, ½lb.; lampblack, 1oz.; yeast, a spoonful; sugar candy, olive oil, gum tragacanth, and isinglass, each 1oz.; and a cow's gall. Mix with two pints of stale beer, and let it stand before the fire for an hour.—G. H.

[4459.]—FURNITURE CREAM.—The following is said to be good:—1st, Soft water, a gallon; soap, 4oz.; white wax in shavings 1lb. Boil together, and add 2oz. of pearlash. To be diluted with water, laid on with a paint brush, and polished off with a hard brush or cloth. Or, 2nd. Wax, 3oz.; pearlash, 2oz.; water, 6oz. Heat together, and add 4oz. of boiled oil and 5oz. of spirits of turpentine.—G. H.

[4459.]—WHITE FURNITURE CREAM.—Take of raw linseed oil 6oz.; white wine vinegar, 3oz.; methylated spirit, 3oz.; butter of antimony, ½oz.; mix the linseed oil, with the vinegar by degrees, and shake well so as to prevent separation; add the spirit and antimony, and mix thoroughly.—R. S. NEILSON.

[4461.]—SCREW CUTTING.—In answer to "H. Williams," I should use wheels of 12 gauge, provided they can go on to the mandrel, in which case the distance between the centre of mandrel and centre of leading screw would be about 7in. If his lathe has only one collar, and a cone centre bearing behind, he will have to put a wheel on the back of his pulley working into another wheel supported by a bracket, and to put the driving wheel of his train into the spindle of this second wheel. In this case the distance of centres would probably (it need not) be much less than 7in., and then wheels as small as 20 gauge are handy. Mine are of 20 gauge, but are gun-metal, cut wheels. Also in this case I should make the mandrel wheel double that carried by the bracket, and use a left-handed leading screw of 8 to an inch, which would by this arrangement be equivalent to a right-handed screw of 4 to an inch applied in the ordinary way, and that is the pitch of screw that I am now putting to my old 5in. lathe in place of one of 10 to an inch that I find too slow for what I now require, only my new screw is of double thread, cut with a screw tool of ½ pitch. I have nearly done my new double-geared 5in. head stock, and shall show it with pleasure to any one who wishes to see it and will first address a letter to me per the Editor ENGLISH MECHANIC.—J. K. P.

[4462.]—STRANGE PHENOMENON.—The phenomenon described proves that "Glowworm" is one of those *few* persons that are capable of being affected by, or sensitive to, odic force. I should feel obliged if "Glowworm," if he has a chance, would experiment a little on the subject, as the existence of the odic force is denied by many. The following is an experiment I recommend him to try: Get a magnet as powerful as possible, and first request a friend to pass it down his back with the poles or ends nearly but not *quite* touching the dress, commencing at the back of the head and slowly drawing it downwards towards the feet, and carefully note the sensation it produces. Afterwards take the same magnet into a dark room at *night*, so as to exclude *every* trace of light, and placing himself about a foot from the magnet look at it attentively for some time—say half an hour—and also note the phenomena that take place. I shall feel obliged by these simple experiments being tried by "Glowworm," as they will help to confirm the truth of a little known and despised branch of science. If successful I will describe other experiments to be tried. The light observed by "Glowworm" is caused by the chemical action taking place in the leaves. I can, if required, name many places where the above light will be seen; over a *new-made grave* it is very often seen, and no doubt has frightened sensitive people terribly, while another person not sensitive would not be able to see anything unusual. In fact, in every case where chemical action is taking place the light will be seen to a greater or less extent.—OPERATOR.

[4464.]—THE MANGANESE BATTERY.—In reply to "M. D.," I beg to state that I am still a regular reader of the ENGLISH MECHANIC, and, by your courtesy, an occasional contributor to the correspondence. The manganese battery continues to work perfectly well, and hardly diminishes in strength. It has been absolutely untouched for many months, with the exception of an occasional addition of water to replace evaporation: The clock keeps better time than a good pocket chronometer in my possession.—W. H. STONE.

[4465.]—TRACING PAPER.—This may be prepared by brushing over one side of a good, thin, unsized paper with a varnish made of equal parts of Canada balsam and turpentine. If required to take water colour, it must be washed over with ox-gall and dried before being used.—T. W. BOORD.

[4465.]—TRACING PAPER.—"H. U." can make a good tracing paper by mixing, with the aid of gentle heat, an ounce of Canada balsam and a quarter of a pint of spirits of turpentine. Wash one side of the paper with this mixture. The black carbonic papers are made by being "painted" with a composition consisting of 2oz. of tallow, ½oz. powdered blacklead, ½ pint of linseed oil, and sufficient lampblack to make it of the consistency of cream. These should be melted together and rubbed on the paper whilst hot. When perfectly dry they will be fit for use.—C. T. R.

[4466.]—CLEANING PRINTS.—Immerse the print in a bath made by adding to strong muriatic acid its own weight in water, and to three parts of this mixture putting one of red oxide of manganese. A print may remain in this liquid 24 hours without harm. If the print has been mounted the paste or other adhesive should be entirely removed previously with warm water. The saline crystals left by the solution will wash away by repeated rinsings with warm water.—SABBAS.

[4467.]—IMPRESSIONS FROM PRINTS.—I give the following recipe, but I have not proved it:—Soak the print in a solution of potash, and afterwards in one of tartaric acid. This produces a diffusion of crystals of bitartrate of potash through the unprinted part of the paper. As this salt repels oil the ink roller can be passed over the surface without transferring any of its contents to the paper, except in those parts to which the ink had been originally applied. The ink of the print prevents the penetration of the saline matter, and so only the lines of the picture will take the ink from the roller.—C. T. R.

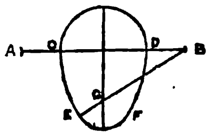
[4474.]—HORSE POWER.—"Lloyd's Sliding Rule" will show the horse power of any high-pressure engine, the pressure on the safety-valve of boiler and diameter of cylinder being given.—T. W. BOORD.

[4478.]—BLUE WRITING INK OR FLUID.—One of the best and simplest is made by dissolving soluble prussian blue in distilled water. The blue is obtained by adding a solution of proto-sulphate of iron to a solution of ferroyanide of potassium and washing the precipitate, after it has acquired a deep blue colour, until it begins to dissolve in the water; it may then be either collected and dried, or at once dissolved for use.—T. W. BOORD.

[4479.]—COLLODION.—In order to avoid ridges when coating the plate, it should be rocked to and fro while the superfluous collodion is draining off into the bottle. I should think that W. Crawley's collodion is too thick.—T. W. BOORD.

[4481.]—BAROMETER SCREW.—There seems no difficulty in determining whether the screw was in any case meant for the use Mr. Tomlinson mentions, by merely measuring whether the scale is divided into true inches or diminished ones. They ought plainly to be always less than full inches in the ratio that the lower mercury surface is less than both surfaces together. Rarely is the tube so small relatively to the cistern that a variation in the difference of level would practically be all visible at the scale. If its inches then are not diminished, I should conclude the original designers contemplated this very clumsy adjustment of level at every reading.—E. L. G.

[4482.]—OVAL.—The following method of describing an "egg-shaped oval" is taken from "Burchett's Practical Geometry"—a ufficient answer to the second part of John Barton's query:—Upon any right line AB



describe a semicircle CD, equal in diameter to the proposed oval. From C and D, with the radius of the semicircle, cut the right line in A and B. From A and B, with radius BC, describe arcs CE and DF. From A or B draw a right line through the transverse diameter, cutting it in G, touching the opposite arc in E or F. From G, with radius GE, describe arc EF, completing the figure. NOTE.—The length of the figure may be increased or diminished by increasing or diminishing the radii AD and BC, and by placing the point G higher or lower on the transverse diameter.—J. NASH.

[4482.]—OVAL.—Works of high geometry, as Sir Isaac Newton's "Enumeratio Linearum Tertii Ordinis," describe plenty of geometrical curves more or less egg-shaped—as that described by a point in the connecting rod, Fig. 1, p. 448 (July 29), but all such ovals, being of equations above the second order, are beyond treatment in popular books. If the question be one of mere drawing, the outline of a hen's egg is best represented, Mr. Denison says, in his "Astronomy without Mathematics," by a semi-ellipse for the small end, joined to a semicircle for the large. Many more elegant ones, as the plover's, are rather composed, I think, of a parabola with a circular arc, which in that case must always be more than the semicircle. The more you have of one curve the less of the other, and the more of parabola the longer the egg, and the greater the circular radius relatively to the parameter. An inferior but passable imitation may be composed of six arcs of circles, but hardly of four; though the drawing books affect to form thus an ideal egg-shaped human head. It should also be known that no ellipse, visibly or plainly different from a circle, can be decently imitated by fewer than eight circular arcs. The arches of old Blackfriars Bridge might have only four, but few probably noticed that they were oval at all. The Roman amphitheatres were, as may be seen by all foreign plans of them, all struck from eight centres at least—never from four—as engraved in one of Mr. Fergusson's books, or like the Kensington Hall of Science. In fact, no race that has anywhere left monuments, before the English of this reign, ever tolerated anything like the crippled four-centred ovals of our builders. The Victorian loss of "eye," or sudden barbarizing, in one generation of all taste in form or colour among us, is a really new and world-wide nuisance, one that, though accounted for, will make the age stink to all others while a relic of it lasts.—E. L. G.

[4487.]—BURNT CLAY.—The red colour is due to the decomposition of salts of iron during the process of burning.—T. W. BOORD.

[4489.]—TURNING COPPER.—Reduce the width of the cutting edge of the tool.—T. W. BOORD.

[4493.]—COIL.—For my own experimental use I designed and made a commutator, such as "R. N." desires, but it is a troublesome job and requires diagrams to explain. It consists of an ebonite cylinder with three series of contact arrangements; the middle one for the primary, the two sides corresponding one to the contacts and the other to the breaks of the primary. There are springs and the requisite conductors to direct the course of the current. I may hereafter fully describe this and its works, but it would be useless for "R. N.'s" purpose, because the driving out of the tube affects the intensity only, not the quantity, and therefore makes no change in the chemical or galvanometric results. I do not at the moment see how to assist "R. N." in gaining his object The tangent galvanometer will be fully described in my next paper. The British unit is about one twenty-fifth of Varley's.—SIGMA.

[4494.]—DISSOLVING RESIN.—You need not dissolve the resin; add to the flour with which you intend to make your paste 1-6 to ¼ of its weight of very finely powdered resin and proceed as usual; this with the addition, when made of a minute quantity of creosote, oil of cloves, or corrosive sublimate, will keep a long time. —T. W. BOORD.

[4500.] — SILVER THIMBLES.—These and other silver articles, when tarnished, may be cleaned by washing with caustic ammonia.—T. W. BOORD.

[4503.]—MENSURATION OF SUPERFICIES.—The area of "T. W. H.'s" triangle is 20·6197, and the following is the manner of working it:—

$$\frac{9·2 + 7·5 + 5·5}{2} = 11·1$$

$$11·1 - 9·2 = 1·9$$

$$11·1 - 7·5 = 3·6$$

$$11·1 - 5·5 = 5·6$$

$$11·1 \times 1·9 \times 3·6 \times 5·6 = 425·1724$$

425·1724(20·6197
4

406) 02517
6) 2436

4121) 8124
1) 4121

41229) 400300
9) 371061

412387) 2923900
2886709

J. NASH.

[4506.]—WATER BAROMETER.—I should be glad to help "Gimel" without price, but glass is perishable, and a journey would be fatal to such a fragile arrangement; besides, each glass requires at first a careful series of observations in order to construct its index (see reply to "Junius" in this number). Any handy workman would easily construct the glass from the drawing, and if "Gimel" could spare ten minutes a day for a week, he would get the range, and could form index therefrom.—CORNUBIA.

[4507.] — MUSHROOM CULTURE. — W. Reed can scarcely expect to grow mushrooms in nothing but mould. The delicate filaments which form the roots of this fungi could not possibly spread through a mass of loam. If he will put about three-fourths dung to one-fourth mould, and well mix, I have no doubt he will succeed. Possibly a less quantity of dung would do if the mould used is full of fibre—like turfs cut from an old meadow. But will not the temperature on the top of the boiler be rather too high?—SAUL RYMEA.

[4509.]—BRASS TUBES.—Brass may be polished with crocus and oil after properly smoothing with emery, but should then be lacquered to make it retain its brilliant surface. Both soldering and brazing have been often described.—T. W. BOORD.

[4511].—WEIGHT OF BALL.—To obtain the weight of a cast-iron ball multiply the cube of diameter in inches by ·136. For wrought iron multiply by ·146, which will give the weight in lbs. To find how much wire ¼in. round can be made from a ball 7in. diameter, first find the weight of a yard of the wire by multiplying the square of diameter by 7·854, which gives the weight per yard in lb. Then divide the weight of ball by the weight per yard of wire. The result will be the number of yards of wire, exclusive of waste in process. By the above rule "Ralph Williams" will find the weight of a wrought-iron ball, 7in. diameter, to be 50lb., and the weight of a yard of ¼in. round wire about half a pound. Therefore $\frac{50}{5·} = 100$ yards.—FERRUM.

[4511.]—WEIGHT OF BALL.—I think "Lloyd's Improved Sliding Rule" would suit Ralph Williams, price about 4s. On referring thereto, it appears to me that a cast iron ball 7in. in diameter should weigh 47lb., and one of wrought iron 50lb.—T. W. BOORD.

[4511.]—WEIGHT OF BALL.—An iron ball 7in. diameter would weigh 49·652lb.; for the weight of a cubic foot of cast iron is 7645oz. Avoir. (Hutton), and the cubic content of a ball 7in. diameter is 179·5948 cubic inches. The following formula will show the working:—

$$\frac{7^3 \times ·5236 \times 7645}{1728 \times 16} = 49·652 +$$

A simpler rule, though not so exact, is: 9 times the cube of the diameter, divided by 64, will give the weight in pounds. So,

$$\frac{7^3 \times 9}{64} = 48·234375$$

The rule is found by assuming that the diameter of an iron ball weighing 9lb. is 4in. It is not quite so much; hence the inaccuracy. This may be drawn into 304 8 9ths feet of round wire ¼in. diameter. The solidity of 1ft. of this wire is found by multiplying the square of the diameter by ·7854 and then by 12. This product, divided into the solid contents of the ball, will give the number of feet into which it can be drawn.

$$\frac{179·5948}{·25^2 \times ·7854 \times 12} = 304·8 \text{ or } 304 \text{ 8-9ths.}$$

J. NASH.

The *Academie des Sciences* offers, this year, six mathematical prizes, each worth 3,000fr. "On the Use of Electricity in Medicine" is a subject for which 5,000fr. are offered.

QUERIES.

[4514.] — STEEL MANDRELS FOR [illegible] LATHES.—Could some of your readers kindly [illegible] turner the best means of forming steel [illegible] collars or bearings and hardening the same for [illegible] lathes?—JOHN THOMAS.

[4515.]—FELT HATS.—Would any brother [illegible] form me how to clean felt hats when they [illegible] shiny?—IGNORANCE.

[4516.] — ASTRONOMICAL PHENOM[illegible] "F.R.A.S." or Mr. Webb kindly give an opinion [illegible] following? A young friend of mine writes to [illegible] follows:—"The moon was very low, being only [illegible] the house at the end of the garden * * * [illegible] it was exactly as if a continual current of air [illegible] off the north edge of the lunar disc, [illegible] sionally with the position of objects, but [illegible] with their sharpness, but quite prevented [illegible] jects being seen. A power of 540 showed [illegible] vibration." My friend's stand is of mixed [illegible] and, though portable before some [illegible] was, I know, quite steady. The house [illegible] garden is distant about 120 yards; [illegible] stands usually about 100 yards from [illegible] Whether it is to vibration of the stand, [illegible] air arising from the roof of the house, I [illegible] —α URSÆ MINORIS.

[4517.]—STAINING GUT FISHING LI[illegible] the best stain for gut lines, and how can I [illegible] —FLUVIUS.

[4518.]—MYROBALANS.—What is myrobalan [illegible] for what is it used?—H. U.

[4519.]—PHOTOGRAPHY.—Can any of our [illegible] readers inform me of a varnish that will pre[illegible] negative while printing, and not stick to the pape[illegible] would prefer one that requires heat to varnish [illegible] any one could tell me how to make it I should be ob[illegible] —YOUNG PHOTO.

[4520.]—PERCH FISHING.—When is the best [illegible] to fish for perch, and what is considered the pro[illegible] tackle? Are there any good perch near London? —EDWIN JONES.

[4521.]—EXTRACTING HONEY FROM THE COMB. —Can any of your numerous correspondents enlighten me as to the best way of extracting the honey from the comb, for domestic use?—AMATEUR BEE KEEPER.

[4522.]—PURE CHARCOAL.—I should feel obliged if "Sigma" would tell me how to make pure charcoal, and what kind of fire and hot plate is pure.—SAMUEL IBBOTSON.

[4523.]—COLOURS FOR TICKET WRITING.—Can any brother reader kindly inform me what ingredients are used, and the way of mixing the following colours as used by ticket writers—red, green, brown, and yellow?—COLOURMAN.

[4524.]—STEAM JOINT.—I have a portable [illegible] boiler, and I wish to have one or two fixed engines [illegible] different parts of my farm, and also to have a [illegible] Cameron's steam pump. In fact, I want to carry [illegible] boiler to where I have an engine or pump instead [illegible] portable combined engine and boiler. The diffi[illegible] have is to get a perfectly tight steam joint [illegible] boiler and engine. As with a portable boiler [illegible] be almost impossible, having regard [illegible] ground and any slight change of place [illegible] the joints of steam pipe tight. This [illegible] could be met temporarily by the use of a flexible india-rubber tube vulcanized, but I am afraid that the heat of steam at a pressure of 80lb. to 100lb. per inch would in a few weeks destroy the india-rubber. Can any of your readers tell me whether any telescopic joint with vertical motion, and motions *right and left* and to or *from engine* has ever been used, and if so, where it can be got?—SCHEMER.

[4525.]—VESUVIANS.—Will some reader oblige [illegible] with a recipe to make vesuvians and cigar lights? —J. B.

[4526.]—ELECTRIC TIME GUN AND BALL.—[illegible] any obliging scientific or other reader of the MECHANIC give me a description of an electrical time gun and ball —I mean a model on the same principle as that [illegible] Edinburgh or Birkenhead, &c.? I have seen them experimented with on the lecture table, and wish very much to construct one myself.—W. [illegible].

[4527.]—AERATED WATERS.—Can any one [illegible] quainted with the manufacture of the above tell me [illegible] cause of nectar turning thick and bitty after [illegible] bottled fourteen days or so? Has different tempera[illegible] anything to do with it, or is it fermentation that [illegible] it? if so, what does the syrup require in it to prevent [illegible] Any information on the above will oblige.—[illegible] WATER.

[4528.]—CARVING AND TURNING WOODEN WARE. —Can any reader inform me how to make hollow [illegible] turnery, such as butter prints, spice boxes, &c.? How are they hollowed out, and by what means do they [illegible] the screws? They must be done quickly, as they are [illegible] cheap.—MAP.

[4529.]—CHAIN ADJUSTMENT TO COMPOUND MICROSCOPE.—Would any reader be kind enough [illegible] inform me what is the principle of the chain adjustment as applied to the compound microscope, and whether [illegible] is sufficiently accurate to take the place of both the [illegible] and fine movements with high powers?—S.

[4530.] — REMOVING PLASTER FROM GLASS CHANDELIER.—I shall feel obliged if any reader can inform me how to remove old plaster of Paris from [illegible] glass chandelier. I want to take one to pieces, and [illegible] not know how to proceed.—OXFORD.

[4531.]—SODA CRYSTALS.—Joseph Roskell having so kindly volunteered information respecting the manufacture of this article, I should be glad of same, for proceeding on a small scale, "if practicable," or other chemical of easy process, marketable; the two pans [illegible] have are cast iron, and contain 120 and 70 gallons respectively, outlet for steam through trap-door in [illegible] —SODA CRYSTALS.

[4532.]—TELESCOPIC, Etc.—Will one of the many readers of your publication inform me whether it would be considered good work for an 8in. reflecting telescope to show Jupiter's second and third satellites fifty-eight minutes after sunrise, the sky being entirely free from cloud?—H. A. C.

[4533.]—FURNACE FOR HEATING MOULDS.—I understand there is in use in the forges in Staffordshire a patent furnace for heating the moulds from which spades and shovels, &c., are manufactured. The furnace is small, of an oblong construction, and has apertures on each side sufficiently large to admit one or two moulds. The end directly opposite the blast is left open, and acts as vent hole and feeder, into or through which the fuel is passed. Can any reader furnish me with particulars of the construction of this furnace, or give me any idea who is the patentee—*i.e.*, if the thing is really patented?—Wm. Scott.

[4534.]—SPECULA GRINDING.—TO MR. PURKISS.—Will Mr. Purkiss be good enough to say whether his machine for specula grinding (described in the English Mechanic) would do for the grinding, polishing, and parabolizing of plano-convex lenses of 4in. or 5in. in diameter? If large lenses (plano-convex) could be parabolized by his machine, could not a large and cheap object-glass be constructed with facility? I presume that a couple of large lenses both plano-convex, one flint, and the other crown glass, parabolized, would be a cure for spherical and chromatic aberration? Could the lenses be tested in the same manner as his specula?—Raymond.

[4535.]—HORTICULTURAL.—Can any one give me a few instructions concerning pruning gooseberry and currant bushes?—G. H.

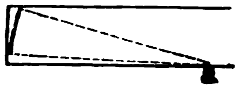
[4536.]—MELTING POINT.—What melting point should I get when I mix paraffines having melting points of 128° and 109° in the proportions of 2 to 1, 3 to 1, and 4 to 1 respectively? *Correct* answers and how it is done will oblige. Is there a latent heat to be taken into account?—Melting Point.

[4537.]—EQUIVALENTS.—Would Mr. G. E. Davis or any of your chemical subscribers kindly favour me with a list of the elementary substances with their equivalents, according to the new notation?—MaO Co^3.

[4538.]—HARMONIUM PAN.—I have an harmonium and I have spoiled the pan experimenting with it. Can Mr. Smith or "Adept" oblige me with the depth of channels, pallet, and reed-holes for a two-row pan, as I should like to make one (or try to do so)? If they would oblige I should be thankful.—W. A. S.

[4539.]—CHIMNEY.—The firm whose engines, shafting, and machinery are under my charge are about to build a new chimney, and I shall be much obliged if you or any of your correspondents will give me the best proportions for it, especially as regards height and size of flue. There are four Galloway boilers to be attached to the chimney, each 24ft. by 7ft. diameter, with 24 Galloway tubes in each; there is also an economizer between the boilers and the foot of the proposed chimney. The works are situated in a valley with hills all around.—William Moody.

[4540.]—MOUNTING PLANE MIRROR IN REFLECTING TELESCOPE.—I should feel obliged if Mr. Proctor or other of your numerous contributors would inform me if there are any drawbacks to a system of mounting the prism or plane mirror in reflecting telescopes shown in the enclosed sketch. The speculum is slightly inclined, as in Herschell's, and the image is received on a reflecting prism placed at the side, the prism being a portion of the eye-piece. This form would seem to me to possess the advantages of an increase of light combined with simplicity of construction, but having had no experience in such matters, I should like to know the opinion of some one of your able writers.—A. White



[4541.]—EMBROIDERING MACHINE.—Can any of your readers tell me upon what kind of a machine the embroidered insertion for ladies' white petticoats is executed? The sewing material is woollen, and the stitch a chain somewhat similar to the Willcox and Gibbs' stitch. I have tried to embroider on the Willcox and Gibbs, but I find it very difficult to make a sharp curve, owing to the great length of the feed. Is there any other chain-stitch machine better adapted for the purpose? I fancy there is. A reply would greatly oblige.—A. Braider.

[4542.]—STEAM PUNCHING PRESS.—Will any of your readers show me how to set steam power to work a vertical screw press, *i.e.*, a press of the kind used for cutting out steel pens by hand, but on a much larger scale? I want 50 blows per minute. An excentric motion, as in the common punching machines, will not do. Toothed wheels will not do. The motion must be continuous, as the work is too heavy and has to be too quickly done to allow of a reversing action.—Punch.

[4543.]—TORTOISE-SHELL COMBS.—Could any reader tell me how to join tortoise-shell combs?—Hairdresser.

[4544.]—PHOTOGRAPHIC.—Can a photographer give or sell cartes-de-visite of persons he takes to other people without their consent?—Photo.

[4545.]—HOGG'S SECRET CODE.—Will "Cryptographer" please give me the information for finding a clue to the cipher, as he promised in No. 278, and also any suggestion he may have to make respecting secret codes?—Argus.

[4546.]—DIVISION PLATE, &c.—Will "J. K. P." kindly give the best numbers for a division plate having three rings of holes, and say whether he considers it impossible (or nearly so) for an amateur to fit up a back-geared headstock having two steel cones running in steel conical collars (both to be hardened and ground to a fit)? I also want to know the best angle for the cones; 35° appears to me too great?—Bierlala.

[4547.]—A FIELD OF BARLEY GROWN FROM OATS.—Can any correspondent throw any light on the following, which I extract from Elihu Burrit's "Walk from London to John o' Groats"?—"It was a large field of barley grown from oats. The barley sown in this field was the first-born offspring of oats. The head and berry were barley, and the stalk and sheaves were oats; and the whole process by which this wonderful transformation is wrought is simply this and nothing more:—The oats are sown about the last week in June, and before coming into ear they are cut down within 1½in. of the ground. This operation is repeated a second time. They are then allowed to stand through the winter, and the following season the produce is barley. This is the plain statement of the case in the very words of the originator of this process, and of this strange transmutation. The only practical result of it which he claims is this, that the straw of the barley thus produced is stouter and stands more erect, and therefore less liable to be beaten down by heavy winds or rain. Then perhaps it may be added this oat-straw headed with barley is more valuable as fodder for live stock than the natural barley straw. But the value of this result is nothing compared with the issue of the experiment as proving the existence of a principle or law hitherto undiscovered, which may be applied to all kinds of plants for the use of man and beasts. If any reader of these notes is disposed to inquire more fully into this subject, I am sure he may apply without hesitation to Mr. John Elkins, of Bruntisham, near St. Ives, Huntingdonshire, who will supply any additional information needed."—S. G.

[4548.]—IMMERSION LENSES.—What are the principle advantages of the immersion objectives? Do they cost much?—M. J. C.

[4549.]—DOES BOILING DESTROY GERMS.—I should like to hear the opinion of your numerous microscopical readers on this interesting question. According to some authorities, there are some germs which are not destroyed unless the temperature of the water is raised 10° or 12° above boiling point.—Sabbas.

[4550.]—THE SMEE AND BICHROMATE BATTERIES.—I am disappointed with "Sigma's" answer to my query (4450), and after procuring the numbers he this week recommends, find myself very little wiser. At page 341, "Sigma" describes the double cell bichromate battery, and says, "Its use in a simple cell system will be referred to afterwards," which has not been the case for this week at page 482, he says, "But I have now dealt with all the forms I can remember of any general interest and practical value, and therefore conclude this part of the subject." "Sigma's" descriptions are not clear enough for the ordinary mind. For instance, the sulphate of lead battery, described at page 482, would puzzle 99 out of every 100 to tell what it was like, and I am sure, from the description, no one could make one. Will any other of your readers answer my query, No. 4450?—M.R,C.S. (a New Subscriber.)

[4551.]—TRANSFERRING ENGRAVINGS TO WOOD.—Can any fellow-reader tell me a simple way to transfer engravings from paper on to wood, and oblige.—Wood Spoon.

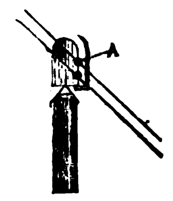
[4552.]—AVIARY.—Will any one tell me what birds I can keep together in an aviary?—Rebaf.

[4553.]—SILVERING CLOCK DIALS.—Would "A Morayshire Man," or some other correspondent, tell me why I, as well as "Poor Clock Jobber," cannot silver a brass plate properly. I had an old-fashioned barometer brought in last week to have the dial silvered. It is one of those which has the mercury showing all up the centre. So I accordingly set to work and carried out "A Morayshire Man's" directions to the letter, and, I must say, succeeded in putting the silver on very well; but, on account of applying a dirty brush to varnish it, I spoilt it; so I set to work and scoured off all the old silver, and began afresh—but all to no purpose; for after I had been rubbing the silver on a little bit it looked just like a decayed bit of bone. I then tried again; and all round the plate near the edges it looked more like copper than anything else; and as for the edges of the plate they looked quite black. How is the plate fixed whilst silvering? I lay mine on a clean bit of rag?—Young Country Watchmaker.

[4554.]—THE PENDULUM.—The law of pendulum motion is, that a weight suspended by a silken cord will move in unequal spaces in equal times. Why, then, should a clock gain time by raising the bob, as by the law a longer swing should be accomplished in the same time as a short one?—Vibrator.

[4555.]—PHOTOGRAPHY.—Will some of our readers kindly give the best process for enlargements upon paper; also the best mode of preparing albumenized paper, and how to free a bath from acetic acid? What is the autotype printing process?—Lex.

[4556.]—TELEGRAPHY.—May I ask some one the use of A in the diagram? It is affixed to the telegraph poles. I heard it suggested that it was intended to hold the wire in the event of the porcelain head breaking. However, they are always put on the inside of the pole if they have any strain.—Mus.



[4557.]—WOOD ENGRAVING.—I have cut out a large steamer for a billhead, but had the sea too coarse and open. Could any one inform me of a composition (if there is such a thing) with which I can fill up the hollows, and re-engrave, or must I have the piece cut off and reversed, and engrave again?—Mus.

[4558.]—STEEL PLATES.—Could any one inform me of the price of steel and copper plates for engraving upon.—Mus?

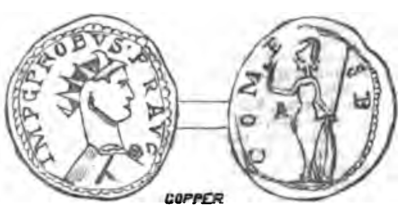
[4559.]—HORSE POWER.—Please inform me the horse power of my boiler; it is working at 40lb. per inch. It is 32ft. 6in. long, 6ft. 6in. diameter, two tubes running through it, each 2ft. diameter.—Thos. Davies.

[4560.]—PAINTING CISTERN.—I have an iron soft water cistern. Can any one tell me what is the best thing I can use to paint the inside with? It has been painted with good white lead paint, but it has shelled off and the white lead fallen to the bottom of the water.—Cistern.

[4561.]—ENGRAVED BRASS PLATES.—What is the general mode of filling in engraved brass plates?—T. D.

[4562.]—VIOLIN STRINGS.—I have a number of violin first strings which I keep in a tin box. Will some reader kindly inform me if I ought to take any other precautions for preserving them besides that of keeping them from the air?—R. E. G.

[4563.]—COPPER AND BRASS COINS.—I should be much obliged if any of the readers of your valuable paper can inform me what the enclosed coins are. The large one is copper and the small one brass.—Wood.


IMP C PROBVS P F AVG
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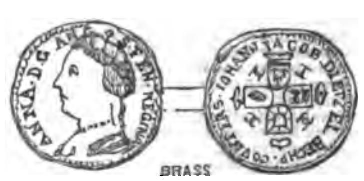
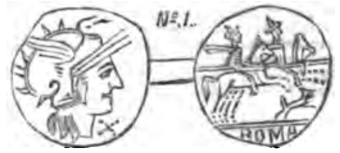
COPPER


ANNA D G ANG SCOT FRAN ET HIB REGINA
IOHANN IACOB DIETZEL

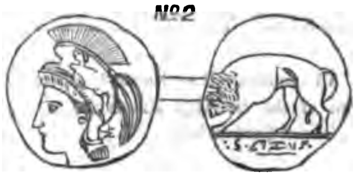
BRASS

[4564.]—TWO SILVER COINS.—Will any of your correspondents kindly describe the coins of which I send sketches if you can afford space for their insertion?—Giles.

No. 1.



No. 2



[4565.]—INDUCTORIUM'S COIL.—Will "Inductorium" kindly state where the ebonite tube may be obtained? also the probable cost of a coil constructed similar to his?—Wreath.

[4566.]—UMBRELLA FRAMES.—Can any of my brother readers tell me how the steel ribs and stretchers for umbrella frames are made? also how much capital would be required to start a small business?—Alpha.

[4567.]—MATHEMATICAL INSTRUMENTS.—Can any reader favour me with practical directions for fitting and fastening the steel leaves used in making the joints of mathematical drawing instruments? I believe they are soldered or brazed in, but am ignorant of the process, and wish to replace some of my present set which have been lost.—S. Stevens.

[4568.]—WEIGHT OF RAILS.—Can any fellow subscriber oblige me with a rule to find the weight per yard of rails of various sections (iron or steel), whether Tees, Doubleheads, or Bridge rails? I can readily find the weight of round, square, or flat bars, but find very great difficulty in finding the weight of rails from the tracings which accompany the orders.—Ferrum.

[4569.]—ESCAPE OF GAS.—Can any of your numerous correspondents account for the following phenomenon?—At the end of last winter we had about 20,000 feet of gas left in our 'ometer. To preserve this we filled the pipes with water, so that nothing could possibly escape either by the inlet or outlet pipes. We are confident there is no leakage at the centre or anywhere else, still the gas has gone; we have not 5,000ft. left today. Can any one give a natural or scientific reason why it is so?—W. C.

[4570.]—A LEGAL POINT.—Can any of your many readers inform me of the real meaning of the *law* in reference to buying and exchanging old metals. I am an ironmonger in the country, and often get old metals brought to be exchanged for new goods. The police here inform me that I can neither *take in exchange nor buy* any less quantity than ½ cwt. at a time, and that if I have to supply a customer with a new copper furnace, I cannot take the old one unless it exceeds the above weight. Is such really the absurd wording of the law, or have the wise heads of our officious local police misconstrued the meaning and intention of the Act? Any information on the subject will be very acceptable to many in the trade, but more particularly to—Ironmonger.

[4571.] RUBBINGS.—Is there any better way of taking rubbings of coins than by using the heelball sold by shoemakers.—W. J. Eggleston.

UNNOTICED QUERIES.

IN future, if any query remains unanswered for four weeks, we shall insert the number and subject of the query in this list, where it will remain for two weeks, if not previously replied to. We trust our readers will look over the list, and send what information they can for the benefit of their fellow-contributors.

Since our last "W. W. H." has answered 3983; 'J. K. P.," 4011; "E. L. G.," 4181, 4174.

4185 Steaming Bottles, p 858.
4188 Designs for Stamping Tea-trays 858.
4189 Stains in Veener, 858.
4140 Foreign Carmine, 858.
4142 Dyeing Woollen Carpets, 858.
4152 Manufacturing Gas from Vegetable Substances, 858.
4157 Reed Organ, 858.
4161 Refrigerator, 858.
4162 Strengthening Steel Wire, 858.
4164 Slits in Steel Gauges, 858.
4170 Smoke Burning, 858.
4172 Boring Bar, 858.
4179 Crayon Drawings, 858.
4184 Lathe Work, 859.
4186 Sheathing Iron Ships with Copper, 859.
4187 and 4258 Steam Carriages. To G. Prew, 859.
4190 Emigration to the Cape and West Indies, 859.
4196 Cement for Fastening Brass Caps to Bottles, 859.
4197 Warming by Hot Water, 859.
4200 Precipitating Cochineal, 859.
4203 Paris, 882.
4205 Naval Architecture, 882.
4207 Black Diamonds for Drilling, 882.
4208 Adulteration, 882.
4209 Water-wheel, 882.
4210 Sign Writing 882.
4217 Harmonium Reeds, 882.
4222 Photography, 882.
4224 Treatment of a Chrysalis, 882.
4232 Unnoticed Queries on Magnetism, 882.
4239 Medical Ceil, 882.
4240 Watchmaking, 882.
4242 Incrustation in Boilers, 882.
4243 Wire Netting Machine, 882.
4246 Glycerine as a Substitute for Cod Liver Oil, 883.
4249 Anatomical Models, 883.
4251 Paint for Aquarium, 883.
4255 Gold Lacquer, 883.

ANSWERS TO CORRESPONDENTS.

*** All communications should be addressed to the EDITOR of the ENGLISH MECHANIC, 31, Tavistock-street, Covent Garden, W.C.

EMPLOYMENT COLUMN.

We have frequently been asked to devote a portion of our space to cheap or rather SMALL Wanted Advertisements, and we now propose to do so under the heading "Employment Column." Hundreds of skilled labourers are continually wanting employment, and very frequently employers are in want of skilled labour. These wants, in a great industrial country like ours, exist under a variety of forms. A brass-founder may want a foreman; or an optician an assistant; a person may want his microscope repaired, his pianoforte tuned, or his manuscripts edited, when in all probability there is just the person to do the work near by. But the two do not know of each other's wants. At the present time there is no national cheap and expeditious medium whereby the one who wants the work done, and the other who is ready and able to do it, may easily place themselves in communication with each other. We think the ENGLISH MECHANIC is just the organ for such a purpose. This, in most cases, may be done in a very few words. We therefore place at the disposal of all who may want it,

OUR EMPLOYMENT COLUMN.

As in the Sixpenny Sale Column, the charge will be sixpence for the first sixteen words, and sixpence for every additional eight words.

The following are the initials, &c., of letters to hand up to Tuesday morning, August 16, and unacknowledged, elsewhere:—

C. B. A., C. S., G. H. R., H. S., W. K., Thos. Hirons, W. L., Robert Mastone, Map, R. S. N., S. O'Connel, J. H., Samuel Cracknell, J. O'Connor, J. H., F. W. Grierson, R. C. Browne, Jun:, M: & Co., J: C. Hudson, R. R. Antrim, J. W. B., Rev. H. D., German Reed, Rev. E. K., C. D. A., R. Cunliffe, E. West, J. A. Lee, J. H. Collins, R. N., W. Seltar, Terrun, J. H. Wheatley, Rev. Dr. T., Jas. Franklin, S. Brors., J. G. B., B. J. W., P. H. F., J. H. W., J. Hinton, H. Ledger, Horace Jones, Scapegrace, J. H. Long, W. Piper, J. R. F., Amateur Tuner, R. W. B., Andes, W. Willis, W. B. H., J. M. W., All's Well that Ends Well, J. R. F., W. & S., S. O., T. W. W., W. E. Maverly, Thinker, John Bell, Beacon Luff, J. H. B., Sergiurs, J. H. P., J. H., T. E. Graham, Geo. Jackson, Frank Chessell, R. D., B. B., Operator, J. W. Cox, G. Buck, R. T., J. Haines, W. D., E. J. Lay, G. W., T. W. Phillips, A Subscriber, Exhibitor at Royal College of Science, J. T., A Poor Mechanic, W. Airey, Vertumnus, Student, J. H. T., Revd. J. H., An Engraver.

B. E. LODDY AND YOUNG JOBBER.—"Second's Practical Watchmaker," in a letter, says:—"I shall be pleased occasionally to reply to such queries as may be in my power to answer."

H. POCKLINGTON.—Thanks. Please send the MS.

E. L. G.—Your other excellent answers next week.

KENSINGTONIAN.—Suggestion not practical.

THE MICROSCOPE.—Q. Sea says, "I am pleased to see that we are to have some information on microscopic subjects. The telescope and bicycles have had their share of space. I hope some friend will give a list of objects easily obtainable and how to mount them."

W. R. BIRT.—"Telescopic work for moonlight evenings," next week.

F. H. S., DEWSBURY, is of opinion there is want of an English Mechanic Improvement Society in his town. Let him, by all means, then, do what he can to establish one.

KENSINGTONIAN.—The pump, or its connection with the well, must be out of order.

M. J. WHEATLEY.—Mr. Baskerville's letter on link motion was in type before yours came.

VELOCIPEDE.—We don't see how your suggestion would "get or gain speed;" besides it would increase the weight of the machine.

AN UPPER FOREMAN.—Is there any need of such a society? Ask some of your *confreres*.

HENRY MUNRO.—Your answer to "Sabbas" as to a good microscope is an advertisement, and, therefore, not inserted. We have decided not to insert replies in future with recommendations and prices of articles. We have known instances where questions have been asked so that an advertisement in the shape of an answer might appear.

THE MICROSCOPE.—Thanks. "An Axmouth Resident" says, "Allow me, through the medium of our MECHANIC, to thank Mr. Pocklington for his kind and courteous reply (183), and also for his promised information on 'How to Choose and How to Work the Microscope,' which I have no doubt will be highly appreciated by many an amateur reader."

S. A. R.—See back numbers. A description and illustration of the Mitrailleuse are given in this number.

W. HARROLD.—Evidently the hall mark.

PATTERN MAKER.—There is no quick method of learning to read and work from mechanical drawings. Practice and attention will alone help you.

TOMETER.—The Patent Office Library, 27, Southampton-buildings, Chancery-lane, is free every day to the public, and contains many valuable scientific books.

H. HOLDERNESS.—For the *second* time we have to ask you to read the journal before you complain of the non-insertion of your communication. Your query was inserted on page 455 (No. 4406).

BONNET.—We cannot advertise manufacturers of lifting jacks gratis.

P. G. GREVILLE.—Questions are selected for insertion not solely for the benefit of the individual questioner, but for our readers generally. We will willingly insert any information which you or Mr. Coffey in reference to his patent (? 4424) may send. Our correspondents are too numerous to keep their addresses.

J. H. S.—Your suggested improvement of the bicycle is insignificant—if, in fact, it is an improvement at all:

J. H. L. says:—"No doubt others have congratulated you on the incorporation of the *British and Foreign Mechanic*, but I think, Sir, you ought to be congratulated on your moderation in the hour of victory. It so happens I know how you were treated about twelve months since. As you have not related the story, I shall not, much as I am tempted to do so. You have permitted the originator and editor of 'the would-be rival,' to pass into contemptuous obscurity, without a parting kick, although you have all the field to yourself."

E. M. D.—Agree with thine adversary quickly.

J. BULL.—See par.—sixpenny advertisements.

FLORIST.—You may kill aphides on geraniums, fuchsias, and various other plants, by dipping them bodily into hot water. The temperature must not be above 140° Fahr., or the tender shoots will be destroyed.

B. Y.—Order through a bookseller.

J. H. W.—Answer through our columns.

E. WEST.—Dr. Ussher fully described the American organs in Nos. 225 and 239.

A LEDGER.—Write to L. Olrick, 27, Leadenhall-street.

J. H.—The curlew may be found feeding on mud flats at the mouths of harbours about this time. It is an excellent bird for the table, although rather out of fashion.

SPERO.—See reply 4483.

C. HUDSON.—You can buy fret saws cheaper than you can make them.

MAY AND MOUNTAIN—Send drawings if you like.

SALT-WATER AQUARIUM.—G. P.—Yes. It is quite possible to keep marine animals alive for some months in ordinary glass tanks. Anemones, hermit crabs, limpets, small mussels, winkles, shrimps, &c., will live a considerable time if the water is properly aërated. Fit a piece of slate in so as to vary the depths; and oyster shells may be fixed to the sides by gutta-percha to act as ledges. The greater portion of the light should be excluded by covering the side nearest the window with thick paper You can obtain sea-water in London at 6d. per gallon.

ONE OF THE FIRM OF B.—We do not remember your former letter. You should have repeated your your question.

T. W. WEDLAKE.—We can give no other information than appears in the article.

THE *ENGLISH MECHANIC* LIFEBOAT FUND.

Subscriptions to be forwarded to the Editor, at the Office, 31, Tavistock-street, Covent-garden, W.C.

Amount previously acknowledged	£196	16	8
J. Harris	0	1	0
F. E. H., Holbeach	0	1	0
	£ 198	18	8

CONGRATULATIONS & TESTIMONIES

(Continued from page 408.)

94 "The whole forms a most valuable and instr[illegible] publication for all who delight in science."—[illegible] *Newspaper.*

95 "The ENGLISH MECHANIC, with its [illegible] illustration and fund of information, is almost [illegible] by its bulk."—*Leamington Courier.*

96 "To those who are anxious to know wh[illegible] done with pence we suggest the postage of 1½ [illegible] the Tavistock-street office for the current [illegible], and we are sure that astonishment will only [illegible] pleasure in turning over the pages of this [illegible] vention."—*Hackney and Kingsland Gazette.*

97 "Your journal, with its moderate [illegible] excellent information, is a great boon to the [illegible]"—H. N. HUMPHREYS, Gas Works, New Bar[illegible]

98 "The best and most useful journal [illegible]"—T. O'BRIEN, North Wall, Dublin.

99 "Nearly all the members of the [illegible] tronomical Society are readers of your [illegible] journal."—WILLIAM F. DENNING, Hon. Sec. [illegible] Astronomical Society, Ashley-road, Bristol.

100 The Rev. Dr. GIBBES, Plymouth, in a letter [illegible] Editor, says he weekly eagerly expects, [illegible] reads with great satisfaction, the ENGLISH [illegible]

101 "While I am writing, I cannot forbear [illegible] word as to the wonderful improvement of the ENGLISH MECHANIC. You must be satiated with congratulations on this subject, but we subscribers must congratulate ourselves. Your latest incorporation will render it additionally valuable and interesting. I have often been struck, in comparing the quality of the questions and contributions, with the immense progress they have made since I first became a subscriber—soon after its commencement. This is at least as noticeable in astronomical and cognate subjects as in any other branch of science which has been treated of. I am sure this flows mainly from the *educational* power of the MECHANIC. The influx of such names as Proctor, Webb, Lockyer, Birt, &c.—not to forget all the other learned though anonymous contributors—has given your editorship the character of quite an era in the history, and a warrant for additional success, of your estimable journal."—T. H. BUFFHAM, Earith, Hunts, July 12.

102 "Within less than four months you have terminated the individual career of three publications by absorbing them into yourself. I have had some [illegible] of journalism, but I never saw a speedier and [illegible] change for the better than has been exhibited by the ENGLISH MECHANIC. You have enlarged [illegible] and improved your type; you give better paper and improved engravings; you have multiplied your [illegible], as you have certainly widened the scope and purpose of your journal."—SUBURBAN.

103 "I hail the arrival of your most [illegible] journal as one of the greatest pleasures of the week, [illegible] must add my testimony to the zeal and ability with which it is conducted."—H. D. CROZIER, Captain, [illegible] Engineers, Gibraltar.

104 "Quite a mine of intellectual wealth. What a satisfaction it must be to your numerous scientific correspondents to act on the give-and-take principle, and so assist each other in substantial improvement."—J. D. SEYMOUR, Albion, Broadstairs.

105 "The absorption of *Scientific Opinion* and the *British and Foreign Mechanic* must have increased your already vast circulation, and proportionately augmented your influence in the country."—JAS. HARRIS, Garlinge, near Margate.

106 "The great and increasing success of the ENGLISH MECHANIC, which has grown from an acorn to an oak tree, is the best guarantee that scientific instruction is making rapid progress in the country. For years past we have had widely circulated and extensively read newspapers and religious publications; now we have an ably edited, many sided, and numerously read scientific journal."—A NEW SUBSCRIBER.

107 "It is as engrossing as a romance to the lover of practical engineering. It is half full of pictures of mechanical and scientific apparatus, and the other half is a concentration of scientific knowledge."—*Illustrated Midland News.*

108 "Its chief charm is that its subscribers are members of a universal instruction society."—THOS. WELLS.

109 "There is something in it for the engineer, the chemist, the microscopist, the electrician, the lover of natural history, the astronomer; in fact, for the student of all branches of science.—SAMUEL JONES.

The English Mechanic
AND
MIRROR OF SCIENCE AND ART.

FRIDAY, AUGUST 26, 1870.

SATURN.

By a Fellow of the Royal Astronomical Society.

(*Continued from page* 506.)

THE ellipticity of the disc of the planet itself, as in the case of that of Jupiter, strikes the eye the moment it is applied to the telescope. On April 19, and later, in May, 1805, Sir William Herschel, examining Saturn with reflecting telescopes of various apertures and focal lengths, thought that it presented a figure "somewhat like a parallelogram, with the four corners rounded off deeply, but not so much as to bring it to a spheroid;" and that very eccentric writer, but assiduous star-gazer, the late Dr. Kitchener, in his singular *omnium gatherum* on "The Telescope," states that he witnessed something of the same appearance in September, 1818, with a 3·6in. achromatic of 46in., and a 4in. achromatic of 10ft. focus. The most elaborate micrometrical measurements, however, made by Bessel in 1833, and repeated by the present Radcliffe observer, the Rev. R. Main, F.R.S., at the Royal Observatory, in 1848, go to show that this effect is probably referable to some optical illusion, and that Saturn is, in reality, an exact spheroid of revolution of considerable ellipticity. The compression adopted in the "Nautical Almanac" is polar semi-diameter = equatorial semi-diameter × ·927. Like Jupiter, the ball of Saturn is diversified by dusky bands or belts, which are very variable in their aspect. Ball, of whom we have before spoken, saw them as early as 1656; Cassini noticed two some nineteen years later; and Herschel, who devoted great attention to them, saw sometimes only two and sometimes more. In 1793, he observed a quintuple banding consisting of three dark and two intermediate bright spaces. He also remarked the dusky hue of the planet's poles, which is, however, a very obvious and persistent phenomenon. By a careful and prolonged examination of various serial changes which occurred in these "belts," Herschel at first fixed the time of Saturn's rotation at 10h. 16m. 0·4s., and afterwards at 10h. 29m. 16·8s.; Schröter gave a longer period, but the exact one must be considered as still *sub judice*. This banding of the planet is doubtless atmospheric, and may be held to be the analogue of our terrestrial trade winds, save that from the enormous velocity with which Saturn rotates on his axis, they must blow parallel to his equator, and not as our own do (so to speak) diagonally. The spectroscope indicates a very marked resemblance between the Saturnian atmosphere and that of the earth. Under favourable circumstances, the dark shadow cast by the rings may be seen on the body of the planet, and of course that of the planet on the rings. A little sustained attention, too, will sometimes show that the globe is not absolutely central in the ring. This is, however, by no means always to be seen. Micrometric measures make the dark opening a very little larger on the east side.

The subjoined view, drawn expressly for this essay, *ad naturam*, represents Saturn as he appeared in a 4¼in. achromatic telescope, with a power of 250, on the night of June 21, 1870, at 10h. 45m. Greenwich mean time, and will serve to illustrate many of the remarks which we have been making. The darker tint of the outer ring A, will be noticed. No division in it is perceptible, but even were this always seen (instead of, as in fact, very seldom) the present position of the planet, only some 16° above the horizon when on the meridian, would effectually preclude the chance of perceiving it. Next, Ball's great division will be noticed, extending right round the ring and passing at a marked and notable distance above the planet's north pole (*below* in the picture, which was of course drawn with an inverting telescope). We then arrive at the broad bright ring B, which shines with a purity and brilliancy contrasting curiously with the dull appearance of ring A, on the one hand, and with the yellow tint of the globe on the other. The faint shading on its inner edge, at the extremities of the major axis of the ellipse which it forms will be observed. And then travelling onwards we find the crape ring C, which, on the night when our drawing was made was of a brightish slate colour. Its tint is not, however; always uniform—nay, it sometimes varies in the two ansæ. It will strike the observer, when he has once fairly got this very wonderful object in view, how much too narrow the portion of it which crosses the ball appears in comparison with those parts of it in the ansæ. None of the engravings with which we are familiar give this curious effect. In all which we have seen the dark ring is represented as far too broad where it crosses the globe of Saturn, and proportionally too narrow in the ansæ. Returning, however, to our own sketch, the marked ellipticity of the globe will be palpable to the student. He will also notice the bright equatorial belt, succeeded by a narrow dark one; that again by a narrow bright one, north of which a dusky capping extends right up to the pole. The shape of the shadow on the ring B will be remarked too, and the fact of its terminating in, or becoming indistinguishable from, Ball's division.

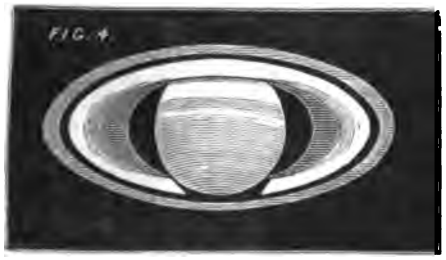


FIG. 4.

We have taken care, as far as possible, to present a facsimile of what we saw at the date referred to above, in order that our readers who may be in possession of instruments of 4in., or thereabouts, in aperture, may know exactly what sort of view of Saturn they may expect, should their telescopes be of adequate goodness. In fact, it may be considered as a kind of test view of the planet in its present position, as the achromatic employed in this observation is one of the very highest excellence; and we have shown absolutely nothing but what was seen at the epoch of the drawing. In most of the modern books on Astronomy, most exquisite pictures—or fancy portraits—of Saturn are given; but these are made up by piecing together a quantity of detail never seen in conjunction at any one time.

Turn we now to the satellites, with which this planet is more richly endowed than any other member of the Solar System,—no less than eight circulating about him. The largest of these (the sixth, reckoning outwardly from Saturn), Titan, was first discovered by Huygnens, on March 25, 1655. It is a very easy object to discern; it may almost always be picked up in the finder of an ordinary telescope on a dark night. The moon exterior to it, Japetus, is also pretty bright, especially at its western elongation. It was first seen by Cassini, in October, 1671. The same astronomer detected the three more minute satellites, now called Tethys, Dione, and Rhea, between the years 1672 and 1684. From this time until 1789, it was believed that no more satellites than these five existed; but on August 28th in that year, Sir William Herschel picked up another; and on the 17th of the following September, yet one more. These two interior moons are now known as Mimas and Enceladus. It was now imagined that no more moons remained to be discovered, and we find in works published as recently as "The Penny Cyclopædia," the statement that Saturn has only seven of these attendants. It is, however, most remarkable that an eighth was discovered on the very same night, September, 19, 1848, by Mr. Bond, in America, and by Mr. Lassell, at Liverpool; it has been called Hyperion, and is situated between Titan and Japetus. We append some details with regard to these satellites in a tabular form.

Number and Name	Sidereal Revolution				Distance from Saturn in his Radii
	d.	h.	m.	s.	
1 Mimas	0	22	37	27·9	3·3607
2 Enceladus	1	8	53	6·7	4·3125
3 Tethys	1	21	18	25·7	5·3396
4 Dione	2	17	41	8·9	6·8398
5 Rhea	4	12	25	10·8	9·5528
6 Titan	15	22	41	25·2	22·1450
7 Hyperion	21	7	7	40·8	26·7834
8 Japetus	79	7	54	40·4	64·359

The smallest optical power, as we have intimated, will suffice to show Titan. Japetus, who apparently travels to a considerable distance from Saturn, and whose orbit, unlike that of the other satellites, is inclined perceptibly to the plane of the ring, may also be readily seen; at all events, when it is situated to the west of the planet. Rhea usually looks something like a (standard) 9·4 magnitude star, but is sometimes brighter, and sometimes not so bright as this. Tethys and Dione are both very faint objects; the latter resembling a standard 11· magnitude, and the former being even fainter than this. They require a first-class telescope and acute vision to see them fairly. Mimas and Enceladus are both beyond the reach of all ordinary instruments, and we need scarcely add that Hyperion is hopelessly so. Transits of Titan over the disc of the planet, where it appears as a black spot, have been seen by Sir William Herschel, on November 2, 1789; by Gruithuisen, in 1833; by Dawes, on April 15, 1862; and by Mr. Gorton on the same night, with a telescope of 3⅜ aperture; while Mr. Banks actually saw it easily *with a 2⅞in. object-glass.* Webb and others also observed it. Dawes witnessed another transit on May 17, in the same year; and on the 25th of that month he watched the immersion of Titan into the shadow of Saturn.

Having thus detailed the principal appearances presented by this grand system, we may very shortly endeavour to decipher their significance, and to [illegible] if we can find any plausible theory to account for them. And, at the outset, we have never opened a book treating of the planetary system which did not contain the statement—or some equivalent one—that "the density of Saturn is about that of cork." Now this assertion can only be made upon the assumption that it is the outline of the *solid body of the planet* which we are looking at; whereas, as must be perfectly obvious from the shifting belts, &c., we are regarding his atmospheric envelope, which may be, and most likely is, of great height and volume. It is also necessary to assume that the globe of Saturn is solid throughout, of which we have not the shadow of a proof. It is then quite credible that the actual structure and density of the planet itself may not differ to any very great extent from those of our own earth, and if this be the case, the vaporous atmosphere would retain sufficient heat, by stopping radiation, to enable people, constituted in no material respect differently from ourselves, to live there.

But what are the rings? Ay, what are they? The answer to this question is by no means so simple as it would appear; and our first difficulty arises in this wise. There is a limit to the cohesion of every known substance. If we tried to model Mont Blanc of its natural size, in jelly, the whole structure would be crushed down flat from its own weight; while it would be obviously impossible to span the Straits of Dover by a single arch of any conceivable material. What then must be the constitution of the stupendous circles of light of which we are speaking? Whatever it may be, it was shown by La Place, in his "Theory of Saturn's Ring," in the Memoirs of the Academy of Paris for 1787, that what appear to us as single rings must consist of numerous concentric ones, and that a rapid motion of rotation round their central axis was essential to the stability of the system. More recently it has been demonstrated by the American Professor Pierce, and after him by Messrs. J. Clerk Maxwell and R. A. Proctor, that even La Place's numerous rings will not rigorously satisfy the conditions of stability, and that it is in a much higher degree probable that these most wonderful luminous hoops are made up of thousands and thousands of minute satellites so closely packed as to affect our eyes with the impression that they form solid plates! Still, this occult question can scarcely be said to be definitely settled, and we can only accept this hypothesis provisionally, as, on the whole, the most plausible that has ever been advanced.

Any notice of this nature would be incomplete without a reference to one of the ablest astronomical monographs which have appeared during the present century,—a work by which its author, previously absolutely unknown beyond the walls of his own university, acquired, *per saltum*, a European reputation,—we mean, of course, "Saturn and its System," by Mr. R. A. Proctor, B.A., F.R.A.S., &c., the familiar contributor to these columns. It would not be going too far to assert that it is impossible to understand the Saturnian system properly without a perusal of the book referred to, and we would in all sincerity counsel every one whom our cursory remarks may have interested in the subject, forthwith to procure and read it. It cannot fail to add a great and additional zest to his contemplation of the most marvellous object in the celestial vault.

Note.—It is necessary to observe, with reference to the first paragraph of this article, on p. 505, that it was written to appear last month—July, but has been delayed through pressure on our space. The reader is further requested to correct the following errata:—In column 3, page 505, line 15, for "structures" read "structure;" and in the same column, line 31 from the bottom, insert a full stop after the words "simultaneously though."

ELECTRICITY—ITS THEORY, SOURCES, AND APPLICATION.

By J. T. Sprague.*

(*Continued from page* 482.)

155. MEASUREMENT.—It has been already remarked that there are three modes of ascertaining the force of a galvanic current—viz., by its magnetic, its chemical, and its heating powers; of these the first is the most convenient, because it interferes very little with the actual passage or work of the current, and is open to inspection at any instant, and thus gives full information as to any fluctuations which may occur. Instruments for this purpose are called galvanometers. They are based on the principle that a magnetic needle tends to place itself at right angles with a galvanic current. The reason of this is to be found in sec. 35 and the diagrams accompanying it. Hence if *over* a magnetic needle at rest and in the same direction, we place a wire, and through it pass a current entering at the southern end, the needle turns with the N. end to the left, or westerly; if the wire be *below* the needle it turns to the right. If the direction of the current be reversed, that is, if it enters at the N. end, the actions are reversed. At present we need deal only with this as a fact, leaving the reasons for after consideration.

If the wire makes a turn round the length of the needle, it is evident all these conditions come into play at once, for the current entering at S. and passing *above* the needle, when the wire turns to the lower side, the current passes from the N., hence both the actions are the same and the needle is deflected to the left with double force; each turn has the same effect, varied only by altered distance and position, provided the same "quantity" is passed, which of course will not be the case if the wire is lengthened and no change made in the battery. Hence the reaction of such a galvanometer is very complicated and can only be thoroughly traced out by an amount of calculation unsuited to these pages, and of little interest except to pure mathematicians.

The practical result is, however, that no definite value can be given to the deflections of an ordinary galvanometer by any means except direct measurement. Most people think only of the degrees of the deflection, and suppose a deflection of 60° to be double that of 30°, which is entirely erroneous. There are only two forms of galvanometer whose teachings can be at once valued, as they are related in one to the tangent and in the other to the sine of the angles of deflection, but even this is only relative, and one galvanometer can only be compared with another by an actual measurement.

156. The Tangent Galvanometer is of most consequence, because the simplest; it is an instrument which should be possessed by every one who has any desire for real knowledge or accurate observations: I will therefore go fully into the principles and construction of the instrument. The fundamental principle, however, it is not necessary to demonstrate mathematically,—it may be assumed as a known fact. It is that if a magnetic needle is placed at the centre of a circular electric current, to whose diameter it bears a very small ratio, the tangents of the angles of its deflections will be exactly proportional to the quantity of electricity circulating. The larger the circle and the shorter the needle, the more absolutely true this is; however, a needle 1in. long in a circle of a foot diameter is correct for all ordinary purposes; this is the proportion of the instrument used in all the experiments in these papers, and the table and particulars to follow will show how nearly true it is, but a circle of 18in. or more would be better.

The instrument may be solidly built on its stand, but it is far better (as, indeed, it is with all galvanometers) to make its working parts movable around a fixed centre which carries the needle, as this permits of exact adjustment in the true magnetic N. and S. line; to effect this a brass rod or strong tube is fitted with three branching feet, each having a screw at its extremity for levelling; over this slides a brass tube, tight enough to be steady, but able to move freely, and provided with a collar and set screw to hold it when adjusted; on this tube the instrument itself is framed. First there is fixed to it at right angles a table of wood or brass, a little lower and proportionately shorter than the diameter of the intended ring. The shape of this is of no great moment, so that it is large enough in the middle to carry the graduated card and cover, but it will be steadier if it tapers away from this to the ring. For ordinary use the simple card fixed to the table, with its zero in the true middle line, will be sufficient; but more accurate results will be obtained by using a graduated circle of much larger radius, and having a movable arm marked with a line down the middle and its extremity adjusted to the graduated circle; by bringing this arm exactly beneath the needle its position is more readily ascertained, the larger circle facilitates the reading, and if the edge is properly graduated the reading may be effected to minutes, or tenths of a degree. This latter is effected by marking on the arm a space from the middle line equal to 11° on the circle, and dividing this into ten equal parts, the one of these which is nearest to a degree division indicates the measure required; the division into minutes is similarly effected by dividing 61° into 60 equal spaces.

The ring may consist of a single band or rod of copper for powerful currents, or a flat band or stout wire may make several turns; both may be united in one instrument by leading off connecting wires, provided with connecting screws, for use, as desired. My own instrument is composed of four turns of No. 13 insulated wire, and to this all the measurements refer, but a further series of four similar turns is added for feebler currents, and the deflections caused by these represent a current about half the value of the same deflection produced by the first four only; several such series may be useful.

From the middle of the fixed central tube rises the point on which the needle is to be placed just in the centre of the ring. The needle itself should be 1in. long, but provided with a very light wire or sheet metal for an indicator, which will lengthen it to 2½in. or 3in. For this purpose the best thing to use is aluminum, because it is the lightest metal, and is very stiff, and may be obtained in sheets of extreme thinness and rigidity.

157.—It may be well here to make some remarks as to the needles, applicable to all kinds of galvanometers. They are usually made far too heavy, and nothing answers better than watch-spring, softened to cut and form it into shape, and then hardened again. It is light, susceptible of the very highest magnetic charge, and easily obtained and worked. I have compared the action of this simple needle, 1in. long, with the aluminum extension to 3in., on an ordinary galvanometer, fitted with a purchased 3in. needle. It deflects to a higher degree, and swings to its point of rest in less than half the time, evidently because it has so much less momentum to exhaust, for of course a heavy needle first resists motion, and then has to exhaust the force it has acquired by its motion. It is, however, not generally known, or at all events little practised in instruments made for sale, that these vibrations, which render experiments so tedious, may be very greatly reduced by placing a stout copper plate under and above the needle. The reason is that a moving magnet generates an electric current in neighbouring conductors. This both means force absorbed to produce the current, and a reacting tendency to stop the magnet—therefore, all galvanometers should be provided with a stout copper plate under the needle, and of somewhat larger radius, and the graduation may be either on this plate or on a paper pasted on it. Additional effect may be gained by cementing a small circle of copper on the glass cover, if this is flat and close to the needle, or else by fixing one over the needle, in any convenient manner. It must be remembered, if a movable arm is employed as before described, and this is of metal, when it is moved it will for the same reason disturb the needle, and tend to pull it after it, and therefore its motion should take place *below* a stout copper plate. This may be effected by causing it to move freely round the fixed central tube, and fixing the copper plate by a socket on to the top of the fixed tube, the point for the nee
being in the middle of this plate. Greater de
cacy may be obtained by suspending the ne
by a fibre of unspun silk, either from a point
nected with the fixed stand, or from the rin
self, where this is not made capable of mo
but for ordinary purposes the other pl
simplest, particularly if the needle is fitted w
an agate centre to diminish friction. Fig.
(see next page), will, with this description ma
the construction of the instrument easy, and
so perfect an instrument is not needed, it is ea
to adopt only the essential parts, a large conduct-
ing ring around a small needle.

158. The accompanying table will, if carefully studied until fully understood, furnish a co
comprehension of the principles of measur
&c. I have expended a great deal of labou
it, because I have never yet met with a w
which those principles are thoroughly exp
and put before readers in a practical mann
has already been stated, that in the tange
vanometer the force of the current is propo
to the tangents of the angles of def
Column I. is the angles; II. the natural ta

I. Deg.	II. Tangent.	III. Ratio of degrees.	IV. Value in units.	V. Hor.
1	·01745	1·	·106	4
2	·03492	2·0012	·213	8
3	·05240	3·0029	·319	12
4	·06992	4·0069	·426	16
5	·08748	5·0132	·533	20
6	·10510	6·0224	·641	24
7	·12278	7·0304	·748	28
8	·14054	8·0533	·857	31
9	·15838	9·0762	·966	35
10	·17632	10·1031	1·075	38
11	·19438	11·1392	1·185	41
12	·21256	12·1232	1·289	43
13	·23086	13·2299	1·406	45
14	·24932	14·2877	1·520	47
15	·26794	15·3547	1·633	49
16	.28674	16·4318	1·748	51
17	·30573	17·5203	1·864	52
18	·32491	18·6295	1·981	53
19	·34432	19·7313	2·099	54
20	·36397	20·8579	2·219	55
21	·38386	21·9977	2·341	56
22	·40402	23·1530	2·463	57
23	·42447	24·3249	2·577	58
24	·44522	25·5140	2·714	59
25	·46630	26.7221	2·843	60
26	·48773	27·9502	2·973	61
27	·50952	29·1989	3·106	62
28	·53170	30·4699	3·241	63
29	·55430	31·7650	3·379	64
30	·57735	33·0648	3·519	65
31	·60086	34·4298	3·063	66
32	·62486	35·8086	3·808	
33	·64940	37·2149	3·959	67
34	·67450	38·6539	4·176	
35	·70020	40·1261	4·269	68
36	·72654	41·6356	4·410	
37	·75355	43·1834	4·594	70
38	·78128	44·7725	4·763	
39	·80978	46·4057	4·937	71
40	·83909	48·0854	5·195	
41	·86928	49·8154	5·300	72
42	·90040	51·5989	5·459	
43	·93251	53·4396	5·685	[illegible]
44	·96568	55·3398	5·887	
45	1·0000	57·3066	6·096	
46	1·0355	59·341	6·396	[illegible]
47	1·0723	61·449	6·537	
48	1·1106	63·645	6·779	75
49	1·1503	65·347	6·951	
50	1·1917	68·292	[illegible]	76
51	1·2348	70·762	[illegible]	
52	1·2799	73·347	[illegible]	77
53	1·3270	76·046	[illegible]	
54	1·3763	78·871	8·391	
55	1·4281	81·839	8·706	78
56	1·4825	84·613	9·001	
57	1·5398	88·241	9·387	
58	1·6003	91·708	9·756	
59	1·6642	95·369	10·144	79
60	1·7320	99·255	10·558	
61	1·8040	103·324	10·992	80
62	1·8807	107·776	11·465	
63	1·9626	112·469	11·96	
64	2·0503	117·438	12·49	81
65	2·1445	122·894	13·07	
66	2·2460	128·711	13·69	
67	2·3558	135·003	14·36	
68	2·4750	141·834	15·09	82
69	2·6050	149·226	15·87	
70	2·7474	157·421	16·75	83
71	2·9042	166·429	17·70	
72	3·0776	176·939	18·82	
73	3·2708	187·438	19·94	84
74	3·4874	199·794	21·25	
75	3·7320	213·868	22·75	
76	4·0107	229·799	24·44	
77	4·3314	248·218	26·40	
78	4·7046	269·570	28·68	
79	5·1445	294·785	31·37	
80	5·6712	324·997	34·57	
81	6·3137	361·874	38·49	
82	7·1153	407·136	43·37	
83	8·1443	466·722	49·65	
84	9·5143	546·381	58·12	
85	11·4300	655·41	69·68	
86	14·3006	819·5	87·18	
87	19·0811	1151·	122·4	
88	28·6362	1699·	180·7	
89	57·2899	3283·	349·2	
90	Infinite	Infinite		

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* "Sigma."

as given in "Molesworth's Engineer's Pocket Book;" if we draw a circle, mark off angles, and carry out their tangents these will be found to bear to the radius of the circle the proportions given, making 45° unity. Column III., taking the angles as the basis gives their proportionate values, taking 1 degree as unity: I have calculated it by dividing column II. by the tangent of 1° ·01745. These three columns are universally available; the others apply to special instruments of my own, but are given in order to explain principles. Column IV. gives the value of each degree of my tangent galvanometer, and therefore of every experiment recorded in these papers in absolute value of work. The principle on which I base the unit will be examined hereafter. It is, however, the unit I have used throughout—viz., the chemical equivalent, but as the measurement of "current" requires *time* to be taken into account, I make ten hours the basis; shifting the decimal point one figure to the left of course converts it into one hour. The way this column is calculated is this, and it is applicable to every tangent instrument:—I carried out several experiments by depositing copper at different rates and noting the degree shown by the instrument. Each experiment continued ten hours, or was reduced to that time, and the weight of copper divided by 31·7 (its unit), gave the number of units corresponding to the degree; for instance, at 16°, 1·749 units were deposited; dividing the ratio of this degree in Column II., 16·4318, we get 9·395 as the tangential value of unit, which, by inspection, is seen to be about one 9·3 degrees.

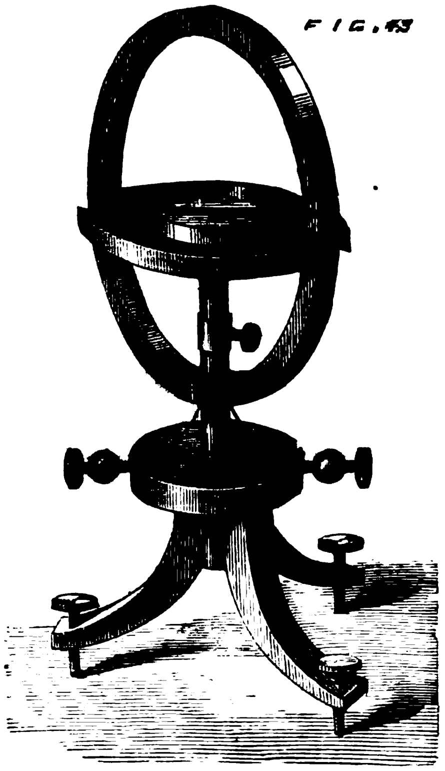
FIG. 43

Exact accuracy is scarcely attainable, as an error even of a hair's breadth in reading the angle affects the result, but the average of several trials at different degrees coming close to this, I took the angular value of one unit as 9·4, and dividing Column III. by this gives the figures of Column IV., the value in units of each degree. For any kind of work we have now only to multiply these figures by the proper unit, and we know what is actually doing. For instance, in electroplating, the instrument marks 25°, the value is 2·843, the unit of silver 108, gives us 30·7 grains per hour being deposited. If magnetic work is being done, it is only needed to ascertain once for all the work the particulår magnet does at any degree, to ascertain a unit or coefficient for that magnet applicable to all other cases. Columns V., VI., and VII., are corresponding deflections of other galvanometers, and their object will be seen as I describe the other forms of the instrument.

It will be seen that the values of the deflections are approximately proportionate to the degrees up to 15 or 16, then the value of each degree begins to increase more and more, and thus, after about 30 degrees, accurate observation becomes difficult, and at 60 one degree is equivalent to three of the lower degrees; still, results are obtainable quite near enough for practical purposes. Thus at 45°, 317 grains of copper were deposited in fifteen hours; this is equal to 6·666 units in ten hours, and the table gives 6·537 or 310 grains in the time; a difference of 2¼ per cent.

(*To be continued.*)

THE MICROSCOPE.—HOW TO CHOOSE AND HOW TO USE IT.

As the optical principles of the microscope are essentially the same as those of the telescope, and have been so frequently treated upon in the pages of this journal, it would be unwise to occupy further space than by saying that a microscope is simply a means by which the eye of the observer is removed further from the object observed, whilst the telescope carries the eye nearer to the object in its field of view. The microscope may be either "simple" or "compound." The former class is *commonly* represented by the single lens of the botanist, but a simple microscope may consist of a combination of several lenses, arranged so as to act as a single one. Of the latter class are "doublets" and "triplets." The compound microscope necessarily consists of at *least* two lenses, one of which is called the eye-glass, the other the object-glass, the two or more lenses being usually connected by a tube of metal. By the use of the compound microscope we obtain a much greater amplification than is possible with a simple lens, inasmuch as the eye receives a magnification of the image formed by the object-glass, and not the image itself. A microscope of this kind may be very easily made by any one possessing the least mechanical ingenuity, but when made will be useless. Every object viewed by its aid will be seen to be surrounded by a "beautiful" coloured fringe, and to be terribly distorted. These several defects, known as chromatic and spherical aberrations, were for a long time insuperable obstacles in the way of microscopic progress; but, thanks to ceaseless effort on the part of the fathers of our science, we may now say that our instrument is about as perfect as can be desired; and that the tale it tells is in the main true and faithful. It is the compound achromatic microscope of which we intend to speak in these papers. To this achromatic microscope there are two essential parts—the mechanical and the optical—*i.e.*, the stand and the lenses.

We now come naturally enough to the enquiry—What constitutes a good microscope? Certain things must be essential. What are they? 1st, as regards the *stand*. This must be solid, heavy, so that it may be free from vibration, and well balanced. It must be capable of being placed in either a vertical, an inclined, or a horizontal position, and of remaining there without being clamped. "The stage should be sufficiently large to admit either edge of a glass slide, 2" in diameter, to be brought under the object-glass." The aperture in the stage should not be less than 1¼" or 2" in diameter, and the stage should be *thin* to allow the oblique pencil to be thrown by the mirror upon any object on the stage. The stage may be either simple or mechanical. If the former be chosen, either the "magnetic stage," the "lever stage," or the "concentric rotating" stage will be found useful. The plan adopted by Messrs. Beck is useful and exceedingly simple, but with high powers is slightly tantalizing, as the focus is disturbed by every movement of the stage, which is merely a thin plate of metal held down by a double spring, the pressure of which may be regulated by a screw (in practice it is advisable to screw this down tightly, as otherwise it has an awkward knack of flying in one's face, to the serious detriment of one's nerve, and possibly of the object), and this plate is doubled under the stage on one side, so as to be grasped by the thumb and forefinger of the right hand. This stage is extremely useful to the working microscopist, and after some years of use we are disposed to speak very highly of it. There is nothing to get out of order, and practised fingers will perform all needful movements quite as delicately as would be possible with the most elaborate "mechanical" stage. Below the stage should be fixed a diaphragm, which should be furnished with a series of holes, in order that a variety of apertures may be available, and the whole arrangement should be capable of being easily turned aside. Mr. Collins's "graduated diaphragm" is perhaps the best possible. The mirror should be full sized and double (concave on one side, plane on the other), and should be capable of movement in all directions, as well as of adjustment nearer to or further from the stage. It is convenient if the mirror be carried by a jointed arm, as a more oblique illumination may be thus obtained.

Arrangements for Altering the Focus.—Every microscope should have a coarse and fine adjustment. The former may be obtained by a rack-and-pinion movement, by a chain and pulleys, or by a watch-spring band. The chain movement is peculiarly smooth and easy, and in practised hands entirely obviates the necessity for a fine movement. This latter is usually obtained by the action of a finely cut screw on a lever. The screw may be graduated so that the distance through which the object-glass passes may be measured and the thickness of an object approximately obtained. The milled heads of all these adjustments should be so placed as to be conveniently accessible, and they *must* work smoothly or they are utterly worthless.

Secondly, the Optical Arrangement.—A student's microscope is usually furnished with two eyepieces, called A and B, being, as nearly as possible, in the following ratios, 1, 2; and with two object-glasses—or, to use henceforward the correct technical term—*objectives* of 1" and ¼" focus respectively (*i. e.* these lenses have the same magnifying power as simple lenses of those foci). The range of these powers is about as follows:—55, 90, 210, 350 diameters. These should be accurately centered and be perfectly corrected. Means of estimating the quality of these lenses shall be given later. A stage condenser and a stand, or bull's-eye condenser, for opaque illumination, will complete the instrument.

The next question that arises is, where shall we go for our instrument? Mr. E. Ray Lankester has lately written in praise of foreign instruments; but we do not see what there is to be gained by going abroad for that which may be obtained better at home. English makers will beat the world for quality, and now—thanks to the Society of Arts and some of our more enterprising manufacturers,—a really good English instrument may be obtained at about the same price as the continental ones. There is hardly any comparison between the convenience of the two classes of instruments. These remarks apply only to the stands.

In lenses, the Germans surpass us by far, PRICE being taken into account, although within the last year our English makers have contrived to turn out very decent lenses at less than half the prices formerly charged. We need only instance Crouch's or Swift's ¼" and Mr. Wheeler's ¼". We will, therefore, look at home for our stand. Where all are equally good it is a difficult (not to say an inviduous) task to instance the best. Those who wish a better-finished class of workmanship may either select their higher priced stands, or look over the catalogues of half a hundred makers and make their choice. The better plan is to select a *good stand*, capable of being increased as funds are available, and to add objectives and accessories from time to time. Such a stand will cost about £10 or £15 with *two* eyepieces. The price of objectives will vary with different makers. A *fair* English inch may be purchased for £2 10s., and a good quarter for about £3. German lenses (Grundlach, of Berlin) of these foci will not cost more than 17s. 6d. and 21s. respectively, and are about equal in quality. Of course the *first-class* lenses of our best makers are unequalled by those of any continental maker; but Messrs. Beck's first-class ¼" costs £5 5s.—a sum as large as many can afford to spend on the whole affair. To such we commend the German lenses.

How to Choose a Microscope.—It will have been seen in what we have said that the essentials of a stand are steadiness in all positions of the body, ample stage room, and proper adaptation for the reception of extra apparatus. The appearance of an instrument is of secondary importance. To test the steadiness of the instrument use the ¼" power, focus carefully, and get some one to walk sharply round the room whilst you observe an object. If there be excessive tremor, reject the instrument at once. Next, try the adjustments, and see that they work smoothly and without "loss of time"—*i.e.*, that they "answer" promptly to the slightest movement of the milled heads in either direction. Use the 1" and ¼" objectives, and also a 3", and see that a small object remains truly in the centre of the field of each power, and that there is no "twist" or sideway movement on altering the focus. So far for the mechanical portion of the instrument. We will add that a short-bodied microscope having a draw-tube for elongation when increased power is desired, is much to be recommended, on the ground that it is far easier to work with. The corrections of the lenses must be carefully tested, and unless the tyro go to a good and well-reputed maker, we would advise him to get some experienced friend to select his lenses for him. The lenses of even the best makers vary considerably, so that it is possible for an experienced man to select a far better lens than might fall to his lot. The power of 1" should not be less than 30 diameters with the A eyepiece. It should give a large, clear field, free from colour, and with a clean, sharp, circular margin. For chromatic aberration the severest test is said to be a radial section of fir. The glandular markings in this should be well shown, and be free from colour with the C eyepiece.* For *flatness* of field the section of an Echinus spine is useful. For definition the pollen of mallow. For ¼" a good test for definition is the scale of the Podura or the *frustules* of *Pleurosigma hippocampus*. The markings on either of these should be clearly resolved. Dr. Carpenter specially recommends Mr. Lealand's preparations of muscular fibre as giving a fair test for lenses of from 4-10th" to 1-5th" focus. Every objective should be tested with a series of eyepieces, as a glass will often perform well with a shallow eyepiece, when a deeper one will render manifest the most atrocious defects.

Having selected our instrument, we will proceed to use it. Before us lie slides of Echinus, of Foraminifera (mounted as opaques), of Diatoms, and the eye of a fly. Having taken our instrument out of its case and put it in order (the maker of each instrument will put the purchaser "in the way of doing this"), we will select a table having a good light. If in the daytime, we will avoid direct sunlight as having too much glare, and select a position in which we can receive light from a *white* cloud. The microscope should be placed in an inclined position, and the mirror adjusted so as to throw an equable light upon the slide, neither too intense, or too much the reverse. Careful use of the diaphragm apertures and focussing of the mirror will give us any variety. We now take our slide of Echinus, and having an inch objective on, place the slide on the stage and in the field. We run down the rack motion until the objective is brought within ¼" of the slide, and then, with our eye to the eyepiece, focus back until we obtain a clear definition. Having turned aside the diaphragm, we proceed to tilt the mirror into different positions, in order to get various degrees of obliquity of the illuminating pencil. We will substitute a slide of Foraminifera for the Echinus spine, and proceed to examine it as an opaque. Having closed the aperture of the diaphragm, we throw a good light on the object by means of the bull's-eye, varying its angle of obliquity until we gain the best effect. The working of the ¼" is essentially the same, but unless we have the aid of accessories, "transparent" objects alone can be used with it, and greater care must be paid to the focussing, &c., of the mirror. We cannot urge too strongly upon our readers the importance of paying special attention to this vital, but, to the beginner, seemingly unimportant, matter of illumination, as truthful interpretation almost entirely depends upon it. The best possible light for microscoping is daylight from a white cloud, but as most of our readers (the author amongst the number) are compelled to work almost solely by night, it is encouraging to know that good results may be obtained from the use of a candle, even if it be protected by a glass shade, and it be not more than 10in. or 15in. from the instrument. The author has used for some years a small paraffine lamp, costing at the outset about eighteen pence, and has found it to answer every purpose, and to be most convenient, inasmuch as it permits a vast variety of "dodges" in illumination to be tried with little trouble. And here let us whisper to the readers of the MECHANIC, "beware of opticians, unless you have a long purse: make what you want when possible—*that* is nearly always."

We have now, we think, gone through our A B C. We have seen *what* our tool is—what are its essentials, and how to put it through *its* A B C. But that is not learning how to use the microscope. We have but learned to make a plaything of it, or at best to look at bought slides. Again, we have but learned the use of a very simple and unadorned compound microscope. We will, accordingly, if our readers be not a-weary, glance at the use of a few accessories, and then try to learn how to use the microscope whether in its simplest or most complete form.

H. POCKLINGTON, Hull.

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[*] I am indebted for many valuable hints on this matter to Dr. Carpenter's valuable "Microscope and its Revelations," and Professor Beale's "How to Work with the Microscope."

ELEMENTARY SCIENCE.*

BY THE REV. E. KERNAN, CLONGOWES COLLEGE.

APPLICATION X.

INCLINED PLANE.

(*Continued from page* 508.)

SCREW SUB-APP. I.—THE SPHEROMETER.—This instrument differs in nothing essential from the micrometer just explained. The original object was to measure the curves of lenses, hence the name "Spherometer," given to it by the inventor, Laroue. To ascertain the curvature of the spherical surface, the feet of the instrument were placed over the lens L, Fig. 91, and the space through which the micrometer screw A should be moved so as *just to touch* the top of the curve, gave the measure of the curve. The medium of comparison used was some perfectly plane surface. For a concave lens, the spherometer feet and screw being made perfectly level on the *plane*, and the height of the micrometer accurately noted from the divided bar A, the amount of depression of the screw required to *just touch* (when the instrument was transferred to the lens) was indicated by the bar A and the micrometer plate.

FIG. 91

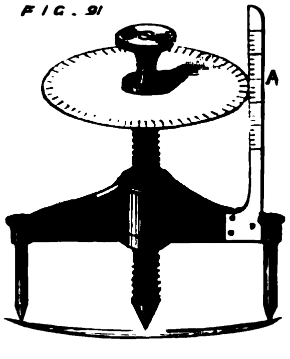
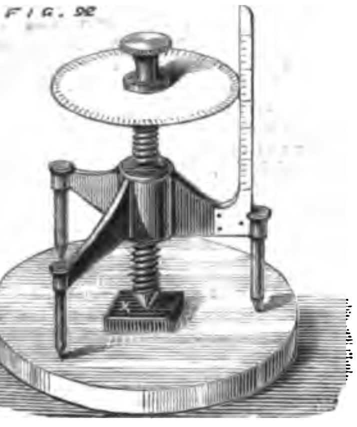


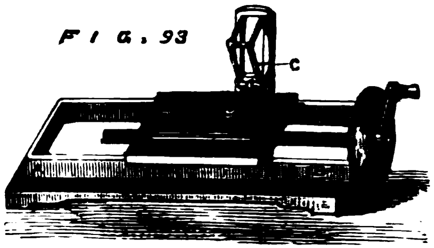
FIG. 92



For convex lenses, the method was reversed. First the lens was *touched* by screw and feet, then the height to which the screw had been raised measured upon the *plane*. Once the height of the curve was known a simple formula supplied to the optician any other element of the lens he might desire. At present, the spherometer is made with three feet, and is chiefly used to know or compare the thickness of very delicate plates, or else to examine very minute effects of expansion or contraction in the same body from various causes. For these purposes, the feet are placed upon a plane surface (Fig. 92), and under the screw is laid the plate, &c., to be measured. The screw is turned down until the point just touches the plate X, and the height of the divided circle C on the index A is exactly noted. The screw is raised a little to allow the removal of the plate X, and then again turned down until the point touches the plane; the difference of position indicated on A shows the thickness of the plate X. So delicate is the measurement of the spherometer, that it will indicate the increase of thickness in a plate of glass when examined a second time after having been slightly warmed by the contact of a finger.

SCREW SUB-APP. II.—THE DIVIDING MACHINE.—The micrometer screw is the basis of the invaluable machine by means of which rules, scales, verniers, &c., can be divided most delicately and most exactly. Theoretically, the dividing machine is a very simple apparatus; but practically, as now perfected, and especially as adapted for division of a curved line, it is considerably complicated. For the present, only the explanation of the simple form employed for dividing a straight line. A few words will describe the machine. A micrometer screw set in a frame, moves, by means of its nut, either the holder of the "graving tool" or the table on which rests the rule, &c., to be divided. When one division has been made the number of degrees on the micrometer "plate" shows how much the screw should be moved before again applying the "graving tool" to make the second division, and so on to the third, fourth . . . . . *n*th division. In Fig. 93, AB is a frame of metal, the top edges planed *level. On these* edges slides the table T, *which holds the measure m*, &c., to be divided. To *the back of the frame is* joined the tool-holder C, *which has a horizontal* motion by which the tool (*a*) cuts the divisions, and a perpendicular motion to lift off the tool, when the table must be moved for the next division. When the work is circular, for instance the dividing of a glass tube or the like, the work (the tube, &c.) is moved *round under* the graving tool. With this simple form of the machine, much is left to the operator,—the number of turns, the short strokes on the measure, the long, the medium strokes, &c. All this is done by the machine itself in the perfected arrangement which shall be explained in the next section on "parallel forces."

FIG. 93



SCREW APP. IV.—THE SCREW PROPELLER.—The moving of ships by what is called a "propeller" has proved to be so successful an application of the screw that it must be treated with exceptional attention. Without, however, going into too many particulars, it can be fully explained in two points—1st. What the propeller is. 2nd. How its action is that of a screw. The first point is easily settled—it requires but a plain statement of fact. The second, of itself not at all clear, becomes quite evident by means of a few principles and practical considerations.

1st. The propeller has no appearance of being a screw. Hence the early notions of it in the minds of many were very far from the reality. A most learned professor at ——— conveyed to his audience the impression that the propeller was a long screw, extending from stem to stern of the ship; and exemplified his explanation by means of the "Archimedean screw" (water-lifting screw), saying, "it turns, and turns." The real propeller is represented in Fig. 94. A the

FIG. 94

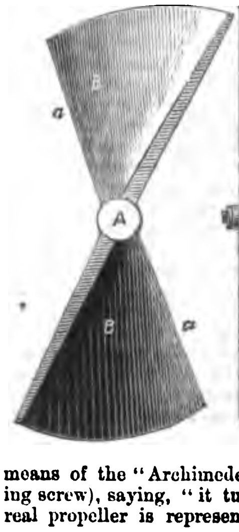


FIG. 95

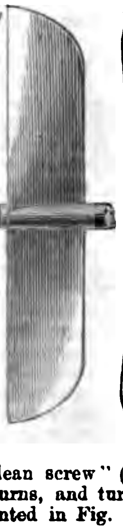
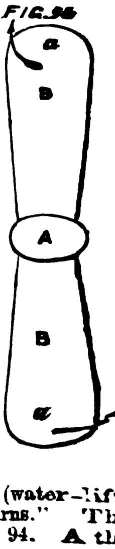


FIG. 96



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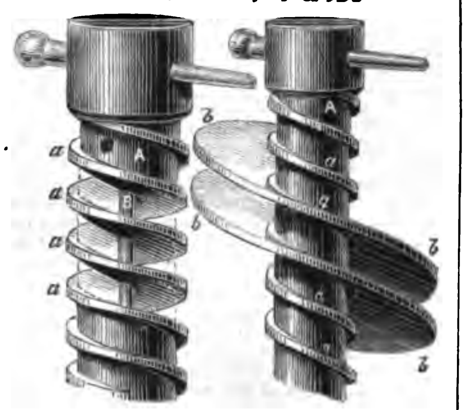
centre or "boss." B B projecting arms, the back edges of which *a a* are slanted *away* from the plane of the paper, which presents an *end view*. *A side view*, Fig. 95, shows the slant. The number of arms varies; there must be two (this is a very common sort); there may be 3, 4, 5, or more. The shape, both as to *outline* and slant, is undergoing changes every day. Of these changes a good idea may be had from the excellent series in the English Mechanic, Vol. IX., pp. 51, 102, &c., by Mr. P. N. Burgh, C.E.

The general form of the propeller, not so easily shown in a diagram, is very clearly represented by a cardboard model. Cut a bit of cardboard (or stiff paper) into the form of Fig. 96. A is the "boss." B B the vanes. Now bend away from their plane the points *a* and *a'*—as the arrows indicate, or the reverse—taking care that the bend is in *opposite directions*; if *a* be brought *out a'* is to be pushed *in*, or *vice versa*. A little delicate manipulation of the arms will give them a graceful slant, which, however, differs from the *strict* notion of the propeller, inasmuch as the slant of the paper model varies from the boss to the point *a a'*. In the propeller, *strictly* speaking, the slant on the "boss" is the same as at the points. Practically, the paper model mounted on a shaft will convey *to the eye* an excellent idea of the propeller, and by the knowledge of its deficiency all danger of error is avoided of considering the curves of the paper to represent exactly the curves of the propeller.

2nd. To see distinctly the *screw action* of the propeller it is only necessary to recall some of the essentials of a screw, with some of their necessary "consequences," and apply these consequences to the correction of defects which at once appear in an ordinary screw used to produce *quick* motion, especially in water. The essentials of a screw are, that it is an inclined plane, the "height" of which is the "pitch" of the screw. Hence it follows (1) that the *cylinder* on which the plane is wound may be reduced to have only the proportions of a *shaft*, *i.e.*, as compared to the "breadth" of a plane. Thus in Fig. 97 there is no change made in the screw A by cutting away the cylinder—dotted line—and producing a *broad thread a a a* winding round a shaft B. The inclined plane is not changed, it is only made *wider*: none of its "elements" have been affected in their action. In the same way the "thread" may be increased in breadth to the dimensions of a "vane" without making any change in the inclined plane. The screw A, Fig. 98, in its form *a a a a* remains the *same screw* in its form *b b'*, except that the plane (the thread) is wider in the latter form. It follows (2) that a body joined to a screw moving in a *fixed nut* will advance in a straight line (at each turn of the screw) through a space equal to the height of the inclined plane, or "pitch" of the screw. The greater the pitch, therefore, the greater the advance. No modification of the pitch can affect the *essentials* of the screw: the "elements" of the inclined plane are *changed* (in their direction, &c.), but not destroyed; their *action* but not their existence is affected. The "pitch," therefore, may be given according to the required motion. It follows (3) that two, three, &c. ... *n* inclined planes may be wound round the cylinder without in any way interfering one with another. This very important conclusion, apparently perhaps difficult to understand, is seen by a simple experiment. Hold in one hand a cylinder of wood, say a pencil or penholder, and trace upon it a spiral, commencing from the end of the cylinder. This spiral may be traced in many ways; it is done very simply by holding the cylinder lightly in both hands, turning it with one hand and marking it with the thumb nail of the other. Having produced a few turns, begin again, but at a point on the end of the cylinder diametrically opposite to the starting point of the first spiral. Trace as before. Examination proves that the second spiral nowhere meets the first. In the same way, *any other* starting point may be taken to begin the spiral, and as to the number of spirals or "threads" the strength of the material is the only limit. A screw thus formed with 1, 2, &c., . . . *n* threads, is called an *Archimedean screw*, as Archimedes is said to have been the first to investigate the properties of a many-threaded screw. To these conclusions one more may be added, which having been fully explained need only be recalled. And this conclusion is that each portion of the screw acts independent of the rest; a small portion will act exactly as the whole screw, provided in that portion the "elements" of the plan are not changed.

FIG. 97 FIG. 98

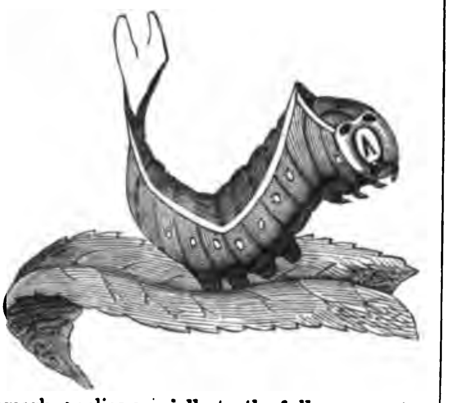


(*To be continued.*)

CHAPTERS ON CURIOUS CATERPILLARS.
SEPTEMBER.

By J. R. S. Clifford.

SOME of our most remarkable native caterpillars are comprehended in the family of the *Cuspidates*, formerly classed with the *Bombyces*, which in several particulars they nearly resemble. The grotesque forms of several are exceedingly unlike what we are accustomed to regard as the ordinary type of caterpillar, and from these moths are produced which are not notable for any marked singularity of appearance. Since the days of quaint old Izaak, of piscatorial memory, the history of that abundant species by river or streamlet, known as the Puss Moth (*Dicranura vinula*) has been recorded in black and white. Fancy the worthy angler, sitting expectant under the branch of a drooping willow, with one eye on his float, and the other surveying the general aspect of nature, of which he was an ardent lover; a twig comes within his reach, and glancing at it, he sees to his astonishment a caterpillar of a totally different kind to any he has before observed. Home he goes, his day's sport done, and amongst other things he does not forget to jot down the outlines of the appearance of this devourer of willow leaves. "He is marked with a St. Andrew's cross, his lips and mouth are somewhat yellow, his eyes black as jet, his forehead purple, his feet and hinder parts green, his tail forked and black, and his whole body stained with red spots." Not a scientific description certainly; yet the reader can surmise from the accompanying figure that it is tolerably correct, or, if he chooses, can compare for himself, for the living caterpillar is to be found through part of September on willow and poplar. Friend Izaak's description, we must remark, applies specially to the full-grown caterpillar; when young, it is almost sooty in hue, and gradually, through successive changes of skin, assumes its more ornamental appearance. On the head, when young, there are two little prominences, which look like ears, and when in a position of repose they look remarkably like lilliputian black cats, hence probably was suggested the vernacular name. After the last change of skin we find that the head is brown, shading into black at the sides. The second segment forms a sort of recess, into which the head can be drawn back; this is pink, with a spot on each side, which, though eyelike, is not an organ of vision, but merely a surface mark. Behind this the body slopes upward to the fourth segment, which is decidedly humped. A white stripe passes on each side, from the head to this hump, then bends to the spiracle on the eighth segment, and turning up again slightly, terminates at the anal horns. This stripe forms a boundary of the two shades of ground colour; above it the body is whitish, streaked with purplish brown; beneath it all is yellowish green, except a blotch on the eighth segment of a brown hue, which sometimes connects itself with the white stripe, and is sometimes altogether absent. The "leading feature" of this caterpillar's singularity is, however, not at the head, but at the tail, which bears a couple of tubular horns, which have a bristly surface, and within these are contained rose-coloured filaments, which can be protruded or withdrawn at the will of the caterpillar, until it is very near its change into the chrysalis, when it ceases to exercise this power. When annoyed the caterpillar of the "Puss" bends these horns forward, and displays the inner horns, but does not, as far as we have observed, attempt to strike with them. In fact, it is evident that they have no power of wounding, nor is any fluid propelled from them; and the statement that the caterpillar, by means of them, drives off the parasites which molest it, is probably a myth. The real defensive apparatus is to be found beneath the head. There is a small transverse slit, only noticeable in the full-grown caterpillar, from which, when provoked, it can squirt a pungent fluid of an acid nature to some distance; and we are assured by an entomologist of experience, that the caterpillar can not only manage to direct this at its pleasure, but also, when annoyed by an inquisitive biped, it takes aim at his eye, as he (the observer) had experienced more than once to his sorrow! Removed from its original habitat, and fed up in confinement, the Puss caterpillar loses this remarkable means of defence, and when touched this slit will be seen to quiver, yet no fluid issues from it. The position assumed by the caterpillar when "standing at ease" is not unlike what is so frequently noticed amongst the *Sphingina*. The head and the front segments are raised in the air, the centre of the body fixed by means of the eight claspers, and the tail and its appendages also elevated. The cocoon which is constructed by this creature for its winter abode is composed of a gummy substance, mixed with portions of the bark of some tree, and it so nearly resembles the trunk on which it is formed, as often to escape notice.



Closely connected with the preceding, though much less in size, are the species called the Poplar and the Sallow Kittens. This is one of the singular instances which occur amongst *Lepidoptera*, wherein two species have very different caterpillars, and yet the moths so nearly resemble each other as to be with difficulty isolated. Of the two the Poplar Kitten (*Dicranura bifida*) is rather the larger, and occurs pretty generally in England and Ireland. The females seem to select shrubby plants upon which to deposit their eggs. The caterpillars remain at rest during the day, spinning a silken pad on the leaf, to which they attach themselves very firmly. The colour of the body is various shades of brown, grey, and yellow, the latter running into green on the fourth segment, which, as in the Puss, is crowned with a hump. The anal horns are green, with two brown rings, the inner horns or filaments being black. The Sallow Kitten (*Dicranura furcula*) appears of late years to have become more scarce. This is still handsomer, and has the second and third segments flattened, the latter rising into a ridge, and giving the caterpillar a singular appearance. The ground colour is white on the back, and an apple green on the sides, striped longitudinally with purple and a deeper green; there are also numerous purplish dots, with a white point in the centre of each; on the second segment are two brownish blotches, and there are faint orange patches on the seventh and eighth segments. The anal horns are white, tinged with purple, the head is a pearly grey. This caterpillar, when not feeding, is fond of retiring to some withered leaf, and thus is occasionally missed by the collector. Both the Kittens are to be found in the caterpillar stage throughout the summer, but rarely later than the beginning of September.

The caterpillar of the Barred Hooktip (*Platypteryx unguicula*) is not unfrequent on pollard beeches at this time, occurring in various places near London, and in different parts of the south of England, but not in the north. The head is slightly notched, and the crown of it rises above the level of the segment behind it, the body tapers towards the extremity, and terminates in a point; it is studded with small warts. The head is pale brown, the body a darker brown; a pale stripe runs from the head to the sixth segment, from which another light brown stripe passes to the tenth segment. The under-side, legs and claspers, are of a pale green. When of full size, this caterpillar spins a web between two leaves, and therein changes to a chrysalis. Of its habits Mr. Newman observes that when not feeding "it rests in a nearly straight position, but with both extremities slightly raised, and not touching the object on which it may be. When roughly touched, or picked off, it very frequently hangs by a thread, and thus suspended, begins twirling round and round, at first slowly, and afterwards with great rapidity." A species very partial to woods is that called the Iron Prominent (*Notodonta dromedarius*), the caterpillar feeding on birch, and sometimes on oak. The head is broad, and cleft above; it is shining and brown. Along the back there are five humps, four of which point backwards, the last one only being erect; the body is of a yellowish green colour, chequered with purplish brown. The cocoon is formed on the ground, and the caterpillar usually attaches one side of it to a fallen leaf; the chrysalis state lasting until the following June. Still more remarkable, from the attitude it assumes in repose, which gives it an extraordinary appearance, is the caterpillar of the Pebble Prominent, called in Latin, *Notodonta ziczac*, from this *zig-zag* or contorted position; the tail being raised, and also the front segments, which are bent twice. The head is large and brown; the body purplish brown, with dark patches on the first three segments, which have light margins; there are also several oblique lines on the sides of several segments, the hinder are yellowish, with brown markings. There are three humps, two of which point backwards; the one at the extremity of the body is directed forwards. Like some others of this family the caterpillars of the Pebble Prominent are frequently attacked by parasitic enemies, and a majority of those taken nearly full-grown will be found thus affected. The cocoon is slight, being of silk, mixed with a little earth. The Swallow Prominent (*Notodonta dictæa*), which seems generally distributed throughout England, is to be found in the caterpillar state in September. This is usually seen on poplar or sallow, and it endeavours to escape notice by placing itself on a twig, and drawing the body close thereto. There is one hump at the anal extremity of the body, marked with a black line at its top. The head is rather large and pale green; the surface of the body is whitish, sometimes a dull green, and sometimes brown; along each side runs a broad and a narrow stripe, the latter being yellowish usually. In some instances these stripes are entirely wanting. The cocoon is large, and attached to a dead leaf.

Many a collector of caterpillars has sought without success for that of the Peach-blossom (*Thyatira batis*). It feeds on the common bramble, a plant not convenient for beating into the net or umbrella, and not very agreeable for a hand search. Like certain Prominent caterpillars, the Peach-blossom in that state rests with both extremities slightly raised. It has also humps, which sometimes vary in number. The most conspicuous one is on the third segment, cleft in the centre, and bending forwards over the head; the others are smaller, and that on the twelfth segment is reduced to a point; the general colour is reddish brown, chequered with grey. The head is largish, bent downwards, and slightly notched. The cocoon is spun upon the pod-plant in August or September.

On reeds, in the fen districts of Cambridgeshire, and rather conspicuous in its colouring, we may detect the caterpillar of the Powdered Wainscot (*Simyra venosa*); directly it is touched, however, it falls, coiled up in a ring. On each segment of the body there is a circle of warts, from which proceed small brushes of hairs. The head is black, with several whitish marks; the body varies much in colour; there is always a broad grey stripe along each side, which is really made up of very small black and white spots; down the back is a broadish black stripe, with a narrow cream-coloured one on each side of it; the legs are glossy, and the claspers greenish and semi-transparent. When of full size, this caterpillar forms its cocoon with great care, and chops up several leaves into fragments, connecting them so as to form a roof-like cover, to secure it from the changes of winter: the moth does not come out until midsummer. In various counties of England the caterpillar of the Brown Moth (*Hadena Pisi*) is now found feeding on broom and other plants; in some years it occurs plentifully on the brake fern about London, and feeding in companies. It is picked up by non-entomologists sometimes and taken to naturalists as a supposed rarity. The general colour is green or brown, and on each side there are two yellow lines—the lower one including the spiracles or breathing pores. It is smooth and flattened, and crawls with great rapidity. The chrysalis is buried and enclosed in an earthen cocoon. In heathy places, and occasionally on the hedgerows, the adult caterpillar of the Emperor Moth (*Saturnia Carpini*) is now to be discovered. This is one of our largest British caterpillars, and though not displaying a great variety of colours is yet a beautiful creature. The body is delicate green, tapering towards the head, the segments showing very distinctly. Each of these is surrounded with a series of pinkish tubercles set in black rings, and giving off short black bristles. The cocoon, which is composed entirely of silk, has often been figured, and is constructed with a double trap-door, to secure the chrysalis from disturbance.

Though not by any means of large size, the caterpillars of the Shark Moths are so conspicuously coloured (mostly) as to render them an easy prey to entomologists—and to birds. On the "blanket plant," or mullein, we may probably find a colony of the Mullein Shark (*Cucullia Verbasci*). These individuals are greenish white, with a transverse yellow band on each segment, besides which there eight or ten large black spots on each; the skin is glossy, and the head yellowish. On golden-rod feeds the striped caterpillar of *C. asteris*, preferring the flowers to the leaves. The Chamomile Shark (*C. Chamomillæ*) feeds upon different species of that and allied genera. This caterpillar is pale yellow, having light red transverse bands, and an olive-green line down the back. The commonest caterpillar of the Sharks is that of *C. umbratica*, which is of a black hue, marked regularly with orange blotches. This feeds upon the common sow-thistle, remaining concealed during the day.

THE PROGRESSION OF LIFE.*

IN some of those minute organisms which the microscope reveals to us, as in the yeast plant, for instance, we have mere aggregations of cells, these cells themselves being to all appearance specks of a structureless, transparent substance. In such forms, so little is the relation between the parts, so little bond of union exists between them, that we scarce know whether to speak of them as individual organisms or not. Each part enjoys a life and activity of its own. A limb of a man cut off is a mere dead thing, but a portion of one of these has that principle of vitality within it whereby it can exist apart from the community to which it is joined. Advancing another step we come to organisms in which these cells become more an integral part of the whole; but in which, nevertheless, there is a great similarity between different portions. Thus in liverworts, mushrooms, lichens, and sea-weeds, the structure of the leaf, stem, and root are all the same; that is to say, portions performing different functions in the economy of the plant are little differentiated from any or all of the other parts. None of those individual cells, or groups of them, are set apart for any specified ends. These are termed Thallogens. Now, in ferns and mosses this is not the case. The root is different from the frond, as the stem is from both. The structure is no longer cellular but vascular, no longer indefinite but definite. There are vessels forming organs of nutrition and reproduction, spores and sporecases, &c. They grow only at the summit, hence are termed Acrogens. These two great divisions are flowerless. In the higher orders of flowering plants we have a still greater complexity of structure. The Coniferæ, or cone-bearing trees—the fir-tribe—are in a measure intermediate between flowering and flowerless plants. "Their organs of fructification are reduced to the simplest form they can possess, while still maintaining the character which distinguishes the reproductive process in flowering plants." The stem-like processes which represent leaves are repetitions of one another, and give the tree a monotonous aspect. In Endogens, the lower division of flowering plants, the leaves are more varied, though the veins are parallel; the parts of the flowers are arranged in threes; the seeds have but one cotyledon; and the fibres of the wood present to us a simpler arrangement than in the higher division. Grass, lilies, and palms may be taken as representatives of this subkingdom. In Exogens, such as our oaks, elms, beeches, &c., we have the most complex arrangement of parts that the vegetable kingdom presents to us. The seeds have two cotyledons; the leaves are intersected with veins; the different tissues of which they are composed are more distinctly marked; the fibres of the wood are more variously, and at the same time more definitely arranged. We have, as in the oak-tree, a whole, a complete organism, in which the structure of different parts varies considerably, which parts have many different qualities, properties, and aspects. We have organs, to which are assigned, or which severally perform, certain peculiar duties or functions, thereby rendering the economy of the plant more complex, thus giving to it a fuller, completer life than is attained by those whose structure is less involved. We may, therefore, conclude that "the difference between the higher and lower divisions of the vegetable kingdom, as a whole, is in the main analogous to that which distinguishes the more civilized, or more highly developed social organism from the earlier, the uncivilized, or less developed one."

Now, if society, as a whole, has had a continuous and progressive history, so, too, has the vegetable kingdom. We find no oak-trees in the primary rocks. In the first strata which succeed those which the action of fire has fused more or less into homogeneous mass, it is simple cellular growth—confervæ, sea-weeds, and lichens—which everywhere predominate. After the lapse of ages, ferns, club-mosses, and Equisetæ are found in abundance—that is to say, the strata nearer our own are characterized still by flowerless plants, but of these it is the higher division, Acrogens, which is noticeable.

That exuberant vegetation, which formed what is now our coal-bed, is made up nearly entirely of plants allied to our conifers, cycads, yews, and the like, which, as we noticed, formed a link between flowerless and flowering plants. Later epochs still saw the preponderance of grasses, lilies, palms, &c. —that is to say, Endogens attain to significance in the economy of the growing world; and, finally, the last geologic epoch—the strata contemporaneous with or immediately preceding the advent of man —is remarkable for the relative preponderance of those complex forms which as Exogens cover the face of the earth at present.

But the character of this progression must not be misunderstood. If Exogens flourish to-day, so do vast numbers of individuals and species belonging to lower classes. To say that the nineteenth century is distinguished from preceding ones by the higher character of the civilization which it presents to us, is not to affirm that the lower forms are absent. In like manner to say Exogens as the highest vegetable organisms characterize the vegetation of the present does not imply that lower ones do not exist.

The analogy between the progression of the human race and that of vegetable existence as a whole holds good also in this, that it is the "relative predominance" of certain types which characterize an epoch, not the entire absence of lower or higher forms. Thus, in saying that Thallogens, Acrogens, Conifers, Endogens, &c., successively distinguish strata which disclose to us the order of the [illegible] development is not to affirm that structures bearing many points of resemblance to the highest as they exist at later periods were not coeval with the lowest. At the present time the difference between what we term the highest vegetable organism and the lowest, as between the civilization of Europe and the barbarism of the African tribes, is immense; but as we go back in time the difference between these two extremes is in both cases lessened—that is to say, that the higher forms of both have arisen by a gradual and insensible evolution from lower ones. The epochs of the geologist are arbitrary. The rocks of one strata are not separated from those of another by any gulf or blank interval. Between these different divisions of the botanist there are many forms which cannot be accurately placed in any category. These classes, families, &c., of plants, with all their special characteristics, have arisen by an insensible gradation from simpler, less definite structures.

The oak-tree was not always such as it is now. We know how the influences of soil, climate, temperature, or cultivation may change the form of a plant until we can scarcely recognize its ancestors—in some cases even not at all. So the varied and different influences which the world in its development has exercised on its vegetation, as a whole, has moulded and fashioned the individual forms which compose it; given unto them those more pronounced and divergent characters which make the difference between existing organisms and those forms which have preceded them, and from which they are derived.

And now let us turn to the animal kingdom. Here, as among vegetables, we recognize a common plan of structure between vast numbers of individuals, and again, great differences between the groups into which by such resemblances they are classified.

The simplest form in which animal life presents itself is a microscopical speck of "mixed jelly or sarcode, comparable in its properties to white of egg." It is scarcely to be termed a structure or an individual, so indefinite the substance of which it is made, so little defined its form from the medium in which it lives. When we come to a creature whose body is a determinate cell, one therefore in which the parts are more obviously related to one another, and interdependent, there is evidently an advance in organization. Aggregations of such cellular bodies into large wholes is a still further advance. Again, when such wholes have certain individual characteristics, and these individuals are united together to form a compound structure, though still in a greater or less degree leading an independent life as in sponges, we speak of such community as forming an organism higher in the scale than the others. "Those little societies of monads or cells, or whatever else we may call them, are societies only in the lowest sense; there is no subordination of parts among them—no organization. Each of the component units lives by and for itself, neither giving nor receiving aid. There is no mutual dependence save that consequent on mere mechanical union."* Even when this "mixed jelly" or these cells constitute an organism, which we may safely call an individual, there is little of that structure which we usually associate with the idea of an animal. Now, here it may be well to remark that, although a strict definition of the terms *higher* and *lower*, and the application of them first to classes, and then logically to different individuals of these classes, lead us into strange absurdities and contradictions, yet it is evident we cannot dispense with them. The source of these contradictions we shall explain hereafter. Enough for the present that the common sense of mankind, basing its judgment on the principles which make one society, one human being superior to another, will affirm that the animal kingdom shows us gradations of rank; that a mollusc is higher in the scale than a sea-anemone, that a fish is superior to an oyster, an eagle to a spider, man to a dolphin or a whale. It is for us to indicate scientifically the general grounds of this distinction. We shall find that, in the main, they are the same as establish the difference between the orders of the vegetable kingdom, as also between the higher and lower social organism.

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* From a treatise entitled "Force *v.* Organization," in *St. Cuthbert's Magazine.*

When we examine the body of one of those compound polyps common to our ponds, we find a mere jelly-like sac in which there is great uniformity of structure; in which, as we have said, the outer tissue may perform the functions of the inner one, and *vice versa;* in which there is no digestive or respiratory apparatus, no heart, alimentary canal, circulatory or nervous system. We have little or nothing of that which has been aptly termed the physiological division of labour. But when we discover a difference between the internal and external covering, a step towards the development of organs of nutrition and of the apparatus of external action; when we find a duct for the conveyance of blood, a part of the body specially devoted to its aëration, a receptacle for the food, nerves to convey sensations, and to serve as sympathetic bonds between the different members, organs, or parts—thus making the exercise of each subservient to the well-being of the whole—we say there is an advance in the organization. The degree in which we find this complexity of structure, the differentiation of function, these varied phases of activity in any organism, shall be determinative of its rank. Therefore it is that the mollusc is higher than the coral polyp; that, of the mollusca, the cuttle-fish with osseous skeleton, with large eyes, strong muscles, a complicated digestive apparatus, and a well-developed brain, is higher than the snail or oyster; that the articulata, as a rule, are superior to the mollusca; that spiders, lobsters, crabs, bees, &c., are higher than whelks and limpets.

When the osseous skeleton which we have noticed in the cuttle-fish divides the body into two cavities, one of which is specially adapted to the organs of nutrition and the other to the principal nerve-centres, with all the wonderful modifications such division implies, we have the vertebrate type of structure. This is an advance on the others, one which makes fishes, as a class possessing it, higher than insects, molluscs, and protozoa. Now a land animal being subject to greater differences of conditions than one which inhabits the sea, will, as a rule, have corresponding differences in its structure, the limbs will be more diverse in their character, organs of nutrition adapted to more complex nature of food; lungs with their myriad interstices will have replaced gills; the blood will be warmer, the machinery for propelling it more complicated; the senses more acute, nerves more intricate, brain more developed. It is therefore that an amphibian is superior to a fish. On the same principle of more complex organization, reptiles as a class present to us a higher type than amphibians, birds than reptiles, and a man, as representative of the mammalia, has an organism decidedly more complicated as a whole than any bird.

However much we may be at a loss when we consider all the details of the vast scheme of life that has been developed on the earth; however much the facts of geology, or more properly palæontology, limited as they are, may seem to contradict some of our notions with regard to it; small as is the portion of the earth's crust that has been explored, or looking at the vast expanse of water on the globe, ever will be subject to the scrutiny of science, enough has been discovered to show us that "the law of the genesis and becoming of the living forms which people the world now, and which have peopled it in past ages, has been one with that of the vegetation which has accompanied them, one with that of man and society which has in a measure come after them."

That is to say, that in the earliest strata we do not find remains of such complex organizations as share the earth with man to-day, and whose structure is more or less allied to his own; nor, as we have said, do we find there either a vegetation with that wonderful diversity of form and colour which delights, and in delighting educates and develops the refined and subtle faculties of the human mind. The whole course of creation has been one harmony of power and form.

In that vast series of ages during which the strata which now form the dry land of the earth were gradually and slowly deposited by the waters, and then raised above the surface of the deep, epochs of greater or less duration have distinguishing characteristics.

The systems of the geologist which denote these epochs, commencing with the earliest that were formed and ending with the more recent, are termed the Cambrian, Silurian, Devonian, Carboniferous, Triassic, Oolitic, Cretaceous, and Tertiary. Now let us glance at the forms of animal life which successively characterize them.

Wheresoever we find the primary rocks, whether in the Ural mountains, in those of Wales or of Canada, in the Steppes of Russia or in the far west of America, there it is that the early traces of life commence in the coral-like masses formed by those microscopic animalcula which we take to be the lowest form of animal existence. Shells also of such minute and simple organisms as are at present found in the ooze of the sea, or amidst its waters. Later, we come to shells of the lower molluscs; crustacea analogous to the embryological forms of species which succeed them; the rocks occasionally reveal to us also the tracks and burrows of worms. But the evidences of life are yet somewhat scanty. The organisms themselves were perishable. The action of fire on the strata has more or less metamorphosed them. In the Silurian epoch, the aspects of life broaden; although the remains of no terrestrial animal have yet been discovered in it, sponges, corals, starfishes, higher molluscs and crustaceans abound. With the Devonian era we enter upon the predominance of gigantic crustaceans with complex limbs, and a correspondingly complicated internal economy; but, above all, it is here that we meet with fishes for the first time. Shoals of them are imbedded in the strata, albeit of so simple a type of structure as to have been mistaken for crustaceans, and even huge water-beetles. In the Carboniferous, many of the lower forms of life already noticed have become more complex; their different species have more determinate and distinctive forms. The bone-encased fishes of the Devonian have given place to forms analogous to some which now are found in Australian seas. With the dry land which now seems to become more general, and the growth of the vast forests which at present afford us coal, the remains of beetle-like insects are discovered. Evidences of terrestrial life are also furnished by fish-like lizards, frog-like reptiles, and a linking and blending of aquatic and terrestrial life as manifested in the characters of Amphibia. In the Permian and Triassic systems we find true lizards and true reptiles abundant—some species of huge size and of high organization. At the same time, the general character of the forms of life contemporaneous with them has altered. The molluscs present greater differences, the bone-encased fishes of the Devonian age have given place to others more resembling those now existing. Insects are more varied. We have yet no evidence of true birds, but only of reptiles walking bird-like on their hind feet; none of true mammals, but only of those which produce their young in so imperfect a state that it has been well said that it is a shell-less egg that is born—it is marsupial-like animals, such as are allied to the kangaroo, which precede the true mammals. In the Oolitic, reptiles abound to such an extent,—wade through the marshes, swim on the sea, fly over the land,—that it has been termed *par excellence* the "age of reptiles." Traces of true birds also become noticeable towards the close of this epoch. But in the chalk these indications became more frequent, and here also are signs of the existence of true mammals. But with the Tertiary epoch, while vast numbers of species which characterized the preceding ages have become extinct, others take their place—become as it were the dominant and special forms of existence. It is here that the birds whose gigantic remains form the curiosities of our museums—the Epiornis of Madagascar, the Dinornis of New Zealand—come on the scene; it is here that enormous mammals, as the Megatherium and Mastodon, are first discovered. The whole of creation has been gradually assuming the aspect it presents to us now. In the Tertiary strata, we perceive how plant, mollusc, fish, bird, mammal are becoming more and more like the forms they exist in to-day. Myriads on myriads of individuals, nay thousands of species arise and decay; only those forms abide which are compatible with the general character of the world's advancing life—which are one with that great scheme which slowly culminates in man; for it is the presence of his remains, or of his productions that now first find a place—have a genesis also and a becoming—in the evolution of that great organism of which he is a part. Considering then such development as we have here indicated; the insensible gradation by which life has attained to its present "wide discourse;" how the inorganic has passed into the organic, mere sensibility to impression into instinct, instinct into intelligence, intelligence into moral ideas, and brute force into delicate organization; how the epochs of the geologist blend with one another, yet possess distinctive features, how the forms which characterize them, widely different as some of them are, may yet be traced back to a similar ancestry; how the life-energy of the world has thus fashioned for itself *one language* and *one history*, we cannot be insensible to the analogy which is suggested by it. The creative and productive energies of nature have stamped each epoch with a particular character, and that character is more complex as the years advance. Looking at the animal life of the world in its totality, its progression is analogous to that of an individual. Taking also the whole of its vegetable life, a similar unity in the plan of development is presented to us. That advance, from the simplest structures of the Laurentian and Cambrian rocks to the varied diversity of the vegetation of the present era, is typified in the growth of every tree in the forest. "Protoplasm into cells, cells into folia, folia into axes, axes into branch-combinations—such in brief are the stages passed through by every shrub; and such appear to have been the stages through which plants of successively higher kinds have been evolved from lower kinds."*

Look again at the simple starchy mass which is the substance of the acorn, and notice the changes which it undergoes. When the influences of heat and light have initiated changes in its molecules, it is not a leaf or flower which is produced; the progress to these is so gradual that we cannot perceive where one state begins and another ends; when the germ is no longer a germ, but plumule and radicle; when the outer tissue of the former begins to assume the appearance of bark; when the first rudiment of the leaf is formed, and when the structure of the roots diverges from the stem. Neither in the evolution of the whole vegetable kingdom can we perceive where the specific characters of one individual class or species begins, nor where, indeed, their influence ends. Vegetable progress, like all other, is continuous, is cumulative. Myriads on myriads of individuals have lived and died, and each has passed on to its successor the advantage it gained. The life of a large tree is a cycle involving other cycles. Each returning spring sees the renewal of its life, the summer its maturity, the autumn its decay. So has the vegetation of the earth, as a whole, had its period of commencement, its exuberant growth, and also its decline. But not only individuals, but vast groups of these, different species and genera, have had their genesis, have gradually attained their highest organization, their greatest perfection, become for a while the dominant forms of the plant-life of the earth, and then gradually disappeared. So have flourished and passed away, for instance, many of the species which form, in a great measure, our coal-beds. They have now no representative in existence.

(*To be concluded next week.*)

MECHANICAL MOVEMENTS.

(*Continued from page 488.*)

280. Another kind of gasometer. The vessel A, has permanently secured within it a central tube *a*, which slides on a fixed tube *b* in the centre of the tank.

281. Wet gas meter. The outer case is stationary, and filled with water up to above the centre. The inner revolving drum is divided into four compartments, B B, with inlets around the central pipe *a*, which introduces the gas through one of the hollow journals of the drum. This pipe is turned up to admit the gas above the water, as indicated by the narrow near the centre of the figure. As gas enters the compartments B B, one after another, it turns the drum in the direction of the arrow shown near its periphery, displacing the water from them. As the chambers pass over they fill with water again. The cubic contents of the compartments being known, and the number of the revolutions of the drum being registered by dial work, the quantity of gas passing through the metre is registered.

282. Gas regulator (Power's Patent), for equalizing the supply of gas to all burners of a building or appartment, notwithstanding variations in the pressure on the main, or variations produced by turning gas on or off, to or from any number of the burners. The regulator-valve, D, of which a separate outside view is given, is arranged over inlet pipe E, and connected by a lever, *d*, with an inverted cup, H, the lower edges of which, as well as those of valve, dip into channels containing quicksilver. There is no escape of gas around the cup H, but

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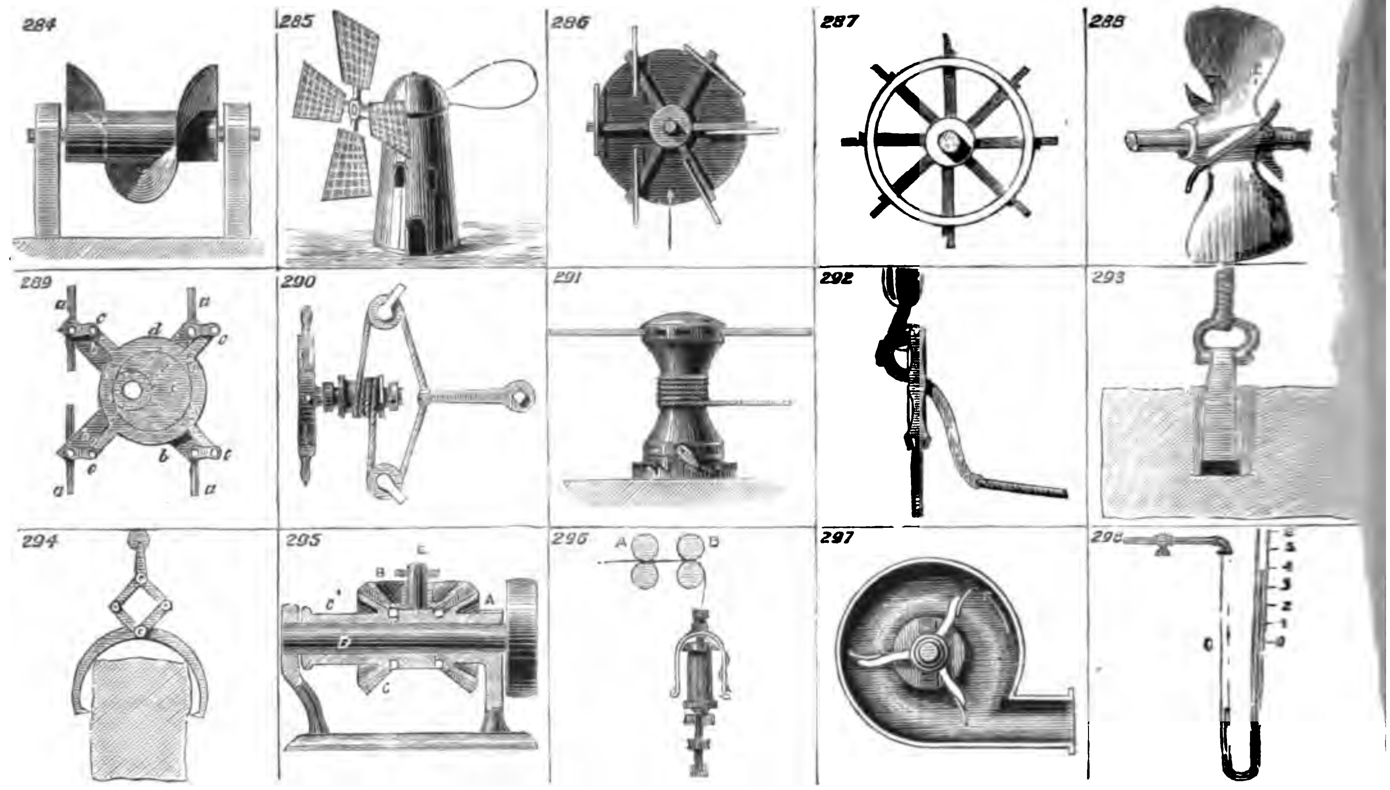
* H. Spencer, "The Social Organism," Essays. Vo . I.

* "Principles of Biology," vol. ii., p 214.



MECHANICAL MOVEMENTS.

there are notches, *b*, in the valve to permit the gas to pass over the surface of the quicksilver. As the pressure of the gas increases, it acts upon the inner surface of cup H, which is larger than valve, and the cup is thereby raised, causing a depression of the valve into the quicksilver, and contracting the opening notches *b*, and diminishing the quantity of gas passing through. As the pressure diminishes an opposite result is produced. The outlet to burners is at F.

283. Dry gas meter. Consists of two bellows-like chambers, A A^1, which are alternately filled with gas and discharged through a valve B, something like the slide valve of a steam engine, worked by the chambers A A^1. The capacity of the chambers being known, and the number of times they are filled being registered by dial-work, the quantity of gas passing through the metre is indicated on the dials.

284. A spiral wound round a cylinder to convert the motion of the wind or a stream of water into rotary motion.

285. Common windmill, illustrating the production of circular motion by the direct action of the wind upon the oblique sails.

286. Plan of a vertical windmill. The sails are so pivoted as to present their edges in returning towards the wind, but to present their faces to the action of the wind, the direction of which is supposed to be as indicated by the arrow.

287. Common paddle-wheel for propelling vessels; the revolution of the wheel causes the buckets to press backward against the water and so produce the forward movement of the vessel.

288. Screw propeller. The blades are sections of a screw-thread, and their revolution in the water has the same effect as the working of a screw in a nut, producing motion in the direction of the axis and so propelling the vessel.

289. Vertical bucket paddle-wheel. The buckets, *a a*, are pivoted into the arms, *b b*, at equal distances from the shaft. To the pivots are attached cranks, *c c*, which are pivoted at their ends to the arms of a ring, *d*, which is fitted loosely to a stationary excentric, *e*. The revolution of the arms and buckets with the shaft causes the ring, *d*, also to rotate upon the excentric, and the action of this ring on the cranks keeps the buckets always upright, so that they enter the water and leave it edgewise without resistance or lift, and while in the water are in the most effective position for propulsion.

290. Ordinary steering apparatus. Plan view. On the shaft of the handle-wheel there is a barrel on which is wound a rope which passes round the guide-pulleys and has its opposite ends attached to the "tiller" or lever on the top of the rudder; by turning the wheel, one end of the rope is wound on and the other let off, and the tiller is moved in one or the other direction, according to the direction in which the wheel is turned.

291. Capstan. The cable or rope wound on the barrel of the capstan is hauled in by turning the capstan on its axis by means of hand-spikes or bars inserted into holes in the head. The capstan is prevented from turning back by a pawl attached to its lower part and working in a circular ratchet on the base.

292. Boat-detaching hook (Brown & Level's). The upright standard is secured to the boat, and the tongue hinged to its upper end enters an eye in the level which works on a fulcrum at the middle of the standard. A similar apparatus is applied at each end of the boat. The hooks of the tackles hook into the tongues, which are secure until it is desired to detach the boat, when a rope attached to the lower end of each lever is pulled in such a direction as to slip the eye at the upper end of the lever from off the tongue, which being then liberated slips out of the hook of the tackle and detaches the boat.

293. "Lewis," for lifting stone in building. It is composed of a central taper pin or wedge, with two wedge-like packing-pieces arranged one on each side of it. The three pieces are inserted together in a hole drilled into the stone, and when the central wedge is hoisted upon it wedges the packing-pieces out so tightly against the sides of the hole as to enable the stone to be lifted.

294. Tongs for lifting stones, &c. The pull on the shackle which connects the two links causes the latter so to act on the upper arms of the tongs as to make their points press themselves against or into the stone. The greater the weight the harder the tongs bite.

295. Entwistle's patent gearing. Bevel-gear, A, is fixed. B, gearing with A, is fitted to rotate on stud, E, secured to shaft, D, and it also gears with bevel-gear, C, loose, on the shaft, D. On rotary motion being given to shaft, D, the gear, E, revolves around A, and also rotates upon its own axis, and so acts upon C in two ways, namely, by its rotation on its own axis and by its revolution around A. With three gears of equal size, the gear, C, makes two revolutions for every one of the shaft, D. This velocity of revolution may, however, be varied by changing the relative sizes of the gears. C is represented with an attached drum, C′. This gearing may be used for steering apparatus, driving screw-propellers, &c. By applying power to C, action may be reversed, and a slow motion of D obtained.

296. Drawing and twisting in spinning cotton, wool, &c. The front drawing-rolls, B, rotate faster than the back ones, A, and so produce a draught, and draw out the fibres of the sliver or roving passing between them. Roving passes from the front drawing-rolls to throstle, which, by its rotation around the bobbin, twists and winds the yarn on the bobbin.

297. Fan-blower. The casing has circular openings in its sides through which, by the revolution of the shaft and attached fan-blade, air is drawn in at the centre of the casing, to be forced out under pressure through the spout.

298. Siphon pressure gauge. Lower part of bent tube contains mercury. The leg of the tube, against which the scale is marked, is open at top, the other leg connected with the steam-boiler or other apparatus on which the pressure is to be indicated. The pressure on the mercury in the one leg causes it to be depressed in that and raised in the other until there is an equilibrium established between the weight of mercury and pressure of steam in one leg, and the weight of mercury and pressure of atmosphere in the other. This is the most accurate gauge known; but as high pressure requires so long a tube, it has given place to those which are practically accurate enough, and of more convenience.

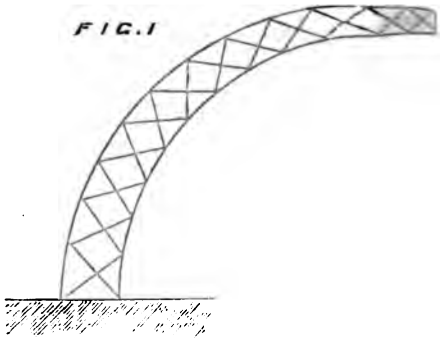
(*To be continued.*)

WROUGHT-IRON CRANES.—II.

(*Continued from page* [illegible]

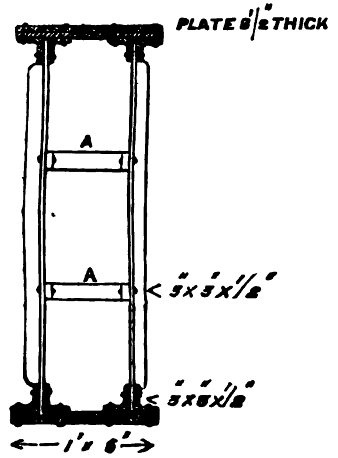
IN our last article on this subject the solid-sided or plate-web crane was the example selected for illustration and description. Its merits were pointed out, and its disadvantages also investigated. Before proceeding to determine the nature and extent of the strains that act upon a crane, we will briefly notice the constructive difference which exists between the open and the solid web crane. To avoid needless repetition, and not to introduce more cuts than are necessary, we will assume that the duty required of the crane is sufficiently severe to necessitate that it should be of the double web type—in fact, an open-sided tubular crane. It will be at once seen that while this form possesses all the advantages with respect to stiffness that is given by the solid-sided form it is also free from its disadvantages. There is no difficulty in examining every part of it, and painting and repairing it when necessary. In Fig. 1 is represented the elevation of a lattice bent crane with a double series of triangles in the web. Frequently the crane has a web of the Warren type, in which there is but one system or series of triangles, but the arrangement of the number of series depends altogether upon the size of the crane, and especially of its depth. The deeper the web, the greater must be the number of intersections of the bars, or the greater must

FIG. 1



the amount of stiffness given to them, either by creasing the sectional area of metal in them, or lopting a form of section adapted to ensure the quisite rigidity. It will be at once apparent that e greater the number of the crossings of the bars e less becomes the actual length of any unsuprted bar. Every intersection of two bars, supsing it to occur at the middle of their respective ngths, virtually reduces those lengths one-half, nd the stiffness of the bars is thus nearly doubled, r while the original strain remains the same, the ndency of the bars to deflect is very considerably minished. This was one of the causes that peedily proved how deficient the Warren system as in those points when girders of large span ere proposed to be constructed on that principle. t was soon discovered that it was absolutely impossible to construct a deep girder with only one eries of triangles. The amount of material that it was necessary to introduce in order to afford the proper degree of stiffness to the bars was very much n excess of that which would be required in a solid-sided or plate girder. It must be borne in mind that the superior economy of the open or lattice type of girder over that of the plate system rests in the web, and in the web alone. The flanges or horizontal members of both systems are nearly identical. If, in designing a large girder on the lattice principle, the saving is not effected in the web, it cannot be obtained in any other part.

FIG. 2



The section of the crane shown in elevation in Fig. 1 is represented in Fig. 2, and, with the exception of the web or sides, does not differ materially from that given in our last article. Directly the horizontality of the flanges is departed from the strains upon the bracing or bars connecting the upper and lower flanges, and constituting the web, become very complicated, and it is by no means easy to ascertain, without some slight consideration, which of them act as struts and which as ties. When we proceed to analyze the strains upon a bent crane, and the manner in which each separate bar is affected by the load, it will be demonstrated that those which slope towards the lower or fixed extremity of the crane are subject to compressive strains, and, *per contra*, the others to those of a tensile description. But this is not a universal rule, for a great deal depends upon the radius of the upper and lower flanges, the depth of the web, and the angle of inclination of the bars. This angle is continually changing, which is the great impediment to the use of mathematical calculation for these examples of construction. In those instances where the flanges, both upper and lower, are horizontal and parallel to one another, the angle of all the diagonal bars is constant, and the calculation of the nature and amount of the strains may be effected either by geometrical diagrams, or by simple and readily deducible formulæ. But directly either or both of the flanges assumes a curvilinear outline this simplicity of calculation is at once lost. The ordinary formulæ are no longer applicable, and those that would theoretically apply to each particular case in question are so exceedingly troublesome, complicated, and uncertain, as to be practically useless. It is not too much to assert that to attempt to employ algebraical or mathematical equations and formulæ to some of the examples of girder construction would be to attempt a practical absurdity. Recourse is therefore had to the graphical method, and by means of a diagram of strains the proportions of the several parts can be accurately determined. At present we are not concerned with this part of the subject, which will be fully discussed in a subsequent article.

A reference to Fig. 2 will show that a plain bar section will not answer for the compressive bars in the web of a bent crane. This is owing to the fact that a plain rectangular bar has little or no lateral stiffness. It is true that when occupying the position of one of the diagonals in the web of a girder designed on the lattice principle, it is stiffened to some extent by the intersections with the other bars. But this is not sufficient, and it becomes necessary to adopt a form of section that by virtue of its own shape shall possess some degree of inherent stiffness and rigidity. Independently of this reason there is another. It is that although the intersections of the bars do contribute to the stiffening of the web of the girder, yet they are not supposed to actually prevent the bar from deflecting. There is little doubt that they in reality do so, but it must not be taken into account when proportioning the bars, because it is always assumed that there is no extra strain brought upon the respective bars by their being riveted or bolted to one another. It is at the same time manifest that if they were prevented from deflecting, in consequence of the points of intersection, there would be a considerable transverse strain induced upon them. This strain, which would increase with the length of the bar, would altogether vitiate the whole principles of girder construction, as we have already frequently explained in our columns.

The form selected for the compression bars in Fig. 2 is that of angle iron, but there are several other forms equally suitable. Of these, tee or channel iron is to be preferred, but they all yield to angle iron in simplicity and facility for attachment. Moreover, the last description of section is that most readily procurable in the market. It can always be obtained of the usual scantlings at a very moderate price per ton, whereas some of the other sections are only to be obtained by special order, thus entailing a long delay, and sometimes are not to be had at all. There is no greater mistake made than to design a structure with a quantity of impossible-shaped material in it. As a rule, always select those forms, sections, and sizes of iron that are the most readily obtained, and at the most moderate cost. It is not only the shape of the iron that is of importance, but the dimensions. When bars beyond a certain length in one piece are wanted, or plates containing more than a certain maximum superficial area, there is an extra price per ton charged. Thus, a narrow plate of about 12in. broad can be procured at the ordinary market prices in a considerably longer single length than one of 24 or 30in. in breadth.

At the time of constructing the Britannia Tubular Bridge over the Menai Straits there was the greatest difficulty experienced in obtaining plates 12ft. in length. Since that time our iron manufacture has made a great deal of progress, but still long plates are very expensive. This is owing to a combination of many circumstances. In the first place, the larger the plate the greater the trouble and expense of handling and transporting it from one place to another. Secondly, the difficulty of rolling a plate or bar that shall be homogeneous in consistency increases enormously in proportion to an increase in the size; and thirdly, larger and more expensive rolling machinery is necessary than for plates and bars of the ordinary dimensions. Besides stiffening the bars in the web of the bent crane in the plane of the elevation of the crane, they also require some bracing in a plane at right angles to the face of the web. The opposite bars have to be braced together transversely, as shown in Fig. 2. This is usually effected by introducing small pieces of bar or angle iron, and riveting them (see A A, in Fig. 2) to the diagonals at their intersections with each other.

In large examples, the opposite diagonals are united, not merely by horizontal pieces of bar, but by a regular system of cross bracing, so as, in fact, to convert the whole couple of diagonals into a small braced girder of itself. Wherever the depth of the girder is small this is not needed, but the plan shown in Fig. 2 will afford all the security required,

We must reserve for the next article on the subject the investigations into the strains upon these braced specimens of construction.—*Building News.*

USE OF ELECTRICITY IN CAUTERIZATION.—The old method of cauterization by fire is to be replaced by the electro-thermic or galvano-caustic apparatus. The latter process is safer and more certain in its operation. It is possible at will to vary the degree of heat, to raise it instantly to the highest intensity, to diminish or suppress it, to render it intermittent or continued, to direct it into deep cavities, and to destroy all the tissues by contact. It is said that the wounds produced by electricity are less liable to contagion and miasmatic infections than those caused by sharp instruments. The apparatus can be made of any desired shape so as to be applicable to all parts of the body, and it is known that important cures have been effected by the introduction of platinum wires and the cauterization by the battery of parts of the body inaccessible in any other way. Electricity has already been tried in cases of bad tumors, in amputations, in excisions of cancers, in destruction of wens, for opening cysts, for removing internal tumors, upon wounds by fire, and in numerous other cases. A recent article in *Cosmos* claims for it the following advantages: The electro-thermic cautery suppresses all pain after the operation; avoids loss of blood; prevents the retention and alteration of the liquids; avoids all putrid and purulent infections; facilitates the organic reconstruction and healing of the parts; affords a method universally applicable, strong or weak, continuous or intermittent; capable of sloughing the tissues, of carbonizing them, of destroying them, of converting them into gas, and must be regarded as one of the most important contributions to modern surgery."

THE FORECASTING OF STORMS.*

IT cannot be denied, that the complicated and constantly varying phenomena of that fickle entity which we denominate the weather form a problem which in the nature of things must be extremely difficult of solution; and it is hardly probable that any man will ever be able in this field of inquiry to reach the same satisfactory results that have rewarded the labours of the astronomer. It is a source of legitimate pride to Americans, however, that in two important departments of meteorological investigation citizens of this country hold the first rank. To Dr. Franklin belongs the honour of discovering and elucidating the principles of electricity, and of demonstrating the influence of that subtle force upon the earth and its atmosphere; and it was Redfield who, something like a century later, deduced from his own careful observations of storms upon our Atlantic coast the important generalization that there is a class of great storms which originate near the equator, in the region of the West Indies, and rapidly advance, according to a fixed law, with a simultaneously gyratory and progressive motion, upon a well-defined curved axis towards the north pole. These storms vary greatly in intensity and in breadth—sometimes being confined to a narrow belt upon or a little way off from the coast, and again extending over a wide expanse of land and sea; but that they uniformly follow the same general course indicated by Redfield has been abundantly established by a great number of subsequent observations. It is not designed here to enter into an elucidation of this important law, but attention is called to it as marking one of the few real and tangible and practical achievements in the field of meteorological science. Its discovery and announcement stimulated investigators both here and in the Old World to renewed energy in their efforts to unravel the mysteries of atmospheric phenomena. The subject of storms, both ocean and inland, was especially studied with quickened zeal and enthusiasm: and in due course of time an attempt was made abroad—first in England, then in France, and afterwards in other continental countries—to utilize the knowledge gained thereby in the interests of commerce, which, ever since it has existed, has been subjected to constant peril and loss from the effects of storms. The prevailing courses of the most destructive storms in various localities having been definitely ascertained, measures have been taken to give warning to exposed points of their approach, by means of the telegraph. This intelligence being promptly communicated by preconcerted signals to all vessels passing within sight of the shore or lying at anchor in harbour or roadstead, such vessels are enabled to take all necessary precautions against disaster before the storm shall burst upon them; and immense damage to shipping has thus in very many instances been avoided.

Notwithstanding the salutary operation of this system abroad, however, and notwithstanding the peril from storms to which our commerce on the great lakes and the Atlantic seaboard is constantly exposed, no measures have been taken in this country, until within the past few months, for the inauguration of such a system here. Early in the present session of Congress, however, the matter was brought to the attention of the House of Representatives by the Hon. Halbert E. Paine, of Wisconsin, who offered in that body a joint resolution providing "for taking meteorological observations at the military stations and other points in the interior of the continent, and for giving notice on the northern lakes and seaboard of the approach and force of storms." The resolution in full is as follows:—

"*Be it resolved by the Senate and House of Representatives of the United States of America in Congress assembled*, That the Secretary of War be, and he hereby is, authorized and required to provide for taking meteorological observations at the military stations in the interior of the continent, and at other points in the States and Territories of the United States, and for giving notice on the northern lakes and on the sea-coast, by magnetic telegraph and marine signals, of the approach and force of storms."

This resolution was promptly passed by both houses of Congress, and on the 9th of February, 1870, became a law by the approval of the President. By General Orders No. 29 from the head-quarters of the army, dated March 15, 1870, the chief signal officer of the army, Brevet Brigadier-General A. J. Myer, is charged, subject to the direction of the Secretary of War, with the execution of the provisions of this enactment, and all commanding officers are enjoined to afford every facility for the successful prosecution of the undertaking; while scientific establishments, commercial associations, and others, are requested to aid, by their co-operation, in the accomplishment of the work.

Professor J. A. Lapham, of Milwaukee, impressed by the frightful aggregate of a single year's disasters to vessels on the great lakes—amounting for the year 1869 to the immense number of 1,914, with an estimated damage to property of over four millions of dollars—was perhaps the first to suggest some action by Government for inaugurating such a system of storm-reporting as, through the efforts of General Paine, has now happily been adopted. It should be remarked that by no means all of the disasters included in the aggregate above given were of that class which might have been obviated by the operation of the system we are considering. Very many were due to imperfect machinery, defective boilers, careless collisions, conflagrations, and other causes. Yet, making all proper deductions on this score, enough remain to be attributed to the destructive force of severe and unheralded storms, to fully justify any action by Government looking to a mitigation of the destruction of property and the peril and often loss of life which they entail. No corresponding statistics are at hand as to the yearly disasters upon our Atlantic seaboard; but these are very numerous, as is well known, and of these a much larger proportion than of the lake disasters are attributable to the agency of storms. Besides the great equatorial storms already alluded to, which in their course towards the pole follow approximately the coast-line of the United States, our coasting vessels are likewise exposed to frequently-recurring tempests, especially in the summer season, which originate probably upon the great desert basin in the interior of the continent, and, sweeping eastwardly across the Mississippi Valley and the great lakes, expend their final fury upon the ocean and its navigaters.

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* Extracted from an article by L. A. ROBERTS in the *Western Monthly.*

Nor must we overlook the damage often worked on land, as well as upon the water, by these latter storms, and by those tornadoes of narrower limit and shorter duration, but often of even greater intensity, which prevail at intervals throughout the Mississippi Valley, and lay waste the narrow belt of country which they traverse. Of this class was a storm which swept through Northern Ohio and on the Alleghany Mountains in Pennsylvania in the summer of 1855, demolishing very many buildings in its course, uprooting trees and razing fences, and causing the death of many persons. So furious was this storm, and yet of so limited a breadth—only about an eighth of a mile—that while in some villages over which it passed scarcely a house escaped damage, in others only the northern or southern section of the town would be devastated; the outer verge of the destructive force being so sharply defined that while one house, that fell within its track, would be almost totally destroyed, another, but a few yards distant, would be wholly unharmed. The course of this storm may even yet be easily traced in the forests through which it raged. It cut a clean swath as it went, leaving openings that look as if they had been cleared for a highway or a railroad. The timber thus prostrated was in some cases utilized for firewood or for lumber; but in many places the trunks of the trees were left in such inextricable confusion and tangle—having fallen in every conceivable direction, and being in some instances individually twisted into splinters, as a result of the rotary action of the storm—that it was found inexpedient, in a country where timber was in plenty, to attempt to "pick up the pieces;" and thus the logs were left to rot and replenish the earth. And now, throughout these storm-openings in the woods, vast thickets of the highbush blackberry have grown up; and so we have, as the latest result of that furious tempest, an almost unlimited abundance yearly of the finest blackberries anywhere to be found.

No one who has witnessed such a storm as this will ever forget it. The imminent peril of a storm at sea may be greater and more appalling; but nothing can be more exciting than one of these fierce whirling tornadoes, accompanied, as they almost always are, by a deluge of rain and an almost constant rolling of thunder and glare of lightning. The storm is heralded by a heavy mass of cloud in the west or southwest, dark, with a sulphurous tinge, over the face of which there is an almost constant play of lightning, and within an ominous muttering of thunder. Then there is a dash of rain, a moaning of the wind, and the next moment the storm bursts upon you. Then the air is full of a tumult of unwonted sounds. Loose shutters, sign-boards, and what not, are dashed against the house. Chimneys are blown into individual bricks, and the bricks come clattering down the flues. Doors and windows are burst open; the house trembles to its foundations; and the next moment you behold your roof following your neighbour's in a wild flight for the open country—going to pieces as it is borne along like a wreck upon the sea—scattering its fragments broadcast, some of them being found afterwards miles away. Such unfortunate persons as chance to be abroad upon the streets when the fury of the tempest is let loose, strive in vain to make headway either with or against the current, and can do no better when blown to the ground than lie prone there and thank their stars if nothing more pitiless than the drenching rain shall fall upon them; for factory chimneys and church spires go down like grass before the mower, and walls are falling on all hands. One poor man, seeking to rescue a span of valuable horses that are hitched to leeward of a house wall that he fears may fall, is too late; for even while he is in the act of untying the halter the wall is down, crushing the horses and burying himself to the middle in its *débris*—and there he stands, upright, stark dead in an instant! A little farther down the street an unfinished frame building goes down even before the workmen upon it can reach the ground, and three men are crushed in the mass of timbers and escape death by a miracle.

All this, and vastly more, in one little village; and a dozen villages are in the track of the monster. Ay, a monster he is, and almost insatiable, but not quite; for right in his course stands a little country-house, the inmates of which, looking westward, hear his roar and see him come crashing through a belt of woods a quarter of a mile away. They make such hasty preparations as they can for the impending catastrophe; but, to their utter astonishment, they find in a minute or so that the storm has passed them by unharmed and is tearing through the woods to the east of them. This characteristic of these tempests has been often observed. While in general they move upon the ground, sweeping it clean as they go, occasionally they rise above it, and again descend—bounding, as it were, like an india-rubber ball that has received a superior ground stroke from the champion batter of a "first-nine."

(*To be concluded next week.*)

CEMENTS AND HOW TO USE THEM.

A GREAT deal has been written concerning different cements, and indeed our periodicals are full of recipes on this subject. But it will be found that the information given is rather in regard to the materials used in compounding these cements than in regard to the manner of using them. And it is unquestionably true that quite as much depends upon the manner in which a cement is applied, as upon the cement itself. The best cement that ever was compounded would prove entirely worthless if improperly applied. We have hundreds of recipes for glues, pastes, and cements of different kinds, and yet the public is constantly on the *qui vive* for new ones, and no more acceptable recipe can be sent to our popular journals than one for a new cement. Now, the truth is, that we have cements which answer every reasonable demand, when they are properly prepared and properly used. Good common glue will unite two pieces of wood so firmly that the fibres will part from each other rather than from the cementing material; two pieces of glass can be so joined that they will part anywhere rather than on the line of union; glass can be united to metal, metal to metal, stone to stone, and all so strongly that the joint will certainly not be the weakest part of the resulting mass. What are the rules to be observed in effecting this?

The first point that demands attention is to bring the cement itself into intimate contact with the surface to be united. If glue is employed, the surface should be made so warm that the melted glue will not be chilled before it has time to effect a thorough adhesion. The same [illegible] more eminently true in regard to cements that are used in a fused state, such as mixtures of resin, shellac, and similar materials. These matters will not adhere to any substance unless the latter has been heated to nearly or quite the fusing point of the cement used. This fact was quite familiar to those who used sealing-wax in old days. When the seal was used rapidly, so as to become heated, the sealing-wax stuck to it with a firmness that was annoying—so much so that the impression was in general destroyed—from the simple fact that the sealing-wax would rather part in its own substance than at the point of adhesion to the stamp. Sealing-wax, or ordinary electrical cement, is a very good agent for uniting metal to glass or stone, provided the masses to be united are made so hot as to fuse the cement, but if the cement is applied to them while they are cold it will not stick at all. This fact is well known to those itinerant vendors of cement for uniting earthenware. By heating two pieces of delf so that they will fuse shellac, they are able to smear them with a little of this gum, and join them so that they will rather break at any other part than along the line of union. But although people constantly see the operation performed, and buy liberally of the cement, it will be found that in nine cases out of ten the cement proves worthless in the hands of the purchasers, simply because they do not know how to use it. They are afraid to heat a delicate glass or porcelain vessel to a sufficient degree, and they are apt to use too much of the material, and the result is a failure.

The great obstacles to the junction of any two surfaces, are air and dirt. The former is universally present, the latter is due to accident or carelessness. All surfaces are covered with a thin adhering layer of air, which it is difficult to remove, and which, although it may at first sight appear improbable, bears a relation to the outer surface of most bodies different from that maintained by the air of a few lines away. The reality of the existence of this adhering layer of air is well known to all who are familiar with electrotype manipulation. It is also seen in the case of highly polished metals, which may be immersed in water without becoming wet. Unless this adhering layer of air is displaced, the cement cannot adhere to the surface to which it is applied simply because it cannot come into contact with it. The most efficient agent in displacing this air is heat. Metals warmed to a point a little above 200°, become instantly and completely wet when immersed in water. Hence for cements that are used in a fused condition, heat is the most efficient means of bringing them in contact with the surfaces to which they are to be applied. In the case of glue the adhesion is best attained by moderate pressure and friction. Another very important point is to use as little cement as possible. When the surfaces are separated by a large mass of cement we have to depend upon the strength of the cement itself, and not upon its adhesion to the surfaces which it is used to join; and, in general, cements are comparatively brittle.

CARBON PRINTING ON ENAMEL TABLETS AND PORCELAIN SURFACES.

THE production of a carbon opalotype is probably one of the easiest feats in photographic printing of any kind. Not so, however, is the printing on a rounded or convex surface, such as an enamel tablet of the usual kind. This is attended with some difficulties, but they are not of such a nature as to prove insurmountable; moreover, the extreme beauty of a picture on a convex or lunette surface is such as to justify the expenditure of almost any moderate amount of labour in order to overcome them successfully. To do this some modifications in the process are requisite. The first and most important one is to procure a tissue *much* more flexible than any hitherto in use; and by flexibility we do not here allude to the gelatined sensitive film itself, but to the paper which is employed as a means of support for that gelatine. The commercial tissue that we have hitherto been using in our experiments has a hard, stiff paper as its foundation, and if tried for the purpose here proposed will require more than ordinary care to ensure a successful result.

When trying some experiments with a view to the writing of the present article, we made some tissue on a basis of thin and imperfectly-sized paper. Whereas the ordinary commercial tissue was so hard and brittle as to admit of its being broken across, this, although when dry still stiff and unyielding, was devoid of brittleness, and after a brief soaking in water became quite limp and flaccid. This last is one of the main conditions of success in carrying out a carbon printing process upon a rounded surface.

With these explanatory observations we now proceed to give such instructions as will enable any careful experimentalist to succeed.

First of all, make a reverse cast from the face of the enamel tablet. This may be done either in gutta-percha or plaster of Paris. The object of this will be seen as we proceed. Now, having a sheet of sensitized tissue placed on the paper (in the darkened room, of course), lay upon it the enamelled tablet on which it is intended to make the picture, and, by means of a penknife or a pair of scissors, cut the pigmented paper to the exact size. Now expose this in the printing frame under the negative, and observe that in the subsequent operations a vignette can be more easily manipulated than if the picture be printed up to the margin. The reason for this has already been stated. The pigmented paper, on being removed from the printing-frame, is placed in cold water, and in the course of a minute or two becomes quite pliable. It is now laid carefully down upon the enamelled tablet and covered with a piece of blotting-paper, which ought also to be cut to the same size.

The mould of gutta-percha or plaster of which we have already spoken is now carefully laid down upon the top of the paper, which then inclines to the exact form of the enamel convex surface, and is also retained in close contact with it. With a very pliable tissue and a very slightly-rounded surface, contact may be made by means of the squeegee, but with enamels of the best form this cannot be done. In this case, the means we have here described or some method analogous must be had recourse to.

When the paper has become partially dry the method of development is precisely similar to that recommended in the former article on transparency printing—viz., immerse the tablet first in cold water for a short time, then in water of nearly the temperature of 100° Fahr., and, after removing the paper, continue to allow the hot water to flow backwards and forwards over the surface until every detail be perfectly visible. Now, before the picture is allowed to dry, immerse in a weak solution of alum, and finally rinse in water and dry. The resulting picture will be quite equal in respect of beauty to anything that can be done by burning-in, and at the same time it will be quite as durable, except with regard to mechanical injury.

The brilliancy of the picture is enhanced by flowing over the surface some clarified albumen, and then immersing it in water sufficiently hot to coagulate this varnish. We have tried other varnishes—among them amber and chloroform—with good effect.

No person except an expert can distinguish between a picture produced by the method described and one that has been burnt-in in a muffle.—*The British Journal of Photography.*

EXPERIMENTS ON THE RESISTANCE OF IRON AND STEEL.[*]

UNDER this title the author publishes the results of experiments, made with the greatest care during a period of twelve years, which verify his theoretic views upon the laws of resistance of these materials. We lay before our readers the author's statement of the laws and their consequences. He says:—

The rupture of material is the consequence of repeated vibrations, none of which reach the absolute limit of resistance. The differences of the tensions which limit the vibrations are therefore proportional to the disturbance of cohesion. The absolute magnitude of the limiting strains is effective only as it diminishes the difference attendant upon increased strain, which difference causes rupture.

The tensions and compressions affecting the same fibre are considered as respectively positive and negative; so that the difference of extreme strains is equal to the greatest tension *plus* the greatest compression.

The following exhibit of the results of experiments illustrates the effect of this law of resistance. With reference to resistance to bending or tension, vibrations may occur within the following limits of safety for each (German) square inch of section:—

Iron..........	Between	+ 160	ctr.	and	– 160	ctr.
	„	+ 300	„	„	– 0	„
	„	+ 440	„	„	+ 240	„
Axengusstahl ..	„	+ 280	„	„	– 280	„
	„	+ 480	„	„	0	„
	„	+ 800	„	„	+ 350	„
Ungehärtelern federgusstahl.	„	+ 500	„	„	0	„
	„	+ 700	„	„	250	„
	„	+ 800	„	„	400	„
	„	+ 900	„	„	600	„

With reference to resistance to shearing:—

Axengusstahl.	Between	220	ctr.	and	– 220	ctr.
	„	380	„	„	0	„

Of course the greatest fibre-strain actually applied is always less than the absolute breaking limit. The following are presented as immediate results of this law:—

Those parts of construction which act positively and negatively, as piston-rods, walking-beams, and the like, must be stronger in the ratio 9 : 5 than those which are strained in only one direction, as beams, bridges, roof-timbers, &c.

In determining the resistance of bridges and large trusses the weight of the structure, since it forms an absolute constant minimum load, may be left out of account, provided the sum of the effect of proper weight and load does not pass the limits of elasticity.

In the case of car-springs the vibrations are between limits whose difference is quite small compared with the maximum tension; hence the coefficient can be taken larger than in ordinary cases if the steel does not suffer an inch strain of more than 800 ctr. It often reaches 900 to 1,000 ctr.; and with good steel a further increase is possible.

Those parts of boilers which are not exposed to the fire, if of cylindrical form, are subject to but slight vibrations, which are caused by the variation of the tension of the steam. Hence a greater strain is allowable than has been generally applied; but in the parts exposed to the fire, not only the waste by burning, but also the motion of the molecules due to the varying temperature, must be considered. It is not improbable that the continued movement of molecules, caused by heat, acts to destroy cohesion, just as vibrations caused by other forces act.

The effect of strain is entirely different, if it is constant and static, from the effect when it is variable and productive of vibrations. It is also important to consider whether a structure is intended to serve a purpose for a limited period, or to stand for an indefinite time. It follows that like factors of safety do not suit all constructions. In every case two factors are necessary; one, which determines the ratio of absolute breaking strength; another, which fixes the ratio to the vibration that induces rupture by indefinite repetition.

The coefficient of safety should be taken large enough in comparison with the absolute breaking strain, that it may compensate for want of homogeneity of material. For this the factor 2 is sufficient. Material requiring a larger coefficient in this respect should be rejected. The limits of elasticity have not thus far been considered, and it must be left to the judgment to determine between what limits continuous deflection is allowable. A single loading, preventing further deflection, can do no harm, if it does not approach the breaking weight. In large structures it is a general rule that the limit of elasticity should not be passed.

As a coefficient of safety for repeated vibration, 2 is in all cases sufficient, and in many cases is higher than necessary.

As a result of his experiments, the author gives the following table of inch-strains for permanent structures:—

For wrought-iron,
Strained in both directions .... 80ctr.
„ „ one direction, total strain ...... 180ctr.
of which not more than 150 ctr. should be due to the variable load. If the constant strain is less than 30 ctr. the permissible total strain must be proportionally less.

For unhammered cast steel,
Strained in both directions................120 ctr.
„ „ one direction, greatest total strain................330 ctr.
of which not more than 220 ctr. should be due to the passing load. The constants apply to pieces of uniform section.

Experiments with spring-steel show that car-springs should not be loaded to three-fourths of the breaking resistance, if the play of the spring is small in proportion to the entire deflection. With a constant strain of 900 ctr. a play of between 900 to 1,200 ctr. is allowed.

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[*] Translated from *Polytechnisches Centralblatt.*

HOW MERCURIAL THERMOMETERS ARE MADE.

A MERCURIAL thermometer is a very simple instrument. A small glass tube, with a bulb at one end, containing mercury, and a graduated scale, constitute all that is essential to it; yet in this, as in many other cases, simplicity begets difficulty. To make this simple combination perform its duty accurately is by no means an easy matter. The first difficulty met with is the want of uniformity in the diameters of the bores of different tubes, and the varying size of the bore in almost every tube. It is scarcely possible ever to find one the calibre of which is the same throughout its length, and, if so found, it is the result of pure accident. It is obvious, therefore, that unless some means of eliminating the errors which would arise from this source be adopted, nothing like accuracy can be expected in the indications of the instrument. As the character of the bore cannot be altered, the desired result must be obtained in another way.

The method employed to obviate this difficulty is called "calibration." Tubes are selected tolerably free from imperfections, and a column of mercury, of one inch or less in length, is introduced into it. The tube is then attached to the frame of a dividing engine, and put in connection with flexible rubber bags, to which pressure is applied, and regulated by screws. The air pressure in one bag being reduced while it is increased in the other, the mercury column may be forced to and held at any part of the tube.

The mercury being thus brought to the portion of the tube where the graduation is proposed to commence, the exact position of one end of the column is marked upon the tube, a microscope with cross wires being employed to aid the eye of the operator in performing the operation with exactness. By means of the rubber bags the mercury is again forced along until the end of the column, where the first mark is made, is brought under the microscope cross wise, placed at the other end, and so on throughout the entire length intended to be graduated. The varying lengths of the column, which are accurately measured in the different positions, are recorded, and indicate the variations in the calibre of the tubes. A permanent mark is made at the end, as at the beginning of the calibration.

It will be seen, that if the spaces successively occupied by the mercury be divided into an equal number of equal parts, any one of these parts will indicate a corresponding increase of volume, although the bore of the tube may vary in its diameter.

The required dimensions of the bulb are found, approximately, by weighing a measured length of the mercurial column, and computing the capacity of the bulb from the known expansion of mercury and its specific gravity.

The bulb may be formed upon the tube previous to the calibration, or afterwards attached. In the former case, however, the thermometers have their scale divided after the determination of the freezing and boiling points, and no tubes can be used except such as are found to be approximately perfect. In the latter case, the arbitrary scale, as marked from the calibration, may be reduced after the determination of the freezing and boiling points into the Fahrenheit scale, by the application of a simple algebraic formula.

The freezing point is determined by placing the bulb in finely pounded ice, from which the water is drained away as it melts. The boiling point is obtained by placing the bulb in steam having the same elasticity as the atmosphere—a peculiar apparatus, devised by Regnault, being generally employed for the purpose.

In putting in the mercury, a small reservoir of paper or glass is fixed upon the upper end of the tube. Heat being applied to the bulb, drives out the air through the mercury, the latter, as soon as the bulb is allowed to cool, descends through the tube, being forced by the pressure of the external atmosphere. The upper end of the tube is then heated and drawn out, ready to be sealed hermetically. The mercury is then boiled in the bulb, to expel all trace of air, and while it is in a state of ebullition, the tube is sealed by directing the flame of a blowpipe against the upper end, which fuses the glass and closes the aperture.

The reader must not imagine that all the manipulations we have described are performed on all thermometers in a perfect and accurate manner. A very large majority of these instruments in common use are entirely worthless for any scientific investigation, although they furnish, perhaps, sufficiently accurate indications for the regulation of the temperature of apartments, and for other ordinary purposes.—*Scientific American.*

SCIENTIFIC SOCIETIES.

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SOCIETY OF ARTS, EDINBURGH.

AT the fourth monthly meeting of this society, Mr. D. W. Kemp delivered the first of a series of lectures on "Experimental Chemistry." In introducing the subject he said he had often been impressed with the value of the advice tendered in that extract from Montaigne's Essays which prefaces the "Correspondence" columns in the ever-increasingly-valuable ENGLISH MECHANIC, and held it as a matter to be deplored that the correspondents in many cases seemed to entirely overlook it, and hence indulged in funny epistles pregnant with "froth"—not even the creamy, healthy froth which precedes and accompanies the flow of genial, heart-inspiring liquid, but more nearly resembling the vapid effervescence from a sick man's o'er-laboured stomach.

Turning to the subject proper the lecturer began by remarking that the chemistry of the moderns is but the alchemy of the ancients in a further state of development. That whereas the ancients had divided all material things into four grand divisions,—Fire, Air, Earth, and Water, chemistry in these days had sub-divided those into upwards of sixty simple bodies, and, what is of more practical importance, had shown how the various elements may be best turned to advantage in the vast workshop of mankind. He then referred at considerable length to the nomenclature and notation of chemistry, explaining and illustrating by experiment the difference between mechanical and chemical elements and compounds. During the remainder of the lecture he confined himself solely to the gas oxygen, and by several very interesting and beautiful experiments showed, in a striking manner, its capabilities of supporting combustion.

The lecture was listened to throughout with the most rapt attention, and at the close several questions were put by the members, some of which were answered by Mr. Kemp.

It was announced that at the meeting in September the president would deliver an address on "The Air we Breathe."

In consequence of the resignation of the secretary, Mr. C. E. Gordon was appointed to that post *pro tem.*

THE OBSERVING ASTRONOMICAL SOCIETY.

Hon. Sec.—WILLIAM F. DENNING, Ashley-road, Bristol.

Report of Observations made by the Members during the period from July 7th to August 6th, 1870, inclusive.

SOLAR PHENOMENA.—Mr. Thomas G. E. Elger, of Bedford, reports that the sun's spots observed in July exceeded in number those recorded during the previous month, but they were, with a few exceptions, small (less than 30" in diameter), and although pretty equally distributed between the two hemispheres, those to the south of the sun's equator presented a remarkable contrast both in type and size to those observed to the north of it; the former, as in June, included some large scattered groups and moderately sized spots of the normal class, while the latter consisted chiefly of solitary specks, without penumbræ, and clusters of minute black punctures, which frequently assumed very grotesque configurations. A striking feature of the large groups observed during the early part of the month was an evident tendency either to close up, or to become dissociated upon reaching a certain position on the disc about half way between the E limb and the centre. On the 25th one of the largest groups observed this year appeared at the E limb. On the 28th it measured nearly 5' in length, and consisted of a large preceding spot 1' 10" in diameter, followed by a draggling train of "wispy" penumbræ, enclosing several small spots. This group dwindled away very rapidly after the 28th. Another large spot, about 50" in diameter, was observed from July 13th to 25th.

Fresh groups observed in the sun's N. hemisphere during July = ... 9
Ditto ditto S. ditto = 12
Maximum number of groups on disc 12 (July 30, 5h. 50m.)
Minimum ditto 4 (July 28, 5h. 50m.)

Mr. Albert P. Holden, of London, says:—"I observed a very interesting spot on June 21, at 7 a.m.;

the penumbra was unusually pale, and the umbra of a decided light *brown* hue. Four darker openings arranged in a square were seen in the umbra, and were readily observed with a very small aperture. A very remarkable circumstance in connection with the sun's spots during the last two months has been their extremely light colour. The light brown tints of the umbra have been very marked, and totally different from the dark hues they usually present, while at times the penumbræ have been so light as to be scarcely visible. In most of them, however, the nucleus (which is ordinarily so difficult to detect) has been very easily seen, as in the case of the foregoing observation. This fact proves the phenomenon seen to be due to the actual lightening of the spots themselves, because if it were merely an optical or atmospheric effect the whole spot would be lighter, and the nucleus would be quite as difficult to detect as before. It is probable that these appearances may be a necessary result of the maximum of sun-spot activity, and are due (as suggested by Mr. Lockyer) to the thinness of the solar envelope at the present time. This would certainly account for the light hues of the umbræ and penumbræ, and also for the frequency and blackness of the nucleus. Mr. Henry Ormestier, Manchester, writes:—"On the 31st July, from 2h. 15m. to 3h. 0m., while looking at the sun with my 3in. refractor, I saw a beautiful large cluster of spots occupying an almost central position on the disc. It occurred to me that the umbra in the largest spot appeared more dense on the western side. I therefore determined to examine it with my 5¼in. refractor. I did so, using a power of 180. The result was that it resolved itself into a very fine nucleus of a somewhat oval shape. After making myself sure that the above was the case, I examined the cluster generally and was struck with the beautiful appearance of the brighter part of the sun's atmosphere. A very bright stream ran across the cluster in a zig-zag direction, separating the penumbra. Some parts of this stream, and particularly the upper part, appeared brighter than others, presenting a very mottled appearance." Mr. William F. Denning, of Bristol, observed the sun with his 3in. refractor, July 14th, from 5h. 30m. to 6h. 10m.; he noticed nine well-defined *maculæ* on various parts of the disc. A particularly large and interesting group of spots was visible in the N. hemisphere. On July 22nd, at 8 p.m., a spot was observed in the same hemisphere, which was divided by two bridges of light. He noticed that the penumbra was invaded by numerous minute lines of light, and that the bridges seemed to present the appearance of *running matter*. This observation was made with power 100 on a 10¼in. reflector, by Browning.

The Lunar Eclipse of July 12.—The Rev. Ralph Prowde, of Northallerton, Yorkshire, observed this phenomenon, and has sent the following:—I observed the eclipse of the moon on the 12th, but the only thing remarkable was the great contrast of shade between the darker and brighter penumbræ. I say *penumbræ*, for I suppose the real umbra of the earth's shadow falls within the moon's orbit. The darker interior cone of shadows obscured the edge of the moon and the objects on its surface as it passed over them almost entirely, but its own edge did not seem to be nearly so regularly round as the lighter enveloping cone of shade." The Rev. S. J. Johnson, of Crediton, reports:—"I had a very favourable view of the lunar eclipse. The sky was clear at first, with a small amount of stratus near the horizon. I first caught sight of the moon at 8.41, but it was 8.49 before it got clear of the clouds. I paid particular attention to the degree of distinction with which the eclipse portion could be seen. When about four digits were covered, I just noticed the copper tint through the telescope. I fancy this would be a little sooner than in the last eclipse I observed (September, 1867), but in that of October 4, 1865, which was only of four digits, the copper tint was very decided at the time of the greatest obscuration. When about six digits, or half the disc, was covered, the copper colour could be clearly seen with the naked eye. I could not make out any particular parts of the moon's surface until 1.35, when I noticed the *mare tranquillitatis* and the *mare serenitatis* showing with beautiful distinctness through the earth's shadow in the telescope. A few minutes after the totality was attained, I was struck with the obscurity of the eastern side of the moon being so much more than I had expected. At 9.55 at least half of its surface was as if blotted out, even when seen through the telescope, although I applied two different powers—70° and 150°. Three of the *seas* at the western side were all I could make out. Possibly a thin coating of cirrus cloud which covered all the sky at this time might account in some measure for the invisibility of the moon. By 10.30 this had entirely cleared away and the Milky Way, very near the moon, was about as distinct as it usually appears on a dark clear night. At this period, being the middle of the eclipse, the upper portion of the moon was the invisible part, all those regions lying round the margin of the disc being alone to be seen except at the vertex where the margin itself was not discernible. At 11.23 the first streak of light was breaking forth at the eastern edge. At 11.45 the red colour was nearly gone and the eclipsed part appeared of a grey colour. At 11.58 I noticed there was no trace of the Milky Way. At 12.24 the lunar circle was complete." Mr. Oliver J. Lodge, of Hanley, reports that "the colour of the moon during the totality was of a most peculiar copper hue, giving very little light indeed. But during the egress of the shadow it was almost as white and silvery as it usually is, although still under the penumbra." Mr. Edmund Neison, of London, says:—"The colour of the eclipsed disc was during the whole time a dull yellowish olive green, both in the telescope and out, but was never dark enough to prevent many of the chief markings and craters being seen. From 10.44, when the lunar disc was fairly above the fog banks, *Aristarchus* was quite distinct as a bright crater, and even before eleven *Grimaldi* was plainly discernible." At Bristol, Mr. William F. Denning observed the phenomenon, and remarks that even at the time of totality many of the most conspicuous objects on the disc were distinctly visible. The copper tint was also very evident. During a portion of the time the moon was overcast with clouds.

Venus.—Mr. Henry Ormestier, of Manchester, observed this planet with 5¼in. equatorial refractor on July 23, at 5 a.m. "The definition was excellent. I observed three dusky spots on the disc, one of which was of very considerable magnitude."

Saturn.—Mr. H. Michell Whitley, of Penarth, Truro, writes:—"July 7th, 10h. 11m., power 208°. The ball of the planet dull yellow colour. N. equatorial ruddy belt conspicuous, and another of same colour between it and pole; pole bluish grey. Edges of disc fainter than centre. Sky in Ansæ much blacker than around planet. Crape ring across ball nearly as dark as ball's division, pale purple. Crape ring very easy in Ansæ. No line of light between it and B."

Occultation.—Mr. Joseph C. Lambert, of Sleaford, witnessed the occultation of B.A.C. 5954, on July 10, and found the exact time of disappearance to be 12h. 40m. 41s. mean time.

Meteors.—Mr. J. C. Lambert "observed a very brilliant meteor at 11h. 40m., July 21. Course from a little below γ Cassiopeiæ to ξ Persei. Nucleus appeared as a star of 1·5 mag., tail nearly 2° long.; colour yellowish white. Duration 2 seconds. During the time of observation, 11h. to 12h. 30m, I observed no less than eleven small meteorites. The course of one of these was from ε Bootis to 43 Comæ Berenices, and immediately afterward one from a little below 43 Comæ Berenices to η Bootis. Could this have been one and the same meteor describing an arc?"

Lunar Observations.—Mr. H. Michell Whitley has made very careful observations of many interesting lunar objects, and the results he has obtained have been sent to Mr. W. R. Birt.

LETTERS TO THE EDITOR.

[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]

⁂ All communications should be addressed to the Editor of the English Mechanic, 31, Tavistock-street, Covent Garden, W.C.

All Cheques and Post Office Orders to be made payable to J. Passmore Edwards.

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"I would have every one write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks: a vice from whence great inconveniences derive their original."—*Montaigne's Essays.*

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⁂ In order to facilitate reference, correspondents when speaking of any Letter previously inserted will oblige by mentioning the number of the Letter, as well as the page on which it appears.

THE SATELLITES OF URANUS.

[257] Sir,—Sir John Herschel gives elements according with Sir William's account. Will "Etudiant" quote Mr. Lassell's exact words? I cannot but think there is some misapprehension. In 1851-2 the determination of the place at which a Uranian satellite reached its greatest elongation would be a matter of extreme difficulty, since the apparent path of the satellite, so long after the Uranian equinoxes, would be an ellipse of but moderate eccentricity. The difference of apparent distance when the position-angle of Uranus was 187½°, and 172½° would not be great.

Richd. A. Proctor.

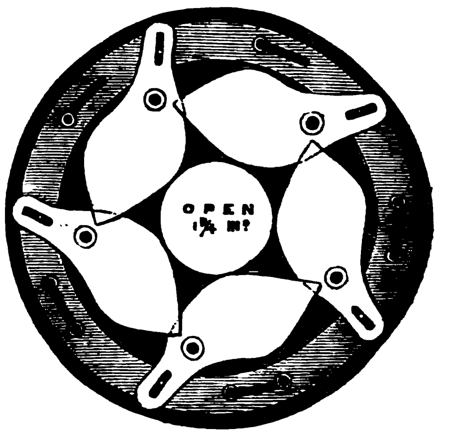
CURIOUS QUESTION.

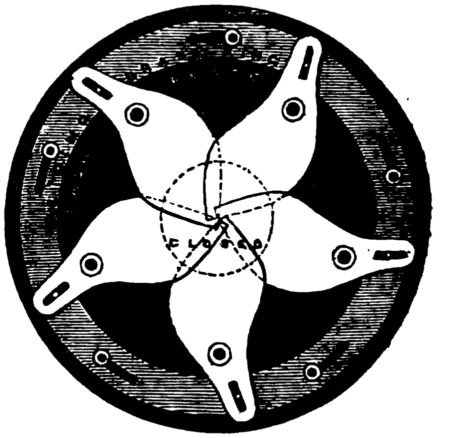
[258] Sir,—The circumstance referred to by "M. L.," (see 235 and 236) would have no effect on the *range*, whether the ball were fired at a great or small angle with the horizon, and to whatever height we conceive the ball to rise, unless atmospheric resistance be taken into account. If we conceive two balls, A and B, fired from a point on the equator at equal angles of elevation and with equal velocities, one due west, the other due east, and a perpendicular from each extending throughout the motion, to the ground; then the motion of A's perpendicular along the ground will exceed the motion of B's, while the balls are rising. And, therefore, if A and B could be suddenly stopped at the one moment when each reached its highest point, the horizontal range of A would be found to be greater than that of B. But in the descent these conditions are exactly reversed, and at the moment of reaching the ground A would be as far to the west of the point of projection as B to the east. But if we take into account the resistance of the air, we have a more complicated matter to deal with. I have not time to go very carefully into the problem, which is probably one of some difficulty; but I believe it will be found that the westerly ball will have slightly the greatest range,—for this reason, that the horizontal motion is greater while each projectile is rising than while it is falling, and the gain of the ball A while rising is therefore greater than the gain of the ball B while falling. But though here the chief effect (I expect) has been considered, *i.e.*, the action of the air's resistance in modifying the shape of the trajectory, yet an effect due to another cause has not been taken into account,—I mean the fact that the upper regions of air are carried somewhat more swiftly than the lower, being at a greater distance from the earth's centre. Owing to this, the ball (B) which is fired towards the east encounters the horizontal resistance due to its horizontal velocity, *minus* the difference between the motion of a point at the earth's surface, and that of a point considerably above the earth's surface (at the equator); while the ball (A) fired westward encounters the horizontal resistance due to the sum of these velocities. Combining this with the accepted relation between velocity and resistance, we can form an estimate of the effect of this cause in diminishing the range of the ball A as compared with that of the ball B. The balance must be struck between this effect and the former. But the only way of realy deciding the question would be to take the equations of motion, and at least partially integrate them. I have the equations before me, but I do not like their look by any means.

Richd. A. Proctor.

THE IRIS DIAPHRAGM.

[259] Sir,—In reply to "Unit" (query 4495), I forward a sketch of the only plan known to me, having never seen any other. Of course the details of construction may be varied indefinitely to suit different purposes and positions. It consists of five thin metal leaves pinned on to a back plate, on which a loose ring slides by means of slots and studs, carrying also the studs that take into the slots in the tails of the five leaves. Washers must be provided under the pins of the leaves to make up the thickness of the sliding ring. The entire thickness will be about 3-16*in.*, and *it is* essential that the broad end of the *leaves be thin, in* order to close well.





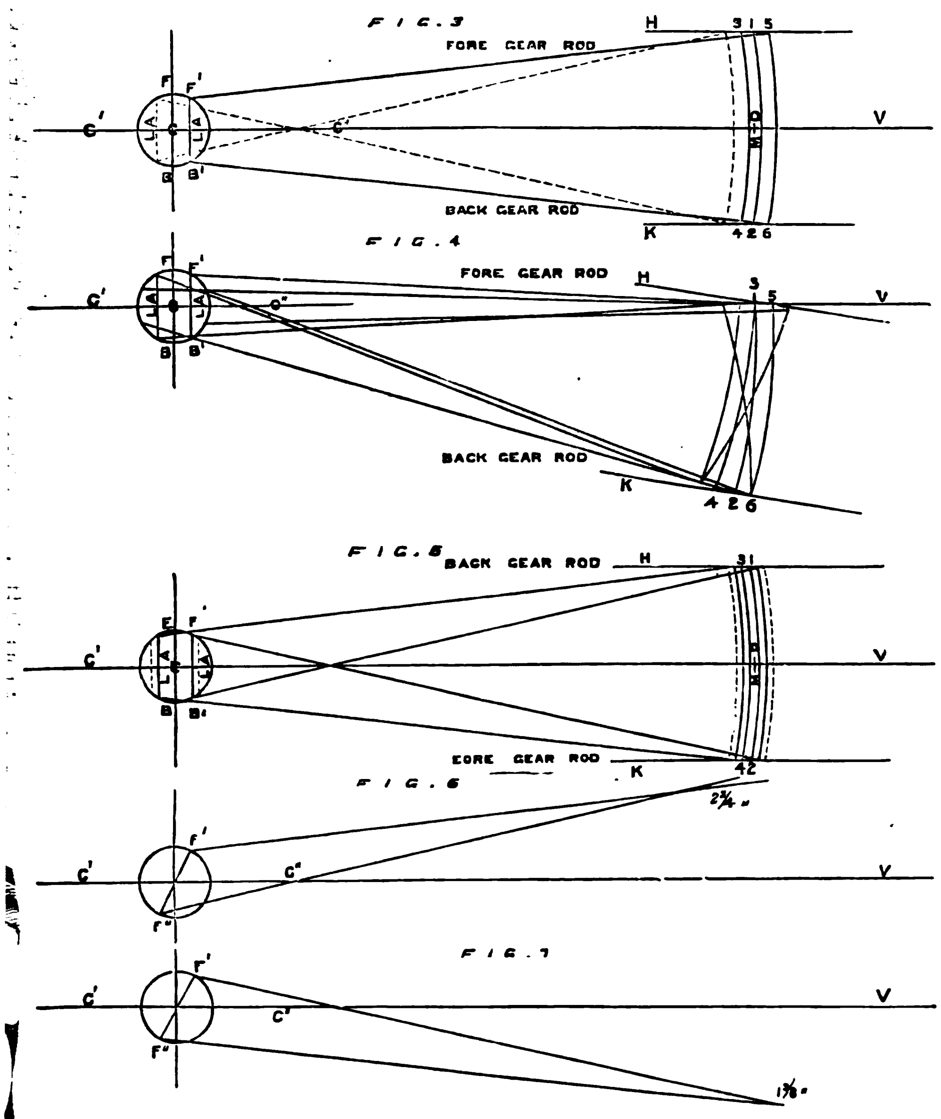
The "Iris Diaphragm" may be used with great advantage in telescopes, in photography, and is especially requisite to complete the illusion of dissolving views, to which it has never yet been applied. The angular motion of the sliding ring may be effected by hand, by lever, or for slow motion by an endless screw and portion of a worm wheel. That motion extends to about 50° or 60°.

Henry W. Reveley.

ALGOL.

[260] Sir,—I would suggest, as that very interesting variable star, β Persei "Algol," is convenient for observation in the evening, that "F.R.A.S.," or other astronomical contributors, should give for the advantage of amateurs the times of the star's variation, which takes place every third day, from 2nd to 4th magnitude.

R. T.



THE LINK MOTION.

ON THE LINK MOTION.—Letter II.

[261] Sir,—Engineers generally try to get in long excentric rods, and in ordinary locomotive practice the length of the rod is often as much as twelve times the throw of the excentric, and seldom I believe less than ten times; but in marine screw engines and in some paddle-wheel engines they are compelled through want of room to use very short rods, and lengths of five or six times the throw are common.

In designing a link motion the first things to be considered are the proportions of the slide-valve, and they are of course determined by the capacity of the cylinder and the speed of the piston. Suppose it is determined for a given engine to have a valve with ⅞in. of lap, and 4½in. of travel, and ⅛in. of lead in full throw, the next things to be determined are the lengths of the excentric rods and the length of the link. Say that space limits us to a 3ft. rod, and as there is no law for the length of the link any more than the excentric rod, we will set it down at 12in. from centre to centre of excentric rod pins. The "lines" of this motion should then be laid down on the drawing board in the two positions shown in Fig. 3. Draw the main centre line C V as that which passes through the centres of the crank shaft and valve-spindle; let C be the centre of the crank shaft, and round it draw a circle 4½in. diameter for the path of the centres of the excentrics, which is equal to their throw; take diametrically opposite points F and B, at right angles to the line C V, as the temporary positions of the centres of the forward and backward excentrics; draw two lines H and K parallel to the main centre line and at equal distances from it, and let them be the length of the link (12in.) asunder. Then take 3ft.—the length of the excentric rod—in the trammel; set one leg in centre F, and mark with 1 the point of intersection of the other leg with line H, and with 4 its intersection with line K. Then set the trammel in centre B, and mark with 2 the intersection of the other leg with line K, and with 3 its intersection with line H. Again set one leg of the trammel in point of intersection 1, and the other leg wherever it comes on main centre line C V, and draw the arc 1, 2; do the same with point of intersection 3, and draw arc 3, 4. These two arcs are the true curvation of the link, and their distance asunder is the amount of motion caused by the crossing of the rods: in the present case it is ¾in., or ⅜in. on each side of the point M D, which is the *mean distance* of the centre of the link from the centre of the crank shaft, and the centre of the link will be at M D when the valve is at the middle of its stroke, covering the ports seven-eighths of an inch on each end. For distinction sake let us call these two positions of the link *the positions of no lineal advance*.

The valve has seven-eighths of an inch of lap, and one-eighth of lead, giving 1in. for the lineal advance of the excentrics. Draw line L A 1in. from centre C and parallel to F B, and where L A intersects the circle at F′ and B′ there are the proper positions for the centres of the excentrics. Once more take the trammel—still set at 3ft.—and place one leg in F′, and mark point 5 where the other leg cuts line H; do the same with point B′, and mark point 6 on line K; draw the arc 5, 6 as before directed, and there we have the position of the link when the crank is on the back centre at C′. The dotted lines show the positions of the gearing when the crank has made half a revolution, and arrived at the front centre at C″, and the rods have crossed.

It will be seen that there is a distance of 2¾in. between these two last positions of the link, although the lineal advance would in itself account for only 2in. distance, but to that we have to add the ¾in. of motion caused by the crossing of the rods, making altogether 2¾in., or 1⅜in. on each side of the "mean distance point." But the valve covers the port only ⅞in., and therefore, when it is moved 1⅜in. from that position by the link it must leave the port ½in. open, or in other words there is ½in. of lead with this valve motion when the link is in "middle gear," and only ⅛in. when in "full throw" with the end of the link opposite the valve-spindle.

In this position, Fig. 4, the forward gear excentric rod is exactly opposite the valve spindle, which therefore derives its motion exclusively from this rod for the time being. The apparatus now assumes the simple character of a valve driven by a *common single excentric and one rod*. The effect of the crossing of the rods has entirely disappeared from this end, but it remains unaltered at the centre of the link, and is doubled at the other end. This is plainly shown by the "positions of no lineal advance" 1, 2, 3, 4, which are coincident at the forward gear end, ¾in. asunder at the middle, and 1½in. asunder at the back gear end of the link. But that does not increase the total motion at that end, which is ever and always equal to the throw of the excentric, notwithstanding what Mr. Harrison says about "that end of the link having double the vibration," and the valve has the exact amount of lead (⅛in.) due to its lap and the lineal advance; but from that position the lead gradually increases as we approach the centre, when the maximum of ½in. is attained, for there the whole effect of the crossing of the rods is felt. Of course the same observations apply to the other half of the link when the rod which actuates it is placed opposite the valve spindle.

Hitherto I have spoken only of that arrangement of link motion in which the lead is *greater* in "middle gear" than in "full throw." I shall now glance at that arrangement which produces a contrary effect on the lead, making it *less* in "middle gear." This is illustrated in Fig. 5. In this figure all dimensions are the same as in Figs. 3 and 4, and the same letters of reference are common to both, the only difference being in the disposition of the rods, which is contrary to that of 3 and 4, for in this the back gear rod is attached to the upper end of the link and the fore gear rod to the lower end. The vibration at the *ends* of the link is still of course equal to the throw of the excentric, and the amount of motion transmitted to the valve *in full throw* the same as in Figs. 3 and 4; but the motion at the centre of the link is considerably reduced, for it is now only 1⅜in. or 11-16ths on each side of the "mean distance point;" but the valve has ⅞in. of lap, and would require to move that much on each side of its middle position before it would begin to uncover the port at all; but the link can only move 11-16ths on each side of the "mean distance point," therefore in this arrangement of the motion, when the valve has ⅛in of lead at the end of the link or in "full throw," *it is actually 3-16ths blind at the centre*, or in "middle gear," and in order to get ⅛th of lead in that position, we must cause the centre of the link to vibrate 2in. (think of that Mr. Harrison), and to do that the "lineal advance" of the excentrics must be increased from 1in. as at present to about 1 5-16in., shown in dot lines, and then the lead of the valve when in full throw will be about 7-16in.

Now what is the reason of all this? Why is it that in Figs. 3 and 4 the vibration of the link at the centre is so much greater than it is in Fig. 5, the lineal advance and every other dimension remaining equal? The crossing of the rods produces a similar effect in both cases, viz., ¾in., as is shown by the "positions of no lineal advance" 1, 2, 3, 4, and does not account for any of the difference, and we must therefore seek it elsewhere, and that too without going into the geometry or trigonometry of the case, for which I know the majority of your practical readers have no relish (neither have I).

Fig. 6, is just a portion of Fig. 3, extracted and laid down separately for sake of greater distinctness. C′ and C″ show the crank on the two dead centres; F′ and F″ are the corresponding positions of the centre of the forward gear excentric, the rod of which is carried to the *upper end of the link;* and between these two positions of the end of the excentric rod there is a space of 2¾in.

Now look at Fig. 7. It is a portion of Fig. 5, showing the forward gear rod attached to the *lower end of the link*. In this case there is a space of only 1⅜in. between the two positions of the end of the rod, and as the back gear rods in both of these cases perform the same as the forward gear rods, there is no necessity to show them or the links, and the figures are plainer without them.

The alteration of the lead of the valve is a grave defect of the link motion,—the *shifting link* motion, I mean, such as we have been considering hitherto; but the *stationary link* is free from that defect. The "shifting link" is so called because in the act of reversing the engine or altering the grade of expansion, the link is moved up or down by the reversing lever or wheel, as the case may be; but the "stationary link," as its name implies, is a fixture, and is suspended or sustained from some fixed point, and has no motion except that imparted by the excentrics. The reversing lever has no connection with this link, but the engine is reversed or expansion altered by means of a rod called the "valve spindle connecting rod" one end of which is jointed to the head of the valve spindle, and the other end carries the slide block, which fits in the slot of the link. The reversing lever is connected with this "valve spindle connecting rod" by any suitable means, so that the attendant can place the slide block to work in any part of the link, either for reversing or expansive working.

The "stationary link," as regards its curvature, is placed the reverse way to the "shifting link," for it is set with its concave side towards the valve spindle, and the radius of its curvature is the length of the "valve spindle connecting rod," but in the shifting link motion the radius of the link is the length of the excentric rod.

The stationary link motion is a much more elegant and scientific piece of work than the shifting link, and it possesses the great advantage of preserving the lead unaltered in all positions; but it has not come into general use, owing to the great length required for its proper development,—a length altogether out of the question in screw boat engines or locomotives.

As I intend to have more to say on this subject, with your permission, in future letters, I shall here bring it to a conclusion for the present, hoping that Mr. Harrison may benefit by what I have written, and acquire therefrom some *correct* knowledge of the construction and working of the "link motion," in place of the erroneous ideas, the absurd crotchets, and the fantastic notions with which his head was so full when he wrote his notable letters in No. 272, page 352, and in No. 280, page 471.

James Baskerville.

GAS.

[262] Sir,—I undoubtedly invited discussion, not about "gas companies, but "how to reduce our gas bills," and "improve our light;" nor do I complain of fair and honest criticism. "Sigma" is far too able a chemist for me to attempt, if I wished, to argue the point he raises, even if you would allow your valuable space being so taken up. But I must totally differ as to his assertion that "it is not even true that the illuminating power is reduced by the alleged removal of illuminating hydrocarbons from the gas." This is a bold assertion for him to make, and is also a contradiction in itself. He admits, further on, that "some of the light-giving properties of the gas are removed," because the gas "cannot be purified without doing so." Other chemists differ from "Sigma" on this point: be it so or not, my words are confirmed by "Sigma" himself, and while other towns are supplied with far richer gas, without difficulty being caused from deposits in the mains, it is idle to tell us that it can't be done in London and other localities, though I hope "Sigma" will believe me to have sufficient common sense not to expect that all inland towns can be economically supplied with such rich gas as Aberdeen and Glasgow.

Your readers can also now judge as to "Sigma's" remarks about the price of London gas; he first told us it was the fault of the consumers; and *now* he admits that *some* companies pay a full dividend of from 7 to 10 per cent. and, not a bonus as I called it, but "arrears allowed by law." In other words, the price is kept up to enable the said companies to divide this excess of profit, to cover their previous mismanagement and their own "ruinous competitions!!"

As "Sigma" admits Professor Frankland is *not* a "gas quack," perhaps you will kindly allow space for the accompanying notice of that gentleman's lecture on coal-gas, before the Royal Institution in 1867, as it will show your readers and "Sigma" that what has been said by me is not all "senseless gabble."

Professor Frankland said that he had just had the illuminating power of the gas supplied to different large towns tested by the standard sperm candles, and then held written and signed certificates in his possession of the results as follows:—Berlin, 15·5 candles; Paris, 12·8; London, 12·1; Vienna, 9·0; Edinburgh, 28·0; Manchester, 22·0; Liverpool, 22·0; Glasgow, 28·0; Aberdeen, 35·0; Greenock, 28·5; Hawick, 30·0; Inverness, 25·0; Paisley, 30·8; Carlisle, 16·0; Birmingham, 15·0. Thus the gas supplied to Edinburgh and Glasgow gives more than twice the light of the gas provided for London. The above shows the average light given by the gas furnished in London; but, in particular instances, it only equals nine candles. The gas of London also, he stated, is richer than it ought to be in sulphur compounds, and in burning gives off too much poisonous sulphurous acid and other gaseous vapours injurious to health and property. London gas is now worse than it was many years ago, although the methods of manufacture have been cheapened by the discoveries of science, all new inventions in this direction having been eagerly taken up by the gas companies, who, so far as is known, have not adopted a single invention which would benefit the consumer. As the gas is damaging to works of art and beauty, the public should, by paying a fair price for it, at least have it of good quality. He concluded by saying, "it should have an illuminating power of twenty candles, below which no gas is fit for household use."

It is indeed much to be regretted that these scientific and interesting subjects are not discussed in a more courteous and liberal spirit, without indulging in personalities and dogmatic assertions and misquotations of each other's words and intentions.

Another correspondent takes objection to the experimental result I gave of the improved light obtained by the very crude apparatus described in No. 263, of the 8th April, but I must explain that such was given simply to show what was the *comparative* result of the process with the same burners, pressure, &c., and not to prove the absolute standard of light obtainable. When that experiment was made, I was living where we were supplied with wretched gas, at 6s. per 1,000ft., which first led me investigate the matter and devise a remedy. Where I am now living we have very fair gas, but I believe there is no law fixing the standard of light to be supplied by rural or provincial gas companies, so that "Sigma's" remarks do not apply to such cases.

I must observe that what has been said by "Sigma" and also by "L. M." (p. 400, No. 66), about street lamps, does not apply to our domestic gas consumption. "Street lamps" require a very small and imperfect carburetter to be fixed to each lamp, and not (as in a house) only one apparatus for all the burners. Dr. Letheby's official report on the experiment distinctly states that the light was at first most excellent, but gradually fell off, and caused great complaints, in consequence of which the attempt failed, as I stated in page 354.

To prove that this is not the case with such apparatus as I have recommended, and which can be now obtained at moderate prices, I subjoin the results of the last year's operation of the one I have used for years, which I designed and fitted up for my own amusement and most decided advantage, for it only cost about 6s., and saves me fully 25s. a year, besides the advantages resulting in better air and less destruction to property. *Not* (as "Lucidus" wishes to make out that I state) from any power of "purifying" in the apparatus, but simply such as is due to the reduced quantity of gas consumed to obtain the required power of light. I filled the carburetter with 1½ gallons of carboline, sp. gravity ·775, April, 1869, and found the power of a small burner (consuming 2ft. of gas per hour, at pressure of 8-10ths) to equal to 6·5 candles. On 1st August, 1870, the carburetter was emptied, after being in constant use and untouched for sixteen months; four pints of fluid remained, sp. gravity ·785, which gave a power of light, with the *same burner and consumption* per hour, equal to 5·9 candles. The carburetter was then refilled, including the residuum above mentioned, when the power of the light was found (all exactly as before) to be equal to 6·3 candles, an interval of twenty-four hours being allowed between the last experiments.

The total of gas consumed in sixteen months was 13,000ft. The number of burners in daily use was three, and occasionally six, with two small gas stoves, by Phillips, in hall and bed-room, in winter nights burning 5ft. per hour of gas, which was *not* carburetted.

Your readers can therefore judge roughly from the above what advantage there is to be obtained in the use of a good carburetter, and if it is wished I shall be happy to give a drawing and description of the one I use, which is *not* a patent; and as I have given you my name, rank, and address, I feel confident you will not impute any improper motive in all I have written, which I thank you heartily for allowing to appear at such length in your really most valuable journal, now a marvel of cheapness and interest. C. D. C.

IRISH MOSS AND COD-LIVER OIL.

[263] Sir,—As I see no one has yet replied to the inquiry of your correspondent about Irish moss, I beg to inform him that it is a kind of sea-weed found on several parts of the coast of Ireland, where it is called *carrigeen*, and it can be obtained at almost any respectable druggist's under its English name. When dried it is picked over, and the finer and clearer parts are kept for medical use, while the darker and coarser are used for feeding pigs, for which purpose it is largely used in many places, boiled up in their ordinary food. Its qualities are somewhat similar to those of Iceland moss and isinglass, but it has the advantage over the former of being nearly tasteless, and over the latter of having a specific action on the lungs, which makes it nearly if not quite equal in value to cod-liver oil. I have known several cases where it alone has effected a cure after the patient had been supposed to be in hopeless decline. The manner of using it is as follows:—Take about as much of the dry moss as will fill a common teacup, and steep it overnight in cold water, which removes most of the *marine* taste which belongs to it. In the morning boil this just ten minutes in a quart of milk, season with any flavour that is agreeable, and when cold it will be found a strong jelly, like blancmange, for which, if carefully made, it may be substituted. It may be made with water as well as with milk for variety, and is particularly beneficial if taken in the morning (*melted*), about a teacupful at a time. Its action in some cases, especially when there is hemorrhage from the lungs, is wonderful. The ordinary price is about 3d. or 4d. an ounce, which, as it is very light, is not expensive; but it is at least a dozen times what it ought to be. A few years since, when I was living at Leeds, I was able to procure it at one shop for 4d. per lb., while the druggists were selling it of the same quality at the same price per *ounce*. If your correspondent who wishes to find a substitute for cod-liver oil will try this I have little doubt he will derive benefit from it. G. Bush.

OUR SIZE AND FORM.

[264] Sir,—While I agree with the "Harmonious Blacksmith" as to the probable enlargement of the English Mechanic at no late period, I differ from him as to the increase in price, for this reason, that many a subscriber who cheerfully pays his twopence weekly now, would, even for the same paper though much larger, begrudge to give the extra penny; and I therefore beg to endorse the able and sensible remarks of your new correspondent "Hopeful," as to an increased circulation, which I am sanguine enough to think could easily be carried into effect were each of your present subscribers to use but a little exertion, and exhibit your most valuable journal to their friends, fellow-workmen, and acquaintances; for it needs no puffing, and only requires to be seen and read to be appreciated. Your efforts in the cause of science and information on general subjects are deserving of the highest praise, and it is only but right that your noble venture should prove a pecuniary success.

J. B. Cockburn.

TELESCOPIC.

[265] Sir,—Permit me to inform your correspondent "Raymond," (4534, p. 527), that the plan he proposes for combining an object-glass would be quite erroneous. A plano-convex lens of flint, in combination with a crown lens of the same form, would only tend to *increase*, and not correct, the chromatic dispersion, while the spherical aberration would remain almost the same. The theory of the achromatic object-glass consists in correcting the dispersive power of the convex crown lens, by using a *concave* lens of higher dispersive power but shallower curvature; and so the opposite tendency of one counteracts the opposite tendency of the other. If "Raymond" seriously thinks of attempting an achromatic O. G., he had better examine one first, and seek to discover the reason for working the four surfaces to different curvatures. Plano-convex lenses, when large, are objectionable on account of the greater difficulty of working a plane than a curved surface. Again, the process of parabolizing is required *only for reflectors*; the surfaces of an object-glass are all supposed to be spherical, the spherical aberration being removed by the concave form of the flint lens. As to the suitability of my machine—to which "Raymond" refers—for working the lenses of an object-glass there is not the slightest doubt, and any object-glass can be tested by the same process that I have described for specula, the only difference in method being that the test-bar should merely be a narrow strip of paper made to adhere to the surface of the object-glass while testing.

As to the query of A. White, on the same page, I believe the drawback he would find would be a want of good definition, which would be equally as noticeable in his proposal as in the "Herschelian" form of telescope, and which, when using high powers, would be simply intolerable; such an arrangement might, however, be made *just tolerable* by making the focal length of the speculum unusually long for its aperture and using only moderate powers. The mischief arises, of course, from the obliquity of the cone of reflected rays with respect to the incident rays, the axial lines of which should exactly coincide with each other to secure the best definition; this necessitates the central position of the plane, and this form, commonly called the "Newtonian," undoubtedly maintains its superiority against all others. W. Purkiss.

READINGS FROM THE GLOBES.—X.

[266] Sir,—On the terrestrial globes, besides the map of the world, there is placed a figure extending an equal distance on each side of the equator, and reaching as far as 23½° latitude, to this figure has been given the name of Analemma, though it is, in fact, nothing more than the names of the twelve months with the number of days in each month, and so arranged as to correspond with the sun's place on each side of the equinoctial. Thus, for instance, the 21st March and the 20th Sept. are placed on the equinoctial line, and come under that part of the brass meridian which is marked 0, and this serves to show that on those two days of the year the sun has no declination. At the northern extremity of the Analemma is June 21st, and this is made to correspond with 23½° North Declination, and in like manner the southern extremity is marked December 21st, and comes under 23½° S.D. The intermediate divisions or gradations being made to correspond with the different declinations of the sun. Now this is a most ingenious and easy method of giving at a glance the explanation of many of the most important phenomena in mathematical geography, and the uses of this figure are varied and most important. Numerous problems may be answered instantaneously, if we only know the principle on which the Analemma is constructed; as, for instance, the sun's declination, in what latitude he is vertical and on what days, the time of his rising and setting, the duration of twilight, and his meridian altitude; so that the Analemma is one of the most useful figures on the globe. In the present instance we shall see its utility in finding the length of the longest days in the frigid zones. Geographers have found it convenient to divide this part into spaces corresponding with the length of time the sun is above the horizon—as, for instance, where the longest day is one month long, where it is two months long, and so on, until it reaches six months long. Now as the sun can shine over half the globe only at once, and as the earth rotates at the poles, some of the places in the frigid zone, in the course of the year, will never go below the horizon at the North Pole six months, 23½° from it one month, and gradually increasing in the intermediate spaces till the pole is reached. When the sun has 5° declination, those within 5° of the pole will have constant day; when 10° declination, those within 10° of the pole will have constant day; consequently the nearer any place is to the pole the longer will the sun be above the horizon. To find, then, the number of days during which this is the case, we have only to look on the Analemma, corresponding with the degree of the sun's declination and the co-latitude, which, in this example, will be the same, and we shall find what we require. When his declination is high, the ecliptic and the tropic of Cancer on the globe nearly coincide, so that the space where the day is one month long is within a narrow strip measuring only 46′, but the second strip is wider, being 2° 15′, the strips gradually increasing in width until the last, which is 7° wide. In Nova Zembla, whose latitude extends from 69° to 78°, the inhabitants of the most northernly part will begin to see the sun, not taking any account of refraction, when his declination reaches their co-latitude, that is 12°, and looking on the Analemma, underneath 12°, we shall find they will see him from April 19th to August 28th, or 131 days; whereas the southern extremity, whose latitude is 69°, will begin to see the sun above the horizon without setting, when his declination is 21°. As, therefore, during six months of the year these strips or belts have a length of sunlight varying from one month to six months, so when the sun is in the opposite declination they must have their nights varying in like manner. But there is this to be considered with reference to the absence of the sun, that it cannot be actually called night, for as twilight lasts until the sun gets 18° below the horizon, and refraction also raises a heavenly body when near the horizon, it will be necessary to see how long it takes the sun to reach 18° below the horizon, and then we shall find that, although deprived of the sun's rays, these places are not without some compensation for his absence—for twilight, refraction, the moon, and the aurora borealis will do their best to impart some kind of cheer to the inhabitants of these benighted regions. When, then, the sun reaches 18° south declination twilight will cease at the N.P., but this declination he will not reach till about the middle of November, and will reach it again before the end of

ary, and during that interval of two months the a must necessarily be above the horizon some part e time, and if it affords no warmth it will at least d light. The intermediate strips or belts, how-, will never be totally deprived of twilight, be-o only those places within 5½° of the pole will be his state. Again, in the temperate zones the dary line where places can have no twilight all t is 48½° north and south latitudes, and this is rtained in this way:—As the greatest declination 3½°, if we add to this 18°, the extent of twilight, we l have 41½° as the distance from the pole of all ces which enjoy this boon in the summer time; con-sently, by subtracting this from 90°, we shall have ° as the parallel where twilight all night ceases—t is, only those places whose latitudes exceed Quebec he western hemisphere, or Paris and Vienna in the tern, can have twilight all night. With respect to south polar regions, the poets of antiquity (see eorgics," Book I. line 244, &c.) could offer conjec-res only, assigning to them the abodes of the in-rnals and the presence of perpetual night; but odern science can offer reasons why the south polar gions should be enlightened during their night in the me manner as their antipodes, and regards such ssertions as arising from the defective knowledge of e ancients on these points, and as embellishments for heir fine poetry.

T. S. H.

HEIGHT OF CLOUDS.

[267] Sir,—Boyle's quotations of certain observations of a small *lucid cloud* near the zenith of Toulouse, between eleven and twelve o'clock p.m., on a clear evening in August, is deficient of date, so that the most important element of an explanation, viz., the age and position of the moon, is wanting. The moon might have been so near the horizon as to illuminate vapour in the higher region of the atmosphere, while a little unnoticed bank of cloud, about the point of her rising, would give the general appearance of a moonless night. With your kind permission I will here place on record my own observations of a similar phenomenon at nine o'clock p.m., on 25th Oct., 1869, in latitude 55° 45′ North, longitude 4° 0′ West, the moon in the 21st day of her age, and declination 20° 53′ North, being E.N.E., near the horizon, but above it, and partially obscured by clouds, giving the appearance of a moonless sky. The sky had the general appearance of being cloudless, as the stars shone tolerably bright, except here and there near the horizon, which was irregular in its outline, partly from clouds and partly from undulations of the ground. On going out of doors I felt as though I was eye-witness to some supernatural phenomenon. A zone of light, stretching across the sky from near the east to near the west, and passing a very few degrees south of the zenith, met my eye. Its *form* was that of a rainbow, but as there were no rain-clouds visible and the sun far below the horizon, and as the bow was without prismatic colours, its origin could be in no way connected with rainfall. Its outline was as distinct as that of any rainbow could possibly be, and it had none of those twinkling motions which are characteristic of the aurora. How long it had been formed before I saw it I cannot say, but it continued fully half an hour quite distinct, and gradually faded away. I concluded then, and I am of the same opinion still, that it was the moon's light, reflected from vapour in the upper regions, so disposed in the atmosphere as to present to my eye the form of a semicircular bow of light in a sky only faintly illuminated by the moon.

J. Steel.

HORSE POWER.

[268] Sir,—I should be much obliged by a reply to the following:—

Horse Power.—1. Given a vertical semi-portable fire-tube boiler, with internal fire-box and vertical fire-tubes, 4ft. high, 1ft. 8in. in diameter; fire box 1ft. 5in. high (between furnace bars and crown of fire-box), by 1ft. 3in. diameter, 7 fire tubes 1ft. 11in. long by 2¼in. outside diameter; water in boiler 10in. deep over crown of fire-box and surrounding vertical sides of same, giving *in all*, including surface of tubes above water line, a total surface exposed to fire and heated gases of about 14 square feet. Draught by a chimney 15ft. high. Feed supplied to boiler at about 50°. Coals of good quality. Required:—

(*a*) *Quantity* of steam of 60lbs. pressure (75 from a vacuum) obtainable from this boiler *per hour*?

(*b*) If the tube surface *above water line* is as effective as that below in the way of *producing* steam? And,

(*c*) If a greater quantity of steam would be made and *how much more* by raising the water line to 15in. above crown of fire-box?

2. Required also to know, if for this quantity of steam (sub. 1 a) a non-condensing engine of 3¾in. diameter of cylinder and 7in. stroke, with common slide valve cutting off at (say) ⅝th stroke, is suitable; and what would be the *proper velocity of piston*, or number of single strokes per minute, in order to correspond with steam supply from boiler (as above); and what would be the *theoretic*, and what the *real* or *effective* horse power thus developed,—presuming upon a general good finish of all working parts.

I think *practical* replies to *practical* inquiries of this sort would be of great service to many seeking information through your wide-spread and highly-instructive journal, and hope, therefore, they will be forthcoming from those of your correspondents so well able to deal with investigations of this kind.

A. W. E.

ISOMETRICAL.

[269] Sir,—I wish to draw the attention of "Isometros" to the circumstance that your engraver has reduced my drawing (p. 524) to make it fit your columns, and curiously enough just sufficiently to make the line A O in Fig. 2 measure 1in., whereas the projection of that line—viz., A O in Fig. 1—is described in the text as 1in. long, which, without this explanation, would make it appear that I had overlooked his requirements under the N. B. in his query on p. 478.

J. K. P.

FIELD BOILER AND PRIMING.

[270] Sir,—Will some of my brother readers kindly advise me in the following difficulty?—Amongst several of the same class, and of like and smaller sizes, I have a vertical semi-portable boiler, constructed on the "Field" principle, of the following dimensions:—Shell, 11ft. 2in. high by 6ft. 7in. outside diameter; fire-box (with water space all around of 6in.), 6ft. 2in. high by 5ft. 7in. diameter; 49 Field tubes 3ft. 7in. long, and 197 do. 3ft. 11½in. long, 2¼in. outside diameter; total heating surface, 691½ square feet; nominal power of boiler, 50 horses; working steam pressure, 75lb. per square inch; depth of water over fire-box crown, 18in.; steam space, 3ft. 6in. high; smoke uptake pipe passing vertically up through steam space; draught very brisk; steam to engine taken off close to top of boiler by half-circle 4in. pipe, having long slots on upper half of surface about ¼in. broad by 2in. long each; feed enters cold near bottom of boiler, and is seemingly pure and quite clear.

Now, although other boilers of like construction and proportions work satisfactorily, this one *primes* so very badly that, with otherwise efficient feed pump full on, it is impossible to keep the proper level of water in the boiler, besides which the safety of the engine is endangered by the presence of water in the cylinder. I want to know what measures should be taken to prevent, or, at least, to *reduce*, the excessive priming in this instance, and an explanation of the probable cause—taking into consideration that in other similar cases it is not found to occur. Can it be owing to the possible unfitness of feed water, and would heating same to near boiling-point before using as feed affect the case? Or is steam made too rapidly, or steam space too small; or is, finally, the method described of taking off the steam unsuitable and open to improvement? Early advice on this to me important subject would much oblige.

A Working Engineer.

P.S.—In my last query, No. 4513, I note mistakes on the part of the printer. The algebraical signs of formula No. 1 should be explained thus:—*n* the theoretic H.P. (*i.e.*, horse power); *f* the area of piston in square inches. Then, again, further on, R is used instead of H.P. (horse power). In query 3, H.P. (horse power) is also to be understood by R, wrongly printed, and the words within the first brackets of this query should be (high *and* low pressure). Then, again, the words "as indicated by an *open* mercurial" wants the the concluding word "gauge" and the right-hand bracket. In the place of "cylinder respectively," it should be read "cylinders respectively."

THE NATURE AND CAUSE OF LIGHT.

[271] Sir,—Being profoundly ignorant of the nature of light—*vide* Mr. Proctor's letter, p. 347—perhaps he will kindly explain the cause of two curious photographic phenomena. If I take a sensitised collodion plate, and cover it with orange-yellow glass, exposure to the action of strong light has no effect. But if it is previously impressed with a latent image, then such an exposure not only destroys the impression, but the plate is fogged all over. Again, if I take four pictures, one after the other, on different portions of the same plate, I find the last exposed requires nearly double the time of the first.

As Mr. Proctor thoroughly understands this subject, I shall esteem it a favour if he will enlighten my ignorance of the cause of these effects. With reference to the zodiacal light, I fancied there was another view, in addition to those described by Mr. Proctor, which shows it to be a phenomenon pertaining to our own atmosphere. Being so densely ignorant, my ideas are, however, worthy of no consideration.

T. A.

EMIGRATION.

[272] Sir,—Obviously the aim of all thoughtful men at the present moment should be to keep the subject of emigration as much as possible in the background. The disturbances on the Continent have created work for the unemployed. Our arsenals and dockyards again team with life and activity; the harvest requires labourers; the drain of German and French subjects from our shores causes vacancies in our warehouses which must, if not permanently, at least temporarily be filled up. Being impressed with these ideas, my intention was to refrain, for the present at least, from giving vent to thoughts upon the subject. However, the letter of "D. G." raises questions which deserve consideration. Candidly, I cannot commend the author of that letter for his thoughtfulness or knowledge of his subject. How am I to understand such phrases as "I would advise none to go who have not had some experience as practical farmers, or," &c., and "this would in no way exclude such mechanics as smiths," &c. If the advice given were followed, viz., that a *farmer*, *smith*, and *carpenter* should emigrate in batches, I think emigration would soon be stopped from the want of practical farmers. Again, as a rule, it is *not* the last-mentioned class who emigrate, or who benefit to any great extent by emigrating. Further, pausing at his declamation against Canadian seasons and hardships, is it not a fact that the American *winter* and *summer* are also extremes? Is Western America a panacea for all the evils under the sun? The prairie, I suppose, offers *no* hardships, it is well intersected by good roads, comfortable houses may there be found in medium quantities, *water* may at all times be obtained, the *Red Indian* never interferes with the pioneer; in fact, such a beautiful picture does "D. G." infer, that one would suppose the only necessary act for a poor mechanic to do in order to gain comfort and competency is to accept advice, gratuitously and sententiously given, but, unfortunately, lacking the most essential quality of correctness. How does it happen, if American railway prospectuses are so genuine, that there exists so much fear regarding the flowery sentences they contain, and so many who *state they have been deceived* by them?

Let not the emigrant be deceived, whether he visits Canada or America, and both possess advantages; he will have to encounter certain hardships, and it is extremely doubtful whether Canada, even with its toilsome wood-cutting, does not present a better sphere for his labours than Western America (at present). "D. G." certainly is extremely vague in the following sentence:—"He can see the lands himself and *make his bargain, then, if he is satisfied*, let him send passage-tickets to his friends." Would it not be best to make the bargain *after* being satisfied with the land, &c., for whether satisfied or not, after the bargain is concluded he can make no further alteration? Although I feel inclined to criticise this extraordinaryletter sentence by sentence, showing the thoughtlessness of its author, I must consider your space. Then, lastly, as to the period of departure. The horrible monster of "hardship" crops up again, and the result is worthless advice. The emigrant's policy must be to leave these shores, so that he may be enabled to arrive at his destination during the *busy season*, whenever that may happen to come, be it spring, summer, or winter. If he desires to succeed the hardships he encounters will make him more energetic.

With regard to the justness of the Canadian Government, the countries open to emigrants, the warning against sailing vessels, I cordially agree with "D. G." In conclusion, if "D. G." had bestowed a little more thought upon his subject, and scorned partiality for the American prairie, giving its drawbacks as successfully as he does those of Canada, his letter would have been pronounced excellent; but holding the view as I do regarding the enormous responsibility resting upon any one who writes upon this subject, I disagree with the remarks made as stated above.

I have seen no better information than that contained in the Government pamphlet, entitled "Information for Emigrants to the British Colonies," 2d.

F.R.G.S.

["F.R.G.S." would have increased the value of his letter if he had mentioned the number and page of "D. G.'s" letter.—Ed.]

BICYCLE RIDING.

[273] Sir,—I have read, with some surprise and considerable amusement, a letter from Mr. R. G. Bennett, in your issue of the 12th inst., in which he asserts the bicycle to be a mere toy, and useless for all practical purposes. This opinion he alleges to be derived from twelve months' experience of the machine, during which time he has not attained an average speed of more than *four* miles an hour, "using force sufficient to thoroughly exhaust himself on a twenty-mile journey." That Mr. Bennett's statement is true as regards himself, I am, of course, bound to allow; but that it represents the general experience of bicycle riders, I most emphatically deny. That he has failed in accomplishing in twelve months what ninety-nine persons out of a hundred could do in three weeks, I can quite believe; but I am bound to protest against his holding up his own lamentable failure as a scarecrow to intimidate others from learning the machine.

The bicycle club to which I belong always travels at the average of eight miles an hour for the whole journey. When the road is down hill, we frequently run, for some two miles, at the speed of twelve to fifteen miles per hour; up hill, we work at from four to six miles an hour; on level roads at seven to eight, or even nine miles an hour if the ground is smooth. If I go out with only a single companion, I travel faster than this, as the delays incidental to a large number riding together do not occur.

Mr. Bennett calls to his support the testimony of a correspondent, who, he states, "proved," some time since, by an "elaborate calculation," that the force necessary for walking a distance of five miles, if put into use on the machine, would only carry three miles, or *little over two-thirds*. I have no doubt that a person who "proved" three miles to be a *little over* two-thirds of five, would be capable of proving anything; and in any matter of theory, I should certainly beat a retreat from so unscrupulous an arithmetician. But I should be most happy to afford Mr. Bennett the opportunity of *practically* testing the "elaborate calculation" before mentioned, by matching my bicycle against his legs for a day's journey. I may mention for his comfort, that I could travel sixty miles in a day with the greatest ease (I have ridden forty miles after five o'clock in the afternoon); and as I should have to work as hard to get three miles as he has to do five (*vide* the "elaborate calculation"), it follows, of course, that to prove this theory he would require to walk *one hundred* *miles a day.* I hope he can. I may add that I am by no means a first-rate rider (compared with others in the club to which I belong), nor am I either physically or constitutionally strong; and again, I have not had anything like twelve months' practice.

I cannot, of course, account for Mr. Bennett's ill-success in utilizing the bicycle, and the consequent striking difference between his experience and mine, no more than I can account for the fact that I am unable to swim a dozen yards, though I have been learning for years, and go into the water a hundred times in a season, while others acquire the art almost instinctively. But this is no reason why I should set down swimming as a useless and unprofitable pursuit, or assert that no one can swim a great distance because I cannot myself get the length of a London bath. It is quite sufficient for me to know that most persons can learn swimming with ease, and that my failure is entirely exceptional, and of course owing to my own dulness. I would have Mr. R. G. Bennett take to himself the same comfort. W. E. MAVERLY.

[274] SIR,—Your correspondent R. G. Bennett (p. 494) is wrong in supposing that I said it would be better on a long journey to carry the bicycle. I never made, nor should I ever think of making, such an absurd statement. I can, however, bring the testimony of a year and a half's bicycle riding to bear out the general tenor of his remarks, which are, nevertheless, in my opinion, a little too condemnatory of the machine. As Mr. B.'s letter is sure to evoke answers from lovers of the bicycle, I trust you will allow me to make a few remarks on the subject in order that your readers may hear both sides of the question from those who have had real experience in the matter.

Every one will admit that the best means of locomotion under the greatest diversity of circumstances, such for instance as the crossing of rough country, is to use the legs with which nature has provided us, supposing of course that the motive power is supplied by the traveller himself. Our natural powers of locomotion are intended to be, as they in reality are, perfect in their adaptability to diversified circumstances. It is under *particular* circumstances that art steps in and for the time being, supersedes nature. Thus a locomotive carries us easily and quickly over an iron road, on which a man could not walk any quicker than on a grass field—the particular circumstances in the present case being of course the smoothness and hardness of the road. If the velocipede question be viewed in this light, the whole matter may be summed up in a few words. Presuming that we have good machines (and I think they are sufficiently good), are the particular circumstances of the case, or, in other words, is the quality of our roads such as to give bicycle riding the advantage over walking to the majority of people? I maintain that the true answer to this question is not to be looked for from those few athletic individuals who, if the bicycle was twice as hard to work as it is, would still go tearing about to the risk of their necks; neither ought we to accept the testimony of those who naturally speak in favour of the machine, because they happen to live where the roads are as smooth as a board. The real answer to the bicycle question can only be given by the general public, and their opinion can only be measured by the use which we see can be made of the machine. It is now about a year since I wrote and predicted the decline of the bicycle fever, and I think we need only look about us to see that it is already taking place. For my own part, I now only see one or two bicycles where I used formerly to see a score, and my observations extend over a pretty considerable area. The fact is, the machine has utterly failed to establish its utility either, as Mr. Bennett says, for practical purposes, or for economising force. On the first appearance of the bicycle in England, it was supposed to be everything that one could wish. It was to be ridden at the rate of 8, 10, or 12 miles an hour, and was, in fact, to go almost "by itself." The experience of a couple of years has, I think, dispelled the illusion, and the instances in which the bicycle is put to any really practical use, such for instance, as a business man travelling to and from his office, or a postman carrying his bags, are remarkably rare. The machine is almost exclusively used either by those who are young and strong, and who find pleasure and benefit in active muscular exertion, or by those who merely use it for the sake of practising "fancy" riding, and for showing off their skill in such feats as standing on the saddle.

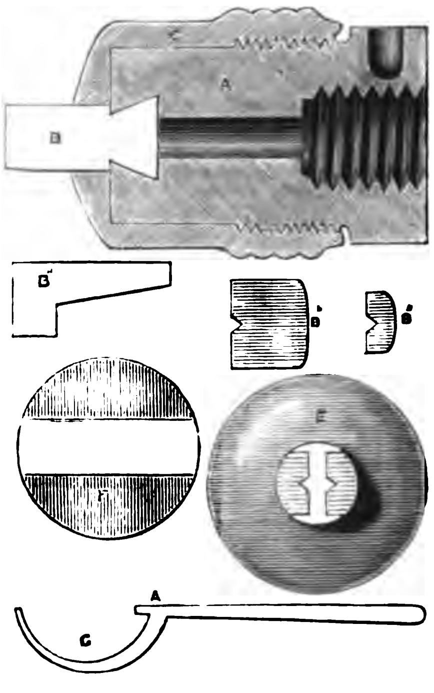
If any one buys a bicycle with the hope of, with ease and comfort, getting any practical use out of it on our roads, just as they happen to come, I am afraid he will be doomed to disappointment, and will be like many others, who, buoyed up with the same hopes, have made a like investment of hard-earned money, and would only be too glad to get it back again into their pockets. I do not attribute the failure of the bicycle to the machine itself, though there is ample room for improvement on this point, but to the state of our roads. Let the road surveyors lay us down an asphalte path from town to town, and I will undertake to say that the use of the bicycle will be as common as that of a horse and trap.

With regard to the rate of speed at which a bicycle can be driven, I quite agree with Mr. B. that some of your correspondents speak in a very random way. They talk, for instance, of "riding ten miles an hour." Do they mean that they can really keep up that speed for any distance, say for ten or twenty miles; or only that they can for a short distance ride *at the rate* of ten miles an hour? I fancy the latter is the real state of the case. Very few riders can, I am sure, keep up a higher rate of speed than six or seven miles an hour for any distance. I have frequently travelled eleven measured miles, containing a fair amount of up and down hill, in an hour and a quarter, and from my own experience I am perfectly certain that the same rate of speed could only be continued by a practised athlete. If every man in the kingdom learnt to ride a bicycle, I very much doubt whether the average rate of travelling would exceed four or five miles an hour. I am quite aware that Messrs. Jones, Brown, and Robinson have occasionally gone 100 miles in a day, and have, moreover, appeared at their desks the next morning as if nothing had happened—their spirits, no doubt, being kept up by the pleasing thoughts of seeing themselves immortalized in the papers; but performances of this kind may very well be classed with such feats as walking 1,000 miles in 1,000 hours. A sensible man would undertake neither the one nor the other, and neither the one nor the other could be performed without the expenditure of a very considerable amount of vital energy, which would require a great deal of rest and food for its proper restoration.

If the machine is good, the road very smooth, the wind not in the face, and the rider strong and healthy, and fond of muscular exertion, he may, with ease and comfort, get some substantial use out of the bicycle; but just in the same proportion as one or more of these favourable conditions fail, in just the same proportion does bicycle riding become a "toil of a pleasure;" and it is the improbability—I may almost say the impossibility—of making these favourable conditions universal, that renders impossible the universal adoption of the bicycle. W.

MORDAN'S SELF-CENTERING WIRE CHUCK.

[275] SIR,—As requested I herewith send you a sketch of Mordan's self-centering wire chuck. I was told twenty-five years ago that Mordan received for it the silver medal of the Society of Arts, and I made my first one twenty years ago entirely from word of mouth description, never having up to the present day seen even a sketch of it. Although I am acquainted with some of the best of workmen, I have never found one that had seen any but mine, and so shall be pleased to hear if any of your correspondents have heard of it. The first one I made had not the plain part at C to guide the cap and keep it true, it is a great improvement.



A, Body of chuck in cast-iron.
B, Dies.
C, Gun metal cap.
B'', Section and end view of dies.
E, Front view of chuck.
F, Front view of cast-iron part.

This chuck takes in from 0 to 10 B. W. G. The cap has four coarse millings to screw it up by. If more power be required a key like G is best, the pin A fitting in holes in cap, so there is no projection to catch the knuckles. R. N.

ELECTRO-MAGNETISM.

[276] SIR,—I have read with great pleasure some articles by "Sigma" in your paper, and hope that if this meets his eye he will favour me with a few remarks on the subject. For many years various persons have attempted to utilize electro-magnetism as a motive force with various success, never arriving, however, at what might be called a useful machine. Now, from what I can see, the difficulty appears to lie in the fact that the influence of the magnet is only exerted within a very short space, and hence most machines have been intermittent in their action,—a serious drawback. I think, however, I have overcome this difficulty completely, but am astonished to find that I do not get the results which acknowledged laws of [illegible] would have led me to expect.

I will state a few of the ideas which [illegible] and inclined me to believe that, [illegible] repeated failures, such a machine was [illegible] constructed so as to give a useful [illegible] sumption of fuel. My first [illegible] motive force was the direct result of [illegible] and that for a definite amount of [illegible] amount of motive force was [illegible] always in such a way that man [illegible] practical purposes. Now the electr[illegible] being uppermost in my mind, I [illegible] steam-engine an application of electr[illegible] was, certainly. A coal fire is nothing [illegible] than an electrical battery where the [illegible] moment they are set free are reunited [illegible] nothing more. Now this heat is the [illegible] battery, and if we could utilize the [illegible] we should be utilizing the whole [illegible] battery consuming so many atoms of [illegible] by the weight of coal and oxygen from [illegible] every engineer knows how small an [illegible] useful power is obtainable. If we look [illegible] other form of battery with acids and [illegible] can apparently collect the whole effect of [illegible] or chemical action, in two wires, we natur[illegible] that if we had a machine which would [illegible] we could give it from these wires and [illegible] effect, we should have a machine which [illegible] cost less than a steam-engine, or rather [illegible] greater power in proportion to the weight of [illegible] sumed. Now I imagined, when I had overcome [illegible] difficulty I mentioned before, I had a machine [illegible] would not be far from giving the desired result. [illegible] that by converting the high speed which ought [illegible] given to a slower, but still useful speed, I should [illegible] well. I have seen small wheels revolving [illegible] thousand times in a minute, but when I come to a [illegible] whose diameter is 16in., and whose weight with [illegible] wheel is 100lb., although it has a perfectly [illegible] power of at least 80lb. acting on its circumference, [illegible] will not give more than 80 revolutions per minute with a battery of 40 cells (sulphuric acid only). Why is this? I cannot understand it.

I might state that by my arrangement the current has to make 1,600 trips on *four* separate wires alternately when the drum makes 80 revolutions. The irons of the magnet poles are 3in. diameter.

THINKER.

LIGHTNING CONDUCTORS.

[277] SIR,—If you would grant me space, I feel it a duty to warn any querist very earnestly against the quackery rife on this subject, and which [illegible] honest, but inadequately informed, writers to make such replies as the two in your current number (p. [illegible]); the first wholly erroneous and mischievous in every point from beginning to end, and the second misleading more than it informs. I would say, *let no one* erect a conductor by advice of others, *or till he has at* least mastered as much of this very *easy subject as he* may in an hour or two from the *shilling* "*Electricity*" in Weale's series, or some other work of the late Sir W. S. Harris, by whose perseverance one class of works, but one only, the ships of the navy, were made lightning-proof. Hardly a building, small or great, is ever now erected that might not be just as absolutely protected, and this generally at half or a quarter the expense that is incurred—when any is—for partial or nominal protection. And I do not know a habitable or used structure in England thus really protected, or at present likely to be so.

Taking the two replies on p. 501 as texts, the points most necessary to be contradicted are these:—1. For "Q. Yorke's" italicized word "sufficient *surface*," read sufficient *bulk* or *capacity*; and understand that a certain minimum area of section, varying with the nature of the metal, is necessary. That is to say, for safety every part of the conductor must be of greater area than the thickest piece *of that same metal* ever known to have been melted by lightning in this climate. This is not the case with F. Bedford's "[illegible]in. iron wire," which would therefore be *simply a source of danger*, and far worse than no conductor at all. That size is also the minimum that could be held safe in *pure copper*, which is six times more conductive than the best iron, and twice as much so as commercial copper. The real minimum of iron that should be allowed is [illegible] square inch, or of copper a third as much, or a quarter, if of very good quality. It is impossible, therefore, you see, for *safe* copper conductors to be supplied, as "Q. Yorke" fancies, for 1s. a foot, though iron ones might be. And whatever might be the case, could we get copper made for the purpose *chemically pure*, as this is not attainable, copper, such as we can get now, is not so cheap, or so effective for a given cost, as iron. Zinc has a greater conductivity than iron, but yet would not be safe in smaller quantity, because we must insure it against heating to its melting point, which is not a quarter so high as that of wrought-iron.

2. Remember that *no part* of the conductor *must be* thinned or narrowed to less than the safe capacity. Where it is joined the pieces must be in flat contact over at least a square inch. If rounded, or touching only like the links of a chain, the *first* serious flash passing will fuse and destroy the contact, and the *second* will have to leap the interval by a fiery explosion. Mr. Walker's *tapering* steel "attractor" again will, the first time it is struck, be scattered in molten drops, to the imminent danger of whatever they touch.

3. As for an "attractor," it has been utterly disproved, these fifty years, that points can attract lightning, were this desirable. They attract the harm-

every-day electricity indeed, and hence their value ightning *preventors*, not attractors. You can dis- rge, silently and without shock, the largest electrical ery, by simply holding one pole while you present arp needle toward the other. In this way there is doubt every right lightning conductor helps in a m to discharge the cloud silently, and *prevents* nes that would, without it, have occurred. But in excessive tension of storm electricity this purpose o better served by delicate needle points than by accidental raggedness of any metal termination. ry experimenter knows this is the case even with an trical machine in good order. Doubtless there is a erence between the action of Messrs. Newall's ntiful "attractors" and a broken bar end in *sun-* *se*, but not in *a storm*. If anything can be said to ract *lightning* it is the pointedness of the whole lding or rising ground. Spikes make no difference, knobs as big as any dome; and nothing can be more surd than carrying out conductors an inch *above* or *yond* what they are to protect. (The poor Duke of rk is *spitted* on the top of his column!)

. Insulation is equally preposterous, as your second swerer perceives. It is abundantly proved the elec- cal passage will never turn aside from the line of st conduction.

5. For his "taken deep enough into the ground," ad simply, "taken to the next metallic mass that s metal communication with the ground." As every dern English building has metal water-pipes from e ground up "to the metal gutters," it is *so far* solutely protected already. Accordingly, I defy you cite a case of damage by lightning in all England, this century, outside a building and below the level f its gutters. They are either on the outside, *above ll gutters*, or inside, *by descending a chimney*. No onductors *to the ground* then are ever wanted,—you ave them already—but simply from chimney tops, or ther "attractors," to the nearest gutters. Whatever netal then you see spent under colour of lightning pro- ection, *lower* than the highest gutter level, is merely obbed in for "*percentage*" by quacks, patentees, rchitects, *et hoc genus omne*, that the mighty wisdom of Mr. John Bull creates as his ornaments and oracles, his *percentagers*. I saw once a poor (not in benefice) parson, whose school-house was being lightning con- ductored entirely *comme il faut*—pointed attractors of highest finish,—the insulators that F. Bedford would basely imitate with "bottle-necks,"—and all. Being a fine day, as they carefully brought the work downwards, before connecting with the ground, it gave beautiful sparks, of course to the astonishment of his reverence, the M.A., whom Oxford had never informed of such a thing as electricity, and of course that showed beyond question that all is right, and we are in the hands of men of true science. Could he or his builder have made sparks appear from the rods? What could be more convincing or satisfactory that what is here spent is well spent? Now this could only be done, observe, with finely sharpened "attractors" and good insulation. Hence you see what all this is wanted for.

6. But though conduction is needed only to the gutters, please observe it is needed from *every* point liable to be struck. Cases innumerable have exploded the old French error that *one* point—the highest—will protect the rest of an object. Ships with every mast protected have been struck on the end of a yard. All we can say is that no case is known of lightning striking a point within or behind the plane of three others, or the line joining two others. This defines exactly, in the largest building or town, *all* the points liable to lightning stroke. They are just as fixed and ascertainable as the number and position of letter-boxes, or of barber's shops. On St. Paul's Cathedral there are four; on Westminster Abbey, seven; on Salisbury Cathedral, six. To know precisely the points needing protection, all you have to do is to imagine a model of your building, and that you have in your hand a circular plane, say, a tambourine, as large as it would stand upon. Whatever point you could touch with the centre of this plane, without touching other points, is a point liable to lightning stroke, and *no other* point is liable. So at least we have a right to say, till some instance be adducible of a point not thus defined being struck. Protection from lightning, therefore, is just as simple and absolute as exclusion of rain from a building, and it is utterly wanton and inexcusable that such a thing as injury to a public building by lightning, in a civilized country, should ever occur or have occurred in this generation. Nowhere but among *percentagers* could it now occur, any more than destruction of historic monuments, or fifty other crying Bedlamisms of the time.

E. L. Garbett.

THE OLD HUNDREDTH IN HAWKINS' NOTATION.

[278] Sir,—Your "Harmonious Blacksmith," gives a version of the "Old Hundredth," and states that the bass sings the diatonic scale in contrary motion, leading one to infer that the whole of the bass is the diatonic. In the first strain it wants the sub-dominant; in the second strain it certainly is the diatonic scale descending; and the third and fourth strains are neither ascending nor descending at all. His laying a stress on this partial diatonic scale seems to imply that it helps to make the arrangement a *gem*. There are English pieces by Attwood, Purcell, Battishill, and Dr. Crotch, that possess this effect, which may be termed a Musical Palindrome; and before which, the "gem" of the "Harmonious Blacksmith" "pales its ineffectual fires." I prefer the old termination of this fine tune to the one he gives; and I cannot understand why the leading note of the third strain in all the four harmonized parts should be omitted.

S. D.

THE SUN.

[279] Sir,—I wish to ask the author of the "Astronomical Notes" on what page of the "Nautical Almanac" is it *stated* that the sun is in the *constellation* Gemini on the 1st July, 1870. On the contrary, we find in that work, as well as in several others on astronomy, that the sun is *stated* to be in a certain *sign* of the zodiac, and to have so much right ascension and declination. It is, indeed, "nonsense" to infer that he is in *a certain part of a constellation from these arcs*; because the point of intersection of the equator and ecliptic is ever varying. The fixed meridian of Greenwich, as it will be readily perceived by every one who has given this subject any consideration, is not, therefore, a similar case. In thousands of years hence would not "F.R.A.S." say that the sun was in the *same* constellation, because his R. ascension was found to be *quite different!* How otherwise, then, I ask can the "inference or conclusion" in question be anything but "illogical."

G. Firth.

LUNAR MOTION.

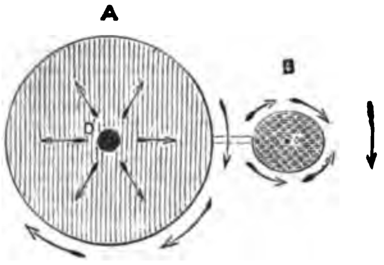
[280] Sir,—I have received the English Mechanic since *Scientific Opinion* has been merged into it, and must state that I am much pleased with the change. I notice a short letter on the above subject in one of your numbers, and an allusion to it by your valuable correspondent "F.R.A.S." I should not think it worth while to dwell on this subject any further, but for the very important results which *motion produces on the matter moved*. It is known that matter moving round an axis or centre has a tendency to fly from that centre; and that, in consequence of this tendency, the earth has become an *oblate-spheroid*, having a greater equatorial than polar diameter.

Now if the moon rotates on an axis passing through itself, it would have the matter at its equator thrown from the centre of motion or axis; and like the earth be an oblate-spheroid, but if it has no such motion, but turns round the centre of its orbit *only*, the lunar matter will move only in one direction, outward, from its centre of motion, and a *prolate-spheroid will be the result*. Movable matter must pass backward from the centre of motion and leave the side nearest the earth or centre of lunar motion bare, and no air or water could exist on the side of the moon turned to the earth.

Though much has been written on the subject, it must be investigated further; it is too important to be dropped. Noting your great success, &c.,

Toronto. Andrew Elvins.

P.S.—The diagram may help to show my meaning. If the disc A turned round the pivot at the centre D, any movable matter would be thrown from the centre towards the circumference, as the small arrows on the disc point. But if a body B revolved round the same centre, and had no rotation round its own centre C, the matter, which would be moved on B, by centrifugal force, would not pass outward in all directions from *its* centre C, but pass backward from the centre of motion at D, over all parts of B, as shown by the small curved arrows; and it will be further observed that all the matter on B moves in the same direction at the same time, which is not the case with it.



ARTILLERY DISCHARGES AND RAIN.

[281] Sir,—Your correspondent "Lex" has misunderstood me. He says, "Supposing, for the sake of argument, that 'R. P.'s' theory be correct, I would ask him of what utility would a continuous discharge of artillery, or a gunpowder explosion, be under a cloudless sky?" I never supposed a cloudless sky; I endeavoured to show the utility of artillery discharges under a cloudy sky. We all know what vast masses of clouds, apparently full of water, passed over the country in June and July, without giving us a drop. This is the time when artillery is wanted. It remains to be seen what discharge of artillery will be necessary to cause rain, this depending in a great measure on the distance of the cloud. I think, if the "inevitable" shower which "Lex" talks about as coming in nine cases out of ten, had occurred one out of ten in the cloudy weather which I have spoken of, this subject would not have been started.

I beg to inform "Lex" that I never imagined that a discharge of artillery would cause a universal rain. It is not to be supposed that a device of man's can supersede the laws of nature; but surely a shower of rain with a range of 20 or 30 miles would be more beneficial than "Lex's" tank-water. I think, after a few more dry summers, something will be done, unless the "law" steps in again to prevent it.

R. P.

EXPOSURE OF PLATES.

[282] Sir,—In answer to "E. T.'s" question, asked some weeks since, allow me to call his attention to a curious discovery recently made by M. Bazin. The time required for the exposure of a plate is now very short, but if the author's observations be good for anything this time may be diminished at least one-third by adopting the plan to be described. It will excite astonishment to learn that the plan consists in admitting to the camera light which does not pass through the lens. M. Bazin makes four holes in the front of the camera, and fits them with glass coloured by a solution of carmine in ammonia, behind which he places another piece of unpolished glass. These holes are uncovered at the same time as the lens, so that the red light falls upon the plate simultaneously with the image through the lens. According to the statement of the author the blacks and high lights are by this means much softened and the half tones greatly improved. The same effect is said to be produced if the sensitised plate be exposed to red light either before or after the picture be taken; in the latter case, of course, before the image is developed. This is a matter on which it is impossible to express an opinion without experiments, and we must content ourselves by calling the notice of our photographic readers to the discovery. I may mention that M. Bazin has tried other colours, but finds red to be the only one which gives satisfactory results.

J. W.

APPROXIMATELY RECTIFYING THE CIRCLE.

[283] Sir,—I was rather surprised when I learned from "E. L. G.'s" letter (250) that the ratio π had been twice wrongly quoted in my letter, as respects the sixth decimal figure; because among other items of *perfectly useless* knowledge, I include my remembrance of the values of π, e, and some other constants to the tenth decimal figure. I suppose that, having the 18 or 19 figures in Mr. Drach's letter before me, I simply copied them figure by figure, and farther on in the letter recopied the resulting figures. An error in the first process might easily occur and remain undetected during the second.

However, I was only writing to point out what I take to be the requirements of a geometrical solution; not to underrate the ingenuity displayed in Mr. Drach's arithmetical approximation.

Neither geometrical or arithmetical ingenuity can, I imagine, produce results of any practical value. During the last six years I have gone through a mass of calculations of different orders, mostly involving, more or less directly, the value of π. But I have never made use any approximation to the natural value of the ratio, except—in very rough work—the old-fashioned fraction $\frac{22}{7}$. In all other cases the logarithm of π has alone been of service to me.

Richd. A. Proctor.

LUNAR COSMOLOGY.

[284] Sir,—At present it would be difficult to reconcile in a popular form the conflicting opinions which are entertained by different observers with respect to the *modus operandi* involved in lunar cosmology. The theory of "Littus Habet Conchas," is one not in any way tending to establish a corresponding physital resemblance between the earth and moon; but other observers are all for terrestrial analogies. Before being finally disposed of, would it not be expedient to accumulate additional observations, and not mix up any other subject indirectly with lunar cosmology at the same time? The writer, "Littus Habet Conchas," does not allude to any published works as records of observations, but simply as the results of his own observations and deductions. So far from identification with earth-like agencies, "L. H. C." objects to even terrestrial terms of analogy being used *with respect to the moon*, the points of physical, mechanical, and chemical difference being so great in his estimation.

L. H. C.

HANDWRITING.

[285] Sir,—Your two correspondents, pages 469 and 515, appear to me to have missed the mark. Writing is the medium for conveying ideas to others with the the smallest amount of labour, therefore he who writes the hand or character most easily deciphered gives to his fellows the greatest pleasure or pain quickly. As to the form of character it matters not, so long as it may be read readily by the greatest number or multitude. It is folly to presume that we are in advance of our progenitors, and history will, I believe, confirm this opinion. If they went slowly to work, they thought deeply, took good counsel previous to starting, and then rapidly carried out the ideas well digested.

But as to writing, the substitution of the steel nib for the quill, caused by degrees a great distinction in the style of penmanship. It is now necessary to write with a light hand and swiftly. What is the consequence? The strokes of the pen, whether up or down, are light and free; in the haste unnecessarily attempted the terminal letters of each word are much smaller and frequently almost illegible.

That a handwriting in proportion as it departs from clearness becomes *stylish*, I do not believe. That illegibility is necessary or favoured in commercial circles, I flatly deny, whatever may be the *presumed* rapidity of thought thereon attendant.

That it takes time to acquire a fairly legible hand, I well know and acknowledge; that it amply repays that labour I believe. Now before me lies a facsimile of a page of the original MS. of "Ivanhoe," without blot or blemish, so legible that he who runs may read. In face of this clear round hand let us hide our diminished heads. Scriptor.

VULCANIZING INDIA-RUBBER.

[286] Sir,—Several of "our" correspondents have recently asked for information about vulcanizing india-rubber—whether it can be "re-worked," how it is made, and sundry other matters in connection with this subject. Premising that the various processes are still somewhat of trade secrets, with your permission I will give the readers of the English Mechanic the facts I have been able to collect.

"Vulcanization," as it is called, had its discovery in America. A Mr. Goodyear made a contract for supplying india-rubber mailbags, which he thought would prove to be a permanent article, but found that the heat and colouring matter softened the material and ultimately destroyed the bags. On the occasion of one of his numerous experiments, a piece of the rubber was accidently brought into contact with a hot stove, and was found to "char," instead of melting, as gum elastic does. Mr. Goodyear proceeded with his experiments, and after trying chalk, magnesia, and sulphur to prevent his rubber softening and sticking, he produced some remarkable results, and the articles being shown about others were induced to try experiments. Among these was Mr. Hancock, the first English patentee, who for some time tried to mix sulphur with the caoutchouc, till, by putting some pieces into melted sulphur in an iron pot and raising the temperature, he found them change, and the lower end of the slips, nearest the fire, turned black, and became hard and horny. The method now practised is to mix caoutchouc with from 2 to 10 per cent. of sulphur, and submit it to a temperature of 270° to 300° Fahr. A higher degree of heat than this is necessary to produce ebonite. In the specification of the patent granted to Thomas Hancock, in 1843, the process is thus described:—"I melt in an iron vessel a quantity of sulphur, at a temperature ranging from about 240° to 250° Fahr., and immerse in it the caoutchouc, previously rolled into rough sheets or cut to any convenient form or size, and allow it to remain until the sulphur has penetrated quite through the caoutchouc, which may be ascertained by cutting a portion of it asunder with a wet knife. If the operation is complete, the colour of the caoutchouc will be changed throughout to a yellowish tint. If there is only a margin of yellow around the cut part the operation must be continued longer, until the colour of the whole is changed, the sulphur adhering to the surface being scraped off; the caoutchouc will then have taken up a quantity of sulphur from one-sixth to one-tenth of its weight." The method of manufacturing various articles is thus described in the specification of the patent obtained in 1846:—"When I manufacture these compounds into articles requiring to be of a permanent shape or form, I make such articles in or upon forms, moulds, plates, engraved surfaces, or patterns, by pressing, fitting, or moulding such compounds . . . in, or upon such moulds or forms, and allowing the articles to remain there exposed to the vulcanizing process, which effectually sets them permanently to the respective forms. In order to prevent adhesion to the mould, I employ silicate of magnesia, either by dusting it on in the form of powder, or with a brush when mixed with water, applied either to the mould or the compound, as may be most desirable."

The "vulcanizer" itself consists of a strong iron vessel which can be opened to insert the articles to be vulcanized, and furnished with stopcocks so as to apply the pressure of steam. The principle properties of the vulcanized article are unalterability by climate or artificial heat or cold; impermeability to air, gases, and liquids; facility of being ornamented by gilding, painting, &c.; insolubility and durability.

The process patented by Mr. Burke consists in the use of the golden sulphuret of antimony to mineralize the caoutchouc. He employs crude antimony ore in fine powder, and converts it, by boiling in water with soda and potash, into the orange sulphuret of that metal by the addition of hydrochloric acid to the fluid. This compound is combined with caoutchouc or gutta-percha, either together or separately, according to the degree of elasticity he wishes to obtain. The mixture is afterwards subjected to a heat of from 250° to 280° Fahr., and is masticated in an iron box. After one or two hours' trituration the compound is removed, and while still warm is strongly compressed in an iron mould, in which state it is allowed to remain for a day or two, when it is subjected to steam heat for a couple of hours. The block thus prepared may be cut to any desired shape, or into rings, sheets, or threads. This is known as the *red rubber*, and as it is not liable to decomposition, or to become rotten or brittle, is well adapted for all sorts of valves.

The vulcanite used by dentists is of course made in a similar way to that above described; a cast of the gums and palate is taken in plaster of Paris, the caoutchouc moulded upon it, and then vulcanized.

It will be evident from the description of the process I have here given that vulcanized india-rubber cannot be *re-worked*. All articles are made of the shape they are intended to retain before vulcanization, and any degree of heat less than that at which the caoutchouc was caused to absorb sulphur has no effect on them; whilst, if the temperature be increased decomposition takes place or the rubber is converted into ebonite.

H. U.

CONTRIBUTORS AND QUERISTS.

[287]—Sir,—"M.R.C.S." (a new subscriber) expresses dissatisfaction with a reply given to him in a spirit happily very different from that of most readers. When a question is put for any one to answer, the reply is voluntary and open to any amount of discussion; but when a question is put to any one by name it is an appeal to the kindness and courtesy of a single individual, and the reply is therefore not a fair subject of complaint, be it what it may. "M.R.C.S." put me a question thus, a full reply to which would have required quite a page of the closest type, and occupied me two or three hours upon an amount of labour to an already very hardly-worked brain, which if I chose to employ commercially would be worth as many pounds. Such a consideration seldom affects me, and I, with many others, have for several years freely given any information in my power, moved partly by my own delight in science, partly by the earnest wish to forward general enlightment and to fully develop this paper, which is the best national educator the world has ever seen, and a marvellous illustration of the amount of true kindness and public spirit really existing among men. But this gives no single reader the title to *demand as a right* from me that I shall give him my time, labour, and knowledge, acquired by long and costly experience. Still less does it give each new reader, when like "M.R.C.S.," he has taken one number of the English Mechanic, a right to ask me to recapitulate for his sole benefit, and to the prejudice of other readers, subjects which I have already deliberately and carefully treated.

Now for his complaints. He says he has procured some numbers I recommended and is very little wiser; well, that may be my fault; but, again, it is at least possible that the fault may be with him. He then asserts that I have not described the bichromate single cell. It is quite certain that I have done so, but it may be in a number not mentioned before by me (being from home I cannot refer). His next complaint is more serious—"Sigma's descriptions are not clear enough for the ordinary mind." If this is really the case I shall be very glad indeed if any reader will point out what requires explanation so that I may attend to it. But my papers are written on a definite plan, with the intention, that on completion, they shall be remodelled and published as a book, which it is my ambition to make the most complete and comprehensive possible within a limited size. My plan is to provide a full explanation of *principles*, to so educate the mind as to render any details comprehensible whenever met, but to give details only where really valuable. Thus with the sulphate of lead battery, of which my description is specially condemned, I think that any intelligent reader, master of the general principles of batteries given by me, would find even that description amply sufficient, but on the other hand, it is quite evident from my remarks that I do not look on this form as worth a detailed description, which if I gave of everything would swell my work into monstrous dimensions. Does "M.R.C.S.." like so many people, imagine that, knowing nothing of a subject, he can by any teacher be put into full knowledge of any special part of it in a few minutes? I may tell all such people that if they want knowledge they must work for it with their own brains, any one else can only give them the materials; and if they wish to understand a subject they must go to the roots of it, and not suppose, as in this case, that they can obtain complete comprehension by reading only a few pages out of a systematic series—a series addressed not only to those who know nothing of the subject, but to those principally whose minds have already been trained by the writer and others,—furnishing all the various branches of knowledge which are needed for perfect comprehension.

Sigma.

THE EYE AND THE TELESCOPE.

[288] Sir,—There is a prevalent, and in my opinion, erroneous notion with reference to this subject, which I should wish to correct. It is supposed by many that the effects of diffraction are attendant only on vision with the aid of a telescope, as if the telescope were something different in principle from the eye. I would assert that effects precisely similar in kind accompany vision with the naked eye. This applies to the phenomena of spurious discs, &c. These effects are merely less in degree from want of magnifying power. There is another point on which I would say a few words. I do not think that the advantage to be derived from keeping both eyes open in telescopic observations, is so generally known as it deserves. In order to keep one eye closed a continuous muscular effort is necessary, which, even after practice, causes fatigue. The simplest plan to remedy this is to attach a blackened strip of pasteboard or tin to the split tube of the eyepiece, projecting on both sides. The object of this is to obstruct all light from the other eye, which is kept open. I think this plan has only to be tried for the comfort of it to be appreciated. S. T. Preston.

A VALUABLE TABLE.—The following table will be found valuable to many of our readers:—A box 24in. by 16in. square, and 28in. deep, will contain a barrel. A box 26in. by 15⅕in. square, and 8in. deep, will contain a bushel. A box 12in. by 11⅕in. square, and 9in. deep, will contain half a bushel. A box 8in. by 8in. square, and 8in. deep. will contain a peck. A box 8in. by 8in. square, 4⅕in. deep, will contain one gallon. A box 7in. by 8in. square, and 4⅕in. deep, will contain half a gallon. A box 4in. by 4in. square, and 4⅕in. deep, will contain a pint.

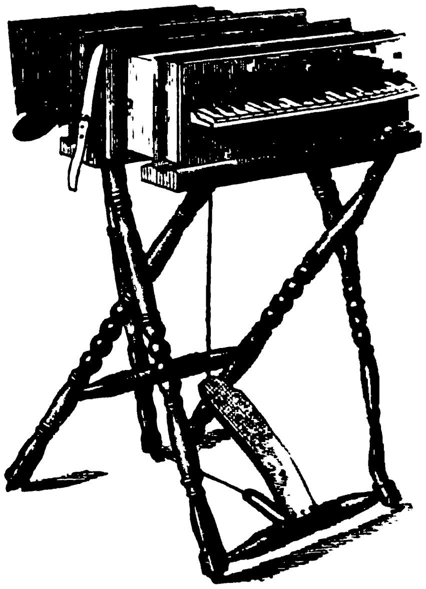
EXTRACTS FROM CORRESPO[illegible]

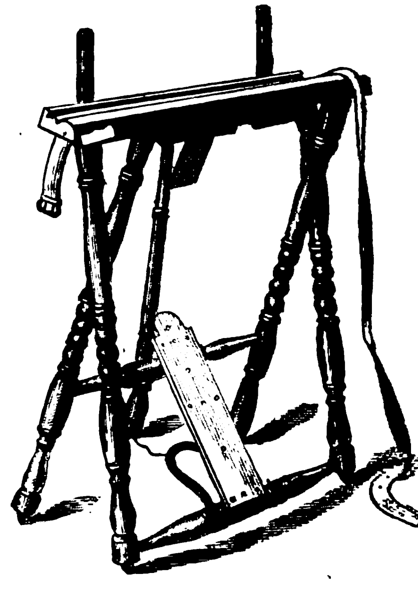
A WORKMAN'S TESTIMONY.—[illegible] Brunswick-road, Sheffield, says:—"I [illegible] for some time to express my appro[illegible] add any testimony to its value. [illegible] tone of some of your recent '[illegible] spondents.' I have subscribed [illegible] periodicals for about twenty year[illegible] such satisfaction from one befor[illegible] many points of interest contain[illegible] the rest being the articles on 'Che[illegible] 'Science for the Young,' 'Music,' [illegible] the 'Correspondence Columns.' If [illegible] I could point out three or four of [illegible] whose hands I should like to gras[illegible] personally for their contributions, [illegible] perhaps be something novel to the[illegible] hands grasped by the somewhat [illegible] of the sons of toil. If some of [illegible] men, who spend their time and mone[illegible] would contrast one number of 'our[illegible] pot of beer,' I think they would at [illegible] that they pay "too much for their whist[illegible]'

REPLIES TO QUERIES.

*** In their answers, Correspondents are [illegible] requested to mention in each instance the [illegible] number of the query asked.

[8934.]—ORGAN ACCORDION STAND.—I [illegible] sketches for the benefit of "Sigmatan," one [illegible] instrument, the other without. When the foot p[illegible]





treadle down the instrument is caused to close; a[illegible] when the foot is lifted the strong spring pulls the bell[illegible] out again by means of the long lever fixed at the bac[illegible] The diagrams explain the rest.—Reed Tuner.

[8949.]—REPUBLIC OF GUAIANA.—I am quite a[illegible]tonished at the remark of "J. G." (p. 499). He sa[illegible] that I am mistaken in stating that the *colonies* of Guia[illegible] are *north* of Venezuela. I never thought nor said tha[illegible] I answered to the query about the "*Republic*" of Guiana that I believed it was *near* Venezuela. I think even [illegible] is part of Venezuelan Guiana. I read in the *Times* some weeks ago an article about a settlement in that country. —Bernardin.

[3949.] — GUAYANA OR GUAIANA. — Besides the usual English error of omitting the first A of this name, a letter quite essential to its sound in any regular orthoepy, "J. G." is very unlucky in limiting the application of what is literally the most defined and naturally-fixed geographical name on any continent in the world. It has always applied to the whole *river island*, or portion of South America that the Oronoco, by its unique bifurcation, detaches and isolates. Rising about the middle of this vast tract, its first course is S.W. and westward, directly *from* the sea it is to reach; then, in the heart of the continent, it splits into two, to the S.W. and N.W., each equal in volume to the Rhine. The former called the Cassiquiare, or *natural canal*, after winding some 150 miles, enters the Rio Negro (chief affluent of the Amazon) at about 1,500 miles from the sea. The other branch, the proper Oronoco, takes its own course, northward, down various cataracts, and then eastward, till in about 1,000 miles it reaches the same ocean; and thus we have the only river in the known world that, like Adam's in Genesis, is "parted," and then compasses a whole land. There are alluvial deltas, of course, but nowhere else is a *land*, a true country, comprising mountain chains and all other elements of a continent, known to be thus moated with rivers and sea. Now the three colonies, to which "J. G." confines the name, form not one quarter, and by far the worst quarter, of this vast and unique land of Guayana. The southern half, or all that drains to the Amazon, is Brazilian, but hardly trodden as yet. More than a quarter, to the N.W., formerly Spanish, is now Venezuelan, forming about half the area of that republic, and praised by Humboldt as the garden of the world. Its capital has not been moved, but very variously named, being the San Tomé and Nueva Guayana of old maps, afterwards Angostura, now lastly Ciudad Bolivar. This quarter, equal in extent to France, all drains to the Oronoco. The only low, moist, and unhealthy Guayana is the remaining or maritime part, comprising the three poor colonies "J. G." has alone mentioned, where the British, Dutch, and French have scratched but the merest margins of low coast. It is remarkable the gold diggings discovered only three years ago in a high and cool table-land of Venezuelan Guayana, had been heard of by Raleigh, and for two centuries regarded as a fable. —E. L. G.

[4131.]—SUNDIAL.—"W. H. C." will find a letter on page 460, Vol. X. of the English Mechanic, which may help him; also on pp. 526, 582, and 634 in the same Vol., also on pp. 14 and 62 in the Vol. now issuing.—Current.

[4161.]—REFRIGERATOR.—In answer to "Chico," ice is easily kept a week in the hottest weather by placing it in a large bag containing plenty of sawdust to cover and surround the ice, the bag being placed in a hole in the ground, in a cool spot, and boards being placed over the hole, and old sacks over them. If the sacks are kept damp all the better. I always keep ice thus, the merchant sending it in a bag of sawdust; in that alone, it often keeps a week.—Current.

[4170.]—SMOKE BURNING.—There is an article on the above subject, p. 875, Vol. X.—Sergius.

[4172.]—BORING BAR.—You must construct some sort of wooden frame to support your bar, and if you take only a small cut at a time no very great rigidity is required. I should take three cuts through a pair of brasses, and the last cut not more than 1-50in. all round. If you take care to level the work first with the spirit-level you can at any moment make sure of your bar, one way at least, by the same means, which may save much time in the event of a cutter sticking and breaking, or if you think the supports may have given way a little by an over strain. I once bored a 5in. hole in a barrel-holding head-stock of a rifling bench thus:—I first fitted on two blocks of hard wood, with a tenon below to go between the sides of the bed, and a bedstead bolt or bedscrew to each to hold it down. I then made a cutter exactly like the shifting side of a Franklin's expanding centre-bit—viz., with the shaving half of the ordinary carpenter's centre-bit, armed with a nicker on its outside edge, and fitted it to the ⅞ bar that I had previously used for the small holes in the other head of the machine. With this new cutter, and the bar and heads used before, I bored holes for taking a 2" bar through the block mentioned above. The cutter for the 5in. hole was made of a piece of flat bar-steel, drawn out narrow at one end, and hooked a bit, so as to be like a roughing-out turning tool in effect, and keyed into a hole in the bar. A large carrier was put on end of bar, and a piece of gas barrel about 4ft. long, shipped over the tail of the carrier, formed a lever. On the other end of the bar another carrier and an old dog chain with a swivel on it, hung over a pulley some distance off, with a weight attached, gave the feed. It happened to be at the coldest time of a very cold winter, or I should have been knocked up probably. Of course if you can fit up an old pedestal or two, and run in some type metal or Babbit's metal bearings (or even lead) round the bar, which has previously been wedged up to its right place, so much the better; and for heavy cuts you would, of course, not depend on the bearing that fir timber would afford.—J. K. P.

[4174.]—GEOLOGY.—"Veritas's" question cannot be replied to positively. It must be a time almost beyond computation—*millions* of years certainly.—Augustus.

[4190.]—EMIGRATION TO THE WEST INDIES.—Two things are to be borne in mind—1, that in the globe's warmer half, viz., in latitudes below 30°, no wood clearing (which is the first essential) nor any outdoor manual labour can be performed by Europeans, except at elevations above 8,000ft., or at least 6,000ft.; 2, that nature has not, in the tropics, made the *exploitation* of a labouring class, however poor—and least of all when they are freed slaves or their descendants—by a richer directing class, possible as she has here. Now, of the British West Indies (though nearly all are hillier than the summit of Scotland), none contain ground high enough for whites to work on, except the part of Jamaica east of Kingston. On these mountains, I believe that Englishmen, or at least "temperance" men, going there young, might, besides their necessaries, raise coffee, and perhaps cotton; but no other of the present staple exports, which require lower and hotter ground. Innumerable wild products of both the high and lowlands, as hard fancy woods, dye stuffs, preserved fruits, oils, and other medicines, ought to be exported; but the miserable social state induced by two centuries of slavery, seems to have permanently banished civilized industry. The island nearly throughout is of wondrous, perhaps matchless, fertility and beauty; but seems of all others the most ruined. The whites have, from being one in ten when the present writer was there, dwindled in a few years, by their own account, to one in forty. Even then, square leagues upon leagues of formerly tilled estates had relapsed into jungle—not what is so called elsewhere, but absolutely *impenetrable* wood 20ft. high—and it must now or shortly differ little in social and physical state from a bit of central Africa, save in the negroes having countless herds of half-wild swine, and being under Baptist fetish-men, instead of Obeah ones.—E. L. G.

[4196.]—CEMENT.—"A New Subscriber" will probably find a cement made of resin and beeswax, coloured with Venetian red, answer his purpose. Say about 2oz. of resin, ½oz. beeswax, and about ¼oz. Venetian red. Melt it gently and stir it well together; and make both the bottle and brass cap hot before applying the cement. —Augustus.

[4196.]—CEMENT.—"New Subscriber" will find the following suit him:—1. Mix a pint of vinegar and a pint of milk; when fully mixed, clear it of the lumps, and let it settle; then sift into the liquid some quicklime, until a thick paste is obtained. Or 2. Alum and plaster of Paris mixed together, which is a very good cement for glass and brass, and will stand well. See also English Mechanic, Vol X., pp. 137, 391, 417, 462, 518, 640, and 660.—Current.

[4226.]—DOUBLE STOCKS.—I quite agree with "Norma" (although only an amateur too) that the best plan to save seed to raise double stocks from is to destroy all flower pips on single flowering plants that have only four petals, and to save the seed from those with five, six, or seven petals: the more petals, the better the seed, although I never saw a pip with more than seven petals bear seed, and then only on the Giant or Brompton Stock. I never saw more than four petals on a pip of the single-flowered annual Dwarf or Ten Weeks' Stock.—W. E. Cordon.

[4340.]—FROM N. G. LAMBORNE.—N. G. Lamborne's velocipede was a four-wheeler, with the ordinary crank motion, driven by the hind wheels, 3ft. diameter; front wheels, 2ft. diameter; crank, 6½in.; swinging treadles, 6in. joint at crank, and 4in. joint which holds the treadle to the frame near the front wheels; frame 5½ft. long, extreme breadth 22in., driven by the vertical tread of the foot; seat over the crank, and so high that the foot would just fairly reach the treadle when at its limit downwards. It is a mistake in placing the seat far away from the driving wheel, and is a proof of bad management in placing the seat and treadles. I do not advise any one to make after this plan, although it is the best that I have seen, except an invention that is *now nursing*. —N. G. Lamborne.

[4368.]—LINING-OUT SHAFTING.—Cut a semicircle (exact) of wood, to fit the bottom brass of each pedestal, and mark on the flat upper side of the wood the exact centre. Set up your pedestals with the wood in, and strain a fine string from one end to the other, to indicate the centre line. Level from one wood in pedestal to the next, and so on with a good spirit level, and block up the short ones with hard wood or sheet lead, till you get them right. Look at your distances apart likewise. Of course the shaft will be put in its place before finally tightening the base bolts.—J. K. P.

[4408.]—INDIA-RUBBER is the inspissated juice of several trees belonging principally to the following botanical orders:—Spurge order, or *Euphorbiaceæ*; fig and mulberry order; dogbane order, or *Apocyneæ*. A complete list of names might be too long, but I beg to quote a few:—(*a*) Spurge order: *Euphorbia antiquorum*, *nereifolia*, &c., of the East Indies (*Soesoera* of the Malay), *Siphonia elastica*, &c., of Brazils, &c. (*b*) Fig and mulberry order: *Ficus elastica*, or Assam India-rubber; *F. indica*, or banyan tree; *F. religiosa*; *Castilloa elastica*; all from the East Indies. *F. Brassii*, Western Africa; *F. macrophylla*, of New South Wales and Queensland; *F. elliptica*, *radula*, *prinoides*, &c., of South America. (*c*) Dogbane order: *Urceola elastica*, of Sumatra; *Calotropis gigantea*, the well-known *Yercum-nar*, or jungle plant of the East Indies; *N'dambo*, and several other lianes of the Gabon; *Willughea edulis*, *Luti Am*, of Bengal, &c. Many trees of the Sapodilla order or *Sapotaceæ*, yield also a milky juice analogous to gutta-percha. I have given (No. 220, p. 272 of our English Mechanic) a note on Balata and Massarandba.—Bernardin.

[4413.] FEED-WATER HEATER.—In answer to S. Crompton, I have no means of taking a diagram of back pressure, not having an instrument. But I do not think he understands my note; he speaks of water being admitted into the heater; I do not call it a heater, as my water is really heated in the exhaust pipe as it leaves the cylinder. My exhaust pipe is 3in. diameter; the pipe from cold water pump travels horizontally for a few feet before entering exhaust pipe, both lying horizontally, so that the water shall not bump in all at once but trickle, as it were, out of the pipe into exhaust nearly the whole of the revolution. Now to satisfy myself, this week I took off the head of the heater 12ft. from where the water entered the exhaust pipe and watched the work of it with 10lb. of steam, and instead of back pressure I had a partial vacuum when the greatest rush of water occurred, so much that the steam returned at that particular point with considerable noise; that point can be seen with steam at 40lb. in the puffs as they leave the pipe for the open air. Again I can get no loud and clear bark from the exhaust when pumping as I can when the water is shut off, and I certainly think the engine works easier when pumping than not: but one point I do not understand, my exhaust pipe direct from the cylinder is 12ft. long, and when I first tried it in 1863 I blew into a close cask of 120 gallons. Then I had twice as much silex deposited on its sides as I do now I have replaced it with an iron one as being more orthodox; I presume the reason is because the wood is the best non-conductor of heat.—One Eye.

[4416.]—PHOTOGRAPHICAL.—If "John" is the fortunate possessor of the fourth Volume of the English Mechanic, he will find all he requires, I think, in the exceedingly good chapters on "Elementary Photography," by "A. H. W.," on pp. 25, 41, 89, 116, 201, 250, and 285 in that Volume.—Current.

[4417.]—SAFETY-VALVE FOR KITCHEN BOILERS. —In answer to "Osmond Dobree," a very good article was brought out some time ago (by Mr. Fletcher, Engineer of the Manchester Association for the Prevention of Household Boiler Explosions), which is said to be unaffected by changes in the temperature. They are made, I believe, for 10s. each, and cost about 10s. more for fixing, if the boiler is in use. It was illustrated and explained, as every other good thing is, in this Journal, in the fifth Volume (p. 391, issued August 16, 1867).—Current.

[4418.]—SILVER COIN.—A Roman Family Denarius; Family *Antonia*, read ANT. AUG. III. VIR. R.P.C., rev. LEG. IV. I find it quoted in one of MM. Lincoln's catalogues, 2s. and 3s., according to preservation. Plated varieties are existing.—Bernardin.

[4421.]—MAKING FLANNEL ADHERE TO BRASS. —One part Venice turpentine to four parts glue, thoroughly mixed, is the best I have tried to make anything adhere to brass.—J. H. P.

[4448.] TRUE MERIDIAN.—A "Young Surveyor" will find that the best way to obtain the astronomical meridian *in the field* is by compass, allowing for the variation of the needle, which in 1869 at Greenwich was 20° 4' westerly. The difference between this value and that for 1860 is about 50' (now probably about 1°). This will not of course apply to any other part of England, but the reply to query 4342 (August 5, p. 477) contains the results of determinations in 1868-9. Practical treatises on navigation give the method of finding the magnetic variation, from which, as just stated, the true meridian is easily found. For the determination of a *fixed* meridian line refer to p. 285, June 10, reply to query 2558, Sundial.—W. R. Birt.

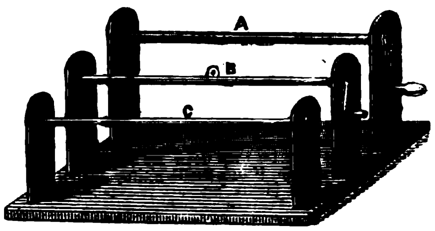
[4461.]—SCREW CUTTING.—I am not sure that *onto* is a dictionary word. Perhaps your compositor has done rightly in altering it to *into* in my letter, on page 525, but he has spoilt my meaning, while improving my grammar. I remember the same thing once before. —J. K. P.

[4465.]—TRACING PAPER.—"H. U." may make any drawing or writing paper transparent by damping it with pure and fresh distilled benzine, and it may be used without causing the ink to run. When dry, the paper resumes its opacity. (See English Mechanic, Vol. X., p. 35; also Vol. IX., p. 397.)—Current.

[4467 and 4551.]—IMPRESSIONS FROM PRINTS AND TRANSFERRING ENGRAVINGS TO WOOD.—Dip a suitable piece of paper into a weak solution of starch and leave it to dry, then moisten with dilute sulphuric acid. The engraving to be copied must be exposed to the vapour of iodine for about five minutes, then applied to the prepared sheet of paper, and the two pressed together for a minute or two in a copying press. The iodine is said to fix itself on every part of the engraving covered by printing ink; such being the case, the remainder of the process becomes evident. I imagine it would be equally applicable to wood. Not proved.—T. W. Boord.

[4472.]—SOLDERING BRITANNIA METAL.—"J. B——r" will find a method of soldering any kind of metal without fire, described on p. 525, Vol. X.—Sergius.

[4473.]—INTENSITY COIL.—I send a rough diagram of a machine made for winding fine wire on to coils. From the following description, "R. F. D." may be able to construct one for his own use. A is a rod that can be taken off the uprights upon which the coil is fixed; C is a wooden rod to carry the reel that contains the wire; B is a brass tube which has a slit in it from end to end. Inside the tube is a small metal bar, with a thread along its whole length, and which can be turned upon its own axis. At B is a stud that screws on to the bar inside the tube, which moves in either direction when the handle is turned; it also has a small hole in it for the wire to pass through on to the coil at A. It will be seen that when the coil is turned by means of A, it draws the wire from the reel C, through B, which can be brought opposite to any part of the coil. I have made large coils on this machine, and have found but little trouble in winding the wire on to them. The handle on B would be best at the other end. With respect to the insulation of coils, it may be said that they cannot be insulated too well; yet it must be understood that the inductive influence of the core and primary coil diminishes as the square of the distance; therefore, what is gained by insulation is partly lost through the space it occupies; an insulator should, therefore, be used that takes up the smallest space. I think "R. F. D." has not insulated his coil any too well.—J. T.



[4474.]—HORSE POWER.—The common rule for calculating the power of a steam-engine is $\cdot 7854\, d^2 p v = 550$-horse power, or $d^2 p v = 700$-horse power—(*a*). But as the steam should be stopped off at ⅔ the stroke $\therefore d^2 p v = 933$-horse power. This is the simplest general expression; but as a commercial expression, $p v$ can be assumed $= 30 \times 3{\cdot}1 = 93$ a constant, which is considered a fair average in calculating the nominal horse power of a steam-engine. Therefore, substituting for $p v$ we have by division $d^2 = 10$ H. P. $\therefore$ H. P. $= \frac{d^2}{10} =$ nominal power of non-condensing steam-engines. And substituting 7lb. per square inch instead of p in equation (*a*) d and v remaining as before, we find H. P. $= \frac{d^2}{32} =$ nominal power of condensing engines. For the actual power of steam-engines, equation (*a*) must be applied in all cases with properly reduced values of p and v, either from tables or otherwise. "Templeton's Engineers', Millwrights', and Machinists' Assistant," 4th edition, contains these tables, and much useful information for the practical man.—R. D.

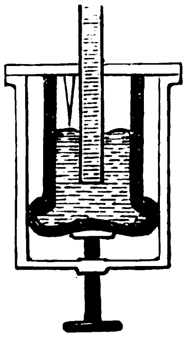
[4474.]—HORSE POWER.—The following is a simple method of finding the horse power of a steam-engine. Square the diameter of the cylinder in inches, and divide the product by 12. The result will be the power with steam of 30lb. to the square inch. From this, the power at any other pressure may be ascertained by simple proportion. For example: Required the power of an engine whose cylinder is 6in. diameter, supposing the steam pressure to be 40lb., 6 × 6 ÷ 12 = 3 (horse power at 30lb. pressure). Then by proportion, 30 : 40 :: 3 : 4 (power at 40lb.)—Vertumnus.

[4477.] — BOOKS. — The "Encyclopædia of Rural Sports," by Delabere P. Blaine, 8vo., 50s., 1852, and "Youatt on Dogs," 8vo., 6s., 1851, are both standard works. Mayhew, Richardson, and Jesse have also written on the same subjects.—Canis.

[4478.]—BLUE INK.—1 Chinese blue, 2oz.; boiling water, 1 quart; oxalic acid, 1oz. Dissolve the blue in the water (rain water if you can get it), then add the acid, and it is ready at once. Or 2, dilute sulphate of indigo with water, until the desired tint is obtained. (See English Mechanic, Vol. X., p. 162).—Current.

[4479.]—COLLODION.—"W. Crawley" appears to handle his plate well up to a certain point—namely, the draining off. He should put down his collodion bottle, and then gently *rock* his plate edgewise, keeping the draining corner down. This will cause the ridges to run into each other. I have found it advantageous in this very hot weather to thin the collodion occasionally with a little sulphuric ether.—Paddy.

[4481.]—"A DIFFICULTY."—The use of the leather bottom to the cistern is, as explained in the work referred to, for the purpose of keeping the fluid in the cistern always at the same level when an observation is made. Since the mercury in the tube is almost continually ascending or descending, that in the vessel is also constantly altering its level, sinking when that in the tube is rising, and *vice versa*. The adjusting screw may be made to work in a light brass frame attached to the vessel. The sketch will perhaps afford some idea of the position and arrangement of the screw.—Exhibitioner at Royal College of Science.



[4482.]—OVAL.—"Symmetrical Beauty," by D. R Hay, is the best book on the subject I ever met with, 8vo., 6s., 1846. By following his directions I have drawn many ovoid figures, and can safely recommend both the above and the author's other works.—H. B. M.

[4490.]—WELDING CAST STEEL.—If "T. O. B." will take great pains in heating his steel, by watching it in a nice gentle fire kept free from dirt, and use the following composition, he will have no difficulty whatever in doing it to his satisfaction:—Take ten parts of borax and one of sal ammoniac; grind them together roughly, and then fuse them in a metal pot over a clear fire, taking care to continue the heat until all spume has disappeared from the surface. When the liquid appears clear the composition is ready to be poured out to cool and concrete, afterwards to be ground to a fine powder. This may be best done by running it into a strong iron vessel, or, if in a smith's shop, into a hole in his swaige; put in a piston, and use the sledge-hammer. A small quantity of this composition will be sufficient, sprinkled on the parts to be welded while in the fire. Care should be exercised in hammering the splice.—Geo. Jackson.

[4496.]—COPPER COIN.—A coin of Adolph Frederic II., King of Sweden.—Benardin.

[4499.]—"FOUL AIR."—The cause of foul air in mines and other places is the presence of decomposing animal or vegetable matter. The gases more frequently present in mines are marsh gas (light carburetted hydrogen) and carbonic acid gas. The former is given off to a great extent from seams in coal mines, and is frequently the cause of fearful explosions resulting in great loss of life. This gas, as its name implies, consists of carbon and hydrogen, and has the chemical formula CH_4. By means of the safety-lamp of Sir Humphry Davy, accidents might in almost all cases be avoided, for when the proportion of marsh gas is so great as to be dangerous, the gauze cylinder of the lamp fills with flame, and thus warns the miner ere an explosion takes place. Carbonic acid is also frequently present in mines and wells. If a light be lowered into the shaft it will be put out, showing that it would be highly dangerous to venture into such an atmosphere. A short time ago there was an account in the newspapers of some men who unfortunately fell a prey to the foul gas in a well; this was probably carbonic acid, and the accident might have been avoided by first letting down a lighted candle. Sulphuretted hydrogen is a gas often present in the vicinity of sewers, and is highly poisonous. These gases may be got rid of by proper means of ventilation. In large mines there should be two shafts, and if the country be undulating, one shaft opening at the higher and one at the lower level will afford a very effectual ventilation. Blowing engines may also be used for forcing pure air into the workings of mines.—Exhibitioner at Royal College of Science.

[4503.]—MENSURATION OF SUPERFICIES.—The rule "T. W. H." has been trying for a three-sided triangle, namely, that the area is the square root of the continued product of the half-perimeter multiplied into the three remainders left on taking each side from that half-perimeter, deserves to be more used than it is; being much easier than the statements of the rule commonly make it appear, and the three sides being better measurable with accuracy than one side and a perpendicular. So I give, as he desires, every figure of the working of his example; but allow me to say, a "three-sided triangle" was quite conceivable without the diagram, especially as no use or mention is made by him of D or the line D B:—

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side A B =   9·2            half sum = 11·1
side B C =   7·5            − C A    =  5·5
side C A =   5·5                       ────
           ─────                        5·6 = a
           2)22·2
           ─────            half sum = 11·1
half sum =  11·1 × a        − B C    =  7·5
           ─────                       ────
× 5      =  55·5                        3·6 = b
× 0·6    =   6·66
           ──────           half sum = 11·1
            62·16 × b       − A B    =  9·2
           ──────                      ────
× 3      = 186·48                       1·9 = c
× 0·6    =  37·296
           ───────
           223·776 × c (= 2 − 0·1)
           ───────
× 2      = 447·552
× 0·1    = − 22·3776
           ────────     area
           425·1744(20·61975, &c.
           4
           ──
     4·06) 25·17
           24·36
           ─────
     4121)  8144
            4121
           ──────
     41229)402300
           371061
           ───────
     412387)3123900
            2886709
           ───────
             237181
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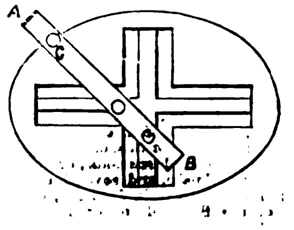
showing the next figure to be 5, and so on. He most likely boggled at the second line of the evolution—the line always the most needing attention. Books do not say, as they ought, that the second figure of a square root must never be written, *unless it be a* 0, nor the second line of computation filled till you have mentally computed the whole *third* line. In the present case, however, as the doubled first figure of root 4 will not go 10 times in 25, you write 0 for the second root-figure, put also a 0 after the four, and bring down a new pair of figures, 17. Then, as 40 goes above 60 times in 2517, the next figure of root is 6, and you append a 6 also to the 40, making 406, to be multiplied by 6 and subtracted, and so on. If "T. W. H." tries the triangles 13, 14, 15; or 5·1, 5·2, 5·3, he will find a terminating root; their areas being commensurable with the square of a side.—E. L. G.

[4504.]—ELLIPSES.—Annexed is a drawing of a simple instrument which night easily be constructed either in metal or wood. The traverse bar A B carries two studs which slide in the grooves of the crosspiece. By turning the traverse bar a pencil point at C is made to describe an ellipse by the rectilinear movement of the studs in the grooves. I believe this instrument was described in the *Mechanic* shortly before its absorption.—T. W. Boord.



[4504.]—ELLIPSES.—I suppose the cheapest and best to be "Cowper's Ellipsograph," made by Holtzapffel, because you can strike the curve (half at a time) with a pen at once, and its range is very large, compared with mine, which too, in its present state, is only fit for a pencil. Mine has advantages, for certain purposes, particularly for isometrical drawing, in which case, as in all others, any *true* instrument I ever saw, except mine, requires two separate adjustments, with the chance of double error, whilst mine only requires setting for the major axis by a scale attached, and the minor axis must be right. Mine would cost a great deal more than Cowper's to make. See p. 420 for description of mine; also letter No. 140, p. 448, for two other cheap plans, either of which does very well if you take care to have a long connecting-rod, compared with the throw of crank—say 12 times, or 6 times the diameter of circle described by centre of crank-pin. Other machines there are, of which I have one, which makes a half-bred sort of egg shape, but very near a true oval; made many years back, by the late Mr. C. of Halifax, who was a very remarkable instance of a self-made mathematician and mechanic out of a hand-loom weaver. I have seen, also, a parabolic compass by him, which is more extraordinary still. "Cowper's Ellipsograph" is on the trammel principle.—J. K. P.

[4511.]—WEIGHT OF BALL.—For the second query of Ralph Williams, it was not stated by any of the three answers, as it should be, that wherever we have to compare one round body with another, as a ball with wire, any reference to π or its parts, ·7854 or ·5236, is out of place, and indeed absurd, as the solution will be exact without them, and only approximate where they are used. His ball being 28 times the wire's diameter, its section is exactly 784 of the wire's section; so that a cylinder 7in. by 7in. would equal 784 times 7in. of wire, and the globe being ⅔ of the cylinder, is exactly 3658⅔in. of the wire.—E. L. G.

[4511.]—WEIGHT OF BALL.—Its content is ⅓ the product of radius and surface; and the surface = 4 of its great circles. A circle of 7in. diameter being nearly 22 round, has nearly 11 × 3½ square inches. Hence the surface of ball is nearly 154, and its content ⅓ of 154 × 3½ = 179⅔ cubic inches, = about 47lb. in cast-iron, or 50 in wrought. In the other question, as the circles are commensurable, that of 7in. diameter equalling just 28 × 28 of a quarter inch, a cylinder 7in. diameter and 7in. long would give 784 times 7in. of the wire; and the ball, being always ⅔ of its containing cylinder, will give ⅔ the above quantity, or 3,658⅔in. of wire exactly. When a ball's content only is wanted, 11-21 of the containing cube is near enough.—E. L. G.

[4512.]—REVOLUTIONS OF BLAST FAN. — The number of revolutions conveyed from one drum to another is inversely as the diameters of the drums. Thus, suppose the driving wheel or drum has a diameter of 6ft., and makes 40 revolutions per minute, and the diameter of the driven wheel is 3ft., we have 3 : 6 :: 40 : x. Thus x = 80, the number of revolutions of the smaller wheel. Of course, the number of revolutions will be much greater than this in the example proposed by "Ralph," but the principle is easily applied.—Exhibitioner at Royal College of Science.

[4512.] — REVOLUTION OF BLAST FANS.—The method I invariably take to reckon up revolutions of blast fans might answer Mr. "Ralph." I ascertain, in the first place, diameter of pulleys, likewise number of revolutions of first mover per minute. Then proceed, by simple proportion—viz, diameter of pulley on first mover divided by diameter of corresponding pulley. The quotient, multiplied by number of revolutions of first mover in a given time, gives speed of second mover or counter shaft. Again, diameter of transmitting pulley, divided by diameter of pulley on fan spindle, the quotient, multiplied by number of revolutions of second mover or counter shaft, gives the speed the fan is driven at. I have a model of blast fan, the principle of which is quite original, so far as I know. The two sides or cheeks are concaved two-thirds entire width of fan, with an aperture to admit air; said aperture crossed by a bridge on each side, for carrying fan spindle. The *curved* blades, formed to suit convex side of cheeks, are secured to a disc. The casing or periphery surrounding disc is placed excentric to same, with breakers crossing space at variable angles to relieve pressure off fan; the whole, connected by tie-bolts, with usual method for driving and discharge, needs no comment. Will any of my brother mechanics express an opinion on its merit?—Williams.

[4512.]—REVOLUTIONS OF BLAST FAN.—Let "Ralph" divide the diameter of driving pulley by diameter of smaller one, then multiply result thus obtained, by number of revolutions of larger pulley.—W. H. Thorpe, Reading.

[4513.]—HORSE POWER.—In this query the pressure of the atmosphere is excluded, as its action and reaction on the indicator is equal and contrary. Hence the formula $R = \frac{f\,s\,v}{33000}$ (1) is correct for non-condensing engines; and, $R = \frac{f\,(s + p)\,v}{33000}$ (2) is correct for condensing engines. But should the atmospheric pressure be included in the application, the formula $R = \frac{f\,(s - p)\,v}{33000}$ (1′) is correct for non-condensing engines and $R = \frac{f\,s\,v}{33000}$ (2″) is correct for condensing engines Lastly, since both pistons go at the same speed, the ratio of expansion $p\ \frac{26^2 + 15^2}{15^2} = \frac{4}{1}$. The Napierian logarithm of $\frac{4}{1}$ is = 3·7 − 2·3 = 1·4 + 1 = 2·4 × 60 ÷ 4 = 36lb. mean pressure throughout the stroke which, introduced in formula (1), will give the theoretic R.—R. D.

[4517.]—STAINING GUT LINES.—I think the best colour to stain gut lines is a kind of greyish green, but it is rather a troublesome process to undertake. Boil a cupful of black tea in a quart of water, allowing the gut to remain in till it has acquired what is called the "red-water stain," when it should be rinsed in cold water and allowed to dry. Then put a handful of logwood chips into a quart of water, and boil till the latter is reduced to a pint. Take it off the fire and throw into it a piece of blue vitriol previously powdered; stir until the copperas is dissolved, when the gut may be put in and kept there till it acquires the desired tint. It will not take many minutes, and the gut should be rinsed in clean water directly it is taken out of the dye. For a slate-coloured stain, which many prefer, a mixture of boiling water and ink is amply sufficient, always remembering to wash the gut thoroughly when the right tint is obtained. Gut can likewise be coloured by any of the aniline dyes sold at the chemists, but I think they might possibly injure its texture.—A. T., Staines.

[4518.]—MYROBALANS.—This is a fruit which grows in India, and is largely imported to Europe on account of the tannin which it contains. The myrobalan is of a pale buff colour, and resembles a slightly shrivelled plum. It consists of fibrous cellular matter enveloping a stone. It is hard and firm, and when beaten with a hammer breaks up into irregular fragments and a light-coloured dry powder. As myrobalans are cheaper than galls and stronger than sumac, they are rapidly superseding those articles. With preparations of iron they dye cotton stuffs a fuller black than can be obtained by sumac.—Dyer.

[4518.]—MYROBALAN.—A kind of dried plum brought from the East Indies, where it is used by the Hindoos in medicine and calico printing. It has an unpleasant bitter taste; produces with iron a durable black dye and ink, and with alum a dark brownish yellow.—T. W. Boord.

[4518.]—MYROBOLANS.—Myrobolans is a bitter fruit brought from India, and used by calico-printers, dyers, &c., for dyeing black and yellow.—Beacon Lough.

19.] —PHOTOGRAPHY.—Procure some good ben- place it in a plate and apply moderate heat until uite fluid, pour it into a cold plate and when quite it may be broken in pieces. Then dissolve 1oz. of ased benzoin in 8oz. of methylated alcohol and 20 a of sandarac. Then add 20 drops of mastic ish, made by melting gum mastic and adding tur- ne to it whilst in a fluid state. The impurities will settle, and it is ready for use. Should the varnish thick add more spirit.—H. J. KINGHAM.

20.] —PERCH FISHING.—I think the best time to for perch is from September to January in large deep es and ponds by the side of a river. There are bers of these in the Thames, and excellent perch ng is to be found near the paper mills at Temple, Marlow. Weirs are the best places in summer , but perch are not in first-rate condition then. re are several methods of fishing for them, and of se different kinds of tackle. I think the most suc- ful in the Thames is the method known as "pater- tering." Attach a lead to the end of a gut line about or 5ft. long, and about 8in. and 15in. above it two rt pieces of gut, about 4in. or 5in. long, with No. 8 hooks fastened so as to stand out at right angles. t with a live minnow or gudgeon—the hook put ough the upper lip. A longish rod, with a free-running , I have always found the best. I prefer the plaited lines myself, as those made of silk and hair "kink" quently and are very apt to hitch instead of running e; besides, they are not so strong as the plaited silk. en all is prepared, with the lead hanging 6ft. or 7ft. m the top of the rod, drop the line gently into the ter till the lead rests on the bottom. Shift the bait ery now and then; don't strike directly you feel a itch, but "bide a wee," and when you feel a second ack tighten the line, and give a sort of "lift," as the rch is rather a delicate-mouthed fish, and if you trike" hard you are apt to lose both fish and bait. rch generally swim in shoals, so if you succeed in nding one keep to the same place. There is another ethod of fishing for perch, which consists in baiting ith brandlings, and using either ordinary tackle or the ottingham style. A few broken worms thrown in now nd then will often attract the fish. In these methods t the float be carried well under before striking.—A. ., Staines.

[4521.]—EXTRACTING HONEY FROM THE COMB. —Cut the comb in pieces with a sharp knife so as to ivide all the cells, and place the pieces in a colander ver a basin or jar to receive the honey as it drains off.— . W. BOORD.

[4522.]—PURE CHARCOAL.—I am rather puzzled by r. Ibbotson's query. Does he mean what we, as hemists, call pure charcoal, or what druggists sell as uch—a very serious difference? Pure carbon is almost mpossible to obtain, except in the form of the diamond, ut a "pure vegetable charcoal" is made by carboniz- ng willow or other wood in an iron retort. I imagine "What kind of fire and hot plate is pure?" must refer to this. For such a purpose, with an iron retort fitted with an exit sufficient only to give vent to the gases, any fire will do, but the purest fire in ordinary use is a spirit lamp. For small quantities a piece of gas-pipe, plugged at one end and partially closed at the other, would serve. N.B.—The "purity" of the charcoal is a superstition, and has nothing to do with the effects.—SIGMA.

[4524.]—STEAM JOINT.—"Schemer" will overcome the difficulty he has experienced in obtaining a perfectly tight joint by having a joint made exactly like a universal swivel of a gas bracket. He can bring the boiler nearer to the engine, or *vice versa*, by a telescopic joint made secure by a stuffing-box.—D. CLARKE.

[4528.]—CARVING AND TURNING SOFT WOOD.— For external surfaces use the gouge and chisel. The insides of boxes, &c., are shaped and finished with what are called hook-tools; their form varies with the taste and requirements of the operator, and considerable practice is necessary to use them properly. The screws are cut with a rough kind of traversing mandril. The tools used for carving are small gouges, chisels, &c., of various shapes and sizes.—T. W. BOORD.

[4529.]—CHAIN ADJUSTMENT TO COMPOUND MICROSCOPE.—This is a very simple and efficient movement, and consists merely of an endless chain working round two pulleys, one of which is furnished with a milled head. The chain is fixed to the "body" of the microscope, midway between its extremities, and also between the pulleys. "S." will easily comprehend its working from this brief description. If not, let him devise the working of a ship's rudder by the "wheel"—the *principles* are the same. As regards its accuracy: I will focus a 1-12" with it, and do nightly use an ⅛" without difficulty. So far as *focussing* is concerned, the fine movement may be dispensed with where the chain movement is used, but the fine movement, if *well* made, is useful for micrometrical purposes, and should always be applied where expense is not of vital importance.— H. P.

[4539.]—CHIMNEY.—If you build a chimney for four large boilers and determine to have a good draught, choose any form—round or octagon is the best—let it be 40 to 50 yards high, 5 yards in diameter at the bottom, and *parallel inside*, most decidedly, all the way to the top.— WAHSROF.

[4540.]—MOUNTING PLANE MIRROR IN REFLECTING TELESCOPE.—Mr. A. White's plan would fail. Herschel shifted the optical axis of his telescope parallel to the tube, and so brought it close to the side. Mr. White shifts his angularly within the tube, which will have no other optical effect than he could get by shifting the tube with the mirror. If he will consider his picture he will see that, without some as yet unknown virtue in the tube itself to force the mirror only to show objects towards which the *tube* is directed, he would only see just such objects as lie in the direction of the axis of the mirror; and very little of them, since he gets the tube (the lower half in his figure) in the way, and only the extreme upper edge of his mirror (as shown in the figure) would be available to form an image.—R. A. PROCTOR.

[4543.]—TORTOISE-SHELL COMBS.—The edges of the fracture should be scraped smooth, so as to overlap each other, and *freed from grease*, then dipped into hot water to soften them, pressed together with hot tongs, and lastly, plunged into cold water till hard again.—T. W. BOORD.

[4546.]—LATHE, &c.—TO "BIERLALA."—If you are limited to three rows of divisions, I think 180, 96, 84, are perhaps the best. I am strongly in favour of a row containing 11, 13, 17; also 19 and 14, if your diameter is sufficiently great, else the 6th and 7th of the 17 row come too close to the 9th and 10th of the 19 row, unless your holes are extremely small. Less than 7in. diameter will scarcely hold them. I have this very day done the fitting of my new double bearing mandril, and got the loose collars and nuts into their places. It is a first-class job for a good hand, and I think very few amateurs would venture to try it—*single-handed* I mean, of course. My hardened fast-collars are coned with the slide rest set 1° taper for the inside of collar, and ½deg. or 30min. taper for the outside of collar and the inside of cast-iron fitting. I do not shrink the collars in by heating the casting, but I put a strong bolt through the hole in the collar, to draw it into its place, and assist its progress by blows of a heavy mallet, while tightening the nut, each collar separately. Do not put one long bolt right through from front to back, or you may break your casting, unless indeed you put a good stout prop in to support the train. Your "35°" in the last line appears to be a misprint. The *loose* collars fit tight on to the cylindrical portions of the mandril, and are adjusted by screw nuts. I do not intend to have the work japanned, as I have *heard* of collars being tempered or losing some of their hardness through excess of heat employed. Mine are as hard as I could make them, and not tempered at all.—J. K. P.

[4546.]—DIVISION PLATE.—The numbers of the division plate which I find most useful are

$$\text{divide into differences}\ \frac{720\quad 360\quad 200\quad 144\quad 120\quad 112\quad 96}{15\quad 14\quad 6\quad 6\quad 11\quad 6\quad 8},$$

(I may add that Edwin Baker, of 14, Mount-row, Berkeley-square, London, issues a list gratis of the "Ready Reckoner for the Dividing Plate;") but there are also found useful for some amateurs who do very fine work these numbers, say—

$$\text{divide into differences}\ \frac{180\quad 136}{8\quad 4}$$

and Holtzapffel's lathes, to some of them were put these individual numbers, 221, 209, for very fine rings or flutes, when you use them all. The other parts I cannot reply to.—WAHSROF.

[4547.]—A FIELD OF BARLEY GROWN FROM OATS.—I think this matter is referred to in "Vestiges of Creation," but has been little discussed; if true, as it most likely is, it is an illustration of "natural selection," and its cognate doctrines, showing how natural species are formed and modified by surrounding conditions.—SIGMA.

[4547.]—A FIELD OF BARLEY GROWN FROM OATS.—"S. G." will find, in the "Vestiges of the Natural History of Creation" (see p. 144, Ed. 8, 1850), the following much earlier mention of this subject:—"It is now fully ascertained that the various bread-forming grains, wheat, barley, oats, rye, are resolvable into one. If wheat be sown in June, and mown down so as not to be allowed to come to ear till the next season, the product will be found to consist partly of rye or some other of the cereals. Oats have in like manner been transformed into rye, barley, and even wheat. Till a recent period, this phenomenon was doubted; but it has been tested by experiment, and reported on by so many credible persons, that it can no longer be rejected. And it appears that poorness of soil has the same effect as mowing down. One observer states that, in a field of wheat, near Lucerne, he saw ears resembling barley, but with grains similar to rye, *growing from the same stem with ears of wheat*." The author refers to the *Gardeners' Chronicle*, 1846, pp. 118, 102, and August and September, 1844; also *Mag. Nat. Hist.* new series, i. 574; and *Rep. Roy. Soc.*, 1846, p. 381.—W. P.

[4548.]—IMMERSION LENSES.—These lenses possess the great advantages of being easy to work, and of possessing greater "penetration" than a "dry" lens. Their price will vary from £8 for a German 1-16in. to £50 for an English 1-50in. of first-class make. If "M. J. C." be a young beginner, and is contemplating the purchase of an "immersion," let him take to heart *Punch's* advice to persons about to be married—"Don't!" He will find an English ¼in. answer all his requirements for some years. If he be an experienced microscopist, he cannot do better than read up the *Microscopical Journal* for the present year and form his own conclusions as to the suitability of this kind of lens to his requirements. Any of our leading makers would show him their working. An English ⅛in. may be purchased for about £4, but I question the utility of applying the immersion principle to lenses of these long foci.—H. P.

[4552.]—AVIARY.—The best time for purchasing birds to keep in an aviary is the fall of the year, now rapidly approaching. This of course applies to such birds as the bullfinch, chaffinch, linnet, greenfinch, reed-sparrow, yellowhammer, &c., which are more likely to live when taken in the autumn. Canaries, being bred under domestication, may be obtained at any time, and are undoubtedly the best birds for aviaries. If "Rebaf" purchases any, let him get the Norwich birds, or the Yorkshire—German ones seldom live more than two years in this country. Goldfinches are also excellent birds to keep, whether on account of their song or their hardiness. Some of them will pair with canaries, producing what are known as "mules," probably the best song-birds known in this country. The siskin is a pleasing bird, with a peculiar song. It much resembles the goldfinch in form and habits, but its notes are inferior, although it sings from the early morning to the late evening. It is very hardy and often lives eight years in a cage. The linnet, of our field birds, is perhaps the sweetest songster, and if taken about October will soon become tame. If taken in the spring it is not likely to live long in a cage; besides being an extra cruelty, as most of them have either young or eggs at that season.—S. G.

[4554.]—PENDULUM.—Your correspondent "Vibrator" has discovered a "mare's nest." He wishes to know "why a clock should gain time by raising the bob, as by the law a longer swing should be accomplished in the same time as a shorter one?" the law being, as he says, that a weight suspended by a silken cord will move in unequal spaces in equal times. In so far as the law of pendulum motion, he is in a sense correct, although stated in such a common-place manner. Yet he fails to see that the unequal spaces do not refer to the length of the pendulum, but to the length of its swing,—that is to say, that a pendulum may vibrate in an arc of 7° or an arc of 4°, and its oscillations be isochronous or nearly so. The raising of the bob shortens the centre of oscillation of the pendulum, and thereby shortens the time of its swing, but makes no alteration in the time it takes to oscillate in a large or small arc of a cycloid, or in a small arc of a circle. Your correspondent should read "Clock and Watchmaking," by E. B. Denison, M.A.—ELECTRO-MAGNET.

[4554.]—THE PENDULUM.—"Vibrator" is in error respecting the pendulum. The following are among the laws of the instrument:—1. *At the same station*, pendulums of the *same length* move through *cycloidal arcs*, whether long or short, in the same time. Common pendulums, which oscillate in *circular* arcs, *practically* possess this property when their arcs do not exceed 5° or 6°. 2. The times of oscillation of pendulums *of different lengths*, vary as the square roots of this length. Thus, if at the same station, one pendulum be four times the length of another, it will take twice as much time to make its oscillation; if nine times the length, thrice the time; and so on. If, therefore, the bob be raised or lowered from any cause, the clock gains or loses accordingly; and hence the necessity for compensation pendulums.—W. P.

[4563.]—BRASS COIN.—This is a jetton or counter of the time of Queen Anne. They were used for calculating. The word "jetton" is derived from the French verb *jetter*, to throw or cast; hence to *cast up* an account.—T. W. BOORD.

[4567.] — MATHEMATICAL INSTRUMENTS. — Broken instruments are hardly worth repair. The plates are steel and brazed in, and could hardly be got out. Excellent French and Swiss cases of instruments are to be had for a song at the second-hand shops. A friend of mine bought a splendid set some time since for 30s., but there seems a prejudice against them. The pens are never so good as Elliott's, but whose are?—J. K. P.

[4570.]—A LEGAL POINT.—Your querist "Ironmonger" does not give any hint as to what part of the three kingdoms the county is situated in which he carries on his business; and as the law regarging the dealing in second-hand goods, old metals, bones and rags, differs so essentially in England, Ireland, and Scotland, and there are besides so many local acts in various towns, that it is almost, if not quite, impossible to give him a satisfactory reply. When he writes again, giving his *locus*, I may then advise him on the legal point. In the mean time, my advice is that he do not trust to the *dictum* of any "common" policeman, but go to head-quarters and see the inspector or superintendent, and ask to see the Act under which their subordinates are acting as to the matter of buying or taking old metal in exchange; and I have no doubt either of these gentlemen will have the courtesy (as I would) to show their authority for the restriction; and if there is an act, your correspondent on reading it can judge by his own common sense whether the local guardians of the peace and public morality have misconstrued the meaning thereof, or are otherwise acting capriciously towards him and others who may also be so circumstanced.—ELECTRO-MAGNET No. 1.

[4570.]—A LEGAL POINT.—In the 32nd and 33rd Vic., cap. 99, 'The Habitual Criminals Bill,' sec. 17, it is enacted:—"Any dealer in old metals, as defined in the Old Metal Dealers' Act, 1861, who shall either personally or by any servant or agent purchase, receive, or bargain for lead, whether new or old, in any quantity at one time of less weight than 112lb., or who shall personally or by any servant or agent purchase, receive, or bargain for copper, whether new or old, in any quantity at one time of less weight than 56lb., shall be liable to a penalty of £5, to be recovered in the same manner as penalties incurred under the said recited act are therein directed to be recovered." It is evident from this that the police have informed you correctly, you being a person dealing in such metals.—THOMAS POWLSON.

QUERIES.

[4572.]—GEOLOGICAL.—Near Malvern are some limestone quarries. Can any of your numerous correspondents inform me to what formation they belong?— PHILOSOPHER.

[4573.]—METHYLATED SPIRIT.—Can "An Associate of the Royal School of Mines," "Beta," or any other reader of the ENGLISH MECHANIC, inform me if there is, *at times*, any difference made in the quantity and quality of the wood spirit which is added to the spirit of wine? Some samples I have succeeded in freeing from the smell of naphtha, others I cannot by the same process.— M. M.

[4574.]—PARAFFINE OIL.—Can any brother reader of the ENGLISH MECHANIC inform me if there is any mixture that can be added to inferior paraffine oil to cheapen and improve it for burning in lamps?—A POOR MECHANIC.

[4575.]—ENAMELLING WATCH-CASES.—Will some other reader kindly inform me how enamelling is done on the backs of gold watch-cases, &c.?—E. J. R.

[4576.]—BLACK BRASSWORK OF MICROSCOPE.— Will some of our kind readers inform me what the inside of the tubes and other parts of the brasswork of microscopes and telescopes is blackened with? If they would give a short description of the process it would oblige.— J. HAINES.

[4577.]—INDUCTION COIL.—TO "SIGMA."—I want to make an induction coil, and feel rather bothered with so many plans of construction that have been recommended. "Inductorium" stated lately that the greatest inductive effect was at the centre of the coil, and *nil* at the two poles. Is it so, or not? If so, a partition in the middle of the coil would cause a loss of the best part of the electro-magnet. Will paper, soaked in paraffine, answer as well as gutta-percha tissue to insulate the layers? and how much would be required? But if "Sigma" would give a working description of what he considers the *best plan* of coil to give a spark 3in. or 4in. with 4 Bunsen's cells, he would oblige.—OPERATOR.

[4578.]—STRETCHING GUT-BAND.—Is there any way of permanently stretching a new gut-band 2in., which is about 8 yards long, and ¼in. in diameter?— T. E.

[4579.]—DUTIES OF GAS ENGINEER.—I should feel obliged if "Sigma" or some of your other correspondents would give me some information concerning the duties of a gas engineer. What books ought to be studied, &c.? Is there any drawing, and what kind?—Graham.

[4580.]—PLAN OF AVIARY.—I want to make an open aviary, so that I can divide it into two or three breeding compartments, or several smaller ones. My greatest difficulty is to feed and clean them when the divisions are in without having it unsightly when they are out. I do not mind a little trouble, as I am pretty handy at wood or wire work.—J. H. P.

[4581.]—LINK MOTION.—Will some reader be good enough to send a sketch showing the action of the link motion?—R. W. B.

[4582.]—GOLD LEAF.—Will some of your readers kindly inform me how gold-leaf books are prepared in gilding so as to prevent the tendency of the leaf to fly about? I have seen gilders use them for out-of-door work. The leaf sufficiently adheres to the paper to make it firm until it touches the gold size, to which it immediately becomes attached, leaving the paper quite clean.—Chemicus.

[4583.]—HALSE'S BATTERY, &c.—Perhaps "M. D." or some other reader of "our" Mechanic, will give a description of how this machine is made. I have also some carbon dust that I want to make into blocks for a Bunsen battery. Will some reader tell me how to proceed to make them?—Northumberland Subscriber.

[4584.]—MANGANESE BATTERY.—Will Mr. Jarman be so kind as to state how many quart size cells of his manganese battery are equal to a one-quart Bunsen battery?—Northumberland Subscriber.

[4585.]—AMBER MOUTHPIECE.—Can any reader tell me how the amber for mouthpieces is softened, so that it can be bent or made pliable?—One of the Oldest Subs.

[4586.]—WORKS ON COTTON.—Can any of your readers (particularly those interested in cotton spinning) give me the name and price of a good work on the cotton plant? I want something of this sort: a work that has plates of the plant, showing the leaves and flowers, also the pods in their various stages; also of different sorts of plants, such as American, Egyptian, Sea Islands, Surinam, Surat, China, &c. If it had the plates coloured, it would be better. I have seen, sometime since, somewhere a drawing of the various lengths of staples of cotton, from the longest to the very shortest, printed on paper, the paper being all black, and the cotton white, and numbered.—A Cotton Spinner.

[4587.]—HARMONIUM.—Will Mr. Hermann Smith tell me if I can remedy the following defect in my harmonium?—All the notes in the bottom octave, with the exception of G and B flat, are very slow in speaking, while all the rest, four octaves, are very good. It makes it very annoying when playing. The tone is remarkably sweet and good.—J. T. Hill.

[4588.]—TELESCOPE.—Will black varnishing the inside of a terrestrial telescope improve its illuminating powers, or will it do harm?—J. T. Hill.

[4589.]—TENDER FEET.—Are there any means of making the feet less sensitive so as not to cause blisters in the course of a podestrian tour?—J. T. Hill.

[4590.]—TOWN GARDENING.—I have, in a large factory town, unsuccessfully endeavoured to grow geraniums and fuchsias; I attribute it to the absence of the sun's rays, and to having gas in the house. I should like to know what plants will grow and flower under these conditions—whether they are annual or not—or whether they are grown from seed or not. I also wish to grow a few hardy plants in boxes on the window-sills outside. I wish to know how to rear them from seed, and the best sorts for growing in the shade.—A Factory Lad.

[4591.]—EGG-BOILER.—Will any brother reader send me a sketch of an egg-boiler fitted with steam jacket, and tell me the cost of fitting one about six horse-power?—Improver.

[4592.]—TEETH OF CHANGE WHEELS.—Will "J. K. P." please to tell me how the teeth of change wheels are struck out? I know how to strike out the epicycloidal form of tooth for wheels that always remain the driver or the driven, but do not know how they are formed when the wheels have to be changed, as on the screw-cutting lathe.—C. C.

[4593.]—PIANO PINS.—TO "W. T."—I beg to tender my thanks to "W. T." for his answer to my former query respecting piano pins, and also to ask him another. I find said piano will not "draw up" within a semitone of the pitch without breaking. Can "W. T." tell me what to do under the circumstances? Can he tell me what sizes of wire to use, and if anything else is the matter?—Man of Necessity.

[4594.]—GOMA OIL.—A German review says:—"The Japanese colony, near Pliersville, in California, has lately cultivated with success an oleaginous plant, belonging to the nettle order, and called *Goma*. The small seeds, enclosed in the capsule, are so rich in oil that the yield of one acre is estimated at 186 pounds of oil. The plant requires much watering, and it is hoped that by artificial irrigation, three crops annually may be obtained. The young sprouts are excellent as salad, the flowers give a rich food for bees, and the fibrous stem will probably be useful in textile fabrics. Goma oil, well refined, is equal to the best olive oil; has a very slight tendency to become rancid, and probably might form a substitute for olive oil in all technical employments. This oil can be got in Germany from MM. Secger and Mäur, in Dresden." Does any brother reader know some more particulars about this plant, its botanical name, &c.? I find *Hoi-mwah* for a Chinese name of *Cannabis sativa*. Might not Go-ma proceed from that word?—Bernardin.

[4595.]—HOUSES FROM STRAW AND WATER-GLASS.—Is it true that houses have been constructed in England the principal material of which was bundles of straw impregnated with water-glass or silicate of soda? Some particulars might interest several readers. —Un Abonne.

[4596.]—JAPAN ISINGLASS.—Is this substance employed for any purpose in industry?—J. I. G.

[4597.]—INDIAN COIN.—Will some kind brother reader inform me from what country is the following copper coin?—Obv.: an elephant, and above, the letter B in Indian character. Rev.: an Indian or Arab inscription. The coin is rather thick and somewhat larger than a farthing.—J. N. D. C.

[4598.]—CRYSTALS IN GREENHEART WOOD.—What are the acicular, gold-yellow, brilliant crystals found sometimes in Turkish oak or greenheart wood? Might it not be *Bebeerine*?—Greenheart.

[4599.]—EFFECTS OF CARBONIC ACID.—I shall be glad to learn through your columns what proportion approximately of carbonic acid gas (the deadly product of our coal-mine explosions) in atmospheric air is fatal to human life? Also what smaller proportion would have the effect of producing only insensibility in the victim?—A. St. Vincent.

[4600.]—PRINTING IN GOLD OR BRONZE.—Will any reader tell me how I can print some cards with gold or bronze ink?—Amateur Typo.

[4601.]—GILDING BOOK EDGES.—How can I gild the edges of some books I have just bound?—A. H. D.

[4602.]—MELTING GLUE.—Will any of our cabinet-maker readers tell me how to melt glue properly? I mean so that I can keep it in the glue-pot and re-melt just as I want it.—S. N. R.

[4603.]—FISHING.—Where can I catch small fish that will do to put in an aquarium, such as bleak, stone-loach and gudgeon.—E. Jamieson.

[4604.]—PICRIC ACID.—Can any of our chemical readers tell me what is picric acid, and how I can detect its presence? It is said that it is used to give a bitter taste to beer.—S. H. B.

[4605.]—PROPELLING A VESSEL BY A WINDMILL.—May I beg some subscriber to inform me whether it is possible to propel a vessel, *head to wind*, by means of a windmill working a fan or screw? A statement to this effect appeared in the *Illustrated London News*, some weeks since, accompanied by a drawing.—Thos. C. Burton.

[4606.]—BRONZING IRON IN PAINT.—Can any of your readers inform me how to bronze ironwork in paint?—C. H.

[4607].—ORGAN BUILDING.—Will some kind correspondent inform me how I can make wood pipes (stop diapason) speak a little *louder*? Also, how can I harden brass wire, so that it will be adapted to make springs for organ pallets?—W. Porteus.

[4608.]—FRICTION: HORSE POWER.—Will some reader state the amount of friction (in pounds) to be overcome by a horse in drawing a load of one ton on a level road, made as follows?—1st. On granite pavement. 2nd. On a broken granite surface. 3rd. On a gravel surface. The two last supposed to be level surfaces. Also what amount of traction (in pounds) is required to draw a ton up a gradient of 1 in 20? Also, how many pounds of force is a horse calculated to exert?—W. B.

[4609.]—AIR-GUN.—TO "T. A."—On p. 499, Reply 4044, "T. A." gives a very clear explanation of the lock of air-gun. Would he kindly give sketches necessary for the construction of an air-cane, with directions showing position of air chamber, valves, charge, &c.?—A. Hunter.

[4610.]—SHUTTERS.—Will any of my fellow millers tell me if the shutters in a patent sweep (on the lead side), should be at the point or heel of the sweep, the rest of the lead side being board? I have an idea the shutters should come down, say two-thirds of the way, and the rest made up as a lead board at the point.—One Eye.

[4611.]—POLISHING VULCANIZED INDIA-RUBBER.—Can any reader inform me how to get a perfect surface on vulcanite for polishing, and what powder, &c., will produce the finest polish on black vulcanite? I have a lathe and circular brushes for it; would cotton brushes be any better than hair ones?—G. N. L.

[4612.]—PORTABLE MILL.—I am much obliged to H. W. Reveley for his reply to my letter. I thank him much for telling me of Smeaton's work, of which I had not known. There is only one thing I need remark on in his letter. He seems to think that the slow motion of the horizontal mill is a great drawback. It may be for some things, but this slow and powerful motion is just what is wanted for other things, *e.g.*, for agricultural purposes, such as Mr. Vallance applied his to; and this, as he says in his letter in the English Mechanic, was capable of drawing seven ploughs, and had arms only 12ft. long. Surely this was "*useful* work," and yet to perform it there was needed no "formidable train of wheels and pinions." If I wanted a mill to turn millstones I should give Mr. Reveley's plan a trial; but as I want a *portable* mill it would not suit. While on the subject, would Mr. Reveley or any other correspondent give a plan for draining a marshy field by wind power? In "Mechanical Movements," No. 259, there is something like what I want, but the *worm wheels* would be difficult to get made here; and, besides, the form of buckets given would not suit, as sand and mud would have to be lifted out as well as water. The land I want to drain is near the river, from which it has been embanked; it is too flat to allow of sufficient fall for the drain. I would sink a well near the embankment, and over this mount the windmill; but whether a horizontal or vertical one would suit best I do not know. For an endless band, with buckets attached, the vertical would be best, I should think. If any practical man will kindly give me an answer I should be much obliged.—Derf Errac.

[4613.]—TREE STUBBER.—Will some one please describe a machine for pulling out the stumps of trees? There is an American machine worked by horse-power. The principle is, I believe, a powerful screw. Particulars would oblige.—Derf Errac.

[4614.]—ELECTROLYSIS.—Will "Sigma," or "Ignorant Irishman," or any other subscriber, kindly say whether electrolysis, such as electrotyping and decomposition of other substances, can be effected by the aid of a magneto-electric machine? An answer through the Mechanic will oblige.—Transparient.

[4615.]—SEWING MACHINE ATTACH[illegible] any of our readers tell me the best form of [illegible] for a shuttle sewing machine; likewise [illegible] make a marker, or creaser, as used in [illegible] &c.; and how to form and fasten the [illegible] I believe is attached to presser foot of [illegible] cording? Diagrams would oblige.—[illegible]

[4616.]—PROBLEM.—Will "C. H. [illegible] din" be good enough to solve the [illegible] of 100lb. is resolved into two equal [illegible] angle of 135°; find magnitude of [illegible] Amicus.

[4617.]—QUERIES ABOUT OIL[illegible] fellow readers of the English Me[illegible] following information?—1st. What [illegible] rendering linseed-oil siccative, [illegible] litharge or other salts of lead? The [illegible] boil the oil with litharge, but this [illegible] a colour for my purpose. 2nd. Is [illegible] being transformed into as quickly dry[illegible] seed, and whether it is subjected to the [illegible] linseed-oil to render it siccative? 3rd. [illegible] line spirit," now sold at the oil-[illegible] purposes, the same substance as the [illegible] chemists in small bottles, under the nam[illegible] collas," and used for cleaning, &c?—J. T.

[4618.]—MANAGEMENT OF BEES.—I [illegible] obliged if you or a brother subscriber [illegible] on what principle, and how the feeding-bo[illegible] are constructed. They are made so that the [illegible] escapes from the bottle as fast as the bees [illegible]. I cannot find out how it is made. I should be [illegible] if some one would tell me how or where I can [illegible] of the honey, and what is the price per lb. [illegible] I must say I was glad to see the subject of bees in the Mechanic, for I think it is a subject that many take an interest in, and if a brother subscr[illegible] some other, would give some information on the [illegible]ment of bees in a series of letters, I think they [illegible] interesting and useful to a great many subscr[illegible] Thos. Poulton.

[4619.]—HARD WHITE METAL.—Can any co[illegible] spondent tell me how to make the hard white metal [illegible] is sometimes used for models? I have seen [illegible] brackets, &c., of working models cast with this meta[illegible] and want to cast some with it, not having the means to do it with brass. I think it is run down in the ladle over the open fire. Please state if it is any use for [illegible] —Hammerman.

[4620.]—EMERY STICKS.—I see an answer about emery wheels by "Matrix." Will he please tell me how emery sticks are made? I am told they are made with shellac and mineral naphtha, but do not know the proportions nor the *modus operandi*. An answer will oblige.—Hammerman.

[4621.]—CHLORIDE OF GOLD.—Will any of our numerous subscribers please inform me how the above is manufactured, as I have some old gold I wish to make into the chloride?—Young Photo.

[4622.]—NITRATE OF SILVER.—I have a silver solution which I use for electro-plating. How can it be again converted into nitrate? Must it be crystallised, fused, and redissolved in nitric acid?—Young Photo.

[4623.]—HORNS.—I have a few specimens of polished cows' horns: would any one give me a recipe for keeping them a good gloss?—Working Man.

[4624.]—PENDULUM SPRING.—I shall feel extremely obliged to "Seconds Practical Watchmaker" if he would kindly answer the following questions, viz.—How to tell the proper length and strength of a pendulum spring. How to tell the pallets and lever depths in the depth tool, and likewise to tell when they are correct when uprighted and in the frame. How to do the adjustment and tell when it is correct, and how to tell when the fusee chain is the proper length.—You[illegible] Jobber.

[4625.]—FLUORINE.—Can "Beta" or any co[illegible] spondent, inform me on what grounds the table at [illegible] Kensington, quoted by him, p. 449, reckons Fluo[illegible] among the normal constituents of our bodies? It dif[illegible] from the other thirteen in the table by not being [illegible] to be ubiquitous in the mineral world. Thus, as [illegible] is known in the home counties, the question would arise if fluorine be necessary to us, whence do Londoners [illegible] it? It is remarkable that only fourteen elements are ubiquitous on earth, and thirteen of these, according [illegible] the table, are necessary to man. Only one of the[illegible] *Aluminium*, has not been found in his body. [illegible] about the fourth most abundant in terrestrial [illegible] and though alum is taken as medicine, and in [illegible] E. L. G.

[4626.]—TUNING BELLOWS FOR HAR[illegible] REEDS.—Will any fellow reader be kind enough [illegible] me a description of the bellows used in tuning [illegible] as requested on p. 287, *ante*? A diagram would be [illegible] —Reed Tuner.

[4627.]—DISCOLORATION OF LEATHER.—Can [illegible] reader give me any information on the following[illegible] have been pressing some leathers into a shape, but after remaining in the presses all night, that they may retain their shape, I find them nearly black. I soak them in water before pressing, and the presses are made of [illegible] What I want is to get them as near to the colour after pressing as they were before, also a quicker way of hardening them, if possible, than by allowing them to remain in the presses all night.—G. A. G.

[4628.]—COILS.—If any reader of your journal has made a coil from the instructions given in "Dyer," will he please state his experience and what difficulties were found to arise?—W. J. P.

[4629.]—MANGANESE BATTERIES.—I have the specification of the patent of the "Leclanché" battery, and wish to ask if any of your readers can enlighten me on the subject. The battery consists of two parts—the generator and accumulator—the former being really the battery, but the accumulator I cannot understand. It has two plates of carbon, one of which is in a porous pot. The patent is No. 2,623, 10th October, 1866, patented in the name of Brandon. The price of the specification is 8d. I also wish to ask in what number Dr. Stone's maganese battery is described.—Viator.

[4630.]—COACH PAINTING.—Will any of our brother readers be kind enough to inform me if there is a bo[illegible] hed on coach painting, and where it is to be bought robable cost? And if there is no such book, will me be kind enough to give me instruction as to de of procedure in coach painting?—An Old Sub- R.

1.]—LATHE QUERY.—TO "J. K. P."—I return s to "J. K. P." for his prompt reply to my query Will he please refer to page iv. of the last number of the English Mechanic? He will there see an rated advertisement of a lathe by Greenwood ers; my head stock is like that one, and back- d; the mandril running in two collars; the bed has with saddle and brackets, to carry screw, same as ration, with swing plate. I wish to fit it to carry ddle backwards and forwards, while the lathe is ng. I find there is 8in. from centre of mandril to of leading screw; will wheels of the 12 pitch do, fitted, with backward and forward motion? Now, many threads to the inch, and what diameter for g screw? The one you mention—8 threads and left- d—would not do in this case, I should say. P.S.— uld like to see his 5in. head stock, but my place of nce is 150 miles from London, which place I should his abode.—H. Williams.

32.]—WEIGHT OF BALL.—Would "Ferrum," in y to my question on the weight of ball, oblige me by working of the sum, as I think he has omitted a in reference to obtaining the weight of a yard of round wire? I don't think he will obtain it simply n multiplying the square of diameter by ·7854, and I not see that to divide 50 by 5 gives 100.—Ralph lliams.

633.]—WEIGHT OF METALS.—Would J. Nash also ige me with the name and publisher of a good prac- l work on the weight and strength of metals gener- y, and with the rules for obtaining the same? How es he find the cubic content of the ball to be 179·5948, d where does he get his decimal ·5236 from in the rmula $\frac{7^3 \times \cdot5236 \times 7645}{1728 \times 16}$? Am I to assume that the me (Hutton) in brackets is the name of the publisher om which he gets his information; if so, would he lige me with the price and particulars? By "Fer- um's" rule there is a difference of 8lb. in the weight of st-iron ball to that of J. Nash's, so I am not exactly a position to decide which to accept, and would be rateful to J. Nash for information respecting the book. -Ralph Williams.

[4634.]—ELECTRIC CLOCK.—May I ask Dr. Stone, ho so amiably, some time ago, described the manganese attery with which his electric clock is worked, add to e obligations we are under to him, a short description f his time-piece, which, I am glad to learn, is giving him o much satisfaction? I think, a considerable time ago, similar request was directed to your readers generally, ut met with no response, except in the "Editorial Correspondence Column," in which was described an arrangement of electric clocks, under what is known as he *remontoire* system, and one of which was, I believe, exhibited in the Great Exhibition of 1851, but there must have been many improvements made since. I understand there is description of such clocks in the earlier volumes of your journal; but as I only go back to Vol. V., they are as hidden secrets to me. Many thanks to your learned correspondent "Sigma."—Electro-Magnet, No. 1.

[4635.]—WATER' COLOURS.—Can any one give me the process of making up pigments into cakes for water-colour painting?—D. G.

[4636.]—INCUBATOR.—I want to make an incubator. By referring back to Vol. X., No. 288, page 108, I find a sketch of one by Mr. J. Pinchen, but not having seen one of any kind, and being entirely ignorant of their principle and construction, I am unable to understand it from Mr. Pinchen's very brief description. If he, or some other correspondent, would make me understand it, I should feel greatly obliged. What is the use of the glass case E, and how is the *mother* D made? How many eggs does each drawer A hold, and what are they placed upon? Are they wooden or zinc drawers? Is there an opening at the end for the chicks to escape through to the *mother*, and do the black dots in the outer end represent *air-holes*? Is the lamp-chamber open all through to the glass case? Of what, and how, are the *moistening-drawers* constructed and connected with the egg-drawers? Is the zinc *boiler* entirely hid from view with the woodwork, and is there no danger of steam bursting it when corked up? What is the best kind of *lamp* to use, and what degree of heat is necessary? What are the dimensions of the different parts of the incubator?—Robin Hood.

[4637.]—FLEXIBLE CEMENT.—Could any of your correspondents suggest a flexible cement, in place of the india-rubber solution, for uniting cloth and india-rubber; something that could be kept ready for use, dry quickly, and resist moisture?—Parvus Puer.

[4638.]—SILK WINDING.—How ought the silk of the silkworm to be wound so that it can be sold? Ought each cocoon to be wound separately, and tied up as one skein; or should the second cocoon be started where the first left off, and so on, until the skein is a large one? Or should about a dozen or so be wound together, so that the ends shall be together, and then tied up as one skein?—C. H. Bolton.

[4639.]—DYEING WOOL AND YARNS.—Will any of your correspondents kindly inform me if there is any book on dyeing wool, &c., and scouring yarns, &c.?—N. E. W.

[4640.]—SOUTH KENSINGTON EXAMINATION PAPERS.—Would any of your kind readers be so kind as to tell me where I could get 4 South Kensington Examination Papers? Subjects:—

Organic	Chemistry—	1st, or Elementary	Paper,	1
"	"	2nd, or Advanced	"	1
Inorganic	"	1st, or Elementary	"	2
"	"	2nd, or Advanced	"	1

I have found it an utter impossibility to get them about this neighbourhood—Heckmondwike, Yorkshire. By inserting this you will oblige a triple subscriber.—J. B. H.

[4641.]—MILL BILLS.—Can any one inform me how to harden mill bills, for I cannot get them to stand?—R. D.

[4641.]—GAS-HOLDERS.—I have a very leaky gas-holder; it leaks at the rivets and all round the angle. Can any one tell me the best cement to use that would stop the leakage, and would be lasting? I have put red and white lead round, but it is not effectual; or would it be safe to caulk it the same as boiler-makers would, while it is full?—R. D.

[4643.]—METERS.—Can any one explain this?—When we are cleaning our purifiers our meter travels backwards. It has indicated 1,000ft. less, although we have shut the centre valve.—R. D.

[4644.]—CORN FLOUR.—Will some fellow-reader kindly inform me the process by which "corn flour" is manufactured from Indian corn (or maize), also from rice?—Josiah R. Neane.

UNNOTICED QUERIES.

In future, if any query remains unanswered for four weeks, we shall insert the number and subject of the query in this list, where it will remain for two weeks, if not previously replied to. We trust our readers will look over the list, and send what information they can for the benefit of their fellow-contributors.

Since our last "Current" has answered 4131, 4161, 4196; "Augustus," 4174, 4196; "E. L. G.," 3949, 4190; "Sergius," 4170; "J. K. P." 4172; "Reed Tuner," 3934.

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USEFUL AND SCIENTIFIC NOTES.

REPAIRING LEAKY ROOFS, Etc.—The following is said to answer well in mending roofs that leak, and for similar uses:—Take two parts by weight of common pitch with one part of gutta-percha, melt together in an iron pot; it forms a homogeneous fluid much more manageable than gutta-percha alone. To repair gutters, roofs, or other surfaces, carefully clean out of the cracks all earthy matters, slightly warm the edges with a plumber's soldering iron, then pour the cement in a fluid state upon the cracks while hot, finishing up by going over the cement with a moderately hot iron, so as to make a good connection and a smooth joint. The above will repair zinc, lead, or iron, and is a good cement for aquariums.

SO CALLED "COLD GALVANIZATION" OF IRON AND CAST IRON.—The metal is first cleaned by being placed in a bath made up of water 1,000 litres; chlorhydric acid, 550 litres; sulphuric acid, 50 litres; glycerine, 20 litres. On being removed from this bath, the metal is placed in a bath containing 10 per cent. of carbonate of potassa, and is next transferred to a metallizing bath consisting of water 1,000 litres; chloride of tin, 5 kilos.; chloride of zinc, 4 kilos.; bitartrate of potassa, 8 kilos.; acid sulphate of alumina, 4 kilos.; chloride of aluminum, 10 kilos. The metal has to be left in this mixture for from three to twelve hours, according to the thickness of the layer of zinc to be desired.

PROPOSED MUSEUM AT BURNHAM, SOMERSET.—A feeling has been expressed that it would be an advantage to provide the town of Burnham with a museum for the collection of the curiosities of the district. The idea (says a local journal) has been prompted by the fact that Mr. E. Rosser, of College-street, who has devoted his attention to geology, is willing to dispose of his collection. One large fossil possessed by Mr. Rosser is an Icthyosaurus, which is much admired. This splendid specimen of extinct animal existence was obtained from Street, near Glastonbury. He has also a very valuable ammonite. Besides these, Mr. Rosser possesses a good collection of minor fossils, stones, crystals, shells, &c. This would form a good nucleus for a museum, and we hope means will be taken to make them the property of the town. Some Roman pottery and other curiosities dug up in the neighbourhood would doubtless be added by their owners.

A SPONTANEOUS COMBUSTIBLE GAS.—The bibromide of ethylene, when mixed with oxygen gas, takes fire spontaneously in the sunlight. The bromine appears to combine with the hydrogen in a manner analogous to the union of chlorine with hydrogen in the sunlight.

REAL AND APPARENT DEATH.—Dr. Laborde, in a paper recently read by him before the Academy of Medicine in Paris, has endeavoured to show that the effect produced on a bright steel needle inserted into the body indicates whether death has or has not occurred. When life is present, he says, the needle, generally very soon, becomes more or less tarnished by oxidation; when, on the other hand, death has taken place, the needle, even at the end of half an hour or an hour will retain its brightness. According to the *British Medical Journal*, M. Laborde believes that, in the first instance, the occurence of oxidation, with its attendant electric phenomena, indicates that death is only apparent; while, in the second, the complete absence of oxidation is a sign of real death. The communication has been referred to a committee, consisting of MM. Gavarret, Béclard, and Vulpian.

PRESERVED BREAD.—This bread is proposed as a substitute for the biscuit and "hard tack" used at sea. It is easily prepared, though the process is somewhat tedious. The bread is baked in the usual way, it is then subjected to desiccation for eight to fourteen days, until it is thoroughly dry; it is then exposed for a short time to the action of steam, and afterwards squeezed into tablets under an hydraulic press for twenty-four hours. The tablets can be preserved for years in hermetically-sealed packages. Bread thus prepared retains a vitreous fracture, can be easily masticated by the teeth, is admirable for bouillon and soup, and experience has shown that 200 pounds of good flour will afford 188 pounds of compressed tablets. An army provided with this bread and Liebig's extract of meat would be prepared for any emergency that might arise. A soldier could easily carry several days' rations in his knapsack.

MUSSEL EATING.—It is surprising the quantity of mussels imported into our manufacturing towns. The working-men appear to feast upon this shell-fish with a marked preference, if we may judge by the large consumption of it. A visit to the markets of Manchester, and like towns, will reveal the fact, that mussels were largely sought after and eaten by the manufacturing class at the time of the year when some restriction should be placed upon their sale, for during the months of May, June, and July, they are a dangerous commodity, not having recovered from the effects of spawning, and in many instances produce serious mischief. We (*Medical Press and Circular*) have lately observed the grave results which arise from a careless indulgence in mussels, from the general rash over the surface of the body—so characteristic of unwholesome fish—to the protracted and, in some cases, fatal diarrhœa. In France, where mussel farming is cultivated with the same care as that of the oysters, and where they are placed under the operation of fishery laws, we find, during four summer months, no mussels are sold for consumption in the markets or shops. Even if they were, they would not be so dangerous as the large, fat mussels to be found in our markets, and consumed with so much recklessness as to future sufferina by the working-men. Disease is engendered and propagated through the carelessness with which the dietary of our people is managed, and serious epidemics arise through incaution. Accordingly, we believe it should fall to the duty of inspectors of markets to prohibit the sale of unseasonable articles of food. How often do we see lobsters and crabs vended at a time when they are most baneful, and how frequently are our professional services required to minister to sufferings arising from the injurious effects of stale or unseasonable shell-fish.

CAUSE OF THE FATIGUE TO THE EYES CAUSED BY ARTIFICIAL LIGHT.—M. V. Meunier states that the great difference between sun and artificial light is due to the fact that, of the light emitted from the former, about half the quantity of rays are luminous and calorific at the same time; but, as regards our artificial light, for ordinary oil (colza oil), the amount of non-luminous, yet calorific, rays is 90 per cent.; for for white-hot platinum, 98 per cent.; alcohol flame, 99 per cent.; electric light, 80, and gas-light, 90 per cent.; while for petroleum and paraffine oils, the amount is 94 per cent. It is this large quantity of caloric rays in artificial light which causes the fatigue to the eyes; but this inconvenience may, according to the author, be almost entirely obviated by intercepting the thermic rays by glass, or, better yet, mica plates. The use of these renders the light soft and agreeable to the eyes.

FLUORSPAR IN GLASS MANUFACTURE.—Herr E. Richters, of Waldenberg, Germany, states that the substitution of fluorspar for lime in the manufacture of glass allows of a great reduction in the amount of glauber salt, and greatly promotes the melting of the frit. As the result of numerous experiments conducted on a large scale, he found that, with the same consumption of fuel and similar length of time, the amount of glauber salt required could be diminished one half by substituting fluorspar which had previously been pulverised and calcined for the lime usually employed. In countries where fluorspar can be had in abundance its introduction into glass manufacture would appear to offer many important advantages. The following are the proportions taken:—With fluorspar: Sand, 111·44lb.; fluorspar, 27·69lb.; glauber salts, 4·90lb.; manganese, 4·09lb; charcoal, 2·00lb.; glass frit, 299·00lb. With lime: Sand, 116·40lb.; lime, 15·55lb.; glauber salts, 8·00lb.; manganese, 3·00lb.; charcoal, 2·00lb.; glass frit, 248·00lb.

ANTIQUITY OF THE MITRAILLEUSE.—We give the following curious evidence that the mitrailleuse is only a revival of an old invention, from "Grose's Military Antiquities" (1801), vol. ii., p. 165:—"A patent was granted by King Charles I. to William Drummond, of Hawthornden, in 1625, for the sole making and vending, for the space of 21 years, of the following machines and warlike engines invented by him. The patent is printed in his works. The third is a sort of machine of conjugated muskets, by the assistance of which one soldier or two are enabled to oppose 100 guns, which machine from its effect, is called the thundering chariot, and vulgarly, the fiery waggon."—*Spectator.*

THE RIGHT AND THE LEFT HAND.—Dr. Dwight, a writer in the *Journal of Psychological Medicine*, maintains that the pravalent use of the right hand in preference to the left is not merely due to habit or education, but is the result of a natural impulse, which he attributes to a difference in the endowments of the two lobes of the brain. He lays down, as probably true, the following propositions:—1. There is an inborn impulse to use, to excite motion, one-half of the brain in preference to the other. 2. One half the brain, the left, has a more acute perception of tactile impressions, while the other, the right, distinguishes more readily different degrees of temperature and weight. 3. This arrangement is occasionally inverted." That we shall ever know the nature and origin of this impulse to use one side in preference to the other, Dr. Dwight thinks impossible; but a step is made, he remarks, when it is admitted that it is an impulse born with us, a part of our organization and is neither due to the arrangement of the arterial system, nor is the effect of habit.

A PUZZLING POSSIBILITY.—When the Russian-American Telegraph is completed, the following feat will be possible: A telegram from Alaska for New York, leaving Sitka, say at 6·40 Monday morning, would be received at Nikolaef, Siberia, at 6 minutes past 1 on Tuesday morning; at St. Petersburg, Russia, at 3 mins. past 6 Monday evening; at London at 22 minutes past 4 Monday afternoon; and at New York at 46 minutes past 11 Monday forenoon. Thus, allowing 20 minutes for each re-transmission, a message may start on the morning of one day, to be received and transmitted the next day, again received and sent on the afternoon of the day it starts, and finally reach its destination on the forenoon of the first day. The whole taking place in one hour's time.

PRESERVED MILK.—If a full milk diet could be obtained for the children in every cottage, how often would the sickly infant live, the poor, ricketty child grow into an active boy, and the overgrown, consumptive-looking youth reach manhood. In fact, how much would the bone and sinew of the rising generation be strengthened, if children could have a liberal supply of milk food, instead of being brought up on washy substitutes, and kept quiet by sugar, stimulants, or opiates. The importation into this country of the pure condensed milk from Switzerland is another step in the right direction—the amelioration and condition of the poor—which modern science has taught us to take; and we also hail with hearty satisfaction the announcement that establishments for the preparation and supply of immense quantities of the condensed milk are now at work in the county Cork, Ireland. In this manner the "green pastures" of the sister isle may indeed be made to confer a substantial blessing upon the crowded and heated towns of England, whose population in infancy is stimulated into unhealthy and unnatural precocity, instead of being soothed and fed by Nature's own food during the ills to which juvenile existence is subject.—*Food Journal.*

WOOTZ.—In 1819, while Faraday was an assistant in the Royal Institution, he made an analysis of wootz which attracted considerable attention, as, besides carbon, it was found to contain only silica and alumina, from which the conclusion was drawn that the peculiar property of the metal was due to the presence of silicium and aluminum. The uncertain state of analytical chemistry at the time of Faraday, says the *Journal of Applied Chemistry*, has induced Rammelsberg to repeat the analysis of wootz, and he has communicated the results of his work to the Berlin Chemical Society. The following is Rammelsberg's analysis:—Carbon, 0·867; silicium, 0·136; phosphorus, 0·099; sulphur, 0·002. It will be seen that the metal contains no trace of aluminum, and Rammelsberg doubts the existence of such a thing as aluminum steel. It is certain that the usual alloys of alluminum and iron are crystalline and brittle and not at all possessed of the properties of steel.

REVERSION SPECTROSCOPE.—An important addition to the resources of spectrum analysis has been made by Zöllner's invention of a reversion spectroscope, by which extremely small changes of refrangibility, and consequently comparatively slow motions of a star or sun-flame, can be detected. It consists of a spectroscope, in which, by reflection, the spectrum of a source of light can be superposed above a reversed spectrum of the same source; so that if a white flame containing sodium be viewed, there will be seen in the upper part of the field a sodium line with the blue end of the spectrum on the one side, and underneath it a sodium line with the red end of the spectrum on the same side. The two bright lines may be made to coincide exactly by an adjustment; and if any change in refrangibility takes place, the motion of the line is doubled, and is also more exactly measured, because it is referred to itself as a standard.

THE PYRAMIDS.—Col. Sir Henry James, in a recent lecture on the pyramids of Egypt, stated that in the king's chamber, inside the pyramid, some of the stones were 30ft. long. These stones, weighing some 90 tons, were not found in Egypt at all, but were brought down the Nile a distance of 500 miles, and then placed in their present position, 100ft. above the level of the ground. With regard to their finish, these Syenite stones are of the very hardest known, and yet they are so exquisitely polished, and built in (to form a casing for the king's chamber) with such superior skill, that the finest sheet of tissue paper could not be inserted between two of the stones, and this after a lapse of 4,000 years. Such workmanship would excite the wonder and admiration of the world, even in this age of science and improvement.

A PETRIFIED SEA-MONSTER.—A very beautiful and interesting petrified sea-monster has, according to the *White Pine Nevada News*, been lately discovered about 100 miles to the south-east of Hamilton, on a high plateau of land containing an extensive deposit of marine shells and the fossil remains of a large variety of extinct species of fish. The petrifaction of this particular monster is perfect, and is estimated to weigh about ten tons. It presents a dual appearance—the head and body are that of a hump-back whale, while the extremities extend into feelers and antennæ, like the polypus or devil-fish, with the exception that they were evidently during life lined with a hard and bony substance. The eyes are set in each side of the head, which is flat and oblong, and are twenty-four inches apart. The mouth is armed with triple rows of teeth, which are sharp in front, but underneath and well into the jaw they turn into grinders, capped by a solid osseous formation, running back from the widest portion of the head.

A NEW INDIAN MEDICINE.—We have received from Mr. Nárayan Dáji, of Bombay, a paper read before the Grant College Medical Society, containing an account of a new Indian drug—the bark of *Ailantus excelsa*, Roxb. This tree is common in many parts of India, and its bark can be obtained in sufficient quantity for general use. The active principle of the bark is called ailantic acid, and its taste is purely and strongly bitter. In doses of from one to three grains ailantic acid, given internally, acts as a tonic and stomachic, exciting the appetite and promoting digestion. When given in large doses (from three to five grains), two or three times a day, its action is distinctly marked, especially in cases of torpid stages of the digestive function, attended with muscular and nervous relaxation and constipation. It is useful in *watery* diarrhœa, and has been found of considerable benefit in the first stage of cholera. It is administered either as decoction, infusion, extract, or tincture of the ailantus bark, and pills can be made containing the concentrated extract. The bark alone contains the active agent, in combination, as far as has yet been discovered, with lime, carbonate of lime, salts of magnesia, alumina, uncrystallizable sugar, gum, and a trace of volatile oil and lignin; its medicinal virtues depend entirely upon an azotized bitter principle possessing an acid nature, and it is this which has been called ailantic acid. The tree is figured in Dr. Wight's "Illustrated Indian Botany."

ANSWERS TO CORRESPONDENTS.

⁂ All communications should be addressed to the Editor of the English Mechanic, 31, Tavistock-street, Covent Garden, W.C.

EMPLOYMENT COLUMN.

We have frequently been asked to devote a portion of our space to cheap or rather SMALL Wanted Advertisements, and we now propose to do so under the heading "Employment Column." Hundreds of skilled labourers are continually wanting employment, and very frequently employers are in want of skilled labour. These wants, in a great industrial country like ours, exist under a variety of forms. A brass-founder may want a foreman; or an optician an assistant; a person may want his microscope repaired, his pianoforte tuned, or his manuscripts edited, when in all probability there is just the person to do the work near by. But the two do not know of each other's wants. At the present time there is no national cheap and expeditious medium whereby the one who wants the work done, and the other who is ready and able to do it, may easily place themselves in communication with each other. We think the English Mechanic is just the organ for such a purpose. This, in most cases, may be done in a very few words. We therefore place at the disposal of all who may want it,

OUR EMPLOYMENT COLUMN.

As in the Sixpenny Sale Column, the charge will be sixpence for the first sixteen words, and sixpence for every additional eight words.

The following are the initials, &c., of letters to hand up to Tuesday morning, August 23, and unacknowledged, elsewhere:—

C. J. Richards, F.R.C., M.D., G. Brian, W. Perryman, C. H. A., G. E. Davis, J. M., J. S., J. W. D., J. M. T., Jas. Page, C. V. Riley, E. Leywood, Payne & Sons, Thomas Hawley, J. H., Lieut. Jas. B., F. H. S., E. H., H. M. M., G. V. M., T. Oseland, R. Brereton, T. H., M. H. B., Sable with MSS., T. S. H., with do., W., Ashworth Bros., Esperance, with MSS., F.R.A.S., with do., H. P., with do., Fellow of the Royal Microscopical Society, with MSS. (next week), T. L. H., A. S. C., Enquirer, S * * * * * * r, M. G. Morgan, Constans Lector, John Ross, F. J. Walker, J. Briggs, A. Bros., A Clergyman, Orme Bros., A. M. W., O. E. R., H. W. Henfrey, A. Tolhausen, D. D., A Carpenter, J. L. F., R. A., Mons Meg., H. Jameson, F. R. T., Billy, Student, A Mineralogist, Fortunate, R. T. Ellieslaw.

J. Harrison.—Your letter displays too much of the fondness of some of our earlier correspondents for calling hard names.

Vigie.—The subject was fully discussed and various expedients suggested in our last volume.

Florist.—See back numbers.

G. Luff.—Will answer by post in a day or two.

A Blacksmith.—Mr. Binn's book would, we think, suit you.

H. H.—The address counts as part of the advertisement.

W. Seaborne.—No stamps enclosed.

T. K.—Your letter is merely a record of failures.

J. B. H.—You ought not to complain of space being unprofitably occupied when you fall into the same error yourself.

P. H. S. says "on the principle that every one should help his neighbour, I venture to ask you if you would wish to insert in the English Mechanic one or two papers on Land Surveying." We should be glad to insert the papers if suitable.

S. R.—Yes. Cannel coal is largely used for making ornaments. It is found principally around Wigan, as well as near Manchester and in Scotland. A very fine cannel is found in Flintshire, where it is used for the distillation of coal-oil.

L. Dickson (Antrim).—To find the dimensions of the chimney for a stationary boiler, multiply the number of pounds of coal consumed under the boiler per hour by 12, and divide the product by the square root of the height of the chimney in feet, the quotient is the area of the chimney in square inches at the smallest part.

B. B.—Yes; apply to the office for Registration of Designs, 1, Whitehall. You had better employ a respectable patent agent. See advertisements.

J. Harper.—Send the drawing and description. If worth insertion they shall appear.

E Jones (Llandudno).—The bird you mention is most likely the herring gull, which is common on the rocky parts of the southern and western coasts. It resembles the kittiwake and the common gull in general appearance; but the bill is yellow; legs, flesh colour; iris, light yellow, with an orange eyelid. In summer, the head, neck, tail, and underparts, are pure white, with a grey mantle, and black and white primaries. It is quite a mistake to suppose that the herring gull feeds only on the fry of fish which swim near the surface. It eats both shrimps and small crabs, and mice and small birds are not safe in its presence. It has even been seen following the plough, and picking out worms and larvæ from the furrows.

Sabbas.—Epidote is a silicate of alumina and lime. There are several varieties of it; and it occurs in granite and other igneous rocks and various crystalline slates.

J. T.—No. Several wires are used in submarine cables, because copper wire is liable to break when coiled. There are seven conducting wires in the 1865 Atlantic cable.

S. G.—The French powder is made of 75 parts of nitre, 12·5 sulphur, and 12·5 charcoal: The Prussian contains 1 part less sulphur, and 1 more of charcoal. The English contains 10 of sulphur, and 15 of charcoal.

C. R. T.—No. It is quite a mistake. Asphalte is a form of hydrocarbon, produced in the interior of the earth by the transformation of carbonaceous matter. It is soluble in about five times its weight of naphtha. The mixture of gas tar with sand or lime is what is known as artificial asphalte:

F. W. Grierson.—Tuesday morning will be too late.

J. W. asks why his "congratulation" is not included in the list published. Simply because he said "*I beg to congratulate you*," &c. We could fill *columns and* columns of such. Our plan hitherto has been *to select* racy and characteristic sentences appertaining to *the* English Mechanic from correspondents' letters, and give them in clusters.

The Sixpenny Sale Column is the only place in which can appear queries sent by Progress, T. E. Lock, Experimenter, English Mechanic (Sunderland), Henry Lousdale.

W. Smith (Northampton).—No stamps with your exchange.

Kansas.—Cain is supposed to have married his sister. On reference to the Book of Genesis you will find the births of *daughters* not recorded until a considerably later period.

J. Melome.—Consult articles on Electricity now appearing.

H. D. (Birmingham).—Described in back numbers.

Northumberland Subscriber.—212 out of print; the other can be had.

R. Y. G.—Steam was known as a motive power long before the time of Watt—even to the ancients.

John Fletcher.—Apparently there is little difficulty in discovering your "method of secret writing." We did so in two minutes. The following is the translation:—"This sort of thing soon uses them up, but there are plenty more in the labour market. What so cheap as flesh and blood? But we have forged the fine wire; now for the artist's touch."

John A. Maclean.—You will receive the paper till the end of your present subscription free of further charge.

R. G. B.—Too frivolous.

C. H.—No book ever published contained a tithe of the information to be found in our back volumes on the practical construction of the harmonium.

W. H. Thorpe (Reading).—A cubic foot of wrought iron weighs 485lb.; of cast iron, 450lb.; of cast brass, 525lb.; of rolled brass, 534lb.; of cast copper, 550lb.; of gunmetal, 549lb.; of lead, 710lb.; of steel, 490lb.

J. A.—Better apply to a surgeon accustomed to the treatment of the ear.

E. Russell.—We are glad you find our Mechanic so useful. We shall, as hitherto, issue title page and index to each half-yearly volume.

Working Man.—Consult any optician or pianoforte maker. Third query inserted.

Hamilton.—Any dictionary will give you the required information. Letters for the Queen are probably sorted by some trustworthy secretary, and from your letter to us we don't think any communication of yours would ever reach her.

One of the Firm.—Assuming all you say to be correct you would certainly have the right to manufacture the articles during whatever period the patent was kept up. Of course it will mainly depend on A.'s receipt, on which advice should be taken.

T. A.—Your letter appears unnecessary. You were not attacked in the letter to which you refer.

A. W. Adams.—See advertisement pages.

Colorado.—Try T. R. Willis, 29, Minories.

F. G. C.—We have illustrated and described several road steam-engines in back Nos.

M. Squire.—Exchanges *must* be prepaid.

S. Barker.—We cannot afford space.

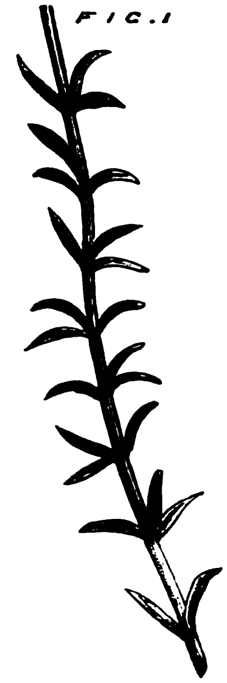
J. B. Cockburn.—No apology is needed. We fully recognised the purity and zeal of *your* intentions, and only regretted that the circumstances to which we alluded prevented our taking advantage of them. You know probably better than we do how difficult it is to prevent fraud in such matters.

W. G. H.—We should be glad to receive a drawing and description of the saw, and, if worth anything, would insert it.

The English Mechanic
AND
MIRROR OF SCIENCE AND ART.
FRIDAY, SEPTEMBER 2, 1870.

CYCLOSIS IN ANACHARIS.

FIG. 1



THE "American" or "new" waterweed is all too common to need much description. The cut (Fig. 1) will enable any of our readers to recognise it at sight. The leaves, of pale green, grow in a whorl of three, the stem being at this point exceedingly brittle. The plant is very easily propagated. Almost the smallest piece thrown into spring water, or into a stream or pond, will rapidly grow and increase, so that the microscopist who once succeeds in obtaining a piece may ensure a constant supply, live wheresoever he may. My own acquaintance with the plant extends only over about twelve months, but during that time I have devoted to it a considerable amount of attention. The results of my observations shall now be given.

The leaves are narrow, and, when full grown, are usually about ⅜in. in length, though in a specimen in my aquarium this length is very considerably exceeded. At the margin there is but one layer of cells, the remainder of the leaf being composed of two layers of cells, somewhat shallow, and of irregular shape and size. A leaf mounted in fluid or glycerine jelly, when examined by polarized light appears as a narrow frame of light when the prisms are crossed. This may or may not be from the presence of silex in these cells. I incline to the latter notion. With a purple selenite and the proper setting of the prisms, these cells assume the peculiarly rich crimson colour which I have usually found to be characteristic of simple cellulose—such as, for example, the cells of Aralia and the parenchymatous cells of rush, of rhubarb, or rumex; and it may be mentioned that the vertical cell walls (separating cells in the same plane) are seen, under a high power, to exhibit precisely similar phenomena of polarization.

For anything like a careful observation of the phenomenon of cyclosis in this plant a power of not greater focus than ¼" is absolutely necessary. A higher power would be useful, but with care and dexterous illumination much may be done with ¼" and a deep eyepiece. It is useful to begin our observations at the broad end of the leaf, and to gradually work our way up. The cut (Fig. 2) gives a fair representation* of the last leaf I worked at. It will be seen that the cells at the broader end are oblong; that in the middle they are irregularly rhomboidal; and that at the upper end they become nearly circular. In the lower cells the current, so far as I have seen, invariably travels along the full length of the cell in a perfectly regular manner. Sometimes towards the middle I have found the axis of rotation to be diagonal, and at the upper end the rotation is not infrequently in a circle. When the leaf is first severed from the stalk rotation is almost invariably suspended for a short time, during which the chlorophyll granules congregate at each end (rarely in the middle, though they are often said always to do so) in the oblong cells, and aggregate in a confused mass in the more circular cells. It is most interesting to watch the gradual commencement of the movement. In the longer cells a single globule usually makes the attempt, and is followed at intervals by one or two others. The phenomenon almost necessitates one to ascribe powers of volition to the granule. The protoplasmic current which carries the granules along is somewhat narrow—perhaps on an average the united current of two sides of an oblong cell would equal one-third of the whole width, and is in these longer cells apparently restricted to its path between the cell walls and the primordial utricle of Mohl. In the more circular (and younger) cells it is common to see the whole cell contents rotate about a central axis.

FIG. 2

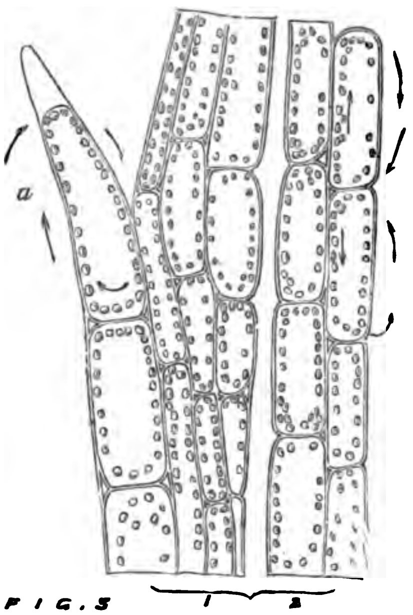


FIG. 3

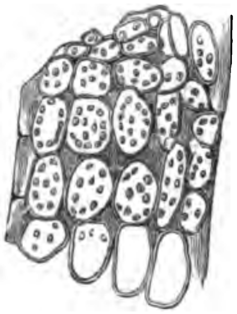
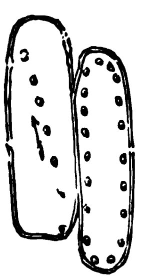


FIG. 4



1, 2. Portion of leaf of *Anacharis alsinastrum*—"a" the hollow spine. The circulating granules do not pass to the point, but make a short cut across.

3. A portion from near point of leaf, showing the more circular form of cell.

4. A cell showing a helical motion. All are magnified about 900 linear.

Very often currents in contiguous cells may be seen to flow in opposite directions, rendering it the more easy to demonstrate that this rotation is wholly distinct from circulation. But what is it? By what is it caused—Osmotic force, or, as has been suggested to me, electrical agency? In the attempt to gain a little light upon this matter, I have immersed leaves of the plant in various fluids of different densities. Perhaps I cannot do better than recount my experiments.

Glycerine Jelly.—This I made of medium solidity. A leaf immersed in it in a warm and moderately fluid state was set aside for some time in an ordinary sitting-room in the month of November. I observed it every fifteen or thirty minutes for upwards of three hours; the whole of this time cyclosis went on rapidly. The next morning, however, all was still.

Glycerine.—I used Price's, of commercial quality. In every case where I have used this fluid at the temperature of the room rotation has ceased almost immediately. The same result has followed immersion in syrup of like density.

Iodine solution immediately stops the current.

Carmine fluid, slightly alkaline with potash, and but faintly coloured, also generally stops rotation. In some cases, however, the phenomenon goes on unimpeded and the current becomes slightly stained.

Acetate of Rosaniline.—The results with this are most interesting. It appears to stimulate the current. The cells in which the rotation has ceased become deeply stained, and in time all the cell walls are also stained. Neither the current nor *rotating* granules are ever stained. The inert matter in the centre of the larger cells becomes stained, and is apparently granular. After the reagent has been applied for three or four hours, a very moderate power will enable one to see the movement of the current of protoplasm very clearly, and most rigidly to mark its bounds.

The younger cells appear to resist the test altogether. A writer in one of our scientific periodicals, some two or three years since, was of opinion that this re-agent enabled him to demonstrate an intercellular substance, which, he said, became deeply stained. Careful observation, will, I think, show this to be a fallacy. A rigid optical analysis with polariscope and most delicate focussing does not reveal more than the simplest of cell walls (consolidated sometimes, with silex), but no intercellular substance. I have further to notice that the phenomenon of cyclosis is almost entirely dependent upon the influence of light. It is most interesting to see how speedily general activity is resumed in cells that were dormant when an intense light is thrown upon the leaf by the mirror. Heat is also a necessary condition. From these considerations I think we can come to but one conclusion—that this is one of those phenomena we call vital, and that it may be regarded as analogous to the circulation of the blood through certain vessels in animals, and as being essentially related to that "simultaneous removal and replacement of matter" which distinguishes "living" from "dead" matter.

H. P.

THE WORLD: ITS FORMATION AND ANTIQUITY.

By Arthur Underhill.

(*Continued from page* 484.)

Chapter VII.

ABOVE the strata of the Cambrian group lies a great class of deposits known by the name of the Silurian system. This formation was first examined and classified by Mr. (now Sir Roderick) Murchison, who, with that zeal in the interests of science by which he has been so uniformly characterised throughout his distinguished career, investigated the whole of this interesting group, and firmly established it as an independent system, both in lithological and palæontological features. In our own country it is found to be mostly developed in that portion of England and Wales formerly occupied by the Silures, whence the name. These people inhabited a large portion of South Wales, and some of the counties which border on that principality; but the system which has been named after them is not co-extensive with the region which they inhabited, and although it is found for the most part *there*, still small masses, or outliers as they are termed, are found distributed over the whole country, and appear in places far removed from that at which it most copiously occurs.

The Silurian system is divided primarily into two groups, called respectively the Upper and Lower Silurians; and these groups are subdivided secondarily into three subgroups, namely, the Ludlow, Wenlock, and Llandeilo series, as in the subjoined list.

UPPER SILURIAN.

Ludlow Series.—Red and green sandstones, with finely marked lamination and ripple-mark.

Micaceous greyish sandstone, clayey limestone (known as Aymestry limestone).

Shale.

Wenlock Series.—Limestone (known as Wenlock limestone).

Clayey shale.

Shaley lime and sandstones.

Grit, sandstone, and shales.

LOWER SILURIAN.

Llandeilo Series.—Grits and shales, white sandstone.

Dark limestone, flags, and slates.

It will be seen from the above statements that the whole of the rocks composing this system are exclusively clayey, sandy, and calcareous (limey).

The fossils of the Silurian epoch are very numerous, and there are a considerable number of species, upwards of 400 having been recorded, comprising fishes, crustaceans, annelids, several orders of molluscs and conchiferæ, crinoids and polyparia. Marine plants are also frequently found, and the whole of the organic remains testify to the sole creation of aquatic beings, as no fossil of any terrestrial animal has ever been found in the system.

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* A faithful full-size drawing would be about 30ft. long and 7 or 8ft. broad. I have therefore given portions of the leaf.

The Llandeilo group is seen principally in the county of Carmarthen, where it occurs on the banks of the Towy for a considerable distance. Its gentle but picturesque scenery renders it a pleasant change to the more wild and rugged rocks of the older formations. The little wooded hillocks, formed by the convulsions of a former age, give to the scene that quiet and peaceful beauty which excites within us an admiration of a passive, rather than of an active kind. Here we find none of those bare, hard, slaty rocks, whose jagged and rugged sides bear witness to the elemental vicissitudes to which they have been exposed; neither do we see those pointed peaks, whose appearance, at once picturesque and sublime, raise in us a sensation of admiration akin to fear; but we have before us the gently undulating ground, rounded and beautiful, with a quiet feminine beauty, so to speak, which soothes the searcher after the sublime and picturesque, as much as the more masculine contour of the Metamorphic and Cambrian groups excite and awe him. I cannot better show the difference between the scenery of these two groups than by comparing them to a sea, which in the Metamorphic and Cambrian districts is as it were upheaved and lashed by the fury of some tropical gale, but which in the localities of the Silurian group is only stirred into a gentle swell, whose billows, wavy yet unbroken, give just enough of variety to prevent monotony, yet not sufficient to cause confusion.

This group, as found in the Caradoc range, exhibits certain peculiarities; the lime and sandstones, upheaved and dislocated by an emission of trap rock, are thrown up into elevated hills and rounded hummocks of considerable height; and the sandstone is in places turned into quartz, by reason of the contact of the molten trap, showing how greatly heat has changed the metamorphic rocks.

Immediately above the Llandeilo series lie the strata of the Wenlock group, the components of which are principally shale and limestone. This series extends from Wenlock as far as the Caradoc range, and embraces a large area of country. The strata are rich in organic remains, and the limestone affords a great proportion of that used for ornamental purposes, the richness of its fossils giving it when polished a variegated aspect most pleasing to the eye. Next in the system comes the Ludlow series, which consists of clayey limestones, grey, red, and green sandstones, and shales. This group is peculiarly interesting, owing to the variety of its strata and the great abundance of its fossils. The Aymestry limestone (so called from the town near which it mostly abounds) is useful in the industrial arts, yielding when burnt a very celebrated lime used as a subaqueous cement. It is in composition clayey or argillaceous, and non-crystalline, but is literally thronged with shells. In the sandstone of this group have been discovered the remains of the first created *vertebrate*, or backboned, animals, in the shape of fish. These fishes belonged to the family of sharks (*Placoids*), and were termed by Sir Roderick Murchison *Sphagodi* (murderous teeth), on account of the sharpness and length of those organs: they appear to have lived upon their weaker brethren of the ocean, and were in fact, to use the words of the author above quoted, "without doubt the pirates of the sea of that period." *Fucoids*, or sea-weeds, are very plentiful in this group; and *Encrinites* (*krinon*, a lily)—so called from their resemblance to that flower—peopled the ocean's bed with their tiny forms. Although from their name it may perhaps be thought that these were vegetables, such was not the case; they were animal organisms of the order Radiata, and were somewhat similar to a star-fish of the present time, anchored to the bottom of the sea by a long stalk-like appendage. Sea-urchin-like creatures were also rife at this epoch, in the form of *Cystideans* (*kystos*, a bladder); curious in appearance were these little specimens of life on a lowly scale, somewhat resembling a small spherical honeycomb perched on the extremity of a waterlily's stalk. *Bivalves*, allied to the oyster and mussel of our day, also flourished in the seas of the Silurian epoch, together with a great variety of *Trilobites* and other Crustaceans of a higher order.

This system has, in common with the two succeeding ones (the Devonian and Carboniferous), been the chief repository of that all-powerful metal, which has in all ages and in all states of society so uniformly influenced man; truly sang Horace:

> Aurum per medios ire satellites,
> Et perrumpere amat saxa, potentius
> Ictu fulmineo.

Which has been translated somewhat freely—

> Stronger than thunder's wingèd force,
> All powerful gold can speed its course,
> Through watchful guards its passage make,
> And loves through solid stones to break.

(*To be continued.*)

AN INTRODUCTION TO INORGANIC CHEMISTRY.*

By George E. Davis,

Honours Certificated Teacher.

(*Continued from page* 507).

Chapter II.

In our last chapter we broke off in the midst of acids, bases, and salts; in the present we will continue the subject, including their crystallography, of which the student should possess a fair knowledge. We will then commence by showing the formation of acids.

The following are specimens of the formation of acids, monobasic and polybasic (di- tri- and tetrabasic):—

1st.—Monobasic hydrogen nitrate (nitric acid).

$$H_2O + \left\{\begin{matrix}NO_2\\ O\\ NO_2\end{matrix}\right. = \left\{\begin{matrix}NO_2\\ HO\end{matrix}\right. + \left\{\begin{matrix}NO_2\\ HO\end{matrix}\right.$$

Water one molecule + nitrogen pentoxide = Two molecules hydrogen nitrate.

2nd. — Dibasic hydrogen sulphate (sulphuric acid).

$$H_2O + SO_3 = SO_2'' \left\{\begin{matrix}HO\\ HO\end{matrix}\right.$$

One molecule + one molecule sulphur trioxide = one molecule hydrogen sulphate.

3rd.—Tribasic hydrogen phosphate (phosphoric acid).

$$(H_2O)_3 + P_2O_5 = PO''' \left\{\begin{matrix}HO\\ HO\\ HO\end{matrix}\right. + PO''' \left\{\begin{matrix}HO\\ HO\\ HO\end{matrix}\right.$$

Water three molecules + phosphorus pentoxide = two molecules trihydrogen phosphate

4th.—The following are specimens of tetrabasic acids:—

$$Si^{iv} \left\{\begin{matrix}HO\\ HO\\ HO\\ HO\end{matrix}\right. \qquad \left\{\begin{matrix}PO''' \left\{\begin{matrix}HO\\ HO\end{matrix}\right.\\ O\\ PO''' \left\{\begin{matrix}HO\\ HO\end{matrix}\right.\end{matrix}\right.$$

Hydrogen ortho-silicate. Hydrogen pyrophosphate.

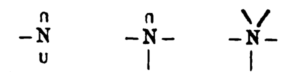
Probably the beginner will be puzzled to know the signification of the above letters or symbols, therefore is annexed a list of the elements with their symbols and atomic weights.

PERISSADS.

Monads, Triads, and Pentads.

Name of Element.	Symbol	Atomic weight.	Molecular weight
Antimony	Sb	122	488
Arsenic	As	75	300
Bismuth	Bi	208	832
Boron	B	11	22
Bromine	Br	80	160
Cœsium	Cs	133	266
Chlorine	Cl	35·5	71
Fluorine	F	19	38
Gold	Au	196·7	393·4
HYDROGEN	H	1	2
Iodine	I	127	254
Lithium	Li	7	14
Niobium	Nb	97·6	
Nitrogen	N	14	28
Phosphorus	P	31	124
Potassium	K	39	78
Rubidium	Rb	85·5	171
Silver	Ag	108	216
Sodium	Na	23	46
Tantalum	Ta	187·5	
Thallium	Tl	204	408
Vanadium	V	51·3	205·2

Perissads are those members of the group of elements which exhibit an *uneven* equivalency: monads possessing one degree of chemical force, triads three, and pentads five. A pentad may act as a triad, or even as a monad, by the mutual saturation of its own force, which may be represented graphically in the case of nitrogen, thus:—



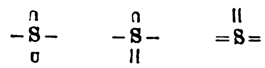
Monad. Triad. Pentad.

ARTIADS.

Dyads, Tetrads, and Hexads.

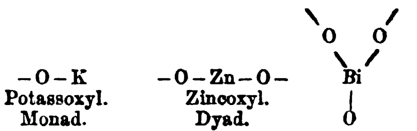
Name of Element.	Symbol.	Atomic weight.	Molecular weight.
Aluminium	Al	27·5	
Barium	Ba	137	137
Cadmium	Cd	112	112
Calcium	Ca	40	40
Carbon	C	12	12
Cerium	Ce	92	
Chromium	Cr	52·5	
Cobalt	Co	58·8	
Copper	Cu	63·5	63·5
Didymium	Di	96	
Erbium	Eb	112·6	
Glucinum	G	14	
Indium	In	74	
Iridium	Ir	198	
Iron	Fe	56	
Jargonium	?	?	
Lanthanum	La	92	
Lead	Pb	207	
Magnesium	Mg	24	24
Manganese	Mn	55	
Mercury	Hg	200	200
Molybdenum	Mo	92	
Nickel	Ni	58·8	
Osmium	Os	199	
Oxygen	O	16	32
Palladium	Pd	106·5	
Platinum	Pt	197·4	
Rhodium	Rh	104	
Ruthenium	Ru	104	
Selenium	Se	79	158
Silicon	Si	28	28
Strontium	Sr	87·5	87·5
Sulphur	S	32	64
Tellurium	Te	128	256
Thorium	Th	115·7 ?	
Tin	Sn	118	
Titanium	Ti	50	
Tungsten	W	184	
Uranium	U	120	
Yttrium	T	61·7 ?	
Zinc	Zn	65	65
Zirconium	Zr	90	

The Artiads exhibit an *even* equivalency of two, four, or six hexads combining as tetrads or dyads, as in the case of sulphur:—



Dyad. Tetrad. Hexad.

Bases are metallic oxides which are decomposed when they come into contact with acids proper, or hydrogen salts when they yield a salt of the metal. Bases contain a metallic radicle called a *basyl;* thus potassium and calcium oxides contain the basyls potassium and calcium. Bases are not to be confounded with the basylous radicles which form salts by combining with chlorous radicles. These radicles, if they are formed from a monad basyl, contain one oxygen atom; if the basyl is a dyad two atoms of oxygen exist, and a triad basyl contains three oxygen atoms united by half their force:—



Potassoxyl. Monad. Zincoxyl. Dyad. Triad bismuth radicle.

Salts are formed by the replacement of the hydrogen atoms in the acids proper by basyls: the haloïd salts are no exceptions, for sodium chloride (common salt) is formed, by the replacement of hydrogen in hydrogen chloride, by the basyl sodium. It is therefore to be looked upon as a salt formed from an acid, rather than as a direct combination of the metallic radicle with a chlorous element.

As an instance of the formation of salts from acids by the successive replacement of hydrogen, we may take the tribasic acid, hydrogen orthophosphate:—

$$\left.\begin{matrix}H\\ H\\ H\end{matrix}\right\} PO_4 \qquad \left.\begin{matrix}Na\\ H\\ H\end{matrix}\right\} PO_4 \qquad \left.\begin{matrix}Na\\ Na\\ H\end{matrix}\right\} PO_4 \qquad \left.\begin{matrix}Na\\ Na\\ Na\end{matrix}\right\} PO_4$$

Tri-hydrogen phosphate. Sodium di-hydrogen phosphate. Di-sodium hydrogen phosphate. Tri-sodium phosphate.

The metallic radicles which enter into combination with the acid radicle, need not of necessity, in a polybasic acid, be of the same kind. The hydrogen in the above orthophosphate may be replaced by different radicles, as in the case of hydrogen sodium potassium phosphate (1), or in microcosmic salt (2).

$$\left.\begin{matrix}H\\ Na\\ K\end{matrix}\right\} PO_4 \qquad \left.\begin{matrix}Na\\ NH_4\\ H\end{matrix}\right\} PO_4$$

Acids, bases, and salts may all be classified as crystalline or amorphous. Crystals are those bodies which possess a symmetrical form, and are bounded by plane surfaces called faces. The line formed by the junction or intersection of two faces is called the edge, whilst the point formed by the junction of three or more faces is called the solid angle.

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* As it is our opinion that a long series is not suitable for a scientific periodical, we have requested the author to give us a few chapters as above.—Ed.

Axes are imaginary lines drawn through a crystal for the purpose of facilitating the description of its geometrical properties and all crystals which can be reduced to the same axes belong to the same system of crystallography.

There are six systems or distinct classes of crystals under which all known forms of crystals can be classed.

1st System.—The octahedral or regular system, called also the cubical system when the cube is considered the typical form. If diagonals be drawn upon each face of the cube they will intersect in the centre of each face; lines now drawn so as to connect the centres of each opposite face will give the axes of the cube, of which there are three. The following minerals crystallize in the cubical or octahedral system:—

Zinc blende, alum, galena, silver, iron, salt, diamond, lead, gold, iridium, fluorspar, and iron pyrites. The crystals of this system exhibit only single refraction and expand equally in all directions when heated.

2nd System.—The typical form of this system is a right prism upon a square base, or an octahedron upon a square base, therefore it is called the right square prismatic system; it is often called the pyramidal system.

If lines are drawn joining each face of a right square prism from the centre they will represent the axes, of which two, as they are formed in a square, must be equal. The characteristic of the second system is three axes, two of which are equal.

Crystals of this system exhibit the phenomena of double refraction, but they possess one negative axis, *i.e.*, one which does not possess this peculiarity. The following minerals are found crystallized in this system:—

Calomel, zircon, rutile, anatase, scheelite, and mellite. The crystals of the above system expand equally in at least two directions.

3rd System.—Rhombohedral or Hexagonal System.—This system is characterized by possessing three equal axes and one which is perpendicular to the other three. The axes may be found by forming the hexagonal prism and joining the centres of the opposite edges, these lines are the three equal axes; the other, and that which is perpendicular to the other three is found by joining the centres of the hexagonal faces.

These substances crystallize in the 3rd system:—Calc-spar, quartz, bismuth, graphite, antimony, emerald, dolomite, ice, tourmaline, hæmatite, apatite, and amethyst. Double refraction and unequal expansion characterize this system.

4th System.—Prismatic or Rhombic.—This system, also called the right, rectangular or rhombic prismatic and orthotypic system, may contain crystals formed either from the prism or octahedron on a rhombic base. There are three axes peculiar to this system, no two of which are equal. The principal axis runs parallel to the long edges in the centre of the crystal; the secondary axes are lines joining the centres of the opposite long faces of the crystal; they are perpendicular to the principal axis.

Cryolite, nitre, sulphur, topaz, citric acid, sulphate of zinc, and bichromate of potash, crystallize in this system. They possess two axes of no double refraction and expand unequally in three directions.

5th System.—The Oblique.—The typical form of this system is an oblique prism or an oblique pyramid upon a rhombic base. The behaviour of the crystals of this system under the influence of light and heat is similar to the preceding system. The principal axis runs in the centre of the prism, parallel to the oblique long edges, joining the two rectangular faces. The secondary axes join the centres of the long faces. In this system two axes are oblique, and the third perpendicular to both.

The following crystals belong to this system:—Carbonate of soda, malachite, sulphate of iron, sulphate of cobalt, gypsum, felspar, Glauber's salt, mica, and realgar.

6th System.—Doubly Oblique or Anorthic System.—This system may be called the crystallic lumber-room: it is the system to which all crystals are referred when they cannot be classed in any of the preceding systems. Most of the forms of this system are characterized by their want of symmetry: they possess three axes, all of which intersect each other obliquely, no two therefore are inclined to each other at right angles.

The following crystals belong to this system:—Sulphate of copper, nitrate of bismuth, native boracic acid, axinite, and Labrador felspar.

A chemical compound generally crystallizes in one form belonging to one system, but some are found to crystallize in two forms, they are then termed dimorphous: as an instance, calcium carbonate is found as arragonite in the prismatic system, and as calc-spar in the rhombohedral system.

Common salt generally crystallizes in cubes, but if deposited from a solution containing urea, the form is altered to that of an octahedron; and sal ammoniac, treated likewise, is said to form cubes instead of octahedrons, which it always furnishes in pure water.

Certain bodies when they take the crystalline form acquire a certain amount of water, which is necessary for the permanence of that form; when this water is expelled the crystal falls to powder, it is therefore called the water of crystallization.

When crystals dissolve in water, the bulk of this latter fluid is not increased if the crystals be anhydrous; if such, however, is not the case, the increase is only by the amount of crystallization water they may contain. From a vast number of experiments upon the subject it is probable that hydrated crystals when in solution exist, not as a solution of the anhydrous salt, but as one of the hydrated crystals. A solution of sodium sulphate saturated at 32·78° C. with the ten-atom hydrate, upon elevating the temperature, about one-sixth of the salt is deposited as anhydrous rhombic octahedrons. If a supersaturated (boiling) solution of sodium sulphate is made, and the vessel closed to exclude nuclei, it may remain for a long time before crystallization sets in, but if nuclei are admitted in the shape of dust, or if touched with anything surfaced with that which is foreign to its composition, it at once solidifies (see *Nature*, Aug. 4; *Chemical News*, xxii., page 560). But before we leave the subject of crystallization we will notice one point which has had such influence in the progress of chemical philosophy.

Substances are termed *isomorphous* when they crystallize in the same system, with an identical or but slightly different angular element, or when they are found intermixing with other substances without altering their form.

Mitscherlich has shown that bodies which possess an analogous constitution, exhibit also a similar crystalline form. Of this we have an instance of the manganese, chromium, aluminium, and iron alums. These alums possess the same crystalline form, and the sesqui-oxides of the above metals are termed isomorphous.

If we examine a crystal of magnesite (carbonate of magnesium) we find it belongs to the rhombohedral system; calamine or zinc carbonate belongs to the same system, and the angles vary but a few (15) minutes; therefore, by the law of Mitscherlich the oxide of magnesium is isomorphous with the oxide of zinc, and the two compounds possess an analogous constitution. Magnesium carbonate is $Mg'' C O_3$, and zinc carbonate is $Zn'' C O_3$. Calcium in calc-spar, iron and manganese in the proto-salts, with nickel, cobalt, and copper, form with the above what is termed an isomorphous group. Acids also form isomorphous groups, as—1st, phosphoric acid, vanadic acid, and arsenic acid; 2nd, sulphuric, chromic, and manganic acids; while molybdic and tungstic acids are also isomorphous.

As an instance of the control of formulæ by the law of isomorphism, I may quote the recent researches of Professor Roscoe on the subject of the true atomic weight and constitution of the salts of vanadium. Berzelius assigned the formula $V O_3$ to the acid oxide; but Rammelsberg, a few years afterwards, observed that *vanadinite* $((Pb Cl_2) + (Pb O)_2 + (Pb_3 (V O_4)_2)$ was isomorphous with *apatite* $((Ca Cl Fl) + Ca_3 (V O_4)_2)$, and with *mimetite* $((Pb Cl_2) + (Pb_3 (V O_4)_2)$, and it was then supposed that anhydrous vanadic acid had an analogous composition to the arsenic and phosphoric anhydrides, viz., $V_2 O_5$. Nothing was done in the matter till Professor Roscoe took it up and thoroughly investigated it. The result of his experiments was, that the vanadium trioxide of Berzelius turned out to be a pentoxide, and the lower oxides exactly agreed with those of phosphorus. From the above experiments, which we might say proceeded from Mitscherlich's law of isomorphism, vanadium has been placed in its proper place among the metals, and its true atomic weight established.

(*To be continued.*)

A PRACTICAL TREATISE ON THE HARMONIUM.*

By Hermann Smith.

(*Continued from page 458.*)

THIRD DIVISION.—CHAPTER VI.

OF THE RESONANCE OF THE CHANNELS.

A musical note, far from being a repetition of the same simple sound, should be considered as the conjunction of subordinate sounds reiterated at proportional intervals. The sweetness of this compound effect or tone appears to depend on the frequent recurrence of interior unison.—Prof. Leslie.

A MUSICAL pipe is of true or perfect length when it is capable of maintaining pulsations which synchronize with the vibrations of the exciting agent. The unison is integral and absolute. Nevertheless there may be many departures from this perfect condition which shall be agreeable to the ear; minute divergences which seem to waver on either side the balance, and variations to a range apparently beyond the governance of the same laws, remote from the same system of tones. An organ would be a very tame and spiritless affair if all its pipes were of perfect standard, and so likewise would the harmonium be if we sought only to use one perfect scale of channels; indeed we consider the principles of the organ and the harmonium to be in all particulars identical. Each instrument helps to explain the other. The pulsations of a pipe have no dependence whatever on sound; they exist prior to it, have a dynamical causation, of which sound is the accumulated effect. The power of transmitting the force is inherent in the constitution of air. This you should bear in mind, that air, being an elastic fluid, must of necessity vibrate or pulsate whenever it is disturbed, even as water is under necessity, in like condition, of gravitating in a series of undulations until it attains equilibrium. If the surface of water is disturbed it is ruffled into waves; of these the eye takes cognizance by means of the intervals of lights and shadows. In analogous modes the results of the elastic force which is active in the air when under disturbance, affect the ear as sounds by reason of its power of estimating the intervals of pulsations. We throw a stone into a lake, and it produces an annular wave; we see the circle expand and spread farther and farther until it subsides into quiet, all its impulse absorbed in the mass of water. It is the same when the air is stricken; it is agitated to undulations which spread and die away in the ambient expanse. If those air-waves have certain periodic times with quick repetition or definite rates of velocity, they become, to our perceptions, music. You should think of the *condition* of the air quite apart from its musical effects. The condensations and rarefactions of air under impulse constitute wave-motion.

Advance now a step further. Confine water in a trough; at one end agitate it, raising waves, these will spread, will travel to the opposite end and not cease there, but return with rebounded impulse, meeting and crossing over other oppositely-advancing waves. In like manner if air is environed, enclosed in pipes, pulsations excited will be returned and rebounded; but the waves of the condensations and rarefactions of air differ in this, that they have definite lengths and a celerity of motion of which water can give but a faint representation; for air is a free ocean surrounding us, and its ratio of elasticity is constant, whereas, in comparison, water is elastic only on its surface. Analogy should not be forced too far: it has its limits, else it would be identity.

The perfect pipe of which we have spoken would be the flue-pipe of an organ. This class of pipes is always regarded by builders and philosophers as being of a nature quite distinct from the class of pipes called reed-pipes. As briefly setting forth the doctrine, we note the following passage by Dr. Bushnan:—"In the flute, flageolet, and diapason organ-pipe the molecular undulations of the air are the source of musical sounds."

And again, Dr. Brewer, in his work on Sound, speaking of reed instruments and reed pipes, says:—"They differ essentially from those (viz., flute and organ pipes). In the former the column of air is only the auxiliary of the sounding body, in the latter it is the sounding body itself."

Our views do not coincide with these, which we believe to be erroneous. We may not stay now to refute them, but can only ask you to take note of the divarication as essential to the full understanding of the statements we have to place before you and the arguments to be founded upon them. No column or body of air is itself capable of sounding or of creating sound; it is always an auxiliary—a resonator, and nothing more. We hold the organ pipe and the harmonium channel to be both resonators. The difference is one of degree only, not of kind, and through all the varieties of pipes and channels we trace but one determining element, the relations of proportion. Thus the full-length eight-feet organ pipe is active in giving simple or integral resonance, the diminutive channel is active in giving multiple or lesser resonance. And what is resonance? If we ask, with a child's persistency, what is resonance? why does resonance increase the power of any tone? text-books and teachers sagely tell us it means "sounding again," or they tantalize with merely formal explanations, which fail to reach the root of the inquiry. The best elucidation we know of is to be found in Brande's "Dictionary of Science and Art." "Resonance.—In music a very indefinite term used in regard to the production or reverberation of sound." Admirably true, for the idea called up by the use of the term resonance is generally as vague as this explanation. Let us hope to obtain a little light at all events on the physical fact we want to express. Evidently the word is wrong; looking to its philological derivation it is seën at once to be inadequate, for we want to express the condition which produces the musical result. The term is naturalized in science and cannot be displaced. It is, however, necessary for the development of our argument that we should define clearly what we mean by "resonance." Let us coin a word for the occasion. When we say a pipe or channel is resonant we would affirm a physical fact, that it is re-undative, that it returns the wave.

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We will halt here and bring up the line of argument with which we started to rejoin at this point. The exciting agent at the mouth of a pipe has a periodic time of movement wherewith the column or body of air, by reason of the perfect accord of its wave-length, responds in faultless synchronism; the two movements meet together in time, or absolute unison. Imagine now that this double-natured pipe affords a parallel to the nature of two notes of a musical scale. Thus, two notes from two distinct musical sources may be sounded, and being of the same pitch, they sound the unison. We spoke of minute divergences,—yes, the tuner well knows that they bear very considerable passage below or beyond absolute unison before they become discordant: yet mark this, the minutest change cannot be effected without producing appreciable difference in the quality of the combined tones. If instead of the unison we combine the octave, the wave of which is as two to one, we perceive a new result. In some kinds of organ pipes we obtain the parallel of this, either by diminished length or by forcing the wave-lengths to break up into lesser waves when we elicit harmonic relation or multiple resonance; hence also channels of length, capacity, and proportion, accordant with the multiple pipe, return the wave with similar synchronism, even as a fifth, or third, or fourth synchronizes with the fundamental note of a chord. Strike the notes of a chord in succession and you can recognize them again as regards the quality of the tones as well as in their pitch. Strike the same notes as a combined chord and we feel that the tones have coalesced into something very different in the effect or display of quality; the blended or compound tone is a new product. A change in characteristics, as of substances when brought anew into chemical union. It may be for better or for worse. We often experience this in harmoniums; one that will render a melody pleasantly will become intolerable as soon as the notes are thrown into combination for harmony, and on the other hand an instrument of real artistic worth will so blend in its harmonies with infinite variety in effects of quality, piquant flavours, glimpses of tonal colour so alluring, that the ear is never satiated with its charms, but finds new beauty, new delights, day after day. The same peculiarities are observable in organ pipes and channels; according to the relation of proportions in the associated generator and resonator, so is the result affecting the ear: some pipes of simple resonance are soft and agreeable, others tame and dull; some pipes of complex resonance and full of harmonics, are harsh and jangled and almost unbearable, others are rich in lovely qualities. What a compound of harmonics in the tone of the French horn, yet what tone more captivating to the musical ear!

We recognize three states of resonance: the integral resonance, or simple undulation of the whole —the diminished or multiple resonance—and the combination of the two into one system, or compound resonance. Resonance may be manifested in two modes: when the generator and resonator are allied, their activity being reciprocative and supporting, as in organ pipes, reed channels, and musical instruments generally; and the second mode, when the generator and resonator are isolated, detached, and merely sympathetic in response, as is the case with musical vases, hollow sounding-boards, and the like. In whatever mode manifested the physical action is the same, giving back the wave—re-undative.

The question remains, why resonance increases the power of tones? The re-undulated impulse, provided it is timed in concurrence with the stroke of the generator, produces an augmentation of sound by reaction upon the agent, thereby increasing the amplitude of its vibration (intensity of tone depending upon amplitude), and by receiving that strengthened energy upon a larger area, and again propagating the impulse of an increased surface upon the external mass of quiescent air. Resonance is to the generating sound an auxiliary in actual force; the arrow flies faster with the wind. It conspires to aid the original impetus, just as on the stage the spring-board aids the vaulter to increase the amplitude of his leap, timed as the swing of the rope to the hand of the trapèze performer; musical vases are as springboards to the wave-tones that leap upon their aërial surfaces. The organ pipe and the harmonium channel differ only in degree, the one superior in extent of surface, the other inferior in the front it can present to act upon the external air. With your fingers you can agitate the air inferiorly, but take a fan in your hand, and you communicate your impulse by the presentment of a superior extent of surface with an enormous increase of power. Thus it is with the organ pipe; its larger orifice and more capacious mouth are the endowment of a giant, as compared with the diminutive scale and little apertures of the harmonium channel. The resonating power of the organ must, therefore, always transcend the capabilities of the harmonium. In a former chapter we illustrated the shapes of the channels; we have now to set forth the scales or dimensions of the channels. Experiment tells us that when channel of about 18in. in length is allied to a reed of 16ft. tone we obtain the best quality of sound that reed is capable of affording. Now we cannot well use such a basis for the scales of the harmonium, or we should occupy almost as much space as with an organ, and have to adopt a similar system in building. No doubt a smoother bass would be gained and better balance of tone, for at present the tenor and bass are shorn of their just proportions, in order to economize space, and hence the roughness or reediness preponderates, drowning the treble, unless great skill is exercised to restrain it within due bounds. The structure of the harmonium is compatible only with a system of reduced scales, and we can but select the best and be content with the compromise.

Scale M, 8ft. tone.

Octave.	Length of Channel.	Depth of Channel.
1st C	4[illegible]in.	1[illegible]in.
2nd „	4in.	1[illegible]in.
3rd „	3[illegible]in.	1in.
4th „	2[illegible]in.	[illegible]in.
5th „	1[illegible]in.	[illegible]in.
6th „	[illegible]in.	0in.

Scale N, 8ft. tone.

Octave.	Length of Channel.	Depth of Channel.
1st C	3[illegible]in.	[illegible]in.
2nd „	2[illegible]in.	[illegible]in.
3rd „	2[illegible]in.	[illegible]in.
4th „	1[illegible]in.	[illegible]in.
5th „	1[illegible]in.	[illegible]in.
6th „	[illegible]in.	[illegible]in.

Scale O, 8ft. tone.

Octave.	Length of Channel.	Depth of Channel.
1st C	4[illegible]in.	1[illegible]in.
2nd „	4[illegible]in.	1in.
3rd „	3[illegible]in.	[illegible]in.
4th „	2[illegible]in.	[illegible]in.
5th „	1[illegible]in.	[illegible]in.
6th „	[illegible]in.	0in.

Scale P, 4ft. tone.

Octave.	Length of Channel.	Depth of Channel.
1st C	3[illegible]in.	1in.
2nd „	3in.	[illegible]in.
3rd „	2[illegible]in.	[illegible]in.
4th „	1[illegible]in.	[illegible]in.
5th „	[illegible]in.	[illegible]in.
6th „	[illegible]in.	0in.

Scale Q, 16ft. tone.

Octave.	Length of Channel.	Depth of [illegible]
1st C	4[illegible]in.	[illegible]
2nd „	4[illegible]in.	[illegible]
3rd „	3[illegible]in.	[illegible]
4th „	3[illegible]in.	[illegible]
5th „	2[illegible]in.	[illegible]
6th „	1in.	[illegible]

In general reference we may [illegible] suitable for flute stop; scale N. [illegible] scale O, for diapason stop; the [illegible] usual 8ft. stops included in [illegible] ments. Scale P, for the fife stop [illegible] tone; scale Q, for bourdon or double [illegible] Yet it must not be forgotten that [illegible] pronounce definitely what quality [illegible] scale of channel will yield, we have [illegible] the character of reeds, the sizes of [illegible] influence of pallets, and other details [illegible] fore, be not too curious about precise [illegible] absolute measurements, for should [illegible] maker's plans you will not of a surety [illegible] sults equal to his, unless you could [illegible] methods throughout up to the final [illegible] work. Your teacher may be lavish in [illegible] his special knowledge, and in giving the [illegible] experience and study, yet there is a [illegible] is incommunicable, and even figures cannot [illegible] the minuteness which only moulds [illegible] channel could adequately supply. Each [illegible] has his own particular set of scales, to which he clings with partiality, and hence his instruments bear features by which they are recognizable [illegible] comparison with instruments of other makers who use different scales. Excellence is of many degrees. To work out new scales a man needs [illegible] be patient in observation and sagacious in inference, sensitive to perceive quality in sounds, and eager to analyze the combinations concurring to produce the ultimate effects. Looking at the variations of channel, each said to respond to 8ft. tone, there seems to be little appearance of law or system; all looks casual and arbitrary, yet experience, the surest teacher, leads us to very different conclusions. The scales for the apertures, which will be given in the next chapter, exercise a most important influence, and rest [illegible] principles deeply involved in the physiology [illegible] the voice, although practically disregarded by manufacturers who disdain study. It is so much easier to rely upon custom, tradition, and rule of thumb. Our anxiety has been to interest you [illegible] the principles which govern the quality of sound. Our next most necessary consideration relates [illegible] the vowel qualities of reed tones, and the [illegible] of apertures thereon; the subject, originally [illegible] vestigated by Kratzenstein, and afterwards [illegible] Prof. Willis, of Cambridge, yields to none [illegible] for the student of the harmonium.

In a passage in the last chapter the [illegible] "larynx," was inadvertently allowed to [illegible] when obviously the word "trachea" [illegible] have been substituted.

(To be continued.)

ELEMENTARY SCIENCE.*

BY THE REV. E. KERNAN, CLONGOWES C

(Continued from page 533.)

APPLICATION X.

INCLINED PLANE.

NOW studying the action of a common [illegible] water, observing its defects, and [illegible] these by the aid of the "consequences," [illegible] will find himself face to face with the [illegible] described in the first point.

It is clear that a screw placed [illegible] work a *nut* for itself, as a common [illegible] does in a piece of timber. The defects of [illegible] mon screw working in water are four in [illegible] To each defect let its remedy be applied [illegible] remedies are to be found amongst the [illegible] sequences." Taking at once an example, sup [illegible] a screw of which the "elements" are mea [illegible] thus: "pitch" ¼in., "breadth" of thread [illegible]

DEFECT I.—YIELDING OF THE WATER.— liquid state being so movable a form of ma the resistance is far from being equal to th the solid state. Hence the screw with "eleme as above would produce little or no motion. small quantity of water which touches the th of the screw would yield to the force concentr thus in a small space.

CORRECTION I.—The "thread" of the scr

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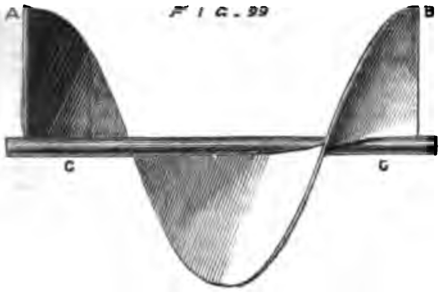
pread out, from being ¼, to (say) 5ft. in breadth. The force now divided over a large surface being much diminished at the parts which make up that urface, the water in contact with these parts is ble to resist,—the screw acts, the body joined to he screw moves.

DEFECT II.—SMALL ADVANCE.—The height of he inclined plane—the pitch of the screw—being so mall (¼in.) the body only moves ¼in. at each urn. The velocity therefore should be somehing incredible for any useful effect.

CORRECTION II.—The "pitch" of the screw is ncreased, say from ¼in. to 16ft. At each turn the ody will advance 16ft. In Fig. 99 is represented *one turn* of a screw of great pitch.

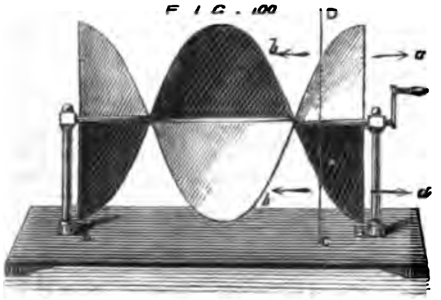
FIG. 99



DEFECT III.—WASTE OF SPACE.—With the extended "pitch" there are large spaces—from A to B and under the two end-portions, C, C, of the shaft, Fig. 99—in which there is no work done. The work then is not so much divided as might be, and consequently the action on the poorly-resisting water is greater than need be.

CORRECTION III.—An Archimedean screw of 1, 2, . . . *n* threads is substituted for the screw with only one thread. The spaces A, B, C, C, of Fig. 99 are filled up by a second spiral, or "thread," in Fig. 100. Two being enough for the most complete explanation, it were better not to render the diagram confused by more spirals. The work being thus much more divided, the water at the different parts is much better able to resist, as the whole amount of resistance (suppose to be the same as before) is now divided over a much larger area. Theoretically, therefore, it ought to be possible to make a screw so that the water should offer *complete* resistance, and consequently the ship should advance at each turn to the *full pitch* of the screw. Experience, however, showed that there was still an unthought-of defect.

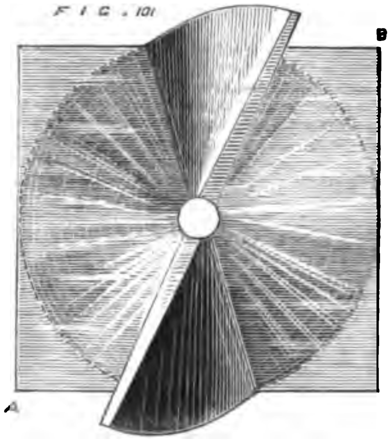
FIG. 100



DEFECT IV.—MOTION OF THE WATER.—Practically it is found impossible to avoid setting the water in motion. The resisting power of the water is so small, that only a *part of the screw* finds a "nut" *immovable* for a moment. Quickly this "nut" receives the rotatory motion of the screw, which motion destroys all resistance to the *remainder* of the screw. Besides this *negative* effect, the moving water has a *positive* retarding action upon the inefficient part of the screw. Suppose that the space C B, Fig. 100, represents the "working part" (as it may be called) of the screw; and that the ship be moving in the direction of the arrows *a*, *a*. All the resistance of the water is overcome in that space C B, and besides the remainder C A having *nothing to work against* as it advances into the moving water, it is opposed by the *backward* motion of this water, which produces a current in the direction of the arrows *b*, *b*, which current strikes the entire *remainder* of the screw. Even were there no retarding current, the *remainder* of the screw would be a drag upon the ship's progress.

CORRECTION IV.—As every portion of the screw acts independent of the rest, "*cut off the useful part.*" The discovery of this correction was the result of an accident, and seems to have preceded the knowledge of the defect. In the early experiments, the screw of one of the first ships was partly broken. To the surprise of all concerned, the consequence of the injury to the screw was *increase* of speed. This fortunate accident led to a series of experiments as to the real useful length. Piece by piece the screw was shortened, each *cut* giving improved speed, until about 1-6th of a turn was reached. Here seemed to be the limit, and it is pretty generally admitted that about 1-6th is the efficient part of the screw. Let the student now imagine a plane cutting off 1-6th of the screw, Fig. 100; the cut-off piece is the propeller, such as was first shown in Fig. 94. As it is almost impossible to give a clear, correct, perspective view of the "cut" by a *side view*, Fig. 101 represents the double spiral turned for an *end view*. The cutting plane A B is seen full front, and exhibits the identity of the cut-off piece with the propeller Fig. 94. The plane is supposed transparent, and shows (*through*) one complete convolution of the double spiral. The apparatus of Fig. 100, being made with one piece movable, removes every difficulty there may be of clearly understanding the screw-action of the now so important propeller. The question "What is the screw propeller?" may now be answered in a few words. "It is a portion of an *n*-threaded screw." This portion is every day receiving new forms, to meet new minor defects, or to suit peculiar circumstances; and in some cases, although the action still continues to be that of the inclined plane, there is a deviation from the outline of the *strict screw*, or "true screw," as it is called. Much as this important subject has been studied, there would seem still to be considerable difference of opinion amongst practical engineers, even as to its most important elements. The question is much complicated by the form of the ship, the currents running to and from the screw, &c. On these points further detail would here be out of place.

FIG. 101



(*To be continued.*)

THE FLUTE AND ITS VICISSITUDES.

BY SABLE.

(*Continued from page* 459.)

THE REVOLUTION OF BÖHM.

FEW instruments have passed through such reverses in the course of reconstruction as the flute, and certain it is that no other has suffered so severe a penalty; and if it is not wholly consigned to oblivion, it is treated with a coldness and neglect as unjust as it is undeserved.

The pianoforte and violin are not more popular *now* than was the flute in the days of the Nicholsons and the Ashes; a concert *then* without a flute-solo would have been quite as unorthodox as the absence of a violin-solo at the present time, and it always elicited an equally hearty and well-merited encore. Our periodicals teem with notices of musical doings; music was never more cultivated and appreciated by the public generally than at this period; new artists and new music appear as regularly as the flowers, and are welcomed with an unfailing interest: but we look in vain amidst the names of those who distinguish themselves as instrumentalists for a flautist—soloists there are in goodly array, but the voice of praise once raised for the "silver-toned" flute is heard no longer. And why is this? Has all love and admiration of the instrument died out? This little couplet, from the pen of a popular writer, says "nay."

> "Her voice . . . .
> So soft it was, and like the note
> You ofttimes hear upon the flute."

And the flute's voice was never sweeter than now; the old "breaks" which formerly somewhat disfigured its evenness are to a great extent removed, and all its time-honoured beauties stand out in greater prominence. Whence, then, the semi-contempt with which it is regarded, even by professors themselves? A greater reproach to the musical world could scarcely exist than the systematic manner in which this elegant and once fashionable instrument is ignored. Is it that further experiment and alteration are feared? That apprehension is groundless; both players and manufacturers have had enough of *that*, and to spare, if vexation, anxiety, and loss are good preceptors; he would indeed be reckless who should adventure more time and money in so "used-up" an undertaking. It is certain that all professional players have now come to a sort of growling understanding as to the flute of their adoption, and *that*, and no other, will they recommend to their pupils.

It is both useless and foolish to cushion facts, even though they be disagreeable. The flute *is* a very difficult instrument to play thoroughly well; it has difficulties inherent to its nature; but so has every other instrument, and it is by conquering these that the student gradually emerges into the professor, and it is by deeming this conquest always imperfect that the professor arrives at distinction. Mr. Chapman (p. 469), writes *as* a master; his observations are the result of experience; the road to proficiency is rugged, albeit the *personal* aid of one like himself will render the rough places much smoother and pleasanter to pupils. A great deal is advanced about the difficulties of the extreme keys, but the *real* difficulty is more often to be found in the composer, and that in what are called the *easy* keys. It is worthy of remark that perhaps the greatest cause of the flute's neglect lies in the lukewarmness and want of energy and industry both of composers and professors. There were giants in "flutedom" in days past—why should there not be again? Whatever man has done, man can do, and greater means are now at his disposal.

The flute *was* what we hope to see it again. Its popularity as a source of recreation and enjoyment was unrivalled, but it was soon to be exiled from the drawing-room, driven from its position as a solo instrument, to become henceforth chiefly the occupant of the workshop and orchestra. As it had engaged admiration and regard, so also it engaged the eye of the critic; its defects were pointed out and enlarged upon, the necessity of a reformation was spoken of, and ere long it was commenced with a vengeance,—it was stripped of its charm and simplicity, and what it gained in its resources and importance it lost in public favour. The defects of the eight-keyed flute lay chiefly in the cramp fingering for F natural. There was a difficulty in passing from octave to octave with freedom; there were some awkward cross and back fingerings; its tone was unequal; some notes were rich and full, others very dull and feeble. There is an obstacle, common to all instruments of its genus—as the oboe, clarionet, bassoon, &c.—which the flute presents to the learner, *i. e.*, passing from the *last* fundamental note to the *first* note of the octave immediately above, which often involves the simultaneous movement of all the fingers; this can never be completely removed, although it is now materially obviated. True it is that the access from C sharp to the D might be rendered *perfectly* easy, but it would simply be transferring the evil to the next note, and in that case the D (now a good note) would be harsh and thin in quality. The violin has its own peculiar difficulties, and the alteration of the distances in the "stop" in the different "positions" on the finger-board, commonly called the "shifts," may be included among the greatest of them; but if the violinist will put all his four fingers down on a string, and *keeping* them *well* down, do a rapid even shake with the *little finger*, he will realize something of the finger-gymnastics of the flute. This is bad enough; but let him replace all his fingers, and keeping the *rest down* try to execute a shake with the *third* finger, and he will experience the pleasant sensation inseparable from the anatomical arrangement of the tendons of this finger employed under such embarrassing circumstances. On referring to the drawing at page 459 it will be seen that two keys, *a* and *b*, are provided for the little finger of the left hand (G sharp and F natural); the use of the latter is sometimes very awkward and perplexing; to the right hand little finger are apportioned the three foot keys; the reader will thus see the labour imposed upon the weak digits. One other key only claims notice in this flute, the long C natural, manipulated sent more individuals than any other (save microscopical organisms), which for thousands of years was the dominant type of life on the globe, as shown by the remains imbedded in its rocks by myriads. The cuttle-fish is generally held to be the most highly organized representative of this sub-kingdom, and its appearance on the earth, or that of forms of the same species strikingly similar, is much later than that of the less highly organized individuals of its division. More, according to the best authorities, even the lower or less specialized members of the family to which it belongs (the Cephalopoda) are also prior to it in point of time, and these much resemble the group (Gasteropoda) considered inferior to it in point of organization. But although one Gasteropod, or many, may have undergone modifications in the course of time, which presented in the end more resemblances to a higher species than to the one to which it or they originally belonged, the theory of progressive development by no means implies that that course was necessary. And so, generally, we may trace back the history of animal or vegetable species on a thousand different lines, but on each the less and less developed organism manifests greater resemblance to the immature forms of other superior organisms, or to the permanent forms of inferior ones. The educated Englishman of to-day presents many distinctive points of character—differs much from the Frenchman, German, Italian, Spaniard, &c.; but step by step, as we go back, these differences become less and less apparent; and, some two thousand years ago, who could have defined their several ancestors among the barbarian inhabitants of the forests of central Europe? How little did these again differ from the ancestors of the Romans! Similarly, classes of Englishmen at present vary greatly; but the forefathers of some of our proudest noblemen, at one time, were very similar to ploughmen and mechanics—not to go lower.

Moreover, our generalization does not imply that Batrachians or Reptiles of some preceding epochs were less highly organized than those which exist in our own. Nay, rather the contrary; that such have been as a class more highly developed than any contemporary with man, as presenting under more generalized forms certain affinities to higher types. Such organisms had their special epochs in ages anterior to that of intellectual man.

Further, though vast numbers of organisms once coeval with molluscs on our globe, and possessing a similar low type of structure, have yet in the course of ages undergone extraordinary changes —have progressed, as we say, to higher types, —yet vast numbers of others remain much the same as they were thousands of years ago. Yea, even such as they were in those primary strata, wherein we find almost the beginnings of the world's life. And have we no "persistent types" of humanity? None in that Eastern portion of the globe to which all history and tradition point as the cradle of the race?

Space prevents our considering further these analogies, as also some problems touched on in the articles on classification just referred to, but to the main difficulty which there presented itself we must devote a few lines, for it is the point we have had in view in writing these articles, in fact it is their *raison d'être!* Having decided that vertebrate animals were from one point of view higher than invertebrate, yet we found that the bee belonging to the latter, on every principle on which humanity bases its judgment of superiority, was higher in the scale than some individuals belonging to the higher type. That, generally, structure could not be taken as a mark of superiority. That, in deciding the relative rank of different organisms, their properties, functions, &c., had to be taken into account, and that since these were different in different species, there was no common ground of comparison. Will not the study of humanity throw light on this question? Is the Englishman, although later, more complex in his organization, superior in all respects to the Greek or Roman? All development, we say, is analogous to human development; the eras of history to the phases of the growing mind, and these again to the epochs of the growing world. That progression is from the simple to the more complex we allow; but is the *more complex* the *more perfect?* In the individual, is it the innocence of childhood, the enthusiasm of youth, the strength and intellect of manhood, or the judgment of age, which constitutes the more perfect phase? What is that "sense of something lost" which haunts the growing man, and which asserts itself in the instincts of the race? Intellectually, humanity has advanced; but does it not suffer some compensation for the advantages it has gained? Is intellect the sole criterion of perfection? Language again is undoubtedly more complex now than in the time of Shakespeare, but can our abstract terms stimulate the imagination, rouse the passions, sway humanity like the simple ones? Is our more complex language then as perfect as when less developed? But that word "perfect" is vague and indefinite. Who has the true type of perfect? or who, having it, can demonstrate to his fellow-men that his is the absolutely right one? In our own opinion, the more complex is *not* the more perfect. But opinion is an unstable and variable thing; the point to which all our arrangements converge is this, —*that a certain amount of force is involved in every organism, and that for every step in higher organization which it gains in its development, an equivalent of power is lost.*

COLOUR AND BRIGHTNESS OF THE MOON'S SURFACE.

THE following extracts from Mr. Birt's letterpress to the fourth area of the Lunar Map are interesting in connection with an unstudied region of the moon's disc which has every appearance of being very ancient, and to have received its external characteristics long anterior to Chacornac's epoch of the production of the smaller and more perfect craters and blow-holes. It is also probable the reader may discover indications of the basis of a theory, which, if built up from telescopic observation and the study of photograms, may intelligibly explain many of the difficulties which now beset selenographical research.

"In numerous portions of the moon's surface, as on that of the earth, we behold the results of the operation of two opposing forces, one by which the features are moulded and, as it were, built up, imparting to the objects so produced an aspect of freshness that it is impossible to question their comparative recent production: the other, by which objects once possessing all the characteristics of a recent formation have yielded, it may have been gradually, to surrounding influences, whatever they may have been, so that at the present time they exhibit the semblance of vast ruins, which in some localities are unrelieved by even the slightest indication of the operation of a force of an opposite character.

"Webb, in his very masterly paper on the moon, in *Fraser's Magazine* for September, 1868, p. 381, speaks of the possibility that the colossal lunar formations may have been the result of forces acting in a more gradual manner, and with less temporary vehemence than may seem to comport with the term *explosion*. It may be that astronomers have paid much more attention to those lunar features which are clearly the results of explosive action, than to those which manifest the presence of a degrading agency. It has been considered that many of the larger forms have been produced by rapid, violent, and tumultuary processes; and however true this view may be, it is certainly inadequate to account for the present appearances of still larger tracts in which no explosive outburst of an epoch which may in any sense be called recent occurs. Nearly filled as well as broken rings, interrupted mountain-chains, comparatively smooth tracts without any well-defined boundaries, are characteristic of such regions; and it may be asked, in what manner and by what agency have they attained their present condition? Has the 'erosion' of Chacornac destroyed the missing portions of the broken rings? and has this 'erosion' acted suddenly or *gradually?* Has the 'diluvial,' restricted by Webb to the expression of comparative fluidity, independent of the nature of the material, invaded and nearly filled previously *deep* craters so as to furnish a connected series of well-known forms, from the smooth-floored walled plain to the just perceptible ring above the surface? Has this same 'diluvial' buried the lower portions and the lateral spurs of continuous mountain-chains, so that now the higher portions alone remain as low, short, and detached ranges in the original line? One cannot help contrasting the continental region, to use a terrestrial analogy in which this area IV A_n occurs, with the magnificent chains of the *Apennines* and *Hæmus*, and the lower and smooth levels of the *Mare Imbrium* and *Mare Serenitatis*, as exhibiting in a very marked degree the results of the forces already mentioned. In the latter we see the effects of comparative *recent* action in the production of vast mountain-chains and the neighbouring extensive level plains. In the former these grand features are wanting. The surface, although far from being smooth, as that of the *Maria*, is roughened only with the remains of former mountains, rings, and craters; the degrading agency, whatever it may have been, appears to have operated almost unchecked in this region, and it is a subject of interesting inquiry as to how this state of things has been effected. Has the filling up, has the wearing down (if such is the case) been gradual? and what forces have been concerned in producing the mutilated forms we now observe?

"Brightness and colour may ultimately become keys by means of which a better acquaintance may be obtained with the chronological sequence of lunar formations. Chacornac refers the great continental formations to an epoch anterior to that of the production of the great plains, this, again, being anterior to the period of explosive energy contributing to the existence of numerous objects, such as bowl-shaped craters and smaller blow-holes, within the interiors of which no intrusive matter is found. Reference, however, is not prominently made to objects in mountainous regions similar to those which we find in various portions of the great plains—viz., partly buried craters and partially destroyed rings, of which we have evidence in this and adjoining areas to the west. The contrast of the general colour of the surface hereabout, as compared with that of the grey plains—its mottled and rugged aspect arising probably from its altered character from that which it possessed at a still earlier epoch—the absence of that sharpness of outline in its remaining mountain-peaks or ranges so characteristic of those which we find nearer to and often on the grey plains, together testify to a much earlier epoch than even that of the production of the partly filled rings on the grey plains. Bright white glistening surfaces, more or less in the neighbourhood of bowl-shaped craters and dark patches of a deep grey, approaching black, appear alike to indicate the most recent formations; the first, it may be, from loose fragmentary incoherent materials ejected from adjacent craters, the last from substances in a state at least of comparative fluidity which have escaped from the interior reservoir at the time of eruption. Phillips compares the bright glistening region of *Aristarchus* to one in which *white* trachyte abounds, and many of the basalts in terrestrial volcanic regions present a dark colour. Between the brightest and darkest of such limited areas on the moon's surface every gradation of intermediate tint occurs; and from a careful consideration of the physical aspects of those regions which, on the one hand, reflect considerably less light than the brighter, and, on the other, considerably more than the darker, it may be inferred that such regions are amongst the most ancient of lunar formations."

Indications exist in the region to which the above extracts refer, that its *earliest state*, so far as our present selenographical knowledge will enable us to judge, was very similar to many of the more recent districts in which perfect craters and mountainous regions intermingle. This was succeeded by the formation of a neighbouring grey plain, accompanied by the invasion of the craters on its borders and the breaking down of their walls facing the plain, remnants of which still exist. A further change posterior to the formation of the plain appears to have been marked by the elevation of a chain of low mountains in the locality of the craters which had been invaded.

A NEW ANTISEPTIC.

THE hydrated chloride of aluminium, to which Mr. John Gamgee has recently drawn the attention of medical men and of the general public, appears, says the *Lancet*, to be a valuable antiseptic. It is quite as potent as chloride of zinc or carbolic acid, and is at the same time non-poisonous, and devoid of unpleasant smell of every kind. These qualities will no doubt ensure its being extensively used, and at no distant date we may expect it to displace the antiseptics which are at present in vogue.

It is somewhat strange that this substance should have been so long overlooked as a possible antiseptic, and Mr. Gamgee certainly deserves credit for suggesting the utilization of it for this purpose. The reason why it has been passed over is probably to be sought in its not being a waste product in any common chemical manufacture. The anhydrous chloride of aluminium, which is manufactured in order to serve for the preparation of metallic aluminium, is far too costly on account of the troublesome nature of the process by which it is prepared —to wit, by passing chlorine at high temperatures over a mixture of aluminium and charcoal. By placing the anhydrous chloride of aluminium in water it is of course converted into hydrated chloride.

The most economical process for the preparation of the hydrated chloride of aluminium appears to be by double decomposition between sulphate of alumina and chloride of calcium (both of which are cheap commercial products). When solutions of these two salts are mixed together, sulphate of lime is formed and appears as a precipitate, whilst the hydrated chloride of aluminium remains dissolved.

On allowing the aqueous solution to evaporate at a very gentle heat and afterwards cooling, crystals of hydrated chloride are produced. If an attempt be made to drive off the water from the hydrated chloride by the application of heat, decomposition will take place. Hydrochloric acid is evolved under these conditions, and oxy-chloride of aluminium is formed, and, by pushing the process, alumina is obtained as the ultimate fixed product.

A NEW GUN.—According to the *Scientific Journal*, of Philadelphia, there is in course of erection, on the east side of New York Bay, a gun that will throw 800 five ounce balls in one minute, to a distance of about two miles. The shot may be either red hot or cold. The gun is circular, and appears like two discs of heavy iron plate, about 4ft. in diameter; upon one side is a funnel to convey the balls through to the proper chamber, without cessation of firing or diminution of speed; the muzzle projects upon the periphery of the circular machine, and may be elevated or depressed at the will of the gunner by the trunnion upon which it rotates. The machine may be worked by manual labour or steam power, and when worked by the latter, it will throw from five ounce balls to eight pound shot and shell, thus making it a destructive implement of warfare.

THE DEFENCES OF PARIS.

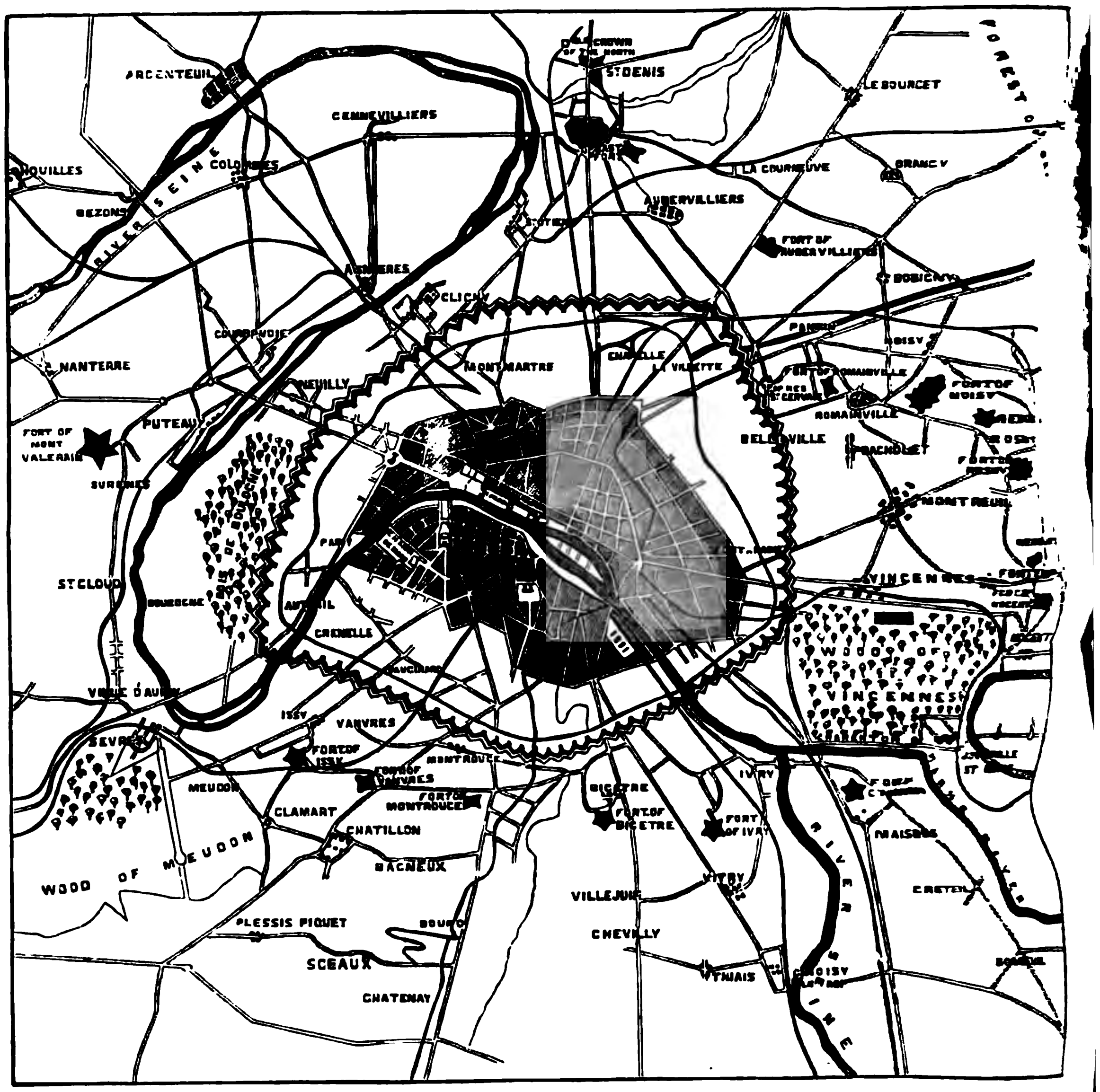
THERE is probably no subject connected with the war which is more interesting than the power possessed by Paris of standing a siege. We have, therefore, thought it well to place before our readers the accompanying map of Paris, showing its fortifications. The drawing has been prepared from the latest maps which can be obtained, and is as accurate as is consistent with the scale.

Paris is situated, to use a military term, à cheval on the Seine, near the junction of this river with the Marne, the latter river covering the city on the east, while a bend of the former protects the western side. The fortifications consist, first, of a chain of detached forts or fortresses commanding the rivers, and, secondly, by an enceinte continué running right round the city. The bastion system of Vauban is adopted throughout.

The exterior line of defence commences at St. Denis on the north, and extends to the Marne at Nogent, a distance of about eight miles. It consists of nine fortresses, and opposes the direct advance of troops from Germany. On the south Paris is covered by a line of six forts, reaching from the Marne to the Seine, a distance of about seven miles. These complete the defence of the south; four are pentagonal and two quadrilateral. They are built of substantial materials, and contain bomb-proof barracks, and have casemated curtains. The third exterior line of defence is eight miles long. It does not consist of a chain of forts, but of the great citadel, Mont Valérien, which serves as a tête-du-pont to the bend of the Seine, which covers Paris to the east. Mont Valérien is supported on one side by Fort d'Issy, and on the other by St. Denis. It is the most important work of the whole. The front toward the river is 460 yards long, and the other four faces average 328 yards each. There is bomb-proof accommodation for stores and 4,500 men. The ring of detached forts, all of which will be easily found in our map, extends over 22½ miles.

Within this is seen the enceinte continué, or continuous line of fortifications. This consists of no fewer than ninety-four bastions. The exterior sides average 328 yards per bastion, forming an enceinte of 30,840 yards, or nearly seventeen miles, probably the largest work of the kind ever executed. The cost was enormous—to judge from Marshal Marmont's opinion, was well spent. Marmont considered the fortifications of Paris "an event the most useful and important in the defence of France." The escarp of the enceinte is 33ft. high, the ditch being 82ft. wide. The distance from the boulevard to the enceinte continué averages about 1,093 yards, and that from the enceinte to the forts is about the same. So long as the forts are unconquered it will be impossible to bombard Paris from a less distance than about 7,000 yards, and even then the siege train will be under fire at a range rather too close to be pleasant.

In addition to these defences it is stated that earthworks are being raised from fort to fort, but we learn from private letters that these are of a very insignificant description, affording good cover, it is true, for riflemen, but not safe against even 6-pounder guns. It is stated that more than 1,000 guns can be placed in position; but this estimate, no doubt, includes a very large number of weapons which, however effective at close quarters, will be practically useless at long ranges.



THE DEFENCES OF PARIS.

THE FORECASTING OF STORMS.*

(*Concluded from page* 538.)

PERHAPS the most terrible storm of this character that ever occurred in the United States was that which destroyed the villages of Comanche (Iowa) and Albany (Illinois) situated upon opposite sides of the Mississippi, on the evening of June 3rd, 1860. This fearful storm will long be remembered by all persons who resided at the time of its occurrence anywhere in the region through which it passed. It commenced as two separate and distinct tornadoes, which, moving eastwardly in well-defined and nearly parallel courses, crossed Cedar River in Iowa 12 miles apart, and then gradually converged, until, at a point about 25 miles west of the Mississippi, they united, and thence advanced in a single column with indescribable fury. After crossing the Mississippi, the force of the storm gradually diminished, and it had subsided into a mild gale by the time it reached Lake Michigan. In this tornado one hundred and thirty-four lives were reported to have been lost west of the Mississippi alone, and over two thousand persons were by its ravages rendered homeless. A gentleman who witnessed the storm at the point of its greatest intensity, describes it as looking, when first observed, "merely like a threatening cloud; but it soon assumed the appearance of a huge serpent, extending from the clouds to the earth, and twisting and writhing with an undulating motion, accompanied by a roaring more terrible than that of the mightiest cataract."

Tornadoes like these, though generally somewhat less intense and destructive than these, prevail every season, and rage with no less fury upon the lakes than upon the land; and as they move almost uniformly from west to east, or from south-west to north-east, and at a range of speed ranging generally from 20 to 40 miles an hour, there would seem to be no reason why such a system of storm reporting as that just established by the Government should not be made immediately available [illegible] rendering invaluable service to our lake commerce. As to the entire practicability of the scheme there can be no question. General Myer, in a letter [illegible] General Paine upon the subject, quotes from [illegible] telegraphic news despatches in a single issue [illegible] Washington newspaper a series of reports [illegible] different points in the west and south-west, [illegible] together map out clearly the course and [illegible] progress of a storm of wind and rain that [illegible] throughout a wide extent of territory in [illegible] last. These reports were made without concert or system, of course, but show conclusive[illegible] valuable practical results may be easily [illegible] through intelligent concert and system. [illegible] the different despatches.

"ST. LOUIS, *January* 17.—A terrible [illegible] thunder and lightning, wind and hail, passed [illegible] the city last evening."

"CHICAGO, *January* 17.—During the thunder-storm last night the mercury stood at 42°" (sic

"LOUISVILLE, *January* 17.—A terrible tornado visited Cave City Station, on the Louisville and Nashville Railroad at an early hour this morning."

"CINCINNATI, *January* 17.—An unusually heav storm of wind and hail, accompanied with thun-der and lightning, occurred here this morning."

"PITTSBURGH, *January* 17.—A heavy rain-storm with thunder and lightning, visited this city at noo to-day."

There is no difficulty in deducing from these dat the fact that on the evening of January 16th, storm prevailed at St. Louis, which, moving east wardly over a broad belt of territory, reached Chi cago some time during the same night, Cave Cit Station the next morning, Cincinnati later in th norning, and Pittsburgh at noon of the 17th,—aving traversed the distance from St. Louis to ittsburgh in some 18 hours, or at the rate of about 0 miles per hour. From the newspapers of the ollowing day it might have been quite as easy to race the storm on to the sea-coast, and perhaps to ather particulars of the damage to shipping which t caused.

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* Extracted from an article by L. A. ROBERTS in the *Western Monthly*.

For several years the Smithsonian Institution as been collecting meteorological observations from ll parts of the country, and labouring to deduce rom the facts thus gathered the laws governing he phenomena of the weather and the climate; and he valuable results so gained can now be drawn pon in inaugurating the new system of storm prediction and reporting. "The determination of the ull details of this system will be arrived at," says General Myer, in a communication to the Secretary of War, "only after careful study of the modes already tested in other countries, and consultation with experienced observers, telegraph companies, boards of commerce, and business men, as to their application or improvement in our own. There will need to be the study and determination of the points for observation; the supply of instruments, and the facilities for their use; the exact observations to be made; the exact form and times in which, when made, they are to be reported; the points at which reports are to be collected and deductions from them had; the places at which and the modes by which these deductions shall finally be announced, by telegraph and signal, and so made useful to the public, for the benefit of commerce, by the warning they may give or the aids they may offer. It is a wise provision of the act," he adds, "that it enables the army to be thus extensively utilized in the interest of commerce, by the exercise of duties already established, and which will require but little additional outlay. It would be needless and unwise to enter upon large expenditures by attempting at the beginning too extended a scope for the endeavour. . . . I would suggest, therefore, that action under the resolution be limited, until the best modes for its execution shall have been wisely determined."

In accordance with this view, he asks for an appropriation, for carrying out the law, of the modest sum of 15,000 dollars, for the current fiscal year, ending June 30, and 25,000 dollars, for the next fiscal year, ending June 30, 1871. As showing that the scheme is regarded with prompt favour by the interests it is designed to benefit, General Myer mentions the fact that the favourable proceedings upon the subject of six boards of commerce had, at the date of his communication, and within little more than a week after the approval of the joint resolution, been received at the office of the chief signal officer.

Professor Joseph Henry, of the Smithsonian Institution, writing to General Paine in approval of the objects of his joint resolution, points out the following conditions as essential to the success of the proposed system:

"1st. The points from which the telegrams are to be sent must be carefully selected and furnished with reliable instruments. 2nd. These instruments must be in charge of persons properly trained to make the observations. 3rd. The telegrams must be transmitted regularly to some central point at fixed hours of the day. 4th. They must at this centre be collated and their indications interpreted by persons having a competent knowledge of the laws to which the motions of the storms are subjected. 5th. I do not think the military posts as now established will be sufficient to fully carry out the plan; additional stations would be required. 6th. An appropriation would be necessary for the pay of the telegrams, furnishing the instruments, and the necessary superintendence."

And Professor Elias Loomis, of Yale College, author of a valuable text-book upon Meteorology, writes to General Paine upon the same subject at length. He says:—

"It is believed that our knowledge of storms is already sufficiently precise to enable a competent meteorologist to furnish information which would be of great value to commerce, provided he had at his command a sufficient corps of observers scattered over a considerable area to the west and south-west, and also had the means of transmitting this warnings immediately by telegraph; and if such a system were pursued for several years, it could scarcely fail to conduce to more precise knowledge, which would render it possible to give more reliable and definite warning of the approach of dangerous storms.

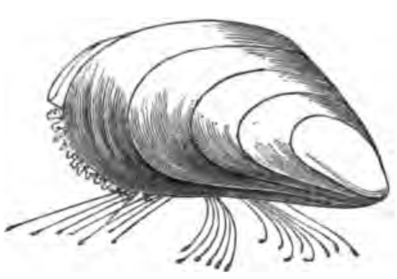
"In order to secure the objects here contemplated, it would be indispensable to have observations from a pretty large number of stations, at intervals not exceeding one or two hundred miles, and scattered over a region to the west and south-west of those points for which the warnings were regarded as specially important. These observations should include all the usual meteorological instruments, but more particularly the barometer, with the direction and force of the wind. The observations should be made daily at fixed hours, and should be reported by telegraph to some competent meteorologist, whose business it should be to compare the reports without delay, and make the proper deductions from them; and whenever a violent storm was in progress, to decide in what direction and with what velocity it was travelling; determine what places it would visit, and at what hour it would arrive: and finally transmit the announcement immediately by telegraph to those places especially interested. Such a system could not be expected to attain satisfactory results without a pretty large number of well-selected stations, and especially without the service of a competent meteorologist to superintend the entire system. The superintendent should be well informed respecting the progress which has been already made in this department of science; he should have strong faith in the practicability of attaining useful results by a system of storm-warnings; and he should have no other engagements which would prevent him from giving his whole attention to this subject, especially whenever a violent storm was raging in any part of the United States."

These coincident views of the two highest authorities in the United States upon all matters relating to meteorological science doubtless foreshadow substantially the actual working of the system when it shall have been fully established. In due time we may reasonably expect to see every lighthouse and other prominent and sightly point upon the borders of the great lakes and the Atlantic coast connected by telegraph with a central meteorological bureau, to which intelligence of an approaching storm can be simultaneously and speedily conveyed—to be in turn communicated, by means of a uniform system of signals, to all vessels within reach, in ample time to enable them to prepare for the coming danger.

That the results of the operation of this system will be in the highest degree valuable, both as regards the immediate practical object of protecting our commerce from disaster, and as furnishing an aid to scientific investigation in a most important direction, there can be no reasonable doubt.

MUSSEL CLIMBING.*

CAN any one see a snail travel, and not ask mentally, "how it does it?" The method certainly is curious. A fleshy disc is protruded, and caused to project in the direction of locomotion; it is then spread out flatly, and while slightly adhering to the object over which it is passing, a contractile energy is exerted, and the little animal bearing its house is drawn onward. Thus by the repeated protrusion, expansion, and contraction of this soft organ, in due time its journey is accomplished. Because of this method of progression on a ventral disc, all those shell-fish, or, properly speaking, molluscan animals, so constituted, are called by the systematists, gasteropods, a term which means ventral-footed. And in rank these gasteropods stand next to the most highly organized of the mollusca. But some of these shell-encased creatures do not travel at all. Take, for instance, the oyster, called a monomyary, because the valves are held together by a single muscle. This sedate bivalve once settled, probably never moves from that spot. But all the dimyaries, or two-muscled bivalves, well represented by the common edible mussels, possess a foot, which is not greatly unlike that of the snails. The mussel's foot, however, presents, in its class, the least developed condition of this organ, for it is a spinner rather than a walker; or, as Owen says, "it is subservient to the function of a gland, which secretes a glutinous material analogous to silk, the filaments of which are termed the byssus," which often serves for attachment to rocks. He farther says, "in most dimyary bivalves the foot is an organ of locomotion." Some of the river mussels in babyhood spin a byssus with which to moor themselves against the currents of the stream. When older grown this necessity is overcome, and the capacity just mentioned is lost. Then the adult turns its foot into a ploughshare, and is dragged along in the furrow it makes in the mud. The razor-shell alternately bores downwards and propels upward, the foot doing all the work. With the foot as an elastic spring the heart-shell leaps along. But the common black mussel, *Mitylus edulis*, and its despised neighbour, the brown horse-mussel, *Modiola plicatula*, who ever saw them walk? Propulsion is not always walking. The scallop with its large adductor muscle, by snapping together its light valves, thus forcibly ejecting the water within against the water without, flits through, and sometimes even skips upon its native element, like an aquatic butterfly. But no pedestrian does so in all Mollusca-dom. Why then should not these pedate bivalves, the mussels, walk as others of their own people do? "For want of brains!" says one. You are mistaken, sir. They have brains, the right kind too, and in the right place,—a real pedal nervemass, or ganglion; a little bilobed brain at the very base of the "understanding" itself, that is, exactly nuder the foot, as was fabled of a very agile dancer, that his brains were in his heels.



Now, if seeing is believing, mussels can walk. We once saw a young brown mussel, of the species *Modiola plicatula*, about five-eighths of an inch in length, turn his foot to most excellent account. We had pulled the youngster's beard off, and then had deposited him at the bottom of a deep aquarium. The water was probably but poorly aërated, hence he was evidently ill at ease, and to our astonishment he at once began travelling over the pebbly bottom, then up the glass side, with the utmost facility and grace. The foot moved precisely as any univalve gasteropod would do, and with the same easy gliding motion. The movement was continued without interruption until it had reached the surface of the water, a distance of not less than 10in., which, added to the distance travelled over the bottom, was probably equal to 14in. At the surface it lost no time in spinning its byssus, which it fixed to the side for a permanent abode.

For its lively colours, perhaps ruthlessly, we had picked this little fellow out of a large family cluster, snugly packed in a hole in one of the piles of the dock. It was a large group of all sizes, literally bound together by the silken cords of—attachment shall we say?

A fellow captive was a full grown, black, edible mussel, torn from its anchorage, a stone near by, at low tide. We afterwards found ensconced in this black shell an amount of intelligence which filled us with astonishment. If his youthful fellow-prisoner could beat him at walking, he was about to accomplish the feat of climbing to the same position by means of a species of engineering of a very high order.

In order the better to understand this singular feat, let us introduce it by the narration of some spider tactics we once witnessed. The insect had captured a large beetle, but could not get it to its web, and seemed indisposed to prey upon it away from its den. It had dragged the prey under the web, which was about two feet above. It ran up to a point close by its web; there it attached a thread by which it speedily descended, and then attached the other end to its booty. Again it ascended, affixed another thread, then descended and affixed to the prey as before. Each thread, in sailor phrase, was made taut. After a good many threads had been in this manner attached, each being stretched tightly, and each pulling a little, the weight was seen to ascend a small fraction of an inch. Again the threads were increased, and again the weight ascended a little more; until at last, after incredible labour, perseverance and skill, the little engineer had the satisfaction of success; for its well-earned booty, with one final, tiny jerk "brought up" at the desired spot. The explanation of all this is simple. Suppose we take a cord of the material known by the ladies under the name elastic, and attach it to an ounce weight. If but very moderately stretched it would certainly pull at least a grain. Supposing it to do that, a second one would pull with equal force, and it would be but a simple estimate to determine how many threads would be required to raise the entire weight. But enough of this. Now for the mussel.

Placed at the bottom of the aquarium, where it had been for a couple of days, it had succeeded in wriggling itself up to one of the glass sides of the tank. This accomplished it protruded its large foot, stretching it up as high on the glass as it could reach, this organ seemingly adhering very tightly. A little hole opened near the extreme forward end of the foot. This tiny hole was really the extremity of a folded or closed groove. Out of this a drop of white gluten, or mucus, not larger than the head of a pin, was exuded and pressed against the glass. There was then a slight withdrawing of the foot, simultaneously with an unfolding or opening of the groove, which contained, as if moulded there, the already completed delicate thread. This done, the partly contracted foot (not drawn into its shell at all, be it understood) was again extended, this time a little higher than before. The groove or spinneret was again closed, except the little opening on the surface of the foot, whence another little drop of mucus appeared, which also was pressed against the glass. Again the foot was withdrawn a little, the lips of the groove unfolded, and the moulded thread set free. This gave thread number two. Each was evidently set at considerable tension. And in this wise, thread after thread was formed and set. I regret that I did not record the exact number, but am sure that it was about twelve or sixteen, and the time occupied was between two and three hours, when lo! up went the mussel, about three-eighths of an inch high. Yes, he was drawn up by his own cords. He was literally lifted from *terra firma.* Not at all suspecting what was to follow I mentally exclaimed "This little fellow knows the ropes."

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* By Rev. S. Lockwood, Ph.D. in the *American Naturalist*.

There was next a period of rest. Whether it was due to exhaustion of material, and was meant to allow the secreting gland time to evolve a fresh supply or not, I cannot affirm; but may say that such was my belief, for after an hour or so it set to work again precisely as before, attaching a new cluster of threads. This cluster was set about ⅜in. higher than the previous one. When this new group of filaments was finished, the same result followed, another lift of a fraction of an inch, but not quite so high as the first. I now suspected its motive—the animal was actually in this singular manner attempting to reach the surface. It wanted to take an airing, and was really in a fair way to bring it about.

While setting its third cluster of threads, I foresaw a serious difficulty in the way, and one against which the spider never has to contend. It was this: after the third lift had been achieved the threads which had accomplished the first lift had changed direction; that is, the ends of the threads, which had pointed downward when pulling up the mussel, were now pointing upward, and were actually pulling it down. Of course the lowermost thread or threads would exert the most retrograde traction. Thought I, "Sir Mussel-man, you will have to exercise your wits now." I rejoice to say that the ingenious little engineer was complete master of the situation. The difficulty was overcome in this way—as each lowest thread became taut in an adverse direction, it was snapped off at the end attached to the animal. This, as I think, was done by two processes; the one by softening that end of the thread by the animal's own juices, purposely applied, as the pupa in the cocoon moistens its silk envelope, when wishing to soften the fibres, so that it can break a hole through which the imago may emerge; the other by a moderate upward pulling, thus breaking the filament at its weakest point.

The next day our little engineer had accomplished the wonderful feat of climbing to the surface by ropes fabricated during the ascent. Without delay it moored itself securely by a cluster of silken lines at the boundary where sky and water met, and was there allowed to enjoy the airing it had so deservingly won. Bravo! my little Mussel-man! No acrobat can beat thee on the ropes.

And what are we to say to all this? Blind instinct, forsooth! Who believes it? The wise men of the ages have written as the tradition of the elders—"byssus-bound," of our Mytilus. But it can make of its bonds mooring lines of safety against the storm, and with consummate skill can build a silken stairway into its own wished-for elysium of delight. It is some three years since the writer witnessed the facts here recorded, and to this day the sight of a mussel inspires him with profound reflection on the ways of Him who made these creeping things of the sea.

Note.—It has seemed to the writer, that in the perfection of movement shown by the *Modiola plicatula*, as given above, a high stage of foot development is indicated, such as would hint at a grade out-ranking *Mytilus edulis*. The figure inserted is that of *M. edulis*; but the process of climbing is the same.—S. L.

THE STORY OF A PIECE OF GRANITE.

By J. E. Taylor, F.G.S.

THERE are few rock substances on the surface of the globe which have received more discussion and been more investigated than myself. I am somewhat proud of the attention I have received in this respect, for most of the leading geologists of every country, for the last century, have devoted themselves to the task of seeking out my antecedents. I am acquainted with a whole library of books, all most learnedly written, and various of them proving the reverse of the other, which have been penned on this inexhaustible subject. Even yet the question can hardly be regarded as finally settled. Every now and then some moot point or another crops up to engage the attention of philosophers, but, thanks to the progress of other sciences, the investigation of these is no longer confined to verbal expressions. It is not a little amusing to remember the hot discussions which were held over me at the beginning of the present century. Philosophers though they professed to be, the disputants resembled political squabblers more than anything else. One set declared I was born amid fire,—the other that I was of purely watery origin. Each believed in their own *ipse dixit*, and, as nothing could be absolutely proved, backed their own opinions by personalities. Somehow or other the former sect, who were called Plutonists, got the better of the latter, who were termed Neptunists. (The origin of these phrases my readers will not find it difficult to understand.) But my Plutonic commentators carried their victory too far. Not content with proving that I was not a mere aqueous rock, they proceeded to declare I was nothing more nor less than one which had cooled down from a fused condition, something like iron slag; nay, it was even urged that I was older than any other rock, and the theorists mapped out an idea—which existed for many years after, chiefly owing to its remarkable novelty—showing how the whole universe was formerly one great cosmical fog; that this diffused matter was condensed into suns, planets, and satellites, each of which existed for ages in a molten condition, owing to the heat evolved during the process of condensation; that the exterior of each planet cooled during the time which followed, and that granite formed part or whole of this cooled envelope! Such in brief was the orthodox notion of my birth, little more than a quarter of a century ago.

Shall I enlighten my readers a little as to the nature of my mineralogical composition? I feel sure that most of them are acquainted with it already, but, if only for form's sake, I must go through with it again. My name is of Latin derivation, and was given me on account of the granular character presented by my different minerals. Generally speaking, these are four in number—quartz, felspar, mica, and hornblende. Very frequently there are also traces of other minerals; but these are the commonest, and those in fact which make up my bulk. The quartz portion you may tell by its glassy appearance, and usually milk-white colour; whilst another good test is its superior hardness. This mineral is almost pure silica, and is one of the most refrangible of known substances. It can with difficulty be slightly dissolved in hot water, under great pressure; whilst it requires a great deal of heat to melt it, and, generally speaking, some sort of flux to set it a-going. The next most abundant mineral in the constitution of myself and relatives (for our name is legion) is that called felspar. Your eye may detect it in any mass, by its pink or flesh-colour, whilst it is so soft that you may scratch it with your finger nail. It is owing to the unusual abundance of this mineral that I am sometimes so friable or "rotten," as the felspar decomposes, and then causes the other minerals to fall asunder, just as the bricks of a wall would if all the cementing mortar were to decompose away, In many districts, as in Cornwall, where granite comes to the surface and has been subjected to atmospheric wear-and-tear for hundreds of ages, it is not uncommon to find the fine felspar washed into a newer deposit. Such is the well-known "kaolin," or China clay of commerce. The chemical composition of felspar is more complex than that of quartz. For instance, although its commonest elements are silica and alumina,—the former the base of common sand, and the latter of clay,—there are also contained in it more or less of soda and potash, lime, magnesia, and iron. Mica, the next commonest mineral I possess, is so well known as hardly to need description. All my readers are surely familiar with the small, thin, silvery-looking scales contained in almost every piece of granite. Its ingredients are much like those of felspar, only differently mixed. Frequently hornblende is a mineral entering into our composition, and my listeners will readily remember it from its black or dark olive-green colour. When it is very abundant, it produces a rock varying from dark grey to black. A great number of what may be termed varieties of hornblende are known to mineralogists. Its chemical composition, generally speaking, is about one-half silica, more than a quarter magnesia, and little more than half a quarter lime: besides these, there are usually traces of iron, alumina, and fluoric acid.

I mentioned above that I had many relatives, who were more or less nearly connected (I cannot say by blood, but by mineralogical similarity of composition). These take various names, on account of their leading peculiarities. Among these the commonest is porphyry, which takes its name from the purple variety used by the ancients in making vases, &c. This my hearer may know from the large and distinct crystals, usually of felspar or quartz, which are embedded in the granular matrix. Through porphyry granite passes into all sorts of allied igneous rocks, such as claystone porphyry, clinkstone porphyry, felspar porphyry, and so on. When hornblende takes the place of mica in the composition of granite, the latter goes by the name of syenite; when talc supplants mica, the result is called protogine. A fine-grained compound of felspar and granite, with equally minute scales of mica, gives to us the varietal name of pegmatite. According to the number of minerals entering into our composition, I and my relatives are roughly classed as binary, ternary, and quaternary granites. All this detail of structure may sound very dry and tedious; but it is absolutely necessary to go through with it, if my listeners wish to be more intimate with me.

Although I have not a distinct recollection of my birth (as indeed, who has?), yet I have more than a suspicion that such elements as soda, potash, lime, &c., greatly assisted as fluxes in bringing me into my original molten condition. I have mentioned the great number of relatives which claim near or distant kinship with me, and I have now only to remark that their affinity to myself has been determined solely by the different circumstances attending their origin. I distinctly and utterly refute the idea that the first-formed crust of the globe was a granitic one! I am fully persuaded it could not possibly have been granite, and I will give you my reasons by-and-by for this seemingly bold assertion. What that cooled crust was, I doubt if science will ever be able to discover. But the fact that it was not granite does not in the least invalidate the theory that every sun, planet, and satellite was so condensed from nebulous matter. This theory must rest on other grounds, and, singularly enough, additional facts are coming to its support every day. We have not the slightest idea of what the primitive rock or crust of the globe was. The antiquated notion that it must have been granitic arose out of mistaken associations. It was found that, however old might be a stratified rock, whether containing fossils or not, some variety or another of granite was older still. Hence followed the hasty deduction, that originally one granitic crust encircled the fluid matter of the interior of the earth. It was shown how subsequent rocks were themselves formed out of the wear-and-tear of this granite, how the latter was in many places covered up by its own débris, and how the so-called metamorphic rocks were those first formed as stratified deposits, but altered to their present appearance through the intense heat of the newly-created seas, along whose bottoms they had been elaborated.

All this is wrong, and it behoves me now to descend from the region of pure hypothesis to that of pure fact. It is just possible, speaking generally of all the varieties of my family, that Protogine may be oldest. This, however, has never been thoroughly determined. One of my reasons for believing I could not have required any very great heat to reduce me to the molten condition, and that in this process the agency of water, as well as of heat, was necessary, is as follows:—Many of the larger quartz crystals entering into my composition are hollow. Frequently these hollows are more or less filled with water. Now, it is a known *fact that* molten matter at a white heat requires *its temperature* to be considerably lowered *before it can even* evaporate the water mechanically mixed with it. *It* has been recently shown that crystallized matter which has undergone pure igneous fusion, has usually cavities in its crystals, not containing water, but either stony matter or a kind of glass, and, in many cases, even a perfect vacuum. Hence the conclusion is arrived at that in the case of coarse-grained granite, containing much quartz, there is actually more proof of the action of water than of dry, ingneous fusion. It is more than probable, therefore, that pressure, heat, and water combined, in the deeply-seated parts of the earth's crust, would cause the rocks to be reduced to a kind of paste, and that this paste would be some variety of granite. I can hardly enter into the abstruse details of the deductions which have been made from the chemical and microscopical examinations of myself and relatives. Suffice it to say they result in proving that *pressure*, and this, generally speaking, of overlying rocks stratified or otherwise, is a preliminary and indispensable necessity to the formation of granite; that, if pressure be absent or less than that required, notwithstanding all the other requirements may be present—such as heat, similarity of mineral ingredients, &c.—such a resulting igneous rock would *not* be granite! It might be a variety of porphyry, or basalt, or greenstone, or, if all pressure were removed, and the molten matter allowed to cool in the open air, simply ordinary lava! From a microscopical examination of various granites, it has been shown that those of the Highlands of Scotland indicate their having been formed under no less a pressure than 26,000ft. of overlying rocks more than were the granites of Cornwall. There is good reason for believing the latter to have required at least 40,000ft. of rock-pressure; so, in that case, the granites of the Highlands must have been formed when 66,000ft. of overlying rocks were piled above them!

One is naturally astounded by the magnitude of these operations, but I assure my hearers there is little doubt as to the general correctness of the deductions. In this way the mineralogical construction of myself and others supplements the teaching of organic remains as to the immense antiquity of the globe! Nothing short of an eternity of time would have sufficed for all the changes which have been rung upon it. There is reason to believe many of my granitic relations are nothing more or less than *re-melted* stratified rocks, and their enclosed fossils! As these have been slowly depressed or submerged, so as to bring the lowest-seated portions within the influence of the earth's internal heat, they have been first metamorphosed into a similar condition to gneiss and mica-schist, and, if the sinking went on, have passed through this stage into that pasty condition which deprived them of all stratified structure, and converted them into what I am myself! Then succeeded a reversal of the movement; so that this granite would be thrust slowly upwards with all the overlying strata piled above it. The movement went on until these were tilted into a continuous mountain-chain, high and extensive table-lands. Meantime the anite nucleus would form the heart of such ountains, the strata dipping away, as in the imalayas.

I fancy I hear some of my listeners remarking—But if granite can only be formed under such mmense pressure, how is it we find such large reas of country where nothing else is to be seen?" a the answer to this we have the gist of the arguent, and I would respectfully ask the special ttention of my audience to it. Let them ask themlves where the materials came from to form the aurentian, Cambrian, Silurian, Devonian, and, in hort, all the other subsequent formations? They ould only have been formed out of the waste of till older and already solidified rocks. Each rmation, therefore, represents the amount of ear-and-tear which went on during the period hen it was deposited. If there had been no ompensation against this levelling process, all he prominences would soon have been worn down o a common level, and the elaboration of more ecent deposits been self-checked. But each suceeding formation shows that this was not the case, ut indicates that the physical arrangements of our lanet have been much the same through all time o what they are at present; that atmospherical nd marine wear-and-tear were counterbalanced by pheaval from beneath; that the exterior force manating from the sun and resulting in all these tmospherical effects, was exactly adjusted by the ative force of the earth, exerted from the interior utwards. These two have been in equable counterpoise from the beginning, otherwise the great ife-scheme of our globle would never have had time or its development!

I hope I have been successful in explaining a great difficulty, and that my listeners now see the reason why I and my relatives come to the surface. It is because the rocks which overlay me at my birth have since been stripped off and slowly removed by atmospheric agencies. All the formations which were then piled above me, are to be found in stratified rocks of later date; therefore, the period of my birth is not limited to any particular geological epoch. I am found at the surface, surrounded by rocks of every age, even including those of the Tertiary. Wherever the pent-up force of the earth's interior has thrust us up, there have we slowly elevated the rocks lying upon us. In many cases this elevation has been so slow that it has hardly exceeded the rapidity with which these overlying rocks have been denuded away! Think of the vast antiquity of our earth's crust, as indicated by these facts alone! Since the granites of the Highlands of Scotland were formed, twelve miles of overlying material must have been removed! Where has it all gone to? Ask the nineteen miles in vertical thickness of the known stratified rocks, all of which have probably been formed since the granite itself. We scarcely need be afraid of Time, when we have Eternity to draw upon!—*Science Gossip.*

ASTRONOMICAL NOTES FOR SEPTEMBER.

By a Fellow of the Royal Astronomical Society.

The right ascension of the sun on September 1st, at Greenwich mean noon is 10h. 41m. 41·22s., and his declination north, 8° 16′ 21·3″; he is consequently to the W. of the star χ Leonis (map, Vol. X, p. 545). He is now approaching the equator; and at 9m. past 6 on the morning of the 23rd, crosses it; when autumn commences. This is, of course, the period of one of the equinoxes, so called from the approximate equality in length of the day and night. The nearest approach to such equality will, however, occur on the 25th, when the day will be about 12h. 1m. long; and the length of the night obviously 11h. 59m. The equation of time to be subtracted from that indicated by any instrument constructed to show the sun's meridian passage, is on the 1st day of the month, 0m. 6·1s., and on the last day, 9m. 59·46s.

The moon enters her first quarter at 58m. past 1 in the afternoon of the 2nd; is full about 12m. past 10 on the night of the 9th; enters her last quarter at ½ past 1 a.m. on the 18th; and is new at 6h. 34m. a.m. on the 25th. At noon on the 1st she is 5·6 days old; at the same hour on the 2nd, 6·6 days old; and so on. On the afternoon of the 6th, at 3 o'clock, libration will bring an additional portion of her S.W. surface into view, and the same cause will operate in rendering more of her S.E. region visible at 1 o'clock in the morning of the 21st. She will be in conjunction with Saturn at 10h. 43m. a.m. on the 3rd; with Jupiter at 9m. past 2 in the early morning of the 18th; with Uranus at 53m. after noon on the 20th; with Mars at 10h. 36m. the next morning; with Venus at 7h. 13m. in the evening of the 23rd; with Mercury at 3h. 11m. a.m. on the 26th; and finally, with Saturn again at 12m. past 6 in the evening of the 30th. She will have occulted him (as will be mentioned immediately) 8m. previously. Three fixed stars and—as we have just said—Saturn will be occulted this month. Firstly, B.A.C. 6448 will disappear at the moon's dark limb at 8h. 7m. on the night of the 4th, and reappear at her bright limb at 9h. 25m. On the 13th, ξ^2 Ceti will disappear at the moon's bright limb at 9h. 27m. and reappear at her dark limb 6m. afterwards. On the 16th, ι Tauri will disappear at the bright limb at 10h. 11m., reappearing at the dark limb at 11h. 7m. Lastly, Saturn will disappear at the dark limb of the moon at 6h. 4m. p.m. on the 30th, and will emerge from behind the bright limb at 7h. 18m.

Mercury is an evening star during September, attaining his greatest eastern elongation at 4h. 33m. in the early morning of the 8th. Having passed this he becomes apparently stationary on the 21st. On the 16th, at 4h. 54m. p.m., he will be in conjunction with the bright star α (Spica) Virginis. He continues in the constellation Virgo all this month. He rises not long before 8 o'clock in the morning at the beginning of the month, and soon after 7 at the end of it; setting at those periods soon after 7 p.m., and about 5h. 30m. p.m. respectively. He souths on the 1st at 1h. 33m. p.m., and on the 30th at 14m. past noon. Venus is a morning star throughout the month, rising on the 1st about 2h. 50m. a.m., and on the 30th about 4h. 17m. a.m., southing at 10h. 25m. a.m., and 10h. 49m. a.m., and setting about 6h. and 5h. 20m. p.m. on those days respectively. She travels from Cancer into Leo during September, and is in conjunction with Regulus at 4h. 48m. a.m. on the 14th. She is in perihelion at 4 in the afternoon of the 20th. Mars is also a morning star, and a little more favourably situated for observation than he has been; albeit he is still an exceedingly minute and insignificant object. He rises somewhere about 8m. past 1 a.m. on the 1st, souths at 8¼m. past 9 a.m., and sets about 5h. 16m. p.m. On the 30th he rises about 0h. 48m. a.m., souths at 8h. 27m. a.m., and sets about 4h. 9m. p.m. He is in the constellation Cancer during the entire month; and in conjunction with μ^2 Cancri at 8 o'clock in the afternoon of the 1st. Jupiter rises on the 1st, about 10h. 31m. p.m., and about 8h. 53m. p.m. on the 30th; after which he is visible all night long. He souths on the 1st at 6h. 51m. a.m. and on the last day of the month at 5h. 8m. a.m. He still remains in Gemini.

The visible phenomena of his satellites during the month of September will be as follows. On the 1st day of the month, the first satellite will be eclipsed at 12h. 18m. 22s. The shadow of the second will pass on to Jupiter's disc at 48m. past 1 in the early morning of the 2nd; the first reappear from behind the planet's body at 3h. 49m., and the shadow of the second will pass off Jupiter's limb at 4h. 20m.; 8m. *afterwards this second satellite will commence its own transit.* This, as most of the readers of this column are aware, is referable to the relative position of the Sun, Earth, and Jupiter: in fact, on the 18th of this month, just 37m. before noon, Jupiter will be in quadrature with the Sun; that is to say, a line drawn from Jupiter to the Sun will form a right angle with one drawn to the sun from the earth. Any one who will make a diagram of this upon a piece of paper, will see how very obliquely the shadows of Jupiter's satellites will fall upon his disc relatively to our line of sight, and hence how it is that their shadows may traverse the whole width of that disc before the moons which cast them come on to it at all. On the night of the 2nd, at 11h. 46m., the egress of the shadow of satellite 1 will take place. The satellite itself will not pass off the disc until 5m. past 1 the next morning. At 1h. 51m. in the early morning of the 4th, the second satellite will reappear from occultation. On the night of the 5th, at 46m. after midnight, the third satellite will begin to transit Jupiter's disc, and will pass off afterwards at 3h. 12m. On the early morning of the 9th the first satellite will be eclipsed at 2h. 11m. 45s., and the shadow of the second come on to the planet's limb at 4h. 22m. On the 9th the ingress of the shadow of satellite 1 will take place at 11h. 26m.; the satellite will come on an hour and twenty minutes later. The shadow will pass off at 1h. 40m. a.m. on the 10th, and the moon itself at 1m. past 3. On the night of the 10th satellite 2 will be eclipsed at 11h. 12m. 23s., and satellite 1 reappear from occultation at 13m. after midnight. The second satellite will reappear from eclipse at 1h. 41m. 27s. a.m. on the 11th, only to be occulted by the body of the planet at 1h. 54m. It will reappear from this occultation at half past 4. On the 12th the ingress of the shadow of satellite 3 will occur at 11h. 25m., and its egress at 48m. past 1 in the next morning. An eclipse of the first satellite will take place at 4h. 5m. 8s. a.m. on the 16th of the month. At 1h. 20m. a.m., on the 17th, the ingress of the shadow of the same satellite will take place, the satellite following its shadow at 2h. 40m. The shadow will pass off at 3h. 34m. Satellite 2 will be eclipsed at 1h. 49m. 3s. a.m. on the 18th, and the first reappear from occultation at 6m. past 2; the second will reappear from its eclipse at 4h. 18m. 29s., and be occulted by the planet at 4h. 32m. a.m. At 11h. 24m., on the night of the same day, the first satellite will pass off Jupiter's disc. On the night of the 19th, the egress of the shadow of satellite 2 will occur at 10h. 46m.; the moon casting it will come on 10m. afterwards, and pass off at 1h. 33m. the next morning. The ingress of the shadow of satellite 3 will take place at 3h. 25m. Satellite 3 will be occulted at 10h. 42m. on the 23rd, and reappear from occultation at 1h. 10m. the next morning. The ingress of the shadow of satellite 1 will take place at 3h. 14m. a.m. on the 24th, and the moon itself follow it at 4h. 34m. At 26m. 52s. past midnight on the 24th, the first satellite will disappear in eclipse, and afterwards reappear from occultation at 3h. 59m. a.m. on the 25th; the second satellite will be eclipsed at 4h. 25m. 38s. At 11h. 2m. at night, on the same day, the first satellite will begin to transit Jupiter; its shadow will pass off at 54m. later, the satellite itself leaving the planet's limb at 17m. past 1 the next morning. On the night of the 26th satellite 1 will reappear from occultation at 10h. 27m. The shadow of satellite 2 will come on to Jupiter's disc at 10h. 46m., and pass off again at 1h. 20m. the next morning. Eight minutes afterwards satellite 2 itself will commence its transit and leave the face of the planet at 4h. 4m. This same moon will reappear from occultation at 11 o'clock on the night of the 28th. Finally, on the night of the 30th, satellite 3 will reappear from eclipse at 11h. 36m. 32s.; will be occulted at 2h. 35m. the next morning, and come out from behind the planet at 5h. 3m.; while 5m. later the shadow of satellite 1 will appear on the disc.

Saturn is still an evening star, but must be looked for early, as he sets between 10 and 11 at the beginning of the month, and between 8 and 9 at the end of it. He is on the meridian at 6h. 42m. in the evening of the 1st, and at 4h. 52m. in the afternoon of the 30th. The time has practically past for favourably observing him. He remains on the confines of Ophiuchus. Uranus is a morning star, rising about 6m. past 1 a.m. on the 1st, and about 11h. 10m. on the last days of the month respectively. He comes on to the meridian in broad daylight all through September, and can only be observed during the hour or two which precede the morning twilight. He is situated throughout September on the confines of Gemini and Cancer. Neptune is not on the meridian until 38m. past 2 on the night of the 1st, but rises about 8 o'clock. He will be a little way to the N.W. of μ Piscium during the entire month, his motion being so exceedingly slow.

Shooting stars are rare in September. There is just a suspicion though of the existence of two periodical showers—one at the beginning of the month, the other in the interval between the 18th and the 25th.

LETTERS TO THE EDITOR.

[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]

*** All communications should be addressed to the Editor of the English Mechanic, 31, Tavistock-street, Covent Garden, W.C.

All Cheques and Post Office Orders to be made payable to J. Passmore Edwards.

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"I would have every one write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks: a vice from whence great inconveniences derive their original."—*Montaigne's Essays.*

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*** In order to facilitate reference, correspondents when speaking of any Letter previously inserted will oblige by mentioning the number of the Letter, as well as the page on which it appears.

THE HERSCHELIAN TELESCOPE.

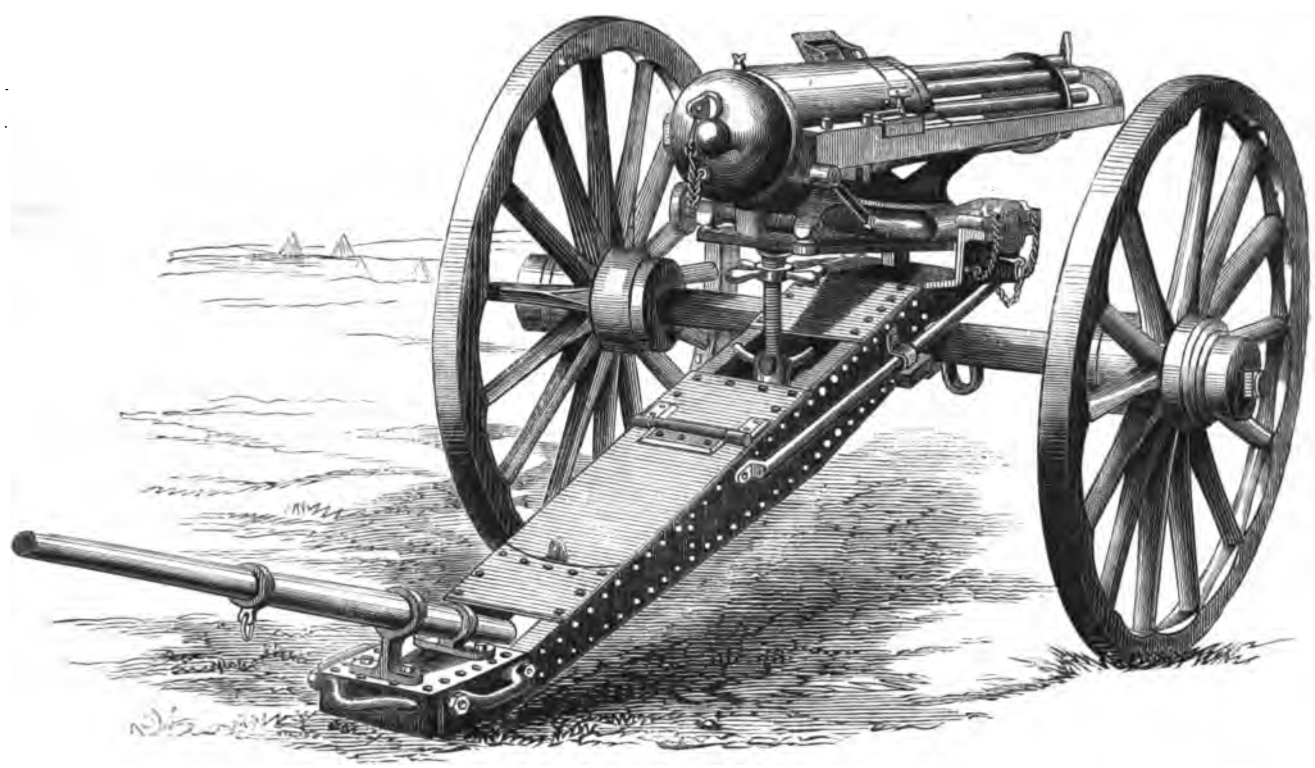
[289] Sir,—In my reply to Mr. White there is an error. A picture in Nichol's "Cyclopædia of the Physical Sciences," deceived me as to the arrangement actually adopted by Herschel. In this picture the axis of the eye-piece is not directed as it should be to the *centre* of the speculum, but parallel to the axis of the tube. This is the arrangement corresponding to the theoretically just way of making a Herschelian telescope, the vertex of the paraboloidal surface to which the mirror belongs falling on the edge of the mirror nearest to the eye-piece. Herschel in reality only tilted his mirror, an arrangement obviously imperfect. But he did not tilt it so that its optical axis passed through the centre of the eye-piece, as in Mr. White's arrangement. Had he done so, he would have had no field of view. He so tilted the mirror that its optical axis had a position mid-way between the axis of the tube and the axis of the eye-piece (regarded as an indefinitely long straight line). In this way the image formed by the mirror was formed by oblique pencils.

Richard A. Proctor.

MR. FIRTH AND "F.R.A.S."

[290] Sir,—I really think that it is too bad of Mr. Firth to continue his absurd comments on the valuable Astronomical Notes by "F.R.A.S." All the readers of the English Mechanic owe a debt of gratitude to "F.R.A.S." for the preparation of these most useful notes. But we cannot expect him to contribute so much of his time for our advantage if his labours are to be continually carped at by some who seem unable to appreciate their value.

Mr. Firth's last letter reminds me of an episode in "David Copperfield." Mr. Dick has been installed into apartments somewhat limited in extent, but sufficient for his requirements; Mrs. Crupp, however, remarks that "there's not room to swing a cat," to which Mr Dick makes the apt rejoinder, that "he doesn't *want*



THE GATLING GUN.

end of this period it may go into turpentine (the best refined) and be left there for a week, and *then* it may be mounted in Canada balsam in the usual manner.

In conclusion I may add the reasons of these operations.

1st. The immersion in potash is to extract fatty matter. This should be borne in mind when regulating the *time* that an object should be allowed to remain in the liquid.

2nd. The immersion in water is to extract the potash.

3rd. The arranging being done at this stage is effected easier and better, and is not lost by the after immersions.

4th. The immersion in spirit, is, as before said, to extract the last trace of moisture.

5th. The immersion in ether is to extract the spirit, as well as to, by its permeating qualities, expel any air bubbles that may have got in during the drying and arranging process.

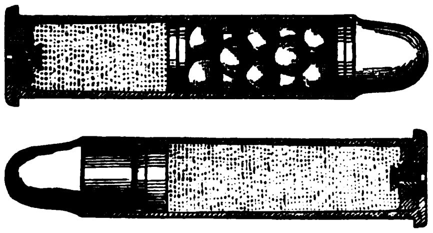
6th and last. The turpentine immersion is to allow some turpentine to take the place of some of the ether, so as to ensure due transparency of the object when immersed in the balsam.

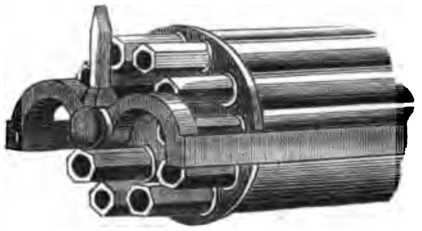
If "Q. Sea" follows these directions, he will be sure of success, even with the largest insects; but beyond everything, let the beginner beware of haste and impatience, for such irregularities are sure to end in dire punishment in the shape of a worthless object.

ACHROMATIC.

THE GATLING GUN.

[294] SIR,—I send you a description, with engravings, of the Gatling gun, or battery, as it has been more properly called. It is the invention of an American gentleman, and was first exhibited in Europe at the Exhibition of 1867. It differs considerably from the mitrailleuse in construction and principle, for whereas he latter weapon can fire 37 shots, either at once or gradually, and must then be loaded afresh, the Gatling gun fires continuously, so long as cartridges are upplied, but it cannot discharge all its barrels at the ame instant. In the mitrailleuse, again, the barrels are fixed, but in the Gatling they revolve. The weapon s made of two sizes—one containing six—the other en barrels, and according to size will discharge from 200 to 400 shots per minute. As many as 1,000 rounds have been fired consecutively, and when it is mentioned that the gun is effective at ranges of 2,000 and 3,000 yards, some idea of its powers may be readily formed. Its main features are briefly summed up as follows:—First, it has as many locks as there are barrels, and all the locks revolve with the barrels. The locks also have, when the gun is in operation, a reciprocating motion. The forward motion of the locks places the cartridges in the rear ends of the barrels, nd closes the breech at the time of each discharge, while the return movement extracts the cartridge shells fter they have been fired. When the ten-barrel gun is being fired, there are five cartridges at all times in rocess of loading and firing, and at the same time, ve of the shells, after they have been fired, are in ifferent stages of being extracted. These several perations are continuous when the gun is in peration. In other words, as long as the gun is upplied with cartridges (which is done by means of "feed-cases," in which they are transported) the several operations of loading, firing, and extracting the cartridge shells are carried on automatically, uniformly, and continuously. The locks operate on a line with the axes and barrels, and are not attached to any part of the gun, but as the gun is made to revolve, they play back and forth in the cavities in which they work, like a weaver's shuttle, performing their functions of loading and firing by their impingement on stationary inclined planes or spiral projecting surfaces. Second, it can be loaded or fired only when the barrels are in motion—that is to say, when the barrels, the inner breech, &c., are being revolved. Third, it may justly be termed a compound machine gun, since the ten barrels, each being furnished with its own loading and firing apparatus, form, as it were, ten guns in one. This is a valuable feature, for in the event of one of the locks or barrels becoming impaired, those remaining can still be used effectively. As will be seen from the engraving I send, the cartridges are supplied by means of a hopper, or inclined trough, and are of two kinds, the one containing a solid bullet or rather shot, the other made up of several shots which are intended to "scatter" before reaching the object fired at. The "solid" cartridge contains a shot of half a pound weight, is of 1in. calibre, and is for use at long ranges; the other is of the same calibre, and contains 15 buckshot and a terminal ball, and will be principally used against masses of cavalry or infantry, or for short ranges in general. The weapon has hitherto been made of but two calibres, 1in. and ½in., but there is no reason to doubt that mechanical ingenuity will go far beyond this limit.





F. G. R., late H.M.R.A.

THE MICROSCOPE.

[295] SIR,—As my own stock of books is somewhat limited, and as I am in the habit of getting others from only four of the London libraries, it would perhaps be stating too much were I to say that no work has ever been published, giving such a vast amount of interesting and useful information upon so many and varied subjects as the ENGLISH MECHANIC. If, however, any of your numberless readers with greater facilities than myself for procuring books, and more time for reading them, should have come across such a work, they would confer an infinite favour upon your correspondent by forwarding its name for insertion in your next issue. There is not a number of the MECHANIC you have sent out, from its commencement to the present time, that I have not gone over; and I look forward to its appearance almost as anxiously as I do for my daily bread.

Not being a "muscular Christian," I have at times thought there has been too much of your space taken up by the bicyclists; and as my experience of astronomy is that the science is more frigid than fascinating, I may perhaps have been a little jealous at the attention the telescope has received in our journal. I myself have a hobby, and I pity the man that has not; mine is the microscope, and I am only too glad to see it receiving more notice in your pages. I should not like to say I have worked at the subject, lest it might imply more than I intended; but after spending many very pleasant hours, I have got to know something about it, and any experience I have gained I shall be happy to place at the disposal of your readers.

I was on the point of writing you a few lines after reading the paper by E. R. Lankester a few weeks ago, for I do not agree with him *in toto*; but fearing it might be construed as an advertisement for certain makers, I refrained. To any one about to purchase an instrument, let me give one word of advice. Get an English stand. The demand is so great, and the competition so active, that, for the more moderate priced ones, nothing is gained by going abroad. Every pattern that has anything to recommend it can be obtained at home; and a person, by paying a visit to the different opticians in town, or writing for their illustrated catalogues if in the country, can find no difficulty in suiting his wants and his pocket at the same time. I know most of the English patterns, and many of the continental ones; I have four different instruments of my own, and my preference is decidedly for English stands. They may perhaps be a trifle dearer, but they are better made, better finished, and more satisfactory in every respect. As regards objectives, however, I can endorse what Mr. L. says, though at the same time I will state that some of the English makers have recently been revising their list of prices, and I have seen some very excellent results from an immersion ⅛ at £4 10s. And here, I think, I cannot do better than answer the query of "M. J. C.," No. 4548, "What are the principle advantages of immersion objectives?" 1st. There is greater clearness, and better definition of the image. 2nd. More light is transmitted to the eye than in the dry objective. 3rd. There is less danger of injuring either the object or the objective, as the distance between the two is increased. And last, but not least, they are cheaper. I have seen several magnificent German 1-18ths at £5 13s. (without carriage) almost, if not quite, equal to an English 1-12th, for which the maker would charge twelve guineas. By introducing a film of water between the object and objective, some of the rays of light from the mirror are made to enter the objective, which would pass outside of it if air instead of water separated the two; because a ray passing from a denser to a rarer medium, is refracted from a perpendicular to the plane which divides them. Again, in employing very oblique light, with a hydro-objective, rays are utilized which would be totally reflected with a pneumo-objective.

And now for a few words on common objects, and how to mount them. I dare say that, like myself, many readers of the Mechanic prefer to do as much of the work themselves as possible; I will, therefore, just give the plan I use for cutting all glasses exactly to one size—viz. 3in. × 1in. I have a board, along one side of which is fastened a strip of wood with an accurately straight edge; also two rules, which are respectively less than 1in. and 3in. by the distance from their edge to the cut which the diamond makes (about 1-16in.). The glass, which should be thin flatted crown, is placed on the board with one edge close to the ledge; the wider rule is placed upon it, also touching the ledge, and thus the glass is cut into strips exactly 3in. wide. The strips are then turned at right angles, and with the smaller rule, the slides, 1in. in width, are cut off. Care must be taken that the ends are square before cutting, or the angles will not be right angles. Having got the glasses, the next thing to consider is whether they are to be covered with paper, or to have their edges ground. The latter process is somewhat tedious; the sharp edge may be taken off on the side of a grindstone, and then smoothed by rubbing on a piece of emery paper laid on a hard flat surface. For slides which are to have cells cemented to them, perhaps the ground edges are the best, whilst for objects which only require the addition of the thin cover, it is perhaps less trouble to cover them with paper; and this is accomplished in the following way:—Cut a strip of thin coloured paper, ¼in. wide and 8in. long, paste one side and place it round the edges of the glass, snip a bit from each corner, both back and front, and then, without wrinkles, carefully lay it down on both sides. Other strips of stouter coloured paper should be cut 1-16th less all round than the slide, and a circle should be cut or punched from the centre; one of these is then pasted on the front, another on the back, care being taken that the apertures correspond; when dry and labelled, and the glass in the centre well cleaned, the slide is ready for the cabinet. For cells, vulcanite rings are very useful, and can be obtained of various sizes. The brass button moulds, which can be obtained at furnishing drapers', also answer well, and are cheap. To fix them the slide should be put on the turntable, a ring of gold size struck on the glass, and after painting one surface of the ring with the same material, it must be dropped on the slide, and a little pressure made use of to expel the air, then put aside to harden. This takes some time it is well, therefore, to prepare a number at once. I think, however, it is the most trustworthy cement that can be employed. Other slides should be prepared with rings of gold size, others with rings of asphalte varnish of different diameters to suit the different sized circles used as covers. Being thus prepared, nothing more is requisite to commence mounting dry objects, a few of which, easy to obtain, and beautiful to contemplate, I will now enumerate.

Perhaps nothing gives less trouble in mounting than the scales which various insects bear on their wings and bodies; and as butterflies and moths are now abundant, a great variety may be secured. Two kinds of scales are found on the male of the common white butterfly, one of which bears a beautiful little tuft at the end. All that is requisite is to take a perfectly clean cover glass, place a wing or portion of wing upon it, press upon it with the tip of the finger, and immediately a number of the scales are transferred to the glass; remove the wing, take up the cover with a pair of forceps, and invert it over a slide on which one of the asphalte rings has been painted; put on a spring clip, and if it does not adhere, holding it for a few seconds above the flame of a spirit-lamp will soften the varnish sufficiently to unite the two firmly together. A small creature with a glistening silvery surface may often be found swiftly gliding about on hearthstones, or in cupboards, as well as in other places,—this is the *Lepisma saccharina*, or sugar-louse. If one of these is captured and stupefied with chloroform, by gently placing a cover upon it, and moving it about lightly, abundance of scales will be procured; care must be taken with all these that the creature is not squeezed so as to make some of its juices exude, or the slide will be unsightly and worthless. Then again there is a number of species of springtails, some found in cellars amongst sawdust, some in greenhouses, in decaying wood, beneath the bark of trees, amongst moss, and in many other places; and many of these are covered with scales; one kind, the *Lepidocyrtus curvicollis*, furnishes a scale which is used as a test for the higher powers. As they are small it is best to place a cover gently on one, and by its struggles the scales will be rubbed off, the exquisite markings on which are almost obliterated by the the least trace of moisture. The wings, legs, and body of the gnat, *Culex pipiens*, are clothed in like manner, and its scales are beautifully iridescent. One of the hunting spiders, the *Salticus scenicus*, has some scales, but they are not quite so easy to obtain. Many British beetles, as the *Curculionidæ*, have their whole surface covered with scales of the most resplendent colours. To mount the scales separately, they must be scraped off; but a far finer slide is made by mounting the whole insect, or the wing-covers only in a cell; it is improved too if the cell is filled with balsam; but of this hereafter.

Portions of the more brightly coloured wings, as of those of the Alpine Blue, form gorgeous objects when the light is thrown down on them from above. A part of a wing, from which the scales have been removed, makes a good transparent object, showing the rows of pits into which the points of the scales are inserted. There is a moth, tolerably common, which flies in the twilight near the ground, called the *Pterophora pentadactylus*, the wings of which are a pure snow-white, the scales are long and thickly set, and intermixed with long compound hairs. Nothing can be more beautiful than this wing, mounted dry, under a low power, with light thrown down upon it from a bull's-eye condenser. Wings of other insects, mounted whole, form valuable additions to the cabinet, as those of *Culex pipiens*, where the scales are seen to be inserted on the nervures of the wings, and forming a fringe all round the edge. Another wing, that of the *Psychoda phalænoides*, is more thickly covered, and with a dark ground illumination—as by the parabola, spot lens, or Lieberkuhn—appears almost as if made of silver. This is a tiny insect, found at dusk on window-panes, where they pop about in all directions, as if they did not know where they were going. A larger insect than the preceding, the *Chrysopa perla*, found flitting about in gardens as it is getting dusk, has clear, pale green wings, which show all the colours of the rainbow when the light falls on them in a certain direction. These are some of the finest, but all are worth examining, and are very little trouble to preserve in the dry way.

Next, I come to some objects which require a protection in the way of a cell. The sand from many parts of the seashore contains numbers of exquisite forms of Foraminifera; that from Dog's Bay, Connemara, is particularly rich; many kinds too are found in the sand which accumulates in drawers in which sponges are kept, or they may be shaken out of sponges when they are new. I think the best way to proceed is to sprinkle a little of the sand on a slide, and place it on the stage, under a low power; I then take a bristle, which is inserted into a bit of stick, and just moistening the tip between the lips pick out those which I require. This is easy enough if the microscope has an erector, but if not, a little practice is required, as the movements appear in the opposite direction to that which you intend. The centre of a cell must be just touched with gold size, the least film possible, or with a little gum; the latter soon dries, but may be moistened again by breathing upon it; on the whole I prefer the former. As the different species are picked out they must be deposited in the cell upon the adhesive medium, and when a sufficient number are obtained the edge of the cell must be lightly touched with some cement, and a cover dropped into its place. Most of these show best with a dark background, and sometimes a circle of black paper is first stuck at the bottom of the cell, or a circle of black varnish is painted on the underneath side; but this prevents the use of the Lieberkuhn, spot lens, or parabola, and can only be used with some of the forms of reflectors, so that on the whole the first mentioned method is to be preferred. From the same source, sponge spicules may be obtained, which appear as if made of the clearest glass spun into a variety of forms: they should be mounted and shown in the same way as the Foraminifera.

Again, quite a cabinet might be filled with the various seeds, most of which show to great perfection, mounted in the way last described. I may mention a few of the more striking ones: foxglove, poppy, pink, henbane, thornapple, mignonette, gentian, pimpernel, snapdragon, tobacco, Escholtzia, St. John's wort, ragged robin, catchfly, chickweed: these are for the most part to be obtained with very little trouble.

Another series of dry objects may be obtained from sections of different woods. Some amount of skill is required in cutting these sufficiently thin, without any special apparatus, but with a very sharp razor it may be done: any one, however, with a little mechanical ingenuity can soon make an instrument for a few pence that will answer every purpose. A shaving of deal from a carpenter's shop will show the pitted tissue, distinctive of the Coniferæ, admirably, but as a rule wood sections are shown best either mounted in fluid or in balsam. The clematis, which does not require cutting so thin as most woods, affords one of the finest sections, and shows as well, if not better, when dry. I need say nothing about pollen, as one of your correspondents has already mentioned it. Portions of the fronds of ferns, displaying the fructification, form beautiful and interesting objects. There are many leaves, too, as the evergreen oak, Deutzia, *Alyssum spinosum*, which are covered with the most exquisite hairs, so that under condensed light the leaves appear as if thickly covered with silver stars. Nothing is required but to dry the leaf thoroughly between blotting-paper, and to secure a portion in a shallow cell and cover it like the rest with thin glass.

I will mention but one more series, and then conclude. The scales of fishes when thoroughly cleaned and dried form a most interesting and varied collection, some being covered with fine lines, others being furnished with sharp and thick-set spines which give them quite a formidable appearance.

I have not by any means got to the end of my subject, but do not wish to encroach too much on your space, which is very valuable; but if what I have written meets with the approval of your readers, and is likely to be of any use, or if they would like to hear from me again at another time, and you will grant me the honour of appearing as a contributor to your pages on microscopic matters, I shall do so with the greatest pleasure. With every good wish for your success,

A Fellow of the Royal Microscopical Society.

[We shall be much obliged if our microscopical friends will write all generic and specific names clearly, thus, *Culex pipiens*. By so doing they will save our compositors much labour, and insure the accuracy of their communications.—Ed.]

BICYCLE RIDING.

[296] Sir,—In velocipede riding I am [illegible] (by experiment) that the vertical tread is a b[illegible] of driving than either the forward thrust of [illegible] or by hand-levers, or both combined. W[illegible] have had a little practice, and with your seat a[illegible] height (as before mentioned), you will find th[illegible] tread to allow you to sit upright and place [illegible] weight of your body alternately on the tre[illegible] much greater ease and speed than any othe[illegible] the weight of body, when properly appli[illegible] sufficient to drive a light-made machine up [illegible] hill on the common road. A practical [illegible] the saddle but very little when ascending [illegible] quently very little load,—the weight of [illegible] as the propelling power instead. The vert[illegible] not like (as one of your correspondents say[illegible] ing the Monument stairs with a half-hund[illegible] back, but more like sitting on horse-bac[illegible] unloaded back and his foot in the stirru[illegible] with the thrust of the foot is very [illegible] drawing back the foot, and then thrusting [illegible] of itself, harder work, at less speed, than [illegible] down stroke, and with it there is a dead w[illegible] tinually on the machine. As in moving the [illegible] a lever you must have whereon to rest the [illegible] lever, and that whereon the lever rests m[illegible] double weight upon it—namely, the world [illegible] force applied to move it; so when you driv[illegible] thrust, you place back on the seat [illegible] pressure; so in driving with levers you [illegible] pressure on the machine at the [illegible] besides the dead weight of your body in the [illegible] the time. Those who drive in that way and [illegible] move the seat far from the driving wheels [illegible] move a great deal of the pressure from the seat [illegible] apply it properly to the crank, and they will find [illegible] is only just enough left to make the driving wheel bite when forced against a hill; when on the level [illegible] little power required to drive it is easily applied. [illegible] can then ride with comfort, read the paper, or smoke your pipe—no joking.

N. G. [illegible]

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[297] Sir,—Although I am not a bicycle rider—simply because I am an old man—[illegible] say, in behalf of young men, one [illegible] Let me ask, for what purpose are [illegible] kept? Is it not, for the most part, for healthy exercise or for amusement? Of course [illegible] The farmer and the soldier [illegible] horses, but there are thousands of [illegible] have no hope of ever being able to keep a horse, [illegible] whom the delight of whirling along on their bicycle is perhaps, even greater than that of those who can keep a horse. I was astonished and delighted a few days ago at seeing a man, apparently between thirty and forty, with the most astonishing command over his bicycle. It must be comparatively easy to ride [illegible] when tearing along on a level road, but the rider that I saw was moving very leisurely through the streets that one usually sees about the station near the watering-place at Ramsgate; he was really "walking [illegible] horse," and occasionally *stopped to look about* [illegible] apparently without an effort, keeping the two-wheeled machine balanced. It was a beautiful one to look [illegible] with a little step by which to mount; and, more[illegible] the rider had evidently "come into town on busin[illegible] his purchases being strapped safely on the spring[illegible] know a young apprentice in my own neighbour[illegible] whose master—a wheelwright—made a bicycle, and [illegible] young fellow goes many an errand thereon to [illegible] time, and when he gets a holiday, instead of [illegible] about, or even going on an excursion by rail, [illegible] his master's bicycle, and makes pleasant expedi[illegible] about the country, which otherwise he could not [illegible] and to places of interest where "the rail" would [illegible] help him. If a little fatigue is incurred, what [illegible] If you cannot do everything on a bicycle that [illegible] could do in a "trap," what then? I am astonished that more young men do not get a bicycle. Old [illegible] am, I think I must begin.

Sen[illegible]

HOW TO SKELETONIZE LEAVES.

[298] Sir,—Before the autumn passes [illegible] should like to lay before the readers of our M[illegible] a method of making some beautiful parlour or[illegible] which may form a pastime for their winter [illegible] although the materials must be collected now. [illegible] leaves are among the most beautiful objects [illegible] and as they can be arranged either in group[illegible] glass shades, made into pictures, as it were, a[illegible] against the wall, or placed in either blank [illegible] albums, they come within the means of all, and [illegible] used to decorate the palace or the cottage. Th[illegible] suitable leaves for the purpose are those from [illegible] botanists call *exogenous* plants, and may be know[illegible] the veins of the leaf branching from a central [illegible] midrib; those from *endogenous* plants rising fro[illegible] base and curving towards the apex of the leaf. [illegible] object in view is to destroy what may be calle[illegible] fleshy part of the leaf, as well as the skin, leaving the ribs or veins. The most successful, and pro[illegible] the simplest, way to do this is to macerate the l[illegible] in rain-water till they are decomposed. For thi[illegible] pose, when the leaves are collected they shou[illegible] placed in an earthenware pan or a wooden tub covered with rain-water, and allowed to stand i[illegible] sun. In about a fortnight's time they should b[illegible] amined, and if found pulpy and decaying, will be [illegible] for skeletonizing, for which process some ca[illegible] camel's-hair brush, as well as one rather stiff (a t[illegible] brush for instance) will be required. When all i[illegible]

pared, gently float a leaf on to a card, and with the soft brush carefully remove the skin. Have ready a basin of clean water, and when the skin of one side is completely removed, reverse the card in the water, and slip it under the leaf, so that the other side is uppermost. Brush this to remove the skin, when the fleshy part will most likely come with it; but if not, it will readily wash out in the basin of water. If particles of the green-coloured matter still adhere to the skeleton, endeavour to remove them with the soft brush; but if that is of no avail, the hard one must be used. Great care will be necessary to avoid breaking the skeleton, and the hard brush should only be used in a perpendicular direction (a sort of gentle tapping), as any horizontal motion or "brushing" action will infallibly break the skeleton. Never attempt to touch the leaves or the skeletons in this state with the fingers, as when they are soft their own weight will often break them.

A very good way of bleaching the skeletons is to prepare a solution of chloride of lime, which must be allowed to settle, and the clear liquid poured into a basin in which the skeletons may be put by floating them off the card. It is as well to have half a dozen ready to bleach at once, as they require watching, and if allowed to remain in too long will fall to pieces. From two to four hours will generally suffice to bleach the skeleton of all ordinary leaves, after which they should be washed in several changes of water, and finally left in clean water for half an hour.

After the leaf has been sufficiently washed it should be floated on to a card and dried as quickly as possible, care being taken to arrange the skeleton perfectly flat, and as near as possible to the natural shape. This can be done with the assistance of the soft brush. When dry the skeleton should be perfectly white, and should be mounted on dark backgrounds, as black velvet or paper. Well grown leaves should always be chosen, and be thoroughly examined for flaws before maceration. Leaves containing much tannin cannot be skeletonized by this process, but are generally placed in a box with a number of caddis-worms, which eat away the fleshy parts, when the skeletons can be bleached in the usual way. Holly-leaves must be placed in a separate vessel on account of their spines, which would be apt to damage other leaves; they make beautiful skeletons, and are sufficiently strong to be moved with the fingers.

It is not necessary to give a list of leaves suitable; but the leaf of the poplar, the apple, the pear, and the ivy may be mentioned as easy ones to commence with. Various seed-vessels may be treated in a similar manner and by precisely similar means, and thus greater variety given to the groups. Wishing our readers success in their experiments, I would remind them that what is worth doing at all is worth doing well, and that "a thing of beauty is a joy for ever."

SABBAS.

THE "PHANTOM" WHEEL.

[299] SIR,—It will be interesting to see the promised illustration of what is the "Harmonious Blacksmith's" notion of a perfect suspending wheel, but pending its appearance I should like to ask your readers not to take for granted his assumption that the "Phantom" is not to be relied upon as a driving wheel. Your correspondent falls into the same error in that respect as Mr. Edmund Tydeman, of Brighton, from the fact that like that gentleman he writes without having seen or tried the wheel in any way. Your editorial shears will I know remorselessly dispose of whatever I may say which tends to import an advertisement into your general columns, so I will simply ask those who are in any doubt about the "Phantom" to await the long-promised further letter of Mr. Tydeman, which will now be written after an extended *trial* of the wheel. It will be recollected that it was a most circumstantial condemnation from the pen of that gentleman which first impugned its value.

At the risk of anticipating the fertile suggestiveness of our sledge-hammer friend, perhaps you will let me point out that the *winding* of the axle in suspended wheels (which after all, is, in our case at least, quite theoretical) may be entirely prevented by carrying a light steel bar from one side of the rim to the other straight through the middle of the axle.

J. A. MAYS, Secretary, Phantom Wheel Co.

[300] SIR,—In looking over your journal of August 12th, I read a letter upon wheels, signed "Harmonious Blacksmith;" perhaps you will allow me to correct a statement in his letter. He says, "Suspension wheels—*i.e.*, phantom wheels, are not rigid enough for driving purposes." I have ridden a veloce with phantom wheels in and about Birmingham for two months, up hill and down, often forty miles in a day, without a slip, and the driving wheel is as firm now as when new. Perhaps "H. B." knows Snow-hill in the town, and Soho-hill, Handsworth, or your readers may. I ride up and down about five times a week, and the driving wheel is rigid enough to carry me up as fast as my strength will permit. If the "Harmonious Blacksmith" would like to be convinced, let him come and see, and make the trial for himself. I know very little about science, but practical experience is always better than paper sketch experience.

J. T. DAWSON.

THE "PHANTOM" VELOCE—AN ACT OF JUSTICE.

[301]—SIR,—In "our" MECHANIC for April the 5th I published some strictures upon a form of wheel patented by the "Phantom" Company, which I then considered to be an adoption of my invention, described in Vol. III., and christened the "Spider Wheel." Some time after the publication of those letters I obtained a "Phantom" on trial, as I hinted in my last letter, and it at once became evident that my wheel and the company's could not be considered one and the same, and that the latter was free from the defects inherent in the former.

I then made a draft of a letter to forward to these columns which pressure of business and illness caused me to thrust aside. The letter of our esteemed friend the "Harmonious Blacksmith" in a recent issue (p. 495) again drew my attention to the subject, and I consider it nothing more than an act of justice towards the "Phantom" company to state that, in my estimation, after a fair trial, their wheel and veloce *can have no competitor*, and I feel bound to confess that I was simply mistaken in ever associating the "Phantom" with the "Spider." I have tested mine (I refer to the "Phantom") in every conceivable way, and find that the correctness of the principle is only equalled by the beauty of the workmanship and cleverness of the design.

I should now be loath to ride any other, and any one who will only take the trouble to *thoroughly master* their peculiarity in steering will never, I am sure, get astride one of the old kind again if he can help it. They certainly do require a much larger amount of practice *at first* than the old kind, but this is abundantly compensated for by an ease and grace of carriage afterwards, that cannot be attained upon others; and of all machines that one would choose for "doing" a long spin this is *the* one.

Perhaps some may say, "But how about the objections you raised in reference to this form of wheel in your letter of April 15th?" This is particularly what I wish to refer to, and I answer, "that they were *real defects* in the original form devised by myself, but that only the first and third can possibly apply to the "Phantom."

The one I possess has been in use now for several months, principally by my brother, of 4, Pelham-square, Brighton, and has seen some very rough usage too, but the most scrupulous examination fails to detect any flattening at the spokes—of which by the bye there are upwards of 80 in the front wheel. The wheels, if turned round upon their axis (the machine being fixed), appear still beautifully true as at first, and as I am informed they are finished by turning in a lathe, and the rims are made each in one piece, it would be a wonder if they were otherwise. So that my first and third objections are effectually disposed of in reference to this wheel. My second objection, grounded on the wires being drawn up "taut," does not obtain at all here, these spokes being *quite slack*, and both more numerous and of much thicker wire than the "Spider." In fact it seems almost impossible to fracture them by any blow they are ever likely to be subjected to. They will bend but not easily break.

And now for my last objection, at once the most serious, and one that was again dug up from its grave by the "Harmonious Blacksmith" last week—the unfitness *per se* of wheels made on the suspensory system to act as drivers or crank-wheels.

This, though it may be considered, and is, a serious defect in very slight wheels with few spokes, like the "Spider," if looked at straight in the face will be seen to be more fanciful than real. Given a wheel *with a stout rim*, having a number of springs for spokes, nearly the same principle will be brought into action here as is developed in the case of india-rubber tires. At first sight it would seem, from the way in which they flatten on the road, that they would be only equivalent to a number of flat surfaces filed upon the periphery of the wheels, and would thus impede their motion. We know this is not so; india-rubber is a highly elastic substance, and that action and reaction are always equal is a law in mechanics, and it must be remembered that precisely so much of the force as is swallowed up in flattening the parts underneath is given out again as these elastic parts are successively set free; in other words, their efforts to recover their original form develop as much force as is required to flatten them. So also is it in the case of elastic spokes *to a nearly rigid tire or rim*, the amount of energy at first absorbed in bending them is given out again by them at the end of the stroke; it is, in fact, only so much force stored up to be utilized when the pressure is about to be removed. I think I am right in my theory, and believe that the "Harmonious Blacksmith" will, upon further consideration, bear me out in this view of the case.

But however this may be, I find by actual experiment, that the crank of my "Phanton" deflects but ·18 of an inch with the whole weight of the body upon it, and when all the spokes have been loosened to allow of its full effect (I question if any veloce wheel will deflect less than this); nor is this surprising when we consider that to do this no less than thirty-two steel wires, each 3-16ths thick, have to be acted upon at once. In short, commend me to the "Phantom" veloce for ease, for speed, and quick obedience to the helm. The sharp curves which this velocipede is capable of making, *with but a slight movement of the fork*, peculiarly fit it for "professional" gyrations and display.

EDMUND M. T. TYDEMAN.

[We have received about forty other letters on the "Phantom" Veloce, all of which speak highly of the machine.—ED.]

THE FLUTE—UNCOURTEOUS CORRESPONDENCE.

[302] SIR,—I cannot refrain from expressing the regret with which I read the letter of "F. F. C.," page 515, more especially as it emanates from an old man, and one claiming to be a musician. There is something touching too, in the mode of its commencement, which, if possible, deepens my regret. Surely less bitterness and prejudice might be justly expected of age. Many of your readers know quite as much about the flute as himself, some of them evidently a great deal more, and the result of their knowledge is far more agreeable both to themselves and others. "He knows all about the abortion," and his conclusion is well worthy of the predicate; he vituperates the instrument and sneers at its great professors—maybe, because he was disgusted with his own failure. With all due deference, I would submit to him the singular value of the instrument which could sustain the interest of talented men under such heavy disappointment, and eventually reward them for such thought and labour. But I forget; he writes, "nothing shall convince me," a blissful state truly: heart or brain can do little under such circumstances. A man with a smaller stock of obstinacy than this might go through life and prove as tough a subject as an inferior beef-steak, and perhaps quite as disagreeable. I am ready to admit that the discussion of the flute may be out of place in your periodical. I am not a young man in years or feelings, and I have been associated with all ages, classes, tastes, dispositions, and capacities; but I am free and grateful to confess I never "chin chinn'd" with the double of "F. F. C." I leave his attack on "the flute and flute-playing," to those who deem it worth comment, and turn to his uncalled for and unjustifiable remarks in holding up to ridicule a body of gentlemen who are at least entitled to the same courtesy and consideration as their fellow men. He is guilty of this in the opening of his letter, and I must say it is unpardonable. He quotes also from an imbecile novel to strengthen an undignified position. There is no reproach in being a curate; all men are, or ought to be curates,—right honourables and right reverends, too, are they in the fullest sense if they be but faithful. Neither is there any harm in being mild: mild men and mild ale are not such despicable company after all, but sour men and sour beer I — well, I hand them over to those who like them. If "F. F. C." cannot adorn the pages of the ENGLISH MECHANIC he can at least refrain from gibbeting himself in th em.

A CLERGYMAN.

ARROWROOT.

[303] SIR,—May I ask Mr. G. Davis if he obtained the arrowroot of which he gives us a plate (No. 196, p. 493) from the Maranta itself, as it differs from what I have hitherto taken for the Maranta starch? I drew my information from the examination of two plates in two different works; both professedly representing the appearance of true arrowroot under the microscope. Now the specimens of starch sold as arrowroot, which I have examined, contained two kinds of grain; one I knew to be potato-starch, having obtained the same from the potato myself, the other presented the same appearance as that represented in the above mentioned plates. Potato-starch is said to be one of the chief adulterations of arrowroot. For these reasons, I felt justified in regarding it, as the true Maranta arrowroot. All the other kinds of starch mentioned in my article (No. 48, p. 395) I obtained from the plants producing them. I have not been able to obtain a piece of the arrowroot plant itself as yet. All are liable to mistakes, from over confidence or otherwise, and if it has fallen to my lot I should like to know it. May I suggest that plates of magnified objects would be of very much greater utility if the real size of the object, or the magnifying power employed, and the circumstances under which viewed, were named?

J. C.

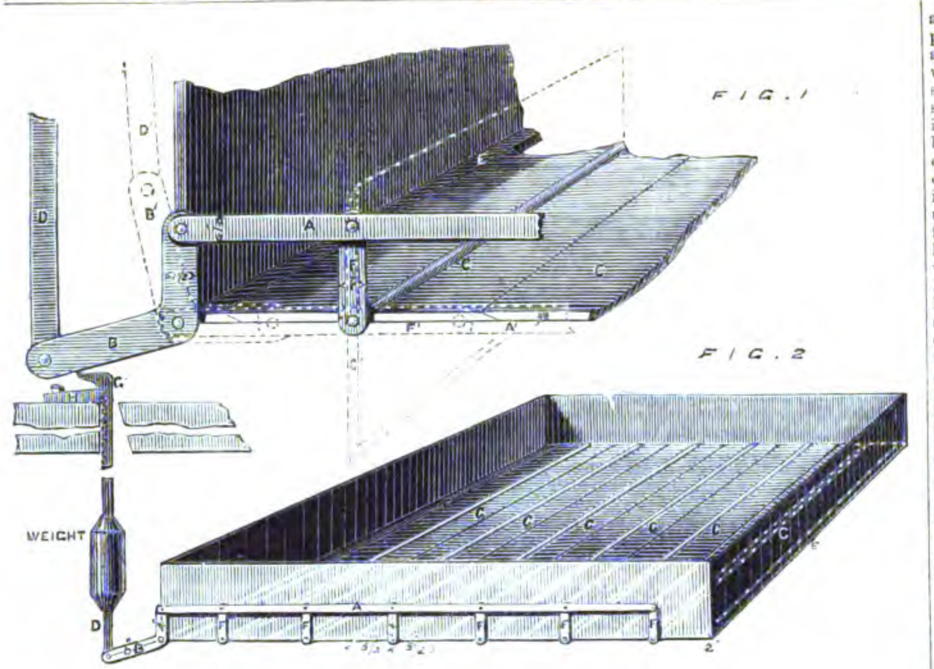
INDUCTION COIL.

[304] SIR,—For medical purposes I find the primary current from the ordinary "medical coil" generally superior to the intense current from the secondary wire of an induction coil, and wishing to construct a medical coil, which shall be capable, if possible, of giving intensity effects, I shall be obliged if "Sigma" will answer the following questions: Can a Rhumkorff induction coil be used for medical purposes, by opening the secondary wire, and working from the primary? in other words, is an induction coil with secondary wire disconnected, equal in every respect to a simple primary single coil machine, having the same size core and same length and size of wire? Does the tension induced in the open secondary wire leave the primary less strong in consequence? Will the effect on the core be increased by building up the *primary* coil, in the form suggested by "Sigma" in letter 256 (p. 522)? Would there be any advantage in making the primary coil conform to an *ellipsoid* (or whatever figure the magnetic lines of the core describe), and then the secondary coil to a similar figure of less excentricity (which would probably be the shape of the curves of the primary induction force)?

W. H. COFFIN.

HOW LL.D.'s AND Ph.D.'s ARE MADE.

[305] SIR,—I noticed some time ago an inquiry as to how degrees in art, &c., were got. I enclose you copy of a circular received by a friend of mine, and which gives all the information needed. It is to be regretted that there are some people so destitute of honour as to become mediums, whereby these degrees may be bought, and that the officials of some of these institutions second their efforts, no doubt for pecuniary motives, instead of allowing them to be earned honestly. And this, no doubt, accounts for the fact that many men, who have gained these degrees by their own individual efforts in the fields of science or art, are so disgusted with this pettifoggery as to have



ASH-BOX FOR LOCOMOTIVES.

discarded them—preferring to remain a plain Mr., than to be associated with a class, some of the members of which have no more right to be comprised in it than "Editors of catch-penny newspapers" mentioned below.

TITANIA.

"Degrees.—M.A., Ph. D., &c.—in *absentia* or *præsentia*—Qualified Gentlemen desirous of proceeding to degrees in arts, law, theology, medicine, &c., receive official instruction and advice by writing to————

"N.B. These degrees and diplomas are guaranteed *bona fide*. Only the applications of authors and other decidedly qualified candidates will be replied to. Unqualified men, busybodies, and 'Editors of catch-penny newspapers,' need not trouble themselves to write, and their personal applications will not be attended to."

P.S.—I can give the address of this *medium* if "Ambitious One" would like it.

ASH-BOX FOR LOCOMOTIVES.

[306] SIR,—I beg to send you a sketch of an ash-box for locomotives, which I think has some improvements upon the method in general use.

Fig. 1, is a part of ash-box with a portion of side removed so as to show the shutter C. A is a connecting rod for moving arms F, as shown in Fig. 2. B is a double arm, one end being attached to the rod A, and the other to the rod D. C is one of the shutters which compose the bottom of ash-box as shown in Fig. 2. E is a piece of bottom for shutters to butt against when closed. F is the arm which connects the rod A with the shutter C. A', B', C', &c., &c., show arms connecting rod, shutters, &c., when opened.

At the end of a locomotive engine's work, when the fire has to be put out, instead of dropping the fire into the ash-box, and then raking it out as is now done, it can be dropped right out on to the ground without any extra work, and in case of an accident the fire can be got rid of altogether, and so cool the fire-box sooner than if only dropped into the ash-box.

ASH-BOX.

SHORTHAND.

[307] SIR,—No system is phonetic, in the most strict sense of the word, unless every sound in the language has a separate character. Mr. Pitman clearly points out the difference of the sounds, but as some of them are very similar a separate character is not required for each; for it is practically found that the legibility is not in any way injured by using one character for two similar sounds, such as *f* and *v*, *sh* and *zh*, &c. One of the advantages claimed for Pitman's system is that should the thick and thin characters be carelessly or accidentally misplaced no mistake can possibly occur; this cannot be claimed for the letters *r* and *w*, *n* and *ng*, *l* and *y*, which have the same characters thin and thick respectively. In Lewis's system, where no two characters are similar, misplacement of them is impossible. As no mistake can occur from the misplacement of such characters as *f* and *v*, why not have one character for both these letters? The number of characters is thus reduced, and the system at once becomes simpler. "W." is altogether wrong in saying the Lewisian system is only as much phonetic as our "A B C" alphabet, and no more, for although Mr. Lewis writes of his system as one of stenography—as, of course, all systems of shorthand are, whether phonetic or not—yet one of the first principles impressed by him on a learner is never to write an unnecessary or mute letter, but always to write a word as sounded, not as spelled. This is why I called his system one of phonography, or phonetic, which words mean "according to sound," so that I used them in their ordinary sense. It is obviously most natural for every shorthand writer to omit all useless letters, the object of his art being to combine brevity with celerity. As I said before, I quite agree with all "W.'s" remarks on phonography; I should never think of comparing a merely stenographical system for clearness and rapidity with a phonographical one. The letters *ng*, as in *wrong*, *running*, &c., can never occur without a preceding vowel, so that all such words may be written either in the ordinary way or by using the termination *ang*, *ing*, *ong*, *ung*, as the case may be.

The sound of most of the diphthongs may be accurately represented by the vowels; the characters of the latter may therefore often be used for the former; for the three, *au*, *oi*, *ou*, which cannot be so represented, a short vertical stroke may be used. Such words as *people* and *leopard* should, in the Lewisian system, be written with an *e*, as sounded, instead of with the diphthong *eo*; words like *pleasure* and *breath* cannot be misread by using the character for *sh* or that for *s* and *z* in the former word, although neither is the *exact* sound, and the single character for *th* in the latter. No mistake could possibly be made by transposing Pitman's diphthong characters in such words as *sound* and *journey*. With the least ordinary care in writing, Lewis's vowels can neither be misplaced nor mistaken, because as each vowel has a distinct character all that is necessary is to write them as near their proper position as convenient, on either side of the consonant—that is, they must only be written in the same order as in longhand: thus no guessing is required, for the order in which they are to be read is as plain as that in which they are to be written, although their exact position is quite immaterial, nor is it of any consequence whether they be thin or thick. I have never heard any one complain of the system being illegible, nor have I found any difficulty in reading it. I cannot admit Mr. Clarke's assertion that the freedom of position of the vowels in this system is a "very prominent defect;" I look upon it as a very great advantage. Mr. Clarke states that, by my "own admission," I have no means of ascertaining whether a vowel in Lewis's system should be read before or after a consonant, because I wrote that in that system "it is not of the least consequence on which side of the consonant a vowel is placed," &c. I admit nothing of the kind; the position of the vowels in Lewis's system being the same with respect to the consonants as in longhand, there can be no difficulty in reading them rightly. In the word *endear*, for example, the first vowel is placed near the commencement of the letter *n*, the second and third near the junction of the *d* and the *r*; these letters form a very acute angle, so that the vowels are placed outside the angle, it being immaterial on which side of the consonants they are written; it is almost impossible to make a mistake. It has been stated more than once that Pitman has only three positions for his vowels, but these *three* positions are on each side of the line; thus there are *six* positions when compared with Lewis's system, in which the vowels may be written on either side of the line. Mr. Moseley acknowledges this. This system admits of the omission of as many vowels as any other, since the method of representing them does not in any way affect this feature.

The fact of the majority of Pitman's prefixes and affixes being disjoined from the word necessitates the lifting of the pen from the paper, an evident loss of time, which, in the case of the affixes, is avoided by Lewis without loss of clearness. The difference of sound between many of the affixes and prefixes respectively is so slight that no mistake can arise from using the same sign for more than one, so that Lewis's signs can safely be used for many more than thirty-nine. Everyone must admit that *by itself* no character can occupy less time in being formed than a dot, but as it is absolutely necessary, *when writing*, to lift the pen *twice* to form it, and utterly impossible to join it to any other character, three or four letters can be written in the time occupied upon it; this was clearly stated in my last letter. Lewis's character for *h* is the same as Pitman's second for *y*, in a horizontal position; it is always joined to other characters, and can never be mistaken. It appears to me that Pitman's other characters for *h* might be mistaken for combinations of *s* with *ch* and *r*. I am not so foolish as to believe or imply that any of Pitman's characters are absurd or useless because Lewis has none similar. I quoted from Pitman's Eleventh Edition because it is the latest I have, and am not aware what is the last, or what alterations have since been made in the system; I was not aware that Pitman had so many grammalogues, or I should not have stated what I did. Has he anything corresponding to Lewis's figures? These are extremely useful in private notes and in very quick writing; it is really impossible to take down a great many dimensions, dates, or statistics of any kind in the ordinary figures when read rapidly. I have seen many tried several times, and have myself often tried it, but never knew any one to keep up with the speaker. Mr. Moseley's statement shows he has never tried to take down figures from a rapid speaker for several minutes at a stretch; he would not have been able to keep pace with him. Lewis's figures are parts of the ordinary figures. It is obviously shorter and easier to write parts of the latter than the whole of them, and the power of joining them is an immense advantage.

A large number of persons learn shorthand without having any intention of becoming reporters. They are not, therefore, very careful to discover the best system, but naturally obtain Pitman's, it being so well known and cheap—Lewis's is neither.

Mr. Moseley states that by merely altering in thickness a mark of any size and shape, it becomes a new character. Evidently one character cannot be made another by being varied in thickness; the character representing any letter must remain the same whatever be its thickness, although it may be used to represent another letter when altered in thickness; besides, thicknesses are but comparative. The thick character of one writer is the thin one of another, so that, according to Mr. Moseley, every different thickness of a mark forms a new character; therefore, an immense number of different characters must be in use amongst various writers. I notice that Mr. Clarke states he by no means admits the eleventh edition of "Pitman's Phonography" to be in any respect inferior to Lewis's system, and at the end of his letter he accuses me of passing an authoritative opinion on Pitman's system without having learned it. His accusation is groundless, for I used to write Pitman's, and made use of it, but have changed it for Lewis's to my advantage; whereas Mr. Clarke knows nothing of Lewis's system, and yet expresses an authoritative opinion on it. Rather inconsistent. Had he known Lewis's, of course he would have accepted the challenge in my last letter, and have floored me at once if he could. Unfortunately none of your correspondents know the Lewisian system, so that, admitting for argument's sake everything claimed for Pitman's, not one can say Lewis's is not superior. Among your six defenders of Pitman every advantage—real and imaginary—of his system is well advocated; Lewis has not this good fortune; it is probable I have not stated all the salient points of his system. That it has been found necessary to so often alter and improve Pitman's system is complained of by many writers of it as a great nuisance. The existence of this necessity is a clear proof that the system was brought before the public long before it was perfected; whereas the present edition—the ninety-seventh—of Lewis's is the same as the twentieth of thirty years ago, this system having been matured before being published. In this edition are to be found the rules for joining many words together, which rules Pitman now has, having adopted them, I have been told, since that time. I am not aware whether Lewis's twentieth edition differs in any way from those preceding.

The chief objects of shorthand are speed, brevity, and legibility; by using as few characters as clearness requires, and their thickness being immaterial, the speed is increased, and the memory less taxed. Lewis's combines these essentials in the most complete manner.

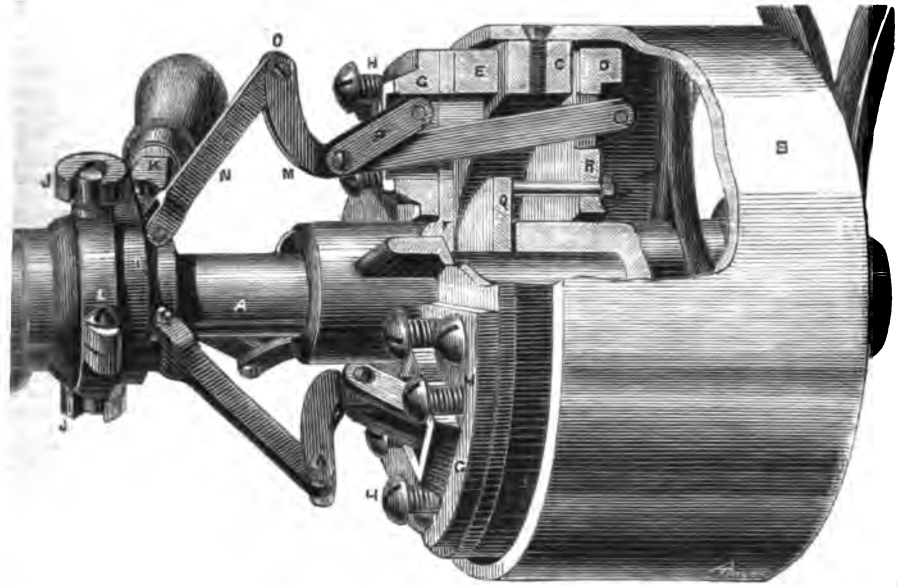
The final sentence of "Mac D.'s" letter doubtless expresses our common sentiment.

FRANK W. GRIERSON.

DYEING, ETC.

[308] SIR,—Many of us are obliged to you for the article "On the Use of Phosphates in Dyeing." These articles I am sure are much prized by those connected with calico printing, and when you consider that 100,000 mechanics (in the strict sense of the word) are engaged in this branch of industry in Great Britain, I only hope that I may have the pleasure of seeing more of them in your valuable journal; and, since the collapse of the *British and Foreign Mechanic*, we have only you to look to as the exponent in our branch of industry. Anything new in dyeing, colour-making, or chemical discoveries, will be hailed by a now pretty large section of your readers. And as the French surpass us so much in this particular line, I trust you will give us your assistance, and put us on a par with other nations. Would one of your readers explain what is meant by an *acid* solution of phosphate of lime (*i.e.*, what acid)? Also, can you give the degrees in Twaddle's hydrometer equal to 50° Baumé. I can get the degrees of Fahr. equal to the centigrade thermometer easily, but cannot fall on what Baumé's proportion bears to Twaddle's hydrometer.

ALEX. S. YOUNG.



LULL'S IMPROVED FRICTION CLUTCH.

LULL'S IMPROVED FRICTION CLUTCH.

:809] Sɪʀ,—The convenience and freedom from ›ck in the use of friction clutches have rendered :m almost essential to many kinds of machinery. .ny devices of this kind have, however, proved unisfactory in use, as they were likely to get out of ler, had in some instances no provision for taking the inevitable wear, and otherwise proved troublene to manage. I send you from the *Scientific erican* a perspective view, with portions broken away show details of construction, of a new clutch, ently patented by Orrin Lull, of Rochester, New rk, U.S.

A is the shaft, and B a pulley arranged to revolve on d independently of the shaft when not clutched.

C is an annular disc, or ring, attached to the inside the rim of the pulley by screws, or in any other sirable manner. D is an interior disc, and E an ter annular disc or ring. The disc, D, is made to proach and gripe the fast ring or disc, C, and thereproduce the required friction.

The friction discs D and E, are connected with the sc F, by a link system, F being keyed to the shaft. ie triangular plates, G, are attached to F by screws, d these plates have also adjusting screws, H, which ke up the wear of the friction discs.

The hub, I, revolves with the shaft, and is made slide thereon by the forked lever, J. This lever s its fulcrum at K, and is connected with the hub a band, L, fitting a groove in I. The band L is .de like an excentric band, in two parts, and has ;s with which the lever, J, engages.

The inner friction disc, D, is connected with the sliding b through links, M and N, the links, M, being bent, shown; M being pivoted to D, and N to the hub, d the two being pivoted together at O. The outer ction disc, F, is connected with the links, M, by the .ks, P, pivoted at both ends. The links, P, are placed an angle with the links, M, so that when the outer ds of the latter are moved away from the shaft, the sc, D, is pressed against the ring, C, drawing it and e pulley, B, against the friction-disc, E, producing iction upon both sides of C, and thus clutching the illey to which C is fixed. A collar, Q, is pulled back the bolt, R, which connects it with the disc, D, ienever the pulley is released from the action of e friction discs, and draws the pulley away from e disc, E, so that it revolves without friction, or nains at rest, as the case may be.

The principle of the toggle-joint is embodied in the stem of links, so that great purchase is obtained, d the motion of the lever necessary to clutch or re.se the pulley is very slight. Wɪʟ. K. Hɪʙʙᴇᴛ.

) WHAT HEIGHT MAY CLOUDS OR EXHALATIONS ASCEND?

[810] Sɪʀ,—In reply to a correspondent, about e subject of the "Exhalations of Air," I may reark to him, having the same books — those of ıaw's Boyle,—that the author endeavours by exriments to prove that such occurrences are only pro.ced by reflection, and in some meagre way by re.ction. Let "S. . . r" consult Vol. I., p. 427, and also l. I., p. 678. Let him also refer to the index at the d of Vol. III., and refer to the subject of air, &c.

A Mᴀɴxᴍᴀɴ.

FREE REED ORGANS v. HARMONIUMS.

:811] Sɪʀ,—I trust you will be able to find me ıce for a few remarks on the letter of Mr. Eustace nton Jones (No. 239), which appeared under the ›ve heading, August 19th. It appears to me that . Jones has come to his conclusions on this subject her too hastily, led away (no doubt) by the undeni.e sweetness of tone and advantages (for certain rposes) of Messrs. Mason & Hamlin's organs.

Now it is a fact, not perhaps generally known, but no less a fact, that the harmonium is, with hardly an exception, the most difficult instrument to play well now extant. I do not of course refer to the violin and instruments of that class, which belong to quite a different branch of the science, but to instruments of its own species, viz., the organ, seraphine, &c. No instrument, perhaps, of any class requires so much *management* to display it to advantage as the harmonium. But this difficulty once overcome, the first-class harmonium affords to the musician an almost endless field of beauty and variety. That this is the case will not be denied by any one who has heard a decent harmonium really well played.

I will proceed to take Mr. Jones's objections *seriatim*. In the first place Mr. Jones says, "the tone is of the reed, utterly and irretrievably reedy." This doubtless is the chief objection to the harmonium, but there is the greatest difference in this respect between one harmonium and another, and even in instruments by the same maker the quality of tone varies very perceptibly. In this point even the player has much in his power; for example, in a 18-stop Alexandre the use of the two 16ft. tone stops (the clarinette in the treble, and the bourdon in the bass) played an octave higher than the music is written, will give a very agreeable diapason tone, which will render a return to the more reedy stops an agreeable variety rather than not. Endless are the pleasing changes thus to be extracted from even the 18-stop Alexandre.

Mr. Jones's next objection, viz., that the bass overpowers the treble, is an unfair one. It only applies to the six-guinea harmonium, and even then by a judicious use of the upper octaves, and by carefully studying how to keep the bass subordinate to the other parts, great perfection of playing may be arrived at. And on the large harmonium the division of the stops into treble and bass renders it entirely the player's own fault if he suffers his right hand to be overpowered by his left. It is the almost invariable habit of the majority of lady players and inferior performers on the harmonium to take the bass in octaves with the left hand, and let the right hand play or slur over the other parts as best it may. It is this which throws the bass into such prominence, as the lower notes on the manual of a six-guinea harmonium are very powerful—on many instruments, indeed, inordinately so.

Mr. Jones says that the sluggish intonation of the harmonium renders it useful for only the slowest of music. This is certainly not the case, as I have not only heard performed on it the most brilliant accompaniments to operatic airs *in public*, but have also myself accompanied many of the airs and recitatives in the "Creation," most of which are very brilliant indeed. I have also witnessed a very creditable *professional* performance of "Faust," in which some of the most brilliant passages were beautifully executed on an ordinary 24-stop harmonium. This will, I hope, convince Mr. Jones that he has condemned the harmonium too hastily. He next says that the harmonium, though better for a church than the discordant instruments it often displaced, is still *very bad, both from the impossibility of distinguishing the air, and the impurity of the tone, which causes it to cut through the voices, and drown them with its buzz instead of supporting them*. Mr. Jones must really not be angry if I ask him, after this sweeping condemnation, whether he has ever heard any one play the harmonium besides the village schoolmaster, or some fourth-rate lady organist. I can tell Mr. Jones, from my own experience, both as a vocalist and an organist, that the ordinary 18-stop Alexandre, decently played, makes a most pleasing and efficient accompaniment for the most delicate solo voice. This is not merely my own opinion unsupported by the evidence and experience of others; and as an example of my meaning I will mention a circumstance which not long ago came under my own notice. A new church having been built in the town near which I at present reside, a 13-stop Alexandre was hired for such time as should elapse before an organ could be procured. A young man, pupil-teacher in the school of that parish, used to play upon it. The music was not liked; the choir were drowned. "But," said the friends of the musical genius (for such he was widely considered), "what can the poor fellow do with a wretched instrument like that? Wait till we get an organ." Well, an organ was procured, and the harmonium went back to the shop from whence it came. Shortly afterwards the professional organist of the parish church in the town gave Handel's "Judas Maccabæus," with the accompaniment of the harmonium and piano. He accompanied all the solos himself on the *harmonium*. When the concert was over, all present, among whom were many excellent judges, were unanimous in admiring the beautiful quality of the harmonium upon which the conductor had played. Imagine their astonishment on learning that it was the identical instrument which they had so often condemned at the new church, and *that it had not been tuned or otherwise altered since its removal thence!*

Now I wish it to be understood that although I thus stand up for the harmonium, I am clearly alive to the beauties of the Hamlin organ. To a person for whom the mastery of the expression stop has proved too much the American organ will indeed be a boon. But for many purposes, such as the performance of the accompaniments of operas or oratorios, where the societies by which they are performed cannot afford a full band, the Hamlin organ will, never, in its present form, supplant the harmonium, for none but the largest of the former have sufficient power for chorus accompaniments.

Finally, as for the £100 Hamlin organ being equal to £300 pipe-organ and superior to anything smaller, I must say that that also is not true as a general affirmation. I will not deny that most small pipe-organs are bad and weak, but there are others not so. Forster & Andrews, of Hull, build an organ from £100 to £120 which contains the dulciana, gamba, flute, principal, open diapason, and fifteenth, pedal pipes (8ft. stopped bourdon, 16ft. tone) and pedal coupler, enclosed in a swell, which is equal in point of quality and tone to any large organ I have ever met with. The stops are all voiced on equal scale with those of the same name in a large organ. This organ is superior to any Hamlin organ now in existence.

Finally, if a person has thoroughly mastered the expression stop of a large harmonium, and is tolerably skilful at combining the stops, he *will* go back to the harmonium for certain purposes, *even after* having tried a Hamlin organ. For drawing-room and church purposes, where ladies are concerned, the latter is a charming instrument; but the feeling and expression to be extracted from a good harmonium by a good player, by a skilful use of the expression stop, would astonish many, and I fancy among the rest Mr. Eustace Hinton Jones.

Everything has its use, and the harmonium and the American organ have each their own special office to perform. We may be quite awake to excellences of the one without depreciating the other and condemning it as useless. R. H. Nᴀsʜ.

GAS.

[812] Sɪʀ,—If "C. D. C." had given information simply as to the means of cheapening gas, I should either have said nothing or applauded him, even if I found reason to criticise his remarks; but when he took up a foolish cry and imputed dishonesty, I, as knowing the truth, felt bound to protest. It is, however, quite out of my wish to maintain a discussion in any form of recrimination, or to say anything with any other view than giving sound information. Thus I may point out that the supposed discrepancy indicated by "C. D. C." (p. 452), is only apparent. In the process of condensation certain light-giving elements contained in the gas as it leaves the retorts are removed, yet it is quite true also, as I said, that the luminous value is not affected, because, as I pointed out before, when leaving the retorts the gas is of no use as a light-giving agent; to make it *practically* available the *theoretical* loss is necessary; but the real point, and that which alone made me intervene, was the unfounded suggestion that this removal, instead of an absolute necessity of the manufacture, was a dishonest and wilful lowering of the value of the gas.

The gas referees have recently published a report discussing these subjects, in which they state exactly what I did—viz., that the required purification involved of necessity a reduction in luminous power. If the other chemists who differ from me as "C. D. C." says on this point, will only prove what they say, their fortune is assured, for "C. D. C." is only just to the companies in admitting their eagerness to adopt any improvement; the addition, as to its being in their own interest and not in that of consumers, is merely one of those jaundiced views common among those who see only public enemies in the companies.

In the name of common sense, what is to be expected? Are we to look for self-sacrifice in commerce, or are we not to admit at once, as intelligent men, that the first object of the companies, as of every merchant and every tradesman, is their *profit* or *dividend*? The real point is, do they seek to gain it as wise tradesmen, knowing that honesty is the best policy, and that what benefits their customers is to their interest; or do they seek it in the spirit of the adulterating grocer who sands his sugar, &c.? A bargain was specially made by Act of Parliament, and if the companies do fulfil the conditions it is nonsense to complain of them; if they do not, *prove it*, and the penalty is provided. Now the companies are justified even by the worst case put forth: they have to give *according to the*

REPLIES TO QUERIES.

In their answers, Correspondents are respectfully ›ested to mention in each instance the title and ›ber of the query asked.

.12.]—GAS METERS.—Among your "Unanswered ›ies" is the above. I should have answered it at ›ime, but was in hopes that some more able pen mine would have done so. The following details I hope, be understood:—Fig. 1 is a dry meter, with

FIG. 1

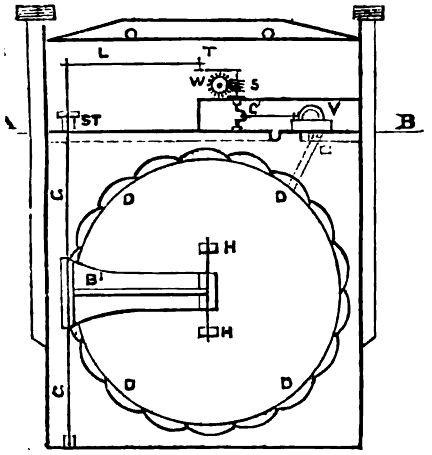
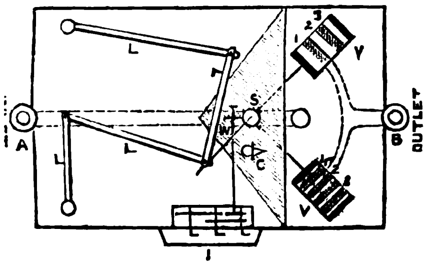


FIG. 2



e front taken off; Fig. 2 is a plan of the same at the .e A B; D D is the diaphragm, the face is of stout tin, d the sides of very supple leather; B' is a bracket, nnected to same at the joints or hinges, H H; G is guide rod, carrying the bracket B; L, the lever ed at top of guide rod; S T, the stuffing-box, to pre- ıt the gas getting into the top of meter; T, tangent regulating meter; W, toothed wheel, fixed on spindle nnected with index; S, spiral screw to turn W; C', ınk to work valves; V, valves. I have only shown e lever and valve in Fig. 1, to prevent confusion. C ı little brass catch, with a weight at one end to keep ıpright, which catches the tangent rod each revolu- n, and prevents the meter being worked backwards dishonest persons. The gas goes in at the pipe ırked "inlet," and through the one shown by the dotted ıe from A, and enters the valve box at the hole shown Fig. 2. It then passes through the valves into the ıphragms or measuring chambers, back again rough the valves, and along the other pipe, shown by tted line to B. The inlet and outlet pipes are carried ›wn the sides of the meter below the dotted line, but ey only act as siphons to catch the condensation. The aphragms move backwards and forwards like two pair bellows, and as the outside is used as well as the in- le, it thus makes four measuring chambers, which filled and employed alternately by the action of the lves. The distance over which the diaphragms travel each revolution is regulated by the tangent T being ›ved nearer to or farther from the centre spindle to ich it is fixed. The valves have three holes or ports; middle one, marked No. 2, is always covered by the of the valve, which is hollow and just large enough cover two holes at once, which are then connected. e hole that is uncovered is open to the gas coming m the inlet, and No. 2 is always open to the outlet e. Nos. 1 and 3 are connected with the inside and tside chambers, which are thus alternately connected th inlet and outlet. There is a cover to the valve box, that the gas does not get into the top of the meter, d the crank spindle works in a stuffing-box, the same the guide rods. The two marks at top of meter are Government stamps. They are put there because meter cannot be altered to register faster or slower, cept by taking the top off and moving the tangent.— HN H. Rumsey.

[4159.]—PHOTOGRAPHY.—I would advise "Young oto" to give "Newman's Diamond Negative Varnish" rial, and I don't think he will give it up. It requires y little heat, dries a clear surface, and never gets ky. I have used it for some time, therefore speak m experience.—John Terras.

[4200.]—PRECIPITATING COCHINEAL.—The fol- ing is taken from W. A. Miller's "Elements of mistry," Vol. III.:—"After treating the powdered in- ts with ether to remove the fat, the insoluble portion igested with water, and precipitated as a purple lead e by plumbic acetate. This must be well washed, omposed by sulphuretted hydrogen, and the filtered ation evaporated to dryness in vacuo over sulphuric l. The resulting body is of a purple brown colour, very ble, and soluble in alcohol or water. By adding alum and ammonia it is precipitated as a crimson powder; the alkaline earths give purple precipitates." Green precipitate is obtained by mixing solutions of cupric sulphate (or nitrate) and sodic carbonate. I have often obtained this precipitate, but not recently, and I do not remember whether it is dark or light.—Oxoniensis.

[4224.]—TREATMENT OF A CHRYSALIS.—Pupæ of such insects as require to be kept damp should be kept in a common flower-pot filled with light earth. In this they should be buried about ½in., and on top of the earth there should be kept a rag moistened about once a week, just sufficient to prevent the earth becoming dry. Other kinds do not require any particular treatment. —A. S. C.

[4242.]—INCRUSTATION IN BOILERS, Etc.—The following description of an invention for the prevention of incrustation in boilers, is extracted from the *Student and Intellectual Observer*, No. XIII. (February, 1869):— "Among the many inventions for effecting this object, one by Mr. C. Weightman Harrison, of Clapham Junction, is simple, and seems to be founded on a scientific principle. He suspends in the boiler a plate of metal—of course immersed in the water—which is connected with the metal of the boiler. The boiler forms one electrode, the suspended plate the other. The size of the metal plate is so proportioned to that of the boiler, that the electro-chemical action upon its interior surface shall be what he terms nascent, or nearly so; and he states that he finds it merely necessary, under ordinary circumstances, to impart a polarity to the shell of the boiler, in order to prevent the adhesion of the precipitated matters. Sometimes he varies the method of carrying out his invention by means of an additional electrical source, so arranged as to transmit alternately positive and negative currents to the shell of the boiler, and to the suspended plate. This arrangement is found greatly to facilitate the production of steam." It is possible, however, that as "A New Subscriber" dates from Brussels he would meet with many difficulties—leaving cost entirely out of the question—the extent whereof alone would prevent the adoption by him of the above invention, although fully convinced of its utility. To obviate this (assumed) difficulty, to a certain extent, I may mention that sal-ammoniac is capable of re-acting chemically, to dissolve, in part, the incrustation; and carbonate of potash, to decompose without completely dissolving it, leaving, it must be admitted, at least carbonate of lime insoluble, and capable, under certain circumstances, of still forming a scale.—S . . . . R.

[4270.]—CHEMICAL.—The following is taken from Fownes's "Elementary Chemistry":—"Magnesium may be prepared by reducing with metallic sodium the double chloride of magnesium and sodium, which is formed by dissolving caustic magnesia in hydrochloric acid, and adding an equivalent quantity of common salt, evaporating to dryness, and fusing the residue. This product, heated with sodium in a wrought-iron crucible, yields magnesium, which may be freed from impurities by distillation. Metallic sodium may be prepared in the laboratory by distilling in an iron retort 717 parts of dry sodic carbonate, 175 parts of dry charcoal, 108 parts of dry chalk. These materials must first be well pounded together. Potassium is prepared in the same way from its carbonate, which is prepared by passing carbonic acid through a solution of caustic potash."—Oxoniensis.

[4274.]—CUPELLING.—The best and most practicable method of cupelling is to make a thick crucible of calcined bone-dust, using stale beer to make it into a paste and shape it, then bake, and when thoroughly dry, place in a muffle furnace and then put in the metal. The bone dust will absorb all but the gold and silver, which will remain in the cupel in the form of bead. The gold can then be separated from the silver by putting the bead into a parting glass nearly filled with aquafortis, using a sand bath with heat, the gold remaining at the bottom perfectly pure. Pour off the solution (nitrate of silver) and add common salt to precipitate it.—M.R.C.S. (A New Subscriber).

[4275.]—TESTING GOLD.—The only method of testing gold otherwise than applying pure nitric acid to the surface (as far as my knowledge of the subject goes) consists in "cupelling" (see answer to No. 4274). The metal should be weighed during each stage of the process.—M.R.C.S. (A New Subscriber).

[4361.]—METHYLATED SPIRIT.—It is no doubt true, as "A Revenue Officer" says, that persons have been fined for disguising methylated spirit and passing it off as a drinkable alcohol without the naphtha, but notwithstanding this, methylated spirit may undoubtedly be drunk as such by any person who finds the flavour to his liking. As a rule all the tinctures now sold in chemists' shops, are prepared with the methylated spirit, and many of such tinctures are for internal application. If "Shellac" desires, I will give him the address of a chemical factory where tinctures of all kinds are made from methylated spirit.—T. L. H.

[4376.]—COD-LIVER OIL, to prevent nausea, should be taken floated on a little cold water, in which had previously been mixed ten to twelve drops of diluted phosphoric acid, which has a tonic effect, and makes the oil agree better with the stomach. The chest should likewise be well rubbed night and morning with equal parts of cod-liver oil and whisky, to be well shaken before applied. The whisky causes the oil to strike into the lung. To prevent the oil staining the linen a piece of oil silk with a bit of flannel next the skin will be required. My wife has tried the above for the last three months, and am thankful to say has derived much benefit.—H. K. N.

[4380.]—COLZA OIL is a general commercial name employed in France, Belgium, &c., for the oil manufactured by expression from the seeds of different species of *Brassica*, and has there the same signification as "rape oil" in England. "Colza," koolzaad, means cole or cabbage seed. "Colza" is the French name for "rape seed," says Mr. P. L. Simmonds, in his "Dictionary of Trade Products."—Bernardin.

[4450.]—BATTERIES.—As "M.R.C.S." desires some one else to answer his queries, I will do so, though, I think, if he carefully reads our ever-obliging friend "Sigma's" answer, and substitutes the word "dear" for "clear," it will be much the same in substance. To query first, no. Second, the bichromate is the strongest, but the Smee keeps in action longest: the length of time of course depends on the work it has to do. Third, Smee's. Fourth, answered by the second. Lastly, yes.—R. M.

[4481.]—A DIFFICULTY.—In answer to "T. A. Burge" (p. 502), I may say that the standard barometer is usually provided with an ivory or metal point, as mentioned by Tomlinson, to which the surface of the mercury in the chamber is raised or lowered by means of the screw before reading. In some, however, the scale and point are moved to the mercury, instead of the mercury to the point. This adjustment, far from being clumsy, is extremely fine and accurate.—A. M. W.

[4490.]—WELDING CAST-STEEL.—Take 1oz. smelts blue, ½oz. rock salt, 2oz. borrocks, pounded together and fused in a ladle over the fire, and when cool reduce to powder; heat the steel to what smiths call a greasy heat; use the powder the same as sand. The weld will be much stronger if veed together instead of common scarfed.—A Blacksmith.

[4517.]—STAINING GUT FISHING LINES.—Gut may be stained a pale brown and favourite colour by steeping it in a strong decoction of warm tea. A blue colour may be given by steeping in a weak logwood decoction for about five minutes, and rinsing afterwards in alum-water.—Vivis Sperandum.

[4518.]—MYROBALANS are dried fruits of different sorts of *Terminalia*, myrobalan order or *Combretaceæ*, imported from India for the use of dyers and tanners. —Bernardin.

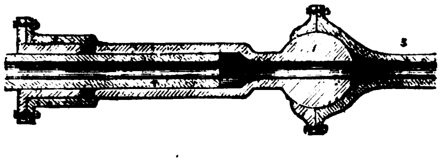
[4518.] — MYROBALANS OR MYROBALONS.— Under that name, are imported from India the dried fruit (a drupe) of several species of *Terminalia*, chiefly *T. Bellerica* and *T. Chebula*, which are used by tanners and in calico-printing for producing a black dye.— Samuel.

[4520.]—PERCH FISHING.—The best time for perch fishing is just coming on, and good sport should be had from now right up to Christmas. There are no fish (that I could ever find) nearer London than, say, Hampton. Fish for them in deep holes, dark corners, under steep banks and near large beds of weeds; as a rule, big fish are never found in shallow water. Use a rod with a stout top and running tackle, good red worms or (for large fish) minnows; hook the minnows through the back under the back fin, in preference to the lip, as the perch seizes the bait crossways; by this method, the hook is at once in his mouth, and you can strike immediately. The "paternoster" is a very killing way to fish for perch, but I would not recommend an amateur to try it as it requires some considerable practice to get into the way of using it.—Terminal.

[4520.]—PERCH FISHING.—The season for perch fishing is from February till October, during which long period they bite with various degrees of readiness, at all hours of the day; a little ruffle on the water assists the angler somewhat. For small perch a "general rod" will suffice; a common line with good-sized gut, and a No. 4 or 5 hook baited with lob worm, grub, or caterpillar; a paternoster line, armed with various baits, is useful for an unknown locality; and perch swim and feed at all depths. For large perch, a strong rod line and swivel trace, armed with minnow or gudgeon, is usually the most killing bait; spinning by tail and gorge hook is also successful, the latter especially in water where there are many weeds. Most canals or slow-running streams afford perch fishing.—Vivis Sperandum.

[4521.]—EXTRACTING HONEY FROM THE COMB. —Cut the combs in a horizontal direction into small pieces and place them in a sieve over an earthen jar. Draining may take two or three days, but the greatest portion and the best quality will be drained off in a few hours. When all that can be got by draining is obtained, the combs may be pressed by hand, but the honey so obtained will be inferior both in quality and colour, as a portion of bee-bread would be pressed through the sieve. If an "Amateur Bee-keeper" wishes to get honey of the finest quality, he must strain the combs from the outside of the hives by themselves, keeping the first drainings separate, as the combs from the centre of the hives are usually darker coloured, and the honey not so good. They should be put to drain in a warm place near a fire. The remaining combs can be made into wax, which I should be glad to explain, if an "Amateur Bee-keeper" desires; but he will find a great deal of very useful information on all points relating to bee-keeping in No. 3 of "Manuals for the Many,"—S. W.

[4524.]—STEAM JOINT.—I think if "Schemer" had a joint made like the one I send a sketch of, he would find it answer his purpose exactly, although I never tried it myself. 1 is a ball-joint, 2 a common stuffing box and gland, 3 pipe from the engine, and 4 pipe from the boiler.—J. S. S.



[4531.]—SODA CRYSTALS.—According to promise, I now beg to give "Soda Crystal" the requisite information respecting the manufacture of this article on a small scale. The soda ash, or, as it is termed, "white ash," from which this article is made, may be purchased from any of the alkali manufacturers in such quantities as he requires, and if there are any in the vicinity in which he resides so much the better as regards his profits. In addition to the two pans, "Soda Crystal" will require a cistern to serve as a settler. If he has nothing better, let him get a large cask that will contain about 160 gallons, and let him provide this with a tap 3in. or 4in. above the bottom, the use of which will be referred to further on. "S. C." must also fix one of the pans over a fireplace, and the other must be left uncased, so that air may play all round it. In the pan over the fire water must be put in to within 6in. of the top, and brought to a boiling heat, after which the ash must be thrown in in small quantities until the density reaches 45° Twaddell, or thereabouts. Care must be taken when putting in the ash that it is kept continually stirred, so as to dissolve every particle of it, for unless this is attended to some of it will get into hard cakes, which it is difficult to dissolve. When this density is attained, the liquid is drawn off into the settler, where all the sediment soon falls to the bottom. In large manufacturing establishments it is customary to throw in a few spadefuls of bleaching powder, which facilitates the deposit of the sediment and causes the crystals to be clearer than they would otherwise be. The clarified liquor is now drawn from the settler by means of the tap at the bottom and conveyed to the pan again. The fire is urged, and the contents of the pan kept in a state of ebullition until the density reaches 54° Twaddell. It is then allowed to cool to about 90° Fahr., when it must be run off into the crystallizing pan, or it may be allowed to crystallize in the same pan, but in this case the crystals will take a longer time before they begin to form, on account of the heat in the surrounding brickwork. Iron rods must be laid across the pan, and just beneath the surface, on purpose to support the crust which forms on the top, and to which a quantity of purer crystals attaches. The crystals will very soon begin to form themselves, and will continue to grow until the density gets too low. When completely crystallized, the liquor, which is termed mother-liquor, is siphoned off, and the crystals allowed to drain, after which they may be cut out with chisels and stored in a dry place ready for sale. The time occupied in the formation of a crop of crystals varies according to the state of the weather: in winter, or very cold weather, it takes about six days, whereas in summer it will require eight or nine days. The quantity of crystals obtained will be above double the weight of ash used. The mother liquor may be used again in making a further quantity instead of fresh water. "S. C." must not expect very large profits from the small quantity that he will be able to produce, but still I have proved by experience that as small a quantity as ¼cwt. of crystals can be made for less than they can be bought from the manufacturers, calculating at the rate per ton. If "S. C." will take particular notice of the quantity of soda ash he uses the first time to bring a certain number of gallons of water to the requisite density, he will have no need to use any of Twaddell's hydrometers at all; to ascertain when the liquor is boiled up to its crystallizing density, viz. 54°, let him take a small quantity in a ladle or cup, and blow on it with his mouth, when, if it forms a scum on the surface he may conclude that it is boiled enough. I trust that I have given the information sufficiently clear to be understood by "S. C." if not let him ask again for what is deficient.—J. Roskell.

[4532.]—TELESCOPIC, Etc.—In reply to "H. A. C.," it cannot fairly be considered good work for an 8¼in. silvered glass reflecting telescope to render the satellites of Jupiter visible in sunshine. One of the satellites, the 3rd, has been seen with only 2in. aperture, 50 minutes before sunset, by Mr. C. Grover. I have very frequently observed the satellites before sunset with a 4¼in. O. G., and have no doubt that the 3rd could be seen throughout an entire day with 3in. of aperture. Let your correspondent turn his telescope on γ^2 Andromeda and if he sees the components fairly divided he may be sure that his telescope is a very excellent one.—Hesperus.

[4541.]—EMBROIDERING MACHINE.—The machine which I think will suit "A Braider" and recommend him to see is the "Excelsior," Whight & Mann, 143, Holborn-hill, price from £6 6s. It makes the double chain stitch the same as the Grover & Baker, with the advantages of a straight needle and a simpler mechanism. It has no feed, therefore the work can be turned right round with the needle for a pivot. I have had one nine months and am quite satisfied with it. The work though quite strong unpicks readily.—O. E. R.

[4546.]—DIVISION PLATE.—"Wahsrof" evidently has not given much attention to this subject or he would not recommend such numbers as he does. For example, a man who has a circle of 720 holes (who ever had?) cannot possibly have any occasion for 360, 144, or 120. The numbers 221 and 209 are the most absurd possible, as one is 11 times 19 and the other 13 times 17, and you cannot obtain twice or three times any of those numbers, as they are all primes, so that you have to pay for boring 430 holes, of which only 60 are of any use at all, the rest not even for "fine rings or flutes." I must confess I cannot understand the lines against which he writes "divide into differences."—J. K. P.

[4546.] DIVISION PLATE.—I have a lathe by Holtzapffel and one by Buck, the division plate on the former contains the following 360, 192, 144, 120, 112 and 96, that on the latter 240, 180, and 108.—T. W. Boord.

[4554.]—PENDULUM.—In answer to "Lex" I beg to inform him that it is not the simple lengthening or shortening of the stroke of the pendulum which regulates the clock, but the alteration in the length of the pendulum itself.—F. J. Walker.

[4556.]—TELEGRAPHY.—In reply to "Mus," I think the band which he describes is to conduct the atmospheric electricity to the ground.—John Legg.

[4556.]—TELEGRAPHY.—In answer to "Mus," he is right in supposing that "A" in the diagram is to prevent the wire slipping off the pole. It is termed a "wire guard," but on all new lines a "hoop guard" is used, that is, a galvanised-iron inch-wide strap, arched over the insulator and fastened both sides. By the way, his diagram is quite wrong, he never saw *two* wires fastened to *one* insulator.—Terminal.

[4560.]—PAINTING CISTERN.—If your cistern is well scraped and dried, a light coat of red lead paint ought to remain good for years.—Vivis Sperandum.

[4563.]—BRASS COIN—is a Nuremberg counter; observe the letters RECHP. "Rechenpfenning" or counter; those letters are always sufficient for classing a coin among the German counters. The present bears even the English word "Counter."—Bernardin.

[4568.]—COPPER AND BRASS COINS.—The first one is a Roman coin of the Emperor Probus, who reigned from A.D. 276 to A.D. 282. It is of the size called 3rd or small bronze. The obverse bears the crowned bust of the emperor to the right, circumscribed IMP. C. PROBVS. P. F. AVG. (Imperator Caius Probus Pius Felix Augustus.) Reverse: a woman standing, holding a branch in her right hand, and a spear in her left. Inscription: COMES AVG. (Comes Augusti.) Common, worth 9d. to 1s. The brass one is not a coin at all, but a common card counter, quite worthless.—Henry W. Henfrey, M.N.S., &c.

[4564.]—TWO SILVER COINS.—No. 1 is a denarius of the Roman family of Antestia. Obverse: the winged head of the Pallas to the right; X for the value in front; and C. ANTESTI. behind (Caius Antestius). Reverse: Castor and Pollux on horseback to the right, with their lances in rest. A dog running below. In the exergue ROMA. This coin is common, worth 2s. Coined about 40 years B.C. The second coin is ancient Greek, but the drawing is very indistinct.—Henry W. Henfrey, M.N.S., &c., &c.

[4578.] METHYLATED SPIRIT.—In common with every other article of commerce methylated spirit varies in quality with the price, or dishonesty of the vendor. The commoner kinds contain considerably more than the regulation quantity of wood naphtha, and again, the wood naphtha itself contains a greater or less amount of tarry matter, according to the purification which it has undergone. The well-known empyreumatic odour of methylated alcohol is due to the presence of tar and other products of destructive distillation.—An Associate of Royal School of Mines.

[4577.] INDUCTION COIL.—The inductive effect of a magnet is greatest at its middle, hence, as "Inductorium" stated, that of the coil is so because it depends upon the magnetism of the core. The partitions do not waste the power as "Operator" supposes, because they are not *additions* but *substitutions*. They are sectional or vertical insulators in place of the ordinary horizontal ones. I consider good paper soaked in paraffine better than gutta-percha tissue of the same thickness. As I have several times said I have not had such experience in making induction coils as to justify my going into such details as are asked for, though I have made many of the coils as fitted for medical use, and have described them. I only make instruments for my own experiments, and induction coils are somewhat serious affairs, and have not, as yet taken up much of my attention.—Sigma.

[4579.] DUTIES OF GAS ENGINEER.—These are very extensive, and vary very much with the size of the works. In any case he has to keep up good discipline. To watch the quality of coal; the perfect state of repair of all the works; to decide upon the degree of heat and duration of carbonisation, &c., all of which can only be acquired by experience based on knowledge. This latter should be a moderate acquaintance with chemistry, and the qualities of materials. In large works the ordinary knowledge of a civil engineer is needed, such as relates to strength of materials and forms, as well as the principles of construction, and a good acquaintance with mechanical drawing. There are many books upon the subject, of which perhaps Clegg's is the best, Bowditch's are useful, and Hughes is a hash-up of a compilation published in Weales' series: I do not remember the titles, and have no list at hand.—Sigma.

[4582.]—GOLD LEAF.—Gold books are rubbed with red chalk, or crocus powder, I believe, but it is done to prevent the gold leaf adhering to the paper, and not, as "Chemicus" supposes, to prevent its flying about. The leaf is nearly always laid on the gold cushion before being applied to the work to be gilt. There are four methods of lifting the leaf from the cushion. 1st. A piece of thin beech, called a trindle, is rubbed on the workman's head, and then applied to lift the gold. 2nd. A piece of stout paper. 3rd. A gilder's tip. 4th. A piece of cotton wool.—Ab Initio.

[4589.]—TENDER FEET.—I think J. T. Hill will find relief if he turns his stockings inside out, and rubs them well with a piece of soap moistened in water. Boots with thick soles are not so apt to blister the feet as thin ones. Blisters also sometimes arise from boots being much too large. Tight boots also have the same effect.—W.

[4590.]—TOWN GARDENING.—"A Factory Lad" will not succeed in growing geraniums and fuchsias anywhere if they are exposed to the fumes of burning gas. Notwithstanding the purification which gas now undergoes there is still too much sulphur in it, and plants of any kind exposed to its effects cannot thrive, and will scarcely live. If "A Factory Lad" will accept my advice he will not attempt to grow anything from seed, but will go to a gardener or a nursery, and buy what he wants just as they are coming into flower, or at any rate when well established. Wallflowers, sweet williams, stocks, asters, and numerous others will bloom almost anywhere if well grown before removal. If, however, he *will* try seed, let him get *Collinsia bicolor*, *Lupinus nanus*, *Eysimum Peroffskianum*, *Nemophila insignis*, Virginia stock, larkspur, convolvulus, candytuft, and some of the other hardy annuals. I have seen these blooming even in London areas, where they get very little *light*, not to mention sunshine. When the seed comes up leave only two or three in a pot, so as to give them room to grow. Geraniums and fuchsias I have seen flourishing in London windows. Sunshine is not a necessity, but they should have as much light as possible. The creeping jenny does well to hang down in front and hide the boxes. Above all things give the plants good wholesome mould, such as turfs cut from a meadow, 2in. thick, and crumbled up with a little sand if necessary. Always keep the leaves clean by syringing or watering, as they act as lungs, and town soot and dust soon block up their pores, and so "choke" the plants.—Saul Rymea.

[4592.]—CHANGE WHEELS.—I think "C. C." had better beg, buy, or borrow Binns' second course, and read therein the chapters on wheel teeth. The scriber for striking the epicycloids is always a portion of a circle of one half the diameter of the smallest wheel of the set, which Willis puts at twelve teeth, and Binns proposes to make fourteen the universal standard for, as it makes a better shaped tooth, the wheels will then interchange anyhow. If the wheel is always to drive the pinion, as in clocks, and supposing the pinion to be a *lantern*, then the scribing circle requires to be the whole diameter, instead of half the pinion; but as the pinions of clocks are commonly only half the size of those used in other machinery, the result is much the same tooth for the wheels in either case. Where a wheel is always driven it requires no top to the teeth, which may all be turned off down nearly to the pitch line, and consequently the teeth of the wheel which always drives do not require cutting much below the pitch line, in fact only enough to clear the shortened teeth of the other wheel. I do not quite understand what "C. C." means by the middle line of his query, as I never knew of any particular rule for the case he proposes, beyond what I have given above.—J. K. P.

[4597.]—INDIAN COIN.—It was struck by Tippoo Saib, the Sultan of Mysore, about the year 1790. It will be remembered that Tippoo was slain at the siege of Seringapatam on the 4th of May, 1799. He struck many copper coins from the Mohammedan year 1215 to 1227 (A.D. 1799). These coins were the double *peisah*; *peisah*, or pice, also called *dudu* or *zahrah*; the half *peisah*, and the quarter *peisah*. All these coins are remarkably distinguished by the figure of the elephant upon them. If "J. N. D. C." would like to forward me his coin, I could tell him its exact date and value.—Henry W. Henfrey, M.N.S., &c., &c., Markham House, Brighton.

[4599.]—EFFECTS OF CARBONIC ACID.—Air containing more than 15 per cent. of carbonic acid is fatal to animal life; in its natural state it contains one part of carbonic acid in 2,500 parts (by measure), a larger proportion than this acts upon the nervous system as a narcotic poison.—T. W. Boord.

[4599.]—EFFECTS OF CARBONIC ACID.—If the proportion of carbonic acid is greater than 3 or 4 per cent. it acts as a poison.—Oxoniensis.

[4599.]—EFFECTS OF CARBONIC ACID.—According to Professor Huxley, the direct poisonous effects of carbonic acid have been greatly exaggerated, for it has been found that air containing from 15 to 20 per cent. of this gas may be breathed without producing any immediate evil effect, providing the quantity of oxygen in the air be increased in a like proportion. These experiments go to show that the destructive power of carbonic acid depends more on the fact that its presence in air renders the proportion of oxygen too small, and thus a species of suffocation or asphyxia is produced, together with any poisonous effects the gas may have. If the air were confined, as in badly ventilated rooms, the carbonic acid would continue to increase and the oxygen to diminish as long as the individual remained, and when 10 per cent. of carbonic acid is thus added to the air with the corresponding removal of oxygen asphyxia will take place. When a much smaller proportion of pure air, say 4 per cent., is replaced by carbonic acid, headache and languidness are produced, and these often end in fainting.—Exhibitioner at Royal College of Science.

[4600.] PRINTING IN GOLD OR BRONZE.—Use gold-size instead of the ordinary ink, and apply gold-leaf or bronze powder when the size is sufficiently dry. The size, &c., may be obtained ready for use at any printing material warehouse, as, for example, at F. Ullmer's, Old Bailey, E.C.—T. W. Boord.

[4600.]—PRINTING IN GOLD OR BRONZE.—This may be easily and cleanly performed by rolling the type with gold size instead of the ordinary printing ink. After the impression is "pulled," gold, silver, or bronze powder is dusted over the paper, and the whole wiped with a piece of cotton wool. Common printing ink answers just as well; but in this case, in wiping off the superfluous metal, care must be taken not to smear the letters, as the *black* ink would, of course, show on the paper. Any colour may be printed in the same manner; and particularly those which lose their lustre when mixed with varnish. Thus, ordinary red ink is "brought out" much better when it is dusted with vermilion powder afterwards.—Saul Rymea.

[4600.]—PRINTING IN GOLD.—"Amateur Typo" should moisten his type with size, or some glutinous composition, then print, and while the card is quite damp, dust it with gold or bronze; when quite dry, carefully brush off the superfluous metal with cotton wool.—Ab Initio.

[4600.]—PRINTING IN GOLD OR BRONZE.—"Amateur Typo" should use gold size in place of ordinary printing ink, and so soon as the impression is taken dust the work over with bronze—procurable from any artist's colourman—afterwards very lightly cleaning the surface with a pad of cotton wool. He will find *gold* far too expensive, whilst bronze will answer every purpose. The operation should be performed in a warm room.—H. T. R.

[4601.]—GILDING BOOK EDGES.—"A. H. D." should proceed in this fashion:—After the edges have been cut, wash with a mixture of one part candy sugar to four of Armenian bole, ground thoroughly together. Add the white of an egg and some water. The whole must now be thoroughly beaten together, till sufficiently thin to be applied with a brush. Use a camel-hair brush to apply the fluid, and when nearly dry, burnish with a wet rag and apply the gold-leaf on a piece of cotton wool. Some binders apply gum water before laying on the mixture of bole and sugar; others merely paint the edges with a solution of isinglass in spirits, and lay on the gold-leaf when nearly dry.—Sabbas.

[4601.] GILDING BOOK EDGES.—Screw the book up as tightly as possible between boards placed even with the edges, scrape the edges perfectly smooth with a steel scraper, burnish with an agate, then colour over with red bole, or chalk ground in soap, rub immediately dry with fine clean paper shavings and burnish again. The size, prepared by well beating up the white of an egg with three times the quantity of water, must then be applied evenly with a large camel's-hair pencil, and the gold laid on with a tip. When dry burnish carefully to avoid rubbing off the gold.—T. W. Boord.

[4601.]—GILDING BOOK EDGES.—"A. H. D." should gild his edges as soon as cut, and if he wishes the edges to show red under the gold, he should first colour the edges with vermilion mixed with glaire, and a little *liquor ammoniæ*; when dry moisten the edge with a little gold size, and while the edge is damp lay on the gold (see reply to 4582). When thoroughly dry burnish with a bloodstone burnisher.—Ab Initio.

[4602.]—MELTING GLUE—Break up your cakes of glue into a saucepan or melting pot, and cover with water. Let it stand a few hours to soak; place it on the fire until dissolved; bring it to boiling point, and strain it through a cloth, and it is completed. If found too thick for your use add a little water; if too thin, place it on the fire, the water will soon evaporate.—Cabinet-Maker.

[4602.] MELTING GLUE.—Soak a cake of glue from 12 to 24 hours in cold water, then drain off the water, put it (the glue) in the glue pot, fill the outer vessel with boiling water and apply heat. The glue will speedily run into a liquid fit for use. The longer it is soaked the more liquid it will be. Glue improves in quality by frequent melting.—J. W. Boord.

[4603.]—FISHING.—" Mr. Jamieson " will find plenty of bleak and gudgeon in the Lea, either at Rye House, Tottenham, or Temple Mills; but he must remember that gudgeon swim near the bottom and bleak near the surface. A good method of angling for bleak is to have a light fly-rod and line, and a No. 1 hook mounted on a bit of the very finest gut, stained greyish green. About 1½ or 2ft. from the hook place a round piece of cork, about as large as a good-sized pea, which will do for a float. Bait with one nice large gentle, and have ready some bran, mixed with sufficient water to cause it to adhere on pressure and yet to crumble up readily when thrown into the water. Choose a likely spot for a swim, which is easily discovered by the bleak rising, throw a handful of bran up stream, and drop the baited hook on the water, letting it float down with the bran till you get a bite. This is considered the best method, but bleak can be taken with anything, only you must fish on the top. They are found in most streams producing dace and roach; and gudgeon are to be caught in nearly every *running* river in the kingdom. Stone-loach are to be found underneath stones; and the best way to catch them is to wade into the water, remove the large stones, and net or spear them. Thames fishermen always rake the bottom when fishing for gudgeon; this is as good as ground bait, or better.—A. T., Staines.

[4604.]—PICRIC ACID is formed by the action of fuming nitric acid upon many organic substances containing nitrogen, such as silk, indigo, salicin, &c., &c., but more cheaply by treating carbolic acid and its derivatives with nitric acid. It is a bright, yellow crystalline substance, possessing great tinctorial properties. It dissolves in about 90 parts of cold water, to which it imparts a yellow colour, and a bitter taste; it is on account of this latter property that it has been substituted for hops in brewing, although, from what I can glean, more importance has been attached to this means of adulteration than it deserves, for it is not so commonly used as is generally supposed. A test which can readily be applied by persons not conversant with chemical manipulation is to take a skein of white silk, and allow it to remain in the ale under trial for a short time, when, if there be any appreciable amount of picric acid present, the silk will be found to have acquired a yellow tint. Another test is to shake the ale well until a good froth is obtained; this, if the acid be present in any quantity, will have a yellow shade.—An Associate of the Royal School of Mines.

[4604.]—PICRIC ACID.—Picric acid or tri-nitrophenic acid, one of the coal-tar dyes, of canary-yellow colour, and very bitter taste. Its tinctorial power is very great, one part distinctly tinging 800,000 parts of water. A simple solution in water is sufficient to dye animal fabrics a fast canary-yellow, although it is generally applied with alum and tartar. Its use as a substitute for hops is objectionable, as it is said to yellow the eyes of those who partake of it. It may be easily detected as follows:—Take a small test tube, say 4in. by ½in., half fill this with the liquid to be tested; add a small bit of potash or soda, about the size of a grain of wheat; warm this over a gaslight until dissolved; now add a small crystal of green copperas; hold the test tube up to the light, and watch the change of colour; if picric acid be present the liquid becomes a reddish brown, but if not present, it becomes a dirty greenish white.—Crow Trees.

[4604.]—PICRIC ACID.—This acid is formed by the action of nitric acid on indigo. Brilliant yellow scales, very bitter and highly poisonous; used in dyeing yellow. its salts are mostly explosive with heat. It throws down a yellow crystalline precipitate, soluble in water, with caustic potash.—J. W. Boord.

[4605.]—PROPELLING A VESSEL BY A WINDMILL.—A vessel could not be propelled *head to wind* by a windmill, for even supposing friction to be put out of the question, and the whole of the power exercised by the wind on the windmill to be utilized by the screw, the result would simply be that the vessel would remain stationary; but as more or less of the power would be lost on account of the friction of the machinery, and as the wind would moreover be acting on the hull and rigging of the ship, the practical result would be that the vessel would go backwards instead of forwards, though not perhaps so readily as if the machinery were not at work.—W.

[4607.]—ORGAN BUILDING.—To make stop diapason speak louder. This can be done—providing the scale will admit—by "cutting-up" the mouths of the pipes higher, as well as by taking out the plugs, which are sometimes put by the builders into the feet to soften the tone by reducing the supply of wind. This requires considerable experience to do; and unless "W. Porters" is a first-class hand at voicing I should recommend him to take his stop to a regular organ-builder, who will, if the thing is practicable, very soon do what he requires, whereas his own efforts may only render his stop uneven and perfectly unbearable. As regards hardening brass wire for pallet-springs, don't have an inch of it in an organ at all, unless you wish to have a constant source of annoyance in the shape of repairs. Steel and galvanized iron wire are almost universally used by builders for pallet-springs.—H. T. R.

[4611.]—POLISHING VULCANITE.—"G. N. L." can get a perfect surface on his vulcanite by removing the scratches with a smooth waterayr stone (wet), and then giving it a good pumicing at his lathe with fine pumice and stiff brush. After washing the pumice off he can polish it with whiting and soft brush. He must keep turning his work about in different directions, so as not to keep brushing in one direction, for if he does, he will never get a surface.—J. C. P.

[4614.]—ELECTROLYSIS.—This can be easily effected by an electro-magnetic apparatus, if arranged to give a "quantity" current, and in one direction only. The ordinary instruments sold would be totally useless, as they are arranged to give a current of high tension or shocks, instead of quantity.—Sigma.

[4618.]—MANAGEMENT OF BEES.—The best bee-feeder is a wide-mouthed glass bottle holding about 1½ pints. Half fill with syrup and tie a piece of coarse cloth tightly over the mouth, place a piece of wire gauze over one of the openings in the board forming the top of the hive, and turn the bottle quickly upside down placing it at once on the gauze. Last winter my bees consumed about a pint in ten days, as nearly as I recollect, but they had very little stock honey in their hive. The bottle, complete, may be had at Neighbour's, Regent-street.—J. W. Boord.

[4621.]—CHLORIDE OF GOLD.—Dissolve the gold cuttings, which should not be too large, in *aqua regia*, this should contain more hydrochloric acid than nitric; evaporate down on a water bath, when a red deliquescent mass of chloride of gold will remain. If a pale yellow powder be left on taking up with water do not throw it away, for it is the sparingly soluble protochloride of gold. The readiest way to get rid of this is to ignite it and re-dissolve the metallic gold thus obtained in some more *aqua regia*, and proceed as before.—An Associate of the Royal School of Mines.

[4621.]—CHLORIDE OF GOLD.—Dissolve the gold in *aqua regia* and evaporate to dryness over a water bath. The residue may then be dissolved in water.—Exhibitioner at Royal College of Science.

[4621 & 4622.] CHLORIDE OF GOLD AND NITRATE OF SILVER.—Chloride of gold, or more properly terchloride of gold, is made by dissolving pure gold, one part, in three parts of nitro-muriatic acid (composed of nitric acid one part, and muriatic acid two parts); when, by the assistance of heat, the solution is complete, evaporate until fumes of chlorine are disengaged (to be distinguished by the smell) and set aside to crystallize. To utilize your old solution of silver add a solution of common salt in excess, *i.e.*, until no further precipitate is produced; collect the chloride thus produced on a filter, wash and dry it, then throw it carefully and by small portions into a red hot hessian crucible containing twice its weight of fused carbonate of potash with a little borax, waiting until the effervescence ceases each time before adding a fresh quantity; when all is in raise the heat considerably to prevent the silver from adhering in globules to the side of the crucible, and allow the whole to cool slowly. The silver thus obtained may be dissolved in nitric acid and crystals obtained in the usual way. The salts obtained in both the above processes should be re-crystallized twice to insure purity. Cuttings of paper filters, &c., containing silver should be burnt, the ashes treated with nitric acid, and the resulting liquid as above.—J. W. Boord.

[4622.]—NITRATE OF SILVER.—Do as you say. Evaporate down to dryness; powder it, and mix with some carbonate of soda, as a flux, and a little charcoal powder, and then fuse.—An Associate of the Royal School of Mines.

[4627.]—DISCOLORATION OF LEATHER.—In the process of tanning, leather is made to take up tannic and gallic acids; these combine with iron, derived from the metallic surfaces of the press, and form tannate principally, and some gallate of iron, both of them are black, hence the stained leather; in fact black ink is formed. This discoloration may be prevented by not allowing the iron surfaces to come in contact with the wet leather. Would it be feasible to apply a thick coat of paint to the presses and so prevent direct contact between the two?—An Associate of the Royal School of Mines.

[4627.] DISCOLORATION OF LEATHER.—When the iron-mould comes into contact with the leather, which contains tannin, a combination is formed similar to that which gives its colour to ink. If the moulds and leather were perfectly dry this would not take place. Brass moulds would not be open to the same objection.—J. W. Boord.

[4627.]—DISCOLORATION OF LEATHER.—"G. A. G." is certain to get his leather discoloured while he uses *iron* upon damp leather. Cannot he use boxwood or something similar?—Ab Initio.

[4631.]—LATHE.—TO H. WILLIAMS.—I should say No. 12 gauge-wheels would do very well. The size of screw may be 1in., unless it is a very long one, in which case it is desirable, I think, to have a bearing close to where the thread terminates on the left of the gap. Of course the smaller the diameter of screw the less the force required to work it, and that is considerable when you are cutting a screw of high pitch. I may as well take this opportunity of stating my firm opinion, that in this case, as in most others where screws are used for any purpose, except as what Holtzapffel calls the "cement" that binds portions of machinery together, a very great economy of force is obtainable by the use of a high-pitched screw. And for your case one of 1in. pitch and 1in. diameter, would, I am quite positive, give a most satisfactory result in working. It would be, perhaps, difficult to get cut, and still more to get a nut made for it; and is moreover so at variance with usual practice, that I should not advise you to act on my opinion, however firm it may be, as I have not tried such a screw yet—though I have everything nearly ready for doing so. You might safely have one of ½in. pitch, with a 4in. threaded screw, cut with a No. 8 screw-tool. I advocate the plan of making the screw in two parts, viz., the plain part at the left-hand of the lathe terminating in a socket, into which either end of the screw may be keyed, a portion of the thread, say an inch at each end, being turned away for the purpose. Close behind the socket comes the extra bearing I propose above, and then you may safely reduce the diameter of your screw. I should strongly advise you to send your screw to Wilkinson, No. 42, St. George's-road, London, to be cut, as you will then have it of a true number of threads to an inch, which is commonly not the case in lathe screws.—J. K. P.

[4638.]—SILK WINDING.—The cocoons must be well steeped in a warm soap-lye, and the floss taken off until the fibre will run easily: then five or six of the fibres are taken together, passed through a small eyelet, or guide, and wound upon a large reel. As soon as any cocoon becomes exhausted or runs down to a mere skin, it must be replaced by a fresh one so as to keep the reeled thread uniform in thickness.—Crow Trees.

[4640.]—SOUTH KENSINGTON EXAMINATION PAPERS.—These papers are to be had of Messrs. Chapman & Hall, Piccadilly, London, stitched together in batches of four or five different subjects, price about 3d. or 4d.—Crow Trees.

[4641.]—MILL BILLS.—"R. D." can get his bills to stand if he is careful not to heat them beyond a bright cherry-red when drawing down the points. The process requires skill, no chemical being used in the water. Begin by carefully and regularly heating the point to be first drawn, and sledging it down to about one-half more than the intended thickness, tapering it in width so that when drawn by the hand-hammer to the proper thickness it is of equal width throughout, as hammering the edge now will cause the corners to fly. After cutting square, and flatting the point, thrust the bill through the fire and heat well up before attempting to heat the end, turning it round so as not to burn the edges; draw the point into the fire and heat to a brightish red, being careful of the corners. Harden by plunging about 2in. of the point perpendicularly into a pailful of cold spring-water. If "R. D." accomplishes all this skilfully, being sparing of heat, though not of labour, his bills will stand dressing the hardest millstone.—T. A.

[4641.]—MILL BILLS.—"R. D." should use yellow prussiate of potash, and plunge into urine, while red hot. As far as my experience goes, that *never fails* if the metal be good.—Ab Initio.

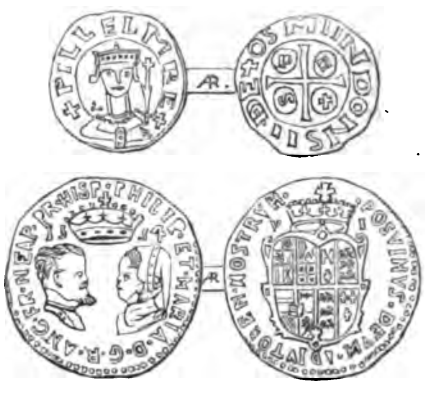
QUERIES.

[4645.]—HYDROGEN LAMP.—I have a hydrogen lamp which is minus the platinum. I went to Jackson & Townson's, and asked for a bit of spongy platinum, and was told that it was a powder. The receptacle for it is like a small thimble turned towards the jet from which the hydrogen issues. Will some one inform me how I am to proceed to put it in working order?—F.R.M.S.

[4646.]—MAGNETO-ELECTRIC MACHINE.—Would some kind brother reader inform me if any experiments can be performed with one of these machines apart from their ordinary medical use,—if so, I should like to know what and how to be performed—so as a number of persons could see it at one time? or if by any means the current of electricity can be made more powerful? Would a coil of wire or helix add to the strength? The answer of some reader will oblige.—Enquirer.

[4647.]—PHOTOGRAPHIC.—TO "MUS," OR "OPERATOR."—Will either of the above gentlemen kindly assist me in the following matters?—1st. By mistake I mixed the nitrate of silver in *filtered soft water*. Does it matter? If it does, what had I better do? 2nd. In looking on the focus screen, the figures (houses, pigeon-house, saw-mills) are not only upside down, but reversed (saw-mills on *left* hand, &c.). I don't think the latter position can be correct. If it is not, how shall I alter it? 3rd. I can get no image on the plate when the developer is poured on. What is the remedy for this? I have taken the English Mechanic regularly for several months, but as I do not see any information applying to my case, I have acted on "Mus's" advice to another correspondent and beg leave to ask for it.—Mendicus.

[4648.]—TWO COINS.—If any reader of the English Mechanic would inform me through the medium of your pages the value and other particulars of the two



coins in my collection of which the above are sketches, they would greatly oblige.—Constans Lector.

[4649.]—FRICTIONAL ELECTRICITY.—I have a cylinder electrical machine, the cylinder (length 18in., diameter 8in.) being supported on two brass pillars screwed into a brass table, into which is also screwed the brass spring to which the rubber is attached; and would esteem it a favour if any reader would kindly explain why I can only get a ¼in. spark from the prime conductor (which is mounted upon a separate glass)?—Patty.

[4650.]—FRENCH LANGUAGE.—Would any reader favour me with the name of a first-class book from which an English person might study the above, also the cost and publisher?—Patty.

[4651.]—POWER OF WATER-WHEEL.—I shall feel thankful if any of my fellow-readers will kindly assist me with a plain rule to find the horse-power of an overshot water-wheel, diameter 16ft., breadth 4ft. Also, would a penstock of 8ft. or 10ft. above the wheel increase its power and also its velocity? If so, in what ratio?—Miller.

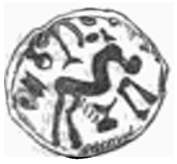
[4652.]—TONING BATH.—I am often troubled with my toning bath not working well. Would any of your readers oblige me with a good, trustworthy formula, giving good uniform tone? I think "Mus," "Operator," and others can supply me with sound information.—John Terras.

[4653.]—SUNDIALS.—One of our friends, "E. L. G." [4131], says sundials can be easily made to show clock time throughout the year, by having two gnomons used alternately for nearly half a year each. He leaves the problem to be solved by your readers. As unfortunately the problem is beyond my ingenuity, I shall feel obliged if he will favour me with further information.—Sundial.

[4654.] — OCCULTATION OF SATURN. — Will "F.R.A.S.," Mr. R. A. Proctor, or some other correspondent, kindly explain the following?—It is stated in the *Nautical Almanac* that the planet Saturn is occulted by the moon on the evening of the 30th September. The disappearance is predicted to occur at 6h. 4m., and the re-appearance at 7h. 18m. So far this is perfectly clear, but on referring to the "Elements of Occultation," in the same volume, I find that the planet will be in conjunction with the moon at 6h. 12m. on the same date and that at the time of conjunction the planet will be situated 56m. of arc distant from our satellite. How can this be, when at 6h. 12m. the planet will be actually occulted by the moon?—Hesperus.

[4655.]—MANGANESE BATTERY.—I have seen Mr. Stone's reply to "M. D." in the last number, regarding the manganese battery, and I am very glad to hear they answer so well. I wish I could say that two cells I use for bell-ringing, had gone untouched for as long a period. The fact is that in my case the connections of the battery corrode, so that I am obliged at least once a fortnight to disconnect, and file binding screws, &c., until quite bright. This is the only trouble I have with the battery, and surely if it will go in one case months without any attention, it will in another. Perhaps Mr. Stone will give me a hint or two on the subject, especially as to some less rough process of cleaning the connections, which at the rate I file them will soon be worn out.—E. H. B.

[4656].—GOLD COIN.—Will Mr. Henfrey or some numismatic friend kindly inform what the gold coin is, and the value, of which I send the exact size and copy? Plain on one side. Weight 2 dwt. 23 grs.—Henry Hoad.



[4657.] — KNOT-STITCH SEWING-MACHINE.— Would "Practical Hand," or some other brother reader, kindly answer the following? I want to make a knotted-stitch sewing-machine, but do not quite understand how to make the looper, nor yet the length of stroke the needle should travel.—J. S. S.

[4658.]—CLEANING GILT FRAMES.—I should be glad to know the best way to clean the gilt frame of a chimney glass. As it is not of recent (cheap) manufacture, I think the gilt will bear operating upon. The gilt is not damaged by accident, but is of a smoky appearance, and being highly ornamental will cost too much to regild.—W. E. M.

[4659.]—TURNING HARMONIUM INTO AN AMERICAN ORGAN.—Could Mr. E. H. Jones (who wrote relating to American organs) tell me if I could make or alter an harmonium into an American organ?—J. W.

[4660.]—WELDING FORKS.—Would some reader be so good as to state the process of welding cast-steel, such as the prongs of forks, &c?—J. W.

[4661.]—CATERPILLAR.—Will some reader of the English Mechanic inform me what is the name of this caterpillar? It has a broad white stripe down the back; a horn on the third segment, black; broad black stripe down the sides, which is marked dimly with orange; head and claspers black.—J. Hampton.

[4662.]—COIL.—I have made an induction coil with ½lb. No. 16 primary wire, and 1lb. No. 35 secondary wire, 9in. long. How much battery power can I use with safety, and how much spark ought I to get without condenser? How long a spark can I expect from a single ½ pint bichromate battery?—Tometer.

[4663.]—BRAKE PIECE.—Can any one favour me with a description of a brake piece that reverses the current of electricity suitable for a coil?—Tometer.

[4664.]—PRESSURE OF WATER.—Can any reader of the English Mechanic tell me if there is any difference in the pressure of water at the bottom of two pipes, both 12ft. high? One is 4in. diameter the whole length; both are vertical; the other 8in. diameter for 8ft. of its length, the bottom 4ft., are 4in. diameter. Is there any difference at the bottom of the two pipes in pressure per square inch?—Holbeck.

[4665.]—PROBLEM.—Would any reader give me a solution of the following problem, taken from the first B.A. Algebra paper, London University? α. "An express train which ought to travel at uniform speed, after being an hour in motion, was delayed half an hour by an accident; after which it proceeded at three-fourths of its original rate of speed, and in consequence arrived at the end of its journey 1h. 50m. behind time. Had the accident occurred (and the same delay and subsequent retardation taken place) after the train had been an hour and a half in motion, the train would have been 1h. 40m. behind time. Find the length of the line. β. Supposing the above question were varied in the latter part of it by your being informed that 'had the accident occurred when the train had gone *half-way*, it would have arrived 1h. 20m behind time;' would that information have been incorrect?" Would it have enabled you to determine the length of the line."—Beverley.

[4666.]—LIQUID BONE MANURE.—I shall be obliged if some of our correspondents can tell me how to dissolve bones, so as to make a liquid bone manure which may be used without injury to plants?—S. W.

[4667.]—CLEANING GUN-BARRELS.—Does "Muzzle Loader" recommend fine emery-paper for cleaning gun-barrels every time that they get foul? I should imagine that it would wear them much more than tow wrapped round the cleaning-rod would.—Needlegun.

[4668.]—THE LATHE.—TO "J. K. P."—I am just going to have a 4½in. centre lathe, with back gear, overhead, and screw-cutting motion, and do not exactly know how to get it: whether I must buy it complete of a maker, or if I could get the castings and have them planed up, and do all the other part that I can myself, and put what I cannot do out to a lathe-maker to be done, such as the leading screw, &c., &c. I have enquired of a great many lathe-makers the price of such a lathe (first-class work, and all the borings hardened steel), and find that some, such as Evans, say about £100, and others gradually lower in price down to £25, which is the lowest estimate I can get. A man in Compton-street, Clerkenwell, offers to make it for that. Now, I consider that £25 is a fair price for this kind of lathe without any chucks, but from what I have heard the higher-priced makers say, I shall not get such a lathe as I expect for that money. The mandrel will be iron, case-hardened, and all the borings of the same material, which would never suit me, as I want this lathe to last me a life-time, if used with care, as an amateur would use a lathe; besides I have not got £70 or £80 to lay out, and it would take me years to save so much, and I want the lathe with as little delay as possible. If, on the other hand, I can get the castings, and have them planed up, for about £6 or £7 (the lathe-makers estimate them ready planed at from £10 to £4 10s.) I ought to get a very good set of castings to work upon, and I think that as I could get through a great deal of the work myself, get the long leading screw cut by a lathe-maker, also the slide-rest screws, and have the pulley divided, &c., &c. (I could fit them in their places myself), it would reduce the cost very considerably—as my time is my own, and, therefore, should not be reckoned in the expense. I have a *very good* 6in. lathe, 3ft. 6in. bed, with slide-rest, face-plate, and chucks, and I know how to use it perhaps as well as the *general run* of workmen. Could I on this lathe with my experience, make an attempt with any chance of success to make the kind of lathe I have endeavoured to describe in this letter, or, at least, the greater part of it? Will "J. K. P." kindly say what I had better do under these circumstances?—Tometer.

[4669.]—OXYHYDROGEN MICROSCOPE.—Can I use my achromatic microscope lenses (1in. and 2in.) with an oxyhydrogen lantern, 3½in. condenser, for showing microscopic objects on a screen? A description of the mounting required would oblige, if possible.—E. H. Jones.

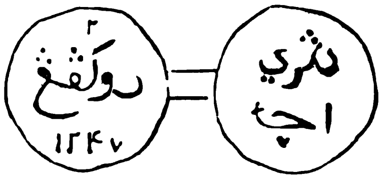
[4670.]—SATURN.—Will any subscriber kindly inform me what part of the heavens to look to to find Saturn, and the same for Jupiter, about from eight till ten in the night? Please to name the constellations they will be in about the time your reply will appear. I looked for Saturn for weeks, but not knowing in what part to look I have not succeeded in finding it.—Young Amateur.

[See "Astronomical Notes," by "F.R.A.S.," in this number.]

[4671.]—ICEBERGS.—Can you or any of your readers say why icebergs were met this year (1870) on the banks of Newfoundland in March? They must have left Baffin's Bay before the sun was seen there. Could they have been detached by an earthquake?—C. J. R.

[4672.]—KITE.—Suppose a large and well-proportioned kite to be properly balanced and inclined in a favourable wind, being free from all direct attachment with the earth, and also the common appendages, would it mount, and if necessary, on a change of inclination, make progression against the said wind by the virtue of the aforesaid counterbalance being dependent from a proper position to some distance beneath, and the inclination being rigid? A speedy reply will much oblige. —W. J.

[4673.]—INDIAN COIN.—I shall be much obliged if any kind reader will describe the Indian copper coin, of which I forward sketch.—Collector.



[4674.]—PROBLEMS.—*a*, through a point given in a circle, draw a chord which will be cut by the circumference in extreme and mean ratio at the given point. *b*, same problem, an angle being substituted for the circle.—X. Y.

[4675.]—POND FOR GOLD-FISH.—I have a pond in which I keep roach, gudgeons, and minnows. I am about to put gold-fish in it. Shall I be able to keep them alive all winter, or must they have protection? If so, what way should I proceed to afford it them? The pond is fed by a spring-water pipe, and is about 20 yards square, and 6ft. deep.—Vivis Sperandum.

[4676.]—NITRATE OF SILVER.—I have a quantity of nitrate of silver precipitate, thrown down with salt from photographic slops. Would some reader kindly tell me how to re-dissolve it, so as to be perfectly neutral and fit for either bath or exciting paper?—Paddy.

[4677.]—WATER POWER.—Would any brother reader inform me what power I could get from a fall of water fifteen feet through an inch pipe, if applied to a turbine wheel? And what size, &c., of a turbine would do? Also what kind of a turbine would be best?—A Regular Subscriber.

[4678.]—BOURNE ON THE STEAM ENGINE.—I am about to purchase a work on the steam engine. Is there a better work on the subject than Bourne's? If there is would one of your readers tell me the price, publisher, &c.?—Thos. Watson.

[4679.]—CIVIL ENGINEERS' EXAMINATIONS.— Would some kind correspondent give me a little information about the Institute of Civil Engineers? What is necessary to become a member? and what is requisite to become a C.E., the cost of [illegible]? —Terminal.

[4680.]—BLEACHING CALICO.—[illegible] spondent can give a few hints on the [illegible] brown calico?—N. S.

[4681.]—INSULATION.—What is the [illegible] of solid ebonite to safely insulate the [illegible] secondary coil giving 4in. sparks in air [illegible] the comparative resistance of [illegible] new insulating material (Dr. [illegible]) Field & Co.? On writing to the [illegible] mation on this point, they simply [illegible] which I find to be softer than [illegible] soluble in chloroform, &c., and melting [illegible] contains paraffine. But the above [illegible] to accurately determine. Also, what [illegible] wires with to prevent them accumulating [illegible] gold when hanging articles in the [illegible] solution (cyanide) attacks gutta-percha [illegible] week, if possible, will greatly oblige.—[illegible]

[4682.]—TONING BATH.—Will "[illegible]" [illegible] as to give me his formula for toning [illegible] purple tint? I cannot find it in back [illegible] only taken it a few months.—Photog[illegible]

[4683.]—VALVE FACINGS OF CYLI[illegible] J. C. Molton or any other obliging subscriber [illegible] if the valve facings of model cylinders are [illegible] whether they are put or brazed on after [illegible] if cast on how is the cylinder finished off? [illegible] I put anything in my crucible (brass) to [illegible] free in casting, and how to avoid the scum [illegible] going in with it, as it chokes up the moulds; [illegible] moulds require to be heated? Thanks to "J. C. [illegible] his last instruction on cylinders.—Amat[illegible] Founder.

[4684.]—TYPE.—Would any reader be kind [illegible] inform me whether there is any decisive test [illegible] tinguish "pirated" from genuine "faces" in type [illegible] whether, if in equal quality of metal, the former [illegible] serviceable to the printer?—Country Printer.

[4685.]—GILDING ELECTRO.—Will some practical electrician give me some information upon what [illegible] known to the trade as solid depositing—*i.e.*, manufacturing solid articles by depositing gold in the way that copper is deposited? Is the solution worked warm or cold? What battery power is used, *arranged for quantity* or intensity? What is the right *proportion of the areas* exposed of the anode and the *cathode? What is the* best surface to deposit upon? *I believe there must be* a large quantity of gold in the solution.—*W. H. Coffin.*

[4686.]—INSULATION.—TO "INDUCTORIUM."—I wish to ask "Inductorium," who describes a mode of making a coil on page 472, No. 275, if he finds the insulation between the primary and secondary coils sufficient? In coils of the ordinary construction only a small part of the secondary circuit approaches the primary, being the layer next to the reel. In the vertical mode the two extremities of the secondary coil are separated from the primary by only the thickness of the reel, and from communicating with each other by twice that thickness plus the resistance of the primary between the two points. In his case the terminals are insulated from each other by their silk covering twice the thickness of the reel, and one of the *rings* plus the length of the primary with its cotton covering. This amounts to only ¾in. solid ebonite, the rest of the resistance certainly being not equal to ¼in. of the same. Is this [illegible] ebonite enough insulation between the terminals of a wire giving 8in. and 4in. sparks *in air*? For his [illegible] certainly hope so.—W. H. Coffin.

[4687.]—"PANCREATINE" AND "PANCRE[illegible] EMULSION."—The above preparations are excellent remedies for indigestion, and are very useful for taking cod-liver oil, but to buy them comes expensive. If [illegible] reader would inform me how I could prepare [illegible] should feel greatly obliged.—H. H.

[4688.]—SEPARATING BEESWAX FROM RE[illegible] &c.—I should feel greatly obliged if any reader could inform me how to separate beeswax from resin and [illegible] foot oil, with which it has been mixed?—Cabinet-Ma[illegible]

[4689.]—PEDOMETERS.—Would any brother [illegible] give me a description of the action of the pedometer?—An Enquirer.

[4690.]—HOROLOGICAL.—Will some of our horological friends who are adepts at the use of the [illegible] give me some practical instructions how I am to proceed in turning down the collet of a verge for fixing the balance? What kind of bow am I to use—its strength, and string—also what kind of graver [illegible] use; size of cutting angle it must have, position [illegible] hand in using, length of stroke for the bow, quickness of speed to suit best; and, above all, whether it [illegible] cut with the work revolving *to* the graver or [illegible] graver? I find in practice that I cannot [illegible] progress when I attempt to cut the work [illegible] with its upper surface towards the graver. All [illegible] appears to be a *mere scrape.* But in the [illegible] when the under surface of the work revolves towards the graver I make better progress. In fact I have frequently taken hold enough *to break the* verge [illegible]. Where is the fault, is it in the bow, the graver, or my self? My friends may judge for themselves of my progress when I tell them that it will take me 2½ hours of hard cutting, scraping, and scratching to turn down the collet of a polished verge, previous to putting on the balance when an adept could do the same work in half an hour. I also wish to know how the pivots of the pinions are got to the required size. Are they turned *with the graver* or *filed down*? I have frequently put new pinions, but always file them down to the required size in the turns, by placing the end of the pinion in a notch at the end of the centre of the turns with the end of the rest as a guard, to keep the edge of the [illegible] from running away from the shoulder of the pivot. Is it the proper way?—Scrape.

[4691.]—POWER OF ENGINE.—Would "Vertumnus" give me the power of an engine whose cylinder [illegible] 2in. in the bore and of 4in. stroke, by the rule he maintains in your last week's issue (4474), and what will [illegible] the necessary thickness of boiler plate, and pressure of steam to work at to attain the power of one horse?—R. W.

—SCREW PROPELLER.—Could one of your aders tell me how to obtain the pitch of a screw r ?—R. W.

—BICHROMATE BATTERY.—Will "Sigma" ther brother correspondent kindly tell me what oper distance to leave between the plates of a ate battery? The plates are 5in. by 2in. Also the best way to fasten the copper wire to the plate ?—THOMAS J. O'CONNOR.

] —HOROLOGICAL.—Would some horological er kindly inform me by what rule watchmakers ct watches—viz., what is the difference between 1m. 5-10th and one 1m. 9-10th? Have they the umber of teeth and leaves to wheels and ? Also, how many sizes of watches do the trade ze ?—B. E. LODDY.

.]—BLEACHING IVORY.—Can any subscriber inform me how the handles of table cutlery that ecome yellow with use, may be restored to their whiteness ?—BLACK RAVEN.

.]—WATER-WORKS.—Can you or any of your ondents inform me the cost of laying mains in and roads per mile? In supplying water by gravi- what head is required to overcome the pressure pipes ?—T. W. C.

.] —TO "INDUCTORIUM."—Will "Inducto- state the size of secondary wire he uses? and as I allows ⅛in. between the discs, must it be wound ards and forwards in this space until filled, and e next, and so on ?—T. W. C.

.]—SPECTROSCOPE.—Can any of your corre- nts give me instructions and drawings for making troscope ?—T. W. C.

.]—SCIENCE AND ART EXAMINATIONS.— ask Mr. G. E. Davis what books he would recom- to one preparing for the Organic Honours Paper, t May's examinations ?—CROW TREES.

0.]—COPIES OF COINS IN ELECTROTYPE. l some kind brother please tell me how to take of coins, &c., in electrotype ?—WILLIAM S. CHER.

1.]—CLEANING COINS.—Will you or one of your readers please to inform me how to clean old (silver and copper) without injuring the coins ?— IAM S. FLETCHER.

2.]—TRUE HEART FOR TRAVERSING.—I l be grateful if any one would inform me, by a sketch or otherwise, how to describe a true heart raversing purposes, from 1in. to 8in.—GOOD S.

3.]—CHANGE WHEELS.—My thanks to "B. H." s answer to query 4871, p. 454, but he evidently kes what I want. He gives me an answer to ge from one hank to another. I want to know how find the proper wheels in the first instance. I never seen a rule myself, and don't know whether is one or not. If "B. H." could assist me any er I should be obliged.—GOOD WORDS.

04.] —CHANGING SURNAME.—I wish to change urname. How can I do it ?—M. SPIEGELHALTER.

05.]—NATURALIZATION.—What steps must I to become a naturalized Englishman?—M. SPIEGEL.

06.]—PHOTOGRAPHY.—I put the water that I the silver prints in into a deep mug and precipitate silver with common salt, and have done so with the test success for two years. The silver precipitated tifully, but now it is just the reverse, it won't per- ate at all, and I have put lots of salt in, but to no l. Would some kind reader of the MECHANIC be good gh to tell me the reason, and if there is a cure, what ?—IN A FIX.

07.]—STEAM.—Can any of our numerous readers me what would be the number of cubic feet of steam minute, issuing from a pipe 2¾in. diameter, under a sure of 40lb, per square inch? Would they also give rule and working of the same, as I have no books ting on the subject? And also say where I could a work on the subject ?—E. J. JACKSON.

708.]—LOSS OF VOICE.—For the last two or three s my voice has been very husky and indistinct, and ave generally to give a short cough before I can k a word. I shall be very glad if some kind reader tell me what will improve it.—A FORESTER.

709.]—TO MR. PROCTOR.—Will Mr. Proctor kindly ish me with the dimensions of the stand figured in "Half-hours with the Telescope," p. 17, and say her he thinks it would be suitable for an instru- t 4in. aperture 5ft. long? I wish to make a stand h shall give a steady motion, and be easily moved place to place. Perhaps Mr. Proctor's experience enable him to suggest some simpler plan that would oderately efficacious.—TURTON.

710.]—FASTENING BRASS TAPS IN KITCHEN LER.—Can any of your numerous readers inform how to tighten a brass tap to kitchen boiler that has ome loose ?—INQUIRER.

4711.]—COLZA OIL.—Will any brother reader be d enough to instruct me how to test the quality of a oil.—M. Q. W.

4712.]—AIR v. STEAM.—I want to substitute air steam (like many others I suppose) but there is supposed impossibility to contend with—namely, t it requires just as much power to force the air into boiler as it does to move the engine. Now if difficulty could be overcome, could any correspon- t tell me, if air even then could cope with steam ?— ous.

[4713.]—BEES.—I wish to remove my hive inside a lding during the winter. Can any reader inform me he bees would pass in and out through a small hole de in a 9in. brick wall, and how bees are fed, or what hould feed them with in the winter? I think a few ers on bees, through the MECHANIC would be found y acceptable to many of its readers.—J. G.

4714.]—HOT OR COLD BATH.—Can any reader give information on the following points? 1st. What ans could I adopt in order to get hot water from a wash-house copper (on the ground floor) to a bath (on the first-floor), without carrying it? Will a pump answer the purpose? If so, what sort? I have an idea that hot liquids cannot be pumped, as they would injure the pumps; is this idea correct, and if so what other expedient can I adopt? If, however, hot water can be pumped, I presume that the same pump will also serve to pump up cold water from the butt? 2nd. Would india-rubber or gutta-percha tubing answer? Any information on these points would oblige ?—A HANDY MAN.

[4715.]—SILK DRESSING MACHINE.—Having seen a letter in the MECHANIC for June 10th signed E. Davis, I should be much obliged if he would, through the MECHANIC, furnish me with the particulars regarding a silk dressing machine he mentions, on which he can change the sheets of silk in a few minutes.—A. T. T.

[4716.]—FINISHING BLACK CLOTH.—Can any of your subscribers inform me of the best method of putting a bright face or finish upon black cloth ?—J. R.

[4717.]—BINDING MAGNETIC WIRE.—I believe it is essential that the winding of the wire for magnetic purposes should be performed as evenly as possible. Like a reel of cotton, I find it difficult, or, indeed, impossible, to accomplish it merely with the hand, as it is produced by the regular manufacturer. Would some one kindly inform me what means to adopt to effect my object ?—MAGNET.

[4718.]—VARNISH FOR BRIGHT STEEL WORK. Can you inform me of any preparation for covering bright steel work, so as to prevent its rusting, and at the same time preserve its bright appearance; something that will have the same effect as varnish on paint, enabling me to wash the work when done ?—THOS. PRIOR.

[4719.]—ELECTRO PLATING.—Will some brother reader kindly inform me how I can electro-plate small articles so that they may keep their colour? The articles are brass and copper.—SCRAWLER.

[4720.]—KALEIDOSCOPE.—Will any of our optical friends tell me how to make a kaleidoscope such as I see in the shop windows; I don't mean the common ones ?—H. K. L.

[4721.]—FOSSILS.—Will Mr. Underhill tell me whether I can obtain many fossils in the neighbourhood of Hunstanton and along the coast to Cromer? What are they; and where ought I to look ?—H. U.

[4722.]—CONSTRUCTION OF SHIPS.—I should be obliged if any correspondent will tell me what is Scott-Russell's "wave-line principle" for the construction of vessels.—N. A.

[4723.]—WATER BAROMETER.—Will "Cornubia" (p. 396), kindly answer me the following questions:— 1st, What a thermometer has to do with graduating the degrees on *his* barometer? 2nd. If the heat would not have any effect in expanding the air contained in the glass bulb, and so effect the height of the column of liquid in the glass tube? 3rd. Why not graduate the degrees on the tube at once, instead of having the revolving apparatus ?—GEOMETROS.

[4724.]—CONSUMPTION OF COALS.—Some time ago there was a commission appointed to inquire into the consumption of coal. Can some one inform me if that commission has yet published its report? And if it has, where, and at what price it may be obtained? Or what amount of coal is consumed in the United Kingdom, in the working of steam engines of all classes, stationary, locomotive, and marine ?—PETRUCHIO.

UNNOTICED QUERIES.

In future, if any query remains unanswered for four weeks, we shall insert the number and subject of the query in this list, where it will remain for two weeks, if not previously replied to. We trust our readers will look over the list, and send what information they can for the benefit of their fellow-contributors.

Since our last J. H. Rumsey has answered 4112; John Terras, 4159: "Oxoniensis," 4200, 4270; "A. S. C.," 4224; "S . . . r," 4242; "M.R.C.S.," 4274, 4275.

4261	Cotton Spinning, p. 406.
4265	Fixing and Colouring Prints on Glass, 406.
4266	Water Gilding, 406.
4269	Associate of Art Degree, 406.
4284	Alabaster Glass. To Mr. J. Leicester, 406.
4286	Alloys for Tin Foil, 406.
4287	Cotton Spinning, 406.
4288	Force Pump for Irrigation, 406.
4292	Friction in Steam Cylinders, 406.
4293	Millers, 406.
4294	Brewing, 406.
4299	Silvering Clock Dials, 407,
4300	Sausages, &c., 407.
4302	Madagascar Matting, 407.
4303	Cast-Iron, 407.
4308	Model Mills, p. 430.
4310	Destructive Soap Powders, 430.
4311	Emigration, 430.
4312	Rocking Chair, 430.
4315	Cleveland Ironstone, 430.
4317	Sizing, 430.
4326	Polariscope for Lantern, 430.
4327	Want of Pressure, 430.
4331	Stone for Trinkets, 431.
4332	Black Glass of Antimony, 430.
4333	Lancashire Black, 430.
4337	Hollow Candles, 430.
4338	Draught Furnace for Smelting Lead Ore.
4339	La Crosse, 430.
4343	Windmill for Working Lathe, 431.
4345	Cracked Boiler Plates, 431.
4346	Concertina, 431.
4349	Heating House with Hot Air, 431.
4350	Barometer, &c., 431.
4351	Case for Ferns, 431.
4352	Weaving, 431.

DOMESTIC RECIPES.

From the *Food Journal*.

VEGETABLE SOUP.—Place one onion, cut in pieces, in a saucepan, with 8oz. of butter, and brown it; then add finely-shredded turnips, parsnips, leeks, carrots (also a white carrot, if procurable), green celery, a little sorrel, one small potato, and a few French beans and green peas, all of which are to be tossed and browned in the butter, with sufficient quantities of salt and pepper. Pour in a little water or stock, crush the vegetables slightly, then fill up with more water, and let the soup simmer for two hours. A little rice or pearl barley can, with advantage, be added to the vegetable. Care must be taken not to get the soup of too thick a consistency.

TO KEEP MUSHROOMS WITHOUT PICKLE.—Let the mushrooms be peeled, and the insides taken out; then lay them to soak in water for two or three hours, after which they must be dried. Lay them on tin plates, and set them up in a cool oven, an operation which must be repeated several times, until they are thoroughly dry. They must then be put in pots, and kept from damp.

TO MAKE KETCHUP.—To a peck of mushrooms, put two handfuls of salt. Let them stand two days; then strain them out, and boil for half or quarter of an hour. Scum them well, and season as you like with ginger, pepper, cloves, and garlic, all of which must be boiled but the garlic; let them stand for a day or two, and then put into bottles with sweet oil, tying over some perforated paper.

A COUNTRY CAPTAIN.—Cut a fowl to pieces as for a fricaseé; salt, pepper, and cayenne pepper it to taste, The fowl must be fried in butter by itself; three or four large onions fried brown in butter are to be sent up with it, with fried crumbs of bread, lemon peel, and gravy as for a roast fowl.—*From an old MS.*

A TURKISH BROIL.—Cut from a small cod-fish as many slices as are required, rub them with a little salt, and dip them in flour; then rub a gridiron with olive oil, lay the fish over, set it on a moderate charcoal fire, and turn the fish often. When nicely browned on both sides, take it off, then cover the surface of a dish with some finely chopped parsley and onions, place the fish over, with one or two lemons cut in quarters round the dish, and serve hot.

USEFUL AND SCIENTIFIC NOTES.

RUSTIC PICTURE FRAMES.—Rustic wood for this and other purposes is in great favour nowadays. According to the *Scientific American*, with a little care in selection of material and skill in handling tools, we may frame our engravings and paintings at slight cost. Oak wood, denuded of the bark, presents a beautifully corrugated surface, out of which the knife easily removes the few fibres which adhere, and it is ready for varnishing as soon as it is seasoned. The "season cracks," should they occur, may be filled with dark brown putty, and will even heighten the general effect. Take a thin board of the right size and shape, for the foundation or "mat;" saw out the inner oval or rectangular form to suit the picture. Nail on the edge a rustic frame made of the branches of hard, seasoned wood, and garnish the corners with some pretty device, such, for instance, as a cluster of acorns. Ivy may be trained to grow around these frames with beautiful effect.

PLATING COPPER AND BRASS WITH ZINC.— According to Böttger, copper and brass can be easily coated with zinc by immersing them in a boiling bath of sal ammoniac containing zinc foil or powder. The deposit of zinc made in this way is brilliant, and adheres firmly to the copper and brass. Whether iron could be coated or galvanized in the same way is not stated by the author, though the use of sal ammoniac in the ordinary process is well understood. He first prepares finely-divided zinc, by pouring the molten metal in a previously strongly-heated iron mortar, and stirring until nearly cold. The pulverulent zinc thus obtained is placed in a porcelain vessel, and to it is added a concentrated aqueous solution of sal-ammoniac. This mixture is heated to boiling; and the copper or brass objects to be coated with zinc (but previously well-cleansed, and, best, even with an acid) are then placed in the liquid, wherein they become coated with a brilliantly-white adhering layer of zinc.

METHOD OF PURIFYING ILLUMINATING GAS. E. Pelouze modifies the Lamming mass now generally employed for the purpose of purifying illuminating gas, by adding sulphuric acid. He sprinkles the purifiers containing oxide of iron and sawdust, with water, to which 20 per cent. of sulphuric acid, of specific gravity 1·53 (53° Baumé), has been added, and after the mass has dried up sufficiently, passes the gas through. After use it is necessary to restore the sulphuric acid, and to remove the sulphate of ammonia that may have been formed. It is said that napthalin is not removed from the gas by this method. A mixture of oxide of iron and sawdust thus prepared would serve an excellent purpose as a disinfecting agent to be added to the earth in the earth-closet, in stables, cesspools, and the like, but where it has to come in contact with metals care must be taken not to have free sulphuric acid present. Ordinary copperas or sulphate of iron and sawdust, with native hematite, or bog-iron ore, would also make a valuable disinfecting mixture, and would be nearly as cheap as any of the others.

NEGLECT OF MUSHROOMS.—How is it that mushrooms should be used so timidly, and left to rot by thousands in field and forest, when, with a rise in the price of flour, or of meat, they might and ought to give dinners for numberless cottagers, whose children could gather these "vegetable beef-steaks" with ease and with profit? Is there not the common mushroom, and the fairy-ring mushroom or Scotch bonnet, the blewitt and the orange-milk mushroom, the morel—and might there not be the truffle, had we less pride in borrowing from our neighbours, and more ingenuity in utilizing the loan? How is it that France is ahead of us in prizing these fungi as delicacies, and Italy very far ahead, so that £4000 worth yearly are sold in the market-place of Rome? We, says the *Food Journal*, pride ourselves on our roast beef; let us not have to blush for the scantiness and dearness of our vegetable accompaniments. M. Roques has called mushrooms, "the manna of the poor," and yet in England the poor do not consider themselves divinely chosen enough to gather this manna.

CARDED OAKUM AS A SURGICAL DRESSING.—So many advantages are possessed by carded oakum as a surgical dressing that we (*Lancet*) expect it to be largely employed in the military hospitals of France and Germany during the present war. As, however, its qualities are not yet so widely known as they should be, it may be useful at the present juncture to refer to them. The material is simply old rope shredded in prisons and workhouses, and carded by machinery. It is of a bright brown colour, with the well-known tarry fragrance. A little of the oakum is roughly drawn into a suitable shape for covering the wound, then wetted, and applied to it. All discharge is absorbed by the dressing, and any bad odour is effectually destroyed. By dipping it into hot water, and covering it with oil silk, a convenient antiseptic poultice is formed, easily made, very light, and answering perfectly its purpose. It thus supersedes the use of lint, ointments, and linseed-meal or bread poultices. It is easily burnt—no small advantage in a crowded hospital, where bad-smelling applications are a fertile source of decrease if not quickly destroyed. Its simplicity of application saves much time and labour—a great consideration where the nursing staff is overtaxed, as must always happen after serious engagements. Its cheapness is another great advantage. Carded oakum can be procured, we believe, for something like ninepence a pound, about a fifth or a sixth of the cost of lint.

NEW ELECTRIC MACHINE.—Among the improvements of the "Influence or Electropher machine," invented by Herr Holtz, of Berlin, a new construction, by Professor Poggendorff, is especially noteworthy. This machine, we learn from the *Monatsbericht* of the Berlin Academy, has two rotating glass plates; and the conductors are placed in a convenient manner, especially adapted for demonstrations in lecture-rooms. It exceeds in efficiency all machines hitherto made, and is manufactured by Borchhardt, of Berlin. For the purpose of cleaning the glass plates, Professor Poggendorff recommends rubbing with petroleum.

ALLOY FOR TAM-TAMS, OR GONGS, AND CYMBOLS.—From the *Chemical News* we have an account of the method now followed by Messrs. Riche and Champion, for making the sound-producing instruments alluded to, which consist of an alloy of 80 parts of copper and 20 of tin, which is hammered out with frequent annealing. An alloy of 78 of copper and 22 of tin answers better, and can be rolled out. The process is similar to that in use in China, and is carried out at Paris by M. Cailar.

POISON PLANTS.—Mr. Worthington Smith records in the *Journal of Botany* an instance of a fatal case of poisoning by eating the root of the water-dropwort, *Œnanthe crocata*, an umbelliferous plant, common in ditches and wet places. A carter at Staplehurst, in Kent, ate some of the roots whilst at work, supposing them to be the wild parsnip. In about an hour he became unconscious and convulsed, and death occurred in another half-hour, before medical aid could be obtained. The man had fed his horse with roots of the same plant, and the animal also expired about two hours after eating them. There is no doubt that the *Œnanthe* is a virulent poison, but it seems strange that the horse as well as the man should not have rejected a plant of so acrid and suspicious a flavour. Several wild Umbelliferæ are amongst the most dangerous of British plants.

THE NEW ACT ON FACTORIES AND WORKSHOPS.—The statute to amend and extend the Acts relating to factories and workshops was passed on the 9th August, in reference to print-works and bleaching and dyeing works, as also to amend the Acts on factories and workshops. There are two parts in the statue and three schedules. The first part relates to print-works and bleaching and dyeing works, and is to be construed as one with the Factory Act Extension Act, 1867; and after January 1st, 1872, the principal Act is to apply to print-works and bleaching and dyeing works. Certain regulations are to be enforced on the 1st of January, 1871, in Turkey-red dyeing works. The second part of the statute relates to fruit and fish preserves. The schedule to the Factory Acts Extension Act, 1867, and the schedule in the Workshop Regulation Act, 1867, are to be construed as if they were contained in each of those schedules. In the schedules the permanent modifications are set forth. In the manufacture of preserves from fruit, and in the processes of preserving or curing fish, women may be employed, between the 1st of June and the 14th of December, for a period not exceeding 14 hours on any one day.

ARTIFICIAL BUTTER.—Apparently astonishing as the idea is, the manufacture of artificial butter (*beurre artificiel*) is seriously contemplated in France. A Parisian contemporary states that M. Mèye, of Paris, has taken out a patent for the manufacture of artificial butter, which according to the journal in question, is to be used as a substitute for that ordinarily exported to England and Russia. The description of the process is, that animal fat is subjected to great pressure, by which the stearine is extracted for making candles, or *bougies*: an oily material being at the same time obtained, the composition of which is identical with that of butter. The question then arises, how is the taste of this "composition" to be rendered similar to that of butter? M. Mèye is quite equal to the occasion; he says that he subjects the animal oil to a succession of scientific processes and manipulations, the nature of which he explains at great length and with marvellous ingenuity. He traces the relations of unsophisticated grease to sophisticated fat, and crowns the edifice in rare style, by showing the precise identity of each with what he calls "butter," and indulges in the most sanguine anticipations about the success of his "invention."

GELATIN.—It is said that an animal fed on gelatin dies rapidly of starvation and inanition. This is perfectly true: but the fact is, that no simple substance given alone will support life. The most nutritive materials, such as albumen, fibrin, gluten—to say nothing of such substances as starch or sugar—all equally fail to support life when given alone.

SCAVENGER BEETLES.—Scavenger beetles are to be seen wherever the presence of putrescent and offensive matter affords opportunity for the display of their repulsive but most curious instincts; fastening on it with eagerness, severing it into lumps proportionate to their strength, and rolling it along in search of some place sufficiently soft in which to bury it, after having deposited their eggs in the centre. I had frequent opportunities, especially in traversing the sandy jungles in the level plains to the north of the island, of observing the unfailing appearance of these creatures instantly on the dropping of horse-dung, or any other substance suitable for their purpose; although not one was visible but a moment before. Their approach on the wing is announced by a loud and joyous booming sound, as they dash in rapid circles in search of the desired object, led by their sense of smell, and evidently little assisted by the eye in shaping their course towards it. In these excursions they exhibit a strength of wing and sustained power of flight, such as is possessed by no other class of beetles with which I am acquainted, but which is obviously indispensable for the due performance of the useful functions they discharge.—*Sir J. E. Tennent's Natural History of Ceylon.*

HARMLESS SALAD HERBS.—It is a pity people, says the *Pall Mall Gazette*, in this country neglect to add to their diet by a more liberal use of harmless salad herbs which are now altogether wasted. Watercress is very well in its way, but is not everywhere accessible. It has lately been pointed out that our sorrel plant is a more delicate and agreeable variety than the wood sorrel so largely used at table in France and Germany; that the common shepherd's purse and lady's smock may supply the place of the watercress; that the famous "barbe des capucins" of the Paris restaurants is nothing more than the blanched shoots of the wild chicory, and that the "salade de chanoine" is our own neglected corn-salad. Our peasants, however, have yet to learn the art of making salad, and the wisdom which selects and dulcifies with oil the bitter qualities of such herbs as the endive or its proposed humbler substitutes, the avens, the bladder campion, and the tender shoots of the wild hop. This art must descend to them from a more cultivated class, and in nothing is the English middle-class table more generally deficient than in the wholesome, varied, and savoury salad which adds an attraction to the simplest fare, and gives something of freshness, if not of refinement, to the richest as to the poorest table.

SEA-CUCUMBERS.—The holothuriæ, or sea-cucumbers, may be regarded in one light as soft sea-urchins, and in another as approximating to the annelides or worms. Their suckers are similar to those of the true star-fishes and sea-urchins. Besides progression by means of these organs, they move, like annelides, by the extension and contraction of their bodies. The mouth is surrounded by plumose tentacula, the number of which, when they are complete, is always a multiple of five. They all have the power of changing their shapes in the strangest manner, sometimes elongating themselves like worms, sometimes contracting the middle of their bodies, so as to give themselves the shape of an hour-glass, and then again blowing themselves up with water, so as to be perfectly globular. The great sea-cucumber is the largest of all the known European species, and probably one of the largest Cucumeriæ in the world, measuring, when at rest, fully one foot, and capable of extending itself to the length of three. Under the influence of terror, it dismembers itself in the strangest manner. Having no arms or legs to throw off, like its relations the luidia and the brittle star, it simply disgorges its viscera, and manages to live without a stomach; no doubt a much greater feat than if it contrived to live without a head. According to the late Sir James Dalyell, the lost parts are capable of regeneration, even if the process of disgorgement went so far as to leave but an empty sac behind. Considering the facility with which the sea-cucumber separates itself from its digestive organs, it is the more to be wondered how it tolerates the presence of a very remarkable parasite, a fish belonging to the genus Fierasfer and about 6in. long. This most impudent and intrusive comrade enters the mouth of the cucumber, and, as the stomach is too small for his reception, tears its sides, quartering himself without ceremony between the viscera and the outer skin. The reason for choosing this strange abode is yet an enigma.—*Dr. Hartwig's "Sea and its Living Wonders."*

ANSWERS TO CORRESPONDENTS.

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*** All communications should be addressed to the Editor of the English Mechanic, 31, Tavistock-street, Covent Garden, W.C.

The following are the initials, &c., of letters to hand up to Tuesday morning, August 23, and unacknowledged, elsewhere:—

Edwin Trayler, R. A. Proctor, J. B., T. S. H., E. O. T., J. B. F., J. P. H., J. H., R. F., R. W. H., Revd. E. Kernan, Scapegrace, Tom H., J. R. T., Ernest Hart, J. Willing, Unprejudiced, W. Perryman, Wm. Black, J. A. Mays, J. B. H., R. I. A., Albert Inchcliffe, St. John T. Gore, Knorferd, Geo. H. Hawley, J. M. Thomas, A. Stringer, H. Pocklington, W. R. Bole, J. Gale, E. B. Fennessey, H. E. Hutchings, H. T. Roche, Trinitrophenic Ferrum, E. W. A., P. S. J., J. Scarr, San Sebastian, Carlos, Geo. Evans, S. Priestley, E. M. Robinson, Velocipede, J. Bourne and Co., H. W. Reveley, M. A. C., J. Lander, J. P. H., A. J. Jarman, Jos. Mosley, J. D., J. Lee, Paddy, J. Bowley, Compensated Balance, J. Keen, H. T. Pocklington, Sable, A. L. C., W. E. D., Chas. Lucas, E. H. Ludgate, J. P. S., J. G., J. C. L., R. W. D., New Subscriber, R. D., G. H., E. Daw, Sergius, Unit, C. B., H. T. A., R. Chapman, Checkache, Carter, Draper, B. Walton, G. H. G., Urban, W. W., Endeavour, J. H. T., James H. Smith, Hopeful.

The Sixpenny Sale Column is the only place in which ca appear queries sent by J. E., Beginner, John Jack S. R.

W. J.—We cannot give the addresses of our contributor If you wish for the address of the gentleman you nam you had better ask for it through *The Sixpenny Sa Column*.

An Associate of R. S. Mines.—We could not unde take to receive the specimens. It would entail t much labour.

J. Gillaird.—The English Mechanic does not exi for the purpose of advertising gratis those who expec a "remuneration for their ideas." We are glad th we seldom receive letters like yours.

A British Workman.—We cannot move in t direction indicated. There will always be cunnin ones on the look out for flats. In all such transactio the weaker party should be doubly cautious.

A Blacksmith.—The following are the correct tabl you ask for:—A Millimetre = 0·0393704in.; a Cent metre = 0·3937043in.; a Decimetre = 3·937043in.; a Metre = 39·370432in., or 3·280869ft., or 1·093623 yards; a Kilometre = 1093·6231 yards; a Myriametre = 6·21877 miles.

A. Allen.—We do not think it would improve the ap pearance of our journal to insert part of the exchanges among the matter. They are to all intents and pur poses advertisements, and should not be bound up with the volume.

Hesperus.—If your claim has been allowed, you will probably share in the settlement which has been made —5s. in the pound, we believe.

D. F. A.—We cannot give the information. Our *Employment Column* was designed to meet cases like yours.

H. B.—Fecula is a term sometimes applied to starch, sometimes to cornflour. The most ordinary description is a pulverulent matter obtained by breaking down the texture of plants, washing with water, and collecting the deposit.

Emery.—B. J. (Birmingham).—No. Emery is a massive granular, or compact variety of a mineral, known as corundum. It takes its name from Cape Emeri, in the island of Naxos, where it is found in abundance, and whence it is largely imported.

B. G. K.—The weight of a foot of round bar iron 1½in. diameter would be 5lb. 13·7oz.; of 1½in. square bar iron 7lb. 7·5oz.

Britannia Metal.—F. C. W.—Britannia metal is composed of equal parts, brass, tin, antimony, and bismuth.

John Hampden (Wilts).—We cannot insert advertisements on condition of any one accepting your challenge and overturning your theories.

Cryptographer.—Next week.

J. B.—"Accessories to the Microscope" next week.

J. O. Brine writes to thank Mr. Geo. Jackson for his reply on melting cast steel.

An Enquirer.—Your query about price, &c., of pluviometers is an advertisement, and therefore not inserted.

Screw Power, by J. K. P.—Next week.

Lex.—You find fault with the style of writing of othe correspondents, and fall into similar errors yoursel You accuse "R. P.," in his letter on *Artillery Di* charges, of "deliberate equivocation," and conclud by saying that his letter "proves nothing beyond h own ignorance." Your reply to "Scriptor" is in th same style. One way to improve others is to set a goo example ourselves.

G. E. Davis.—MS. of Inorganic Chemistry and letter

E. L. G.'s letter and replies next week.

Jos. Millington.—We expressed your idea.

J. M.—We don't answer queries by post.

Bernardin.—Your suggestion for a passport is good for the Continent, but of no service to *English* mechanics.

Achromatic.—Your proffered articles on the "Microscope" would be acceptable, provided you do not go over ground covered by others.

H. W. T.—Your query has no practical value.

Useful.—See answer to "H. W. T."

Filters.—W. E. Ivey will find full information on this subject in Vol. X., pp. 112, 152, 578, 611.

A. W. Priest.—Purchase the volumes of the Englis Mechanic containing "The Lathe and its Uses."

Seconds Practical Watchmaker.—Next week.

J. O'Connel.—We know no reason to alter the opinion expressed on your pictures.

J. Baskerville on "Link Motion," next week.

The Phantom Wheel.—We have received dozens of letters on this question in answer to the "Harmonious Blacksmith," *all* testifying to the inaccuracy of his statement on the want of rigidity of these wheels. We never before witnessed such a concurrence o opinion. We have not room even to give extract from the letters.

A. G. V. Goodeur.—Send us the best you can.

Organ Building.—"R. W. D." and others inquire "Adept." The last we heard of our esteemed corre spondent was that he was unwell, but that he ho soon to be able to continue his papers. Not hav heard, we fear he is not recovered. It so happ that Mr. Kimble, another able correspondent organ building, wrote us about ten weeks since that he was obliged to go to another climate for the benefi his health.

W. W. Harris.—See footnote to Hermann Smit article on "Harmonium," No. 268, p. 173.

Robert R.—See series of articles on "Painting Decoration" now appearing in the *Building News*.

J. M.—Isocheimal means "equal winters;" *i.e.*, hav the same mean winter temperature. It is from Greek—*isos*, equal; *cheima*, winter.

R. E. Y.—"Beuheyl" is a mining term and signifie living stream. It is applied by tin miners to any p tion of a rock which is impregnated with tin.

S. R. B.—The pancreas is a fleshy gland situated un and behind the stomach, secreting a saliva-like f which assists digestion. The literal meaning of word is "all flesh."

he English Mechanic

AND

IRROR OF SCIENCE AND ART.

FRIDAY, SEPTEMBER 9, 1870.

STRACT OF A PAPER BY DR. ZÖLLNER, N THE TEMPERATURE AND PHYSICAL CONDITION OF THE SUN.*

By Richard A. Proctor, B.A., F.R.A.S.

Author of "Other Worlds than Ours," &c.

A PAPER of considerable scientific interest has recently been contributed by Dr. öllner to the subject of the "Sun's Physical ndition." The following paragraphs may be garded as an abstract (and, in some places, a anslation) of this paper, which would be too ng to appear in full in these columns. It has emed best to give the calculations in full, ecause, though too complex to be understood by ll our readers, they will be acceptable to many. he results to which they lead can hardly fail to e generally interesting.

The solar prominences may be divided into wo characteristic forms—those resembling clouds r smoke, and those which present all the eatures of mighty eruptions. Sometimes one, sometimes another form will be most prevalent over a particular region of the sun's surface. When we study prominences of the latter form attentively we can scarcely doubt that they are really due to eruptions of glowing hydrogen. Now, if we assume that these eruptions are caused by an excessive pressure exerted on the hydrogen while yet beneath the sun's surface (and no other theory seems available, unless we abandon altogether the guidance of recognized analogies), we must suppose that there is a stratum partitioning off the inner masses of hydrogen from the hydrogen atmosphere outside the photosphere.

The conception of such a stratum has been forced even on those who hold, like Respighi, that electricity causes these signs of eruptive action. But, adhering to the simpler and more natural supposition of a difference of pressure, we have the means of answering some very important questions respecting the temperature and physical condition of the sun.

We have in the case of perfect gases:—

1st. The law of Mariotte and Gay-Lussac.

2nd. The constant ratio which subsists between the specific heat at constant volume and the specific heat at constant pressure.

This ratio, when once determined by recognized methods, for any gas, must be regarded as unchangeable—like the atomic weight of substances and other such constants. In order to deal with the eruptive prominences, as instances of the outflow of a gas from one space into another, we assume, for the sake of simplicity, that there is a constant pressure in both spaces, and neither gain nor loss of heat.†

Put

A = the heat-equivalent of work (the reciprocal of Joule's equivalent).

v = velocity with which the gas flows from the opening.

g = force of gravity at the sun's surface.

κ = the constant ratio—

$$\left[\frac{\text{specific heat of gas when pressure is constant}}{\text{its specific heat when volume is constant}}\right].$$

c = the ratio of the specific heat of the gas to that of water.

t_i = the absolute temperature of the gas in the inner space.

t_a = the absolute temperature of the outflowing gas in the plane of the vent.

p_i = the pressure of the gas in the inner space.

p_a = the pressure of the gas in the plane of the vent.

Then according to the mechanical theory of heat, we have (on the assumed conditions)

$$A\frac{v^2}{2g} = \kappa c\,(t_i - t_a) \qquad (1)$$

$$\frac{t_i}{t_a} = \left(\frac{p_i}{p_a}\right)^{\frac{\kappa-1}{\kappa}} \qquad (2)$$

Assume further that

$a_{,}$ = the mean height of the barometer in metres.

ρ = density of the gas, at the temperature of melting ice, and at the pressure corresponding to the barometric height $a_{,}$ at the earth's surface.

σ = density of the gas in the inner space mentioned above, under pressure p_i and at the absolute temperature t_i.

α = the coefficient of expansion of the gas for 1° Centigrade.

From the law of Mariotte and Gay-Lussac we have the following relation:—

$$\sigma = \frac{\rho}{a_{,}\,\alpha}\cdot\frac{p_i}{t_i} \qquad (3)$$

The pressure p_a may be considered as equivalent to the pressure of the outer solar atmosphere at its base.

Next let

h = a certain height above the base.

p_h = the pressure at this height.

t = the absolute temperature of the solar atmosphere assumed to be constant.

r = radius of the stratum separating the inner from the outer space.

$\rho_{,}$ = specific gravity of mercury at the temperature of melting ice.

$g_{,}$ = force of gravity at the earth's surface.

$a_{,}$ = mean height of the barometer.

ρ = the density of our atmosphere at the temperature of melting ice, and under the influence of gravity $g_{,}$ and atmospheric pressure $a_{,}$.

Then we have, from known laws, the formula

$$\log_{\varepsilon}\left(\frac{p_a}{p_h}\right) = \frac{\rho\, g\, r\, h}{\rho_{,}\, g_{,}\, a_{,}\, \alpha\, t\,(r+h)} \qquad (4)$$

And in order to associate this formula with the preceding, we must assume

1. That the main portion of the solar atmosphere consists of the same gas which flows out to form the eruptive prominences.

2. That the absolute temperature of the solar atmosphere t is equal to the temperature t_a at the level of the vent.*

We have thus the ρ of formula (4) identical with the ρ in (3), and $t = t_a$.

It is now necessary to remodel and simplify our equations.

Put H = height which a body would reach if projected with velocity v from the sun's surface. We have then, taking into account the diminution of gravity,

$$v^2 = 2\,g\,H\,\frac{r\,H}{r+H}$$

$$\text{or} \quad \frac{v^2}{2g} = \frac{r\,H}{r+H}$$

Substituting in equation (1) we get

$$t_i = \frac{r\,H\,A}{\kappa\,c\,(r+H)} + t_a$$

$$= a + t_a \text{ suppose}$$

$$= a + t \qquad (I)$$

Write also, $\frac{1}{q}$ for $\frac{\kappa-1}{\kappa}$; b for $\frac{\rho}{\alpha\,a_{,}}$; and m for $\frac{g}{g_{,}\,\rho}$. Then equations 2, 3, and 4, become

$$\frac{t_i}{t} = \left(\frac{p_i}{p_a}\right)^{\frac{1}{q}} \qquad (II)$$

$$\sigma = b\,\frac{p^{i}}{t_i} \qquad (III)$$

$$p_a = p_h\,\varepsilon^{\,b\,m\,\frac{r\,h}{(r+h)t}} \qquad (IV)$$

And eliminating, we deduce

$$\sigma = \frac{b\,p_h}{a+t}\left(\frac{a+t}{t}\right)^{q}\varepsilon^{\,b\,m\,\frac{r\,h}{(r+h)\,t}} \qquad (V)$$

From this equation, if any three of the four quantities σ, p_h, h, and t can be determined by observation, or shown to lie within certain limits, the fourth, or the limits between which the fourth lies, can be calculated. But the limiting values of the quantities σ, p_h, and h can be determined partly by spectroscopic analysis, partly by other modes of observation. Thus we can estimate the limits of t (that is, the temperature of the hydrogen atmosphere). These limits substituted in I. give (from the known value of H) limits for the inner temperature t_i; and thence, by means of III. and IV., we can estimate the limits of the pressures p_i and p_a.

The lowest value for t is obviously 0. So that the minimum value of t_i is

$$a = \frac{r\,H\,A}{\kappa\,c\,(r+H)}$$

As the density of the solar atmosphere at moderate distances from the sun has been shown to be almost evanescent, we may, for simplicity, assume that H is equal to the mean height of the eruption prominences.*

Many prominences 3′ in height have been seen. But let us take H at only 1·5′.

The heat-equivalent A may be put as $\frac{1}{424}$ (taking the metre as unit of length, and centigrade degrees of heat). According to Regnault's latest results, $\kappa\,c$ is 3·409 for hydrogen; and according to Dulong, κ for hydrogen is 1·411.

Zöllner here enters into a discussion of the probable value of r. From a consideration of facts already made public, he comes to the conclusion that the stratum which separates the inferior gaseous masses from the outer atmosphere must lie beneath the photosphere—which is the stratum where, through increased pressure, the spectrum of the hydrogen atmosphere becomes continuous. Taking the nuclei of spots as probably corresponding to the lower stratum, and the depth of such nuclei as 8″, he suggests as a probable value for r,

$$r = R - 8'', \text{ where } R = \text{sun's radius,}$$

or putting R = 16′ at the sun's mean distance,

$$r = 15'\,52''$$

Taking Hansen's value of the sun's mean parallax (8″·9159) we have

r = 680,930,000 metres
8″ = 5,722,000 ,,
and H = 64,370,000 ,,

Substituting these values in the expression for t_i (when $t = 0$) we find

$$t = 40{,}690° \text{ Centigrade.}$$

Giving H a value twice as great as this,

$$t_i = 74{,}940° \text{ Centigrade.}$$

These are minimum values of t for the assumed heights 1·5′ and 3′, respectively, to which the eruptive prominences are supposed to reach.

Zöllner here pauses to inquire whether the ascent of the prominence matter may not be due to the same principle which makes heated air ascend in a chimney, rather than to projection through a resisting medium. Of course, in the former case, his whole argument would fall to the ground, because instead of compressed hydrogen rushing out through an opening into a relatively rare atmosphere, there would be relatively rare hydrogen rising by reason of its lightness through a denser atmosphere. He rejects this conclusion, however, on account of the enormous velocity with which the prominences have been observed to rise—whether their formation is measured directly and timed, or by spectroscopic observations depending on the change of wavelength of light from prominence-matter moving towards or from the eye. He finds that the velocity of projection† necessary to hurl matter to the observed height attained by the prominences corresponds well with these observed velocities, whereas no such velocities could be expected if the hydrogen merely rose by reason of its relative lightness.

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* Dr. Zöllner, "*Ueber die Temperatur und physische Beschaffenheit der Sonne.*"

† There would commonly be a great departure from both conditions, but a little consideration will show that for the purpose of the present inquiry these conditions are necessary, while the results obtained may be trusted as indicating the limits of temperature and pressure in the cases considered.—R. A. P.

* Zöllner infers the justice of the second supposition, from the fact that the bases of the prominences seem about as bright as the chromosphere. But though there is very little apparent difference, yet the photographs taken during the American eclipse indicate the existence of a real difference of brightness. For the edge of the lunar disc is eaten away, so to speak, at the bases of the prominences. It is true that Dr. Gould considers this is due to specular reflection at the moon's surface, but there is every reason to believe that Dr. Curtis is right in regarding the peculiarity as "a phenomenon of the dark room"—*i. e.* a purely photographic effect. However, it is important to remark that Dr. Zöllner's results are not importantly affected by a change in the assumptions.—R. A. P.

* In other words, Zöllner here assumes that the height to which the erupted gas is *observed* to be projected through the resisting atmosphere, is not very far less than that to which it would be projected by a like force, *in vacuo*. Owing to the probable compression of the erupted gas, the supposition is admissible, at least for the purpose of the above inquiry. The maximum rather than the mean height of the prominences should be taken, however; because obviously we cannot suppose all the observed prominences to be really projected from the edge of the disc, many must be *foreshortened portions* of prominences.—R. A. P.

† I am led to notice here the amazing conception of Mr. Mattieu Williams's, that matter is projected from the sun far beyond the orbits of Mercury and Venus, and even beyond the orbit of the earth and Mars. It would not be difficult to show the enormous improbability that any explosive forces exerted by the sun could produce such results; but setting aside all such reasoning, and giving all due weight to the possibility of a tangential motion being imparted as well as a radial motion, it is certain that any bodies so projected must return to the point of projection. Setting aside the relatively minute effects of planetary perturbations, any body projected from the sun, even tangentially to his surface, must continue to have the place from which it was projected as a point of its orbit. Yet Mr. Williams gets his projectiles altogether free of their source, and so makes them act all manner of unexpected parts. They become meteors, though the orbits of most meteors pass

To resume, then, the consideration of the limiting values of t_i.

We can deduce a limit for t by discussing equation V. It may be readily shown that σ cannot exceed the mean specific gravity of the sun, or 1·46. Giving σ this value in V.; to a the value 40,690° deduced above, to h the value 8″ at the sun's distance, expressed in metres, and to p the limiting values 0·500^{mm} and 0·050^{mm} deduced by Wüllner, we get the following values for t.

When $p_h = 0{\cdot}500^{mm}$ $t = 29{,}500°$
,, $p_h = 0{\cdot}050^{mm}$ $t = 26{,}000°$

The mean value 27,700° will be adopted.

Now, differentiating equation V. with respect to t, the differential coefficient $\frac{d\sigma}{dt}$ is found to be negative,*—that is, as σ diminishes t increases. Therefore since the above value of t has been obtained by giving σ its maximum value, 27,700° is the minimum value of t. It corresponds to a value of 0·180^{mm} for p_h; which value will accordingly be adopted in the following computations.

It may be noted in passing that the high values obtained for t, show that iron can only be present in the form of vapour in the solar atmosphere.

Taking

$$t = 27{,}700° \text{ we get}$$
$$t_i = 68{,}400°.$$

Putting these values in II., we find

$$\frac{p_i}{p_a} = 22{\cdot}1\,;$$

that is, the pressure within the space from which the prominences flow is 22·1 times greater than the pressure at the surface of the fluid layer supposed to separate the compressed gas from the gas outside.

Again from formula IV. (putting h as 8″) we get

$$\frac{p_a}{p_h} = 766{,}000,$$

or the pressure on the fluid surface of the sun is (on the assumptions we have made) 766,000 times greater than the pressure at the height where the hydrogen spectrum begins to be continuous owing to pressure.

Putting

$$p_h = 0{\cdot}180^{m} \text{ we get}$$
$$p_a = 184{,}000 \text{ atmospheres,}$$
$$\text{and } p_i = 4{,}070{,}000 \quad ,, \quad .$$

Reckoning the depth at which in a fluid of specific gravity 1·46 the mere hydrostatic pressure would be p_i, we find that this depth is 139 geographical miles, or about 650 English miles; that is at about 1-658th of the sun's semi-diameter, or 1·46 seconds of arc below the limb.

Even taking the case of a dense atmospheric shell of hydrogen, we find that for a temperature of 68,400° (t_i) we have a pressure of 4,070,000 atmospheres (p_i), only 27″ beneath the visible limb of the solar disc, or about 1-36th of the visible solar semi-diameter.

This shows how quickly the pressure must increase within the sun's globe, and justifies the supposition that, even at the enormous relative temperature undoubtedly existing, the so-called permanent gases—hydrogen, oxygen, and nitrogen for instance—can only exist in the form of glowing fluids.*

A very surprising result follows, when we consider in turn the case of a nitrogen or oxygen atmosphere, having the same specific gravity and temperature as the hydrogen atmosphere (at the level of the dividing stratum), and reckon the pressure existing in each atmosphere at that height where the hydrogen spectrum begins to become continuous. Taking the pressure of the three atmospheres as equal to 184,000 atmospheres, at a depth of 8″ beneath the sun's visible limb, we get (with the temperature $t = 27{,}700°$)

For hydrogen $p_h = 180$ millimetres
,, nitrogen $p = \frac{323}{10^{78}}$,,
,, oxygen $p^h = \frac{124}{10^{88}}$,,

So that the quantity of these two gases, on the above suppositions, may be regarded as absolutely evanescent where the spectrum of hydrogen begins to become continuous. This would also clearly be the case if we supposed the weight of the two atmospheres many millions of times greater, though it would only require that the weight of given quantities of nitrogen and oxygen should be 14 and 16 times (respectively) less than it actually is to cause these two gases, under the assumed conditions, to have a density coincident with that of the hydrogen at the sun's visible limb. It is easy to calculate, by means of formula III., and the known specific gravity of oxygen and nitrogen, how great the weight of each atmosphere must be in order that the density at a depth of 8″ beneath the sun's limb may reach its maximum value 1·46. We thus find that the weight of the oxygen atmosphere can amount to but 0·56, that of the nitrogen atmosphere to but 0·64, where the weight of the hydrogen atmosphere is represented by unity.

It appears, then, that putting out of question the existence of disturbances in the solar atmosphere, the rays sent from the hydrogen which exists at so great a pressure as to give a continuous spectrum, can pass through so small a quantity only of glowing oxygen and nitrogen, that the absorption would be imperceptible, and therefore (as we know to be the case) the spectroscope could afford no sign of the presence of oxygen or nitrogen in the solar atmosphere.

However, as the absorption-lines of iron and other metallic elements show that we might (were mere quantity in question) expect to find traces of the presence of oxygen and nitrogen, it is necessary to add to the above considerations the circumstance that the permanent gases have but slight emissive power compared with the vapours of ordinarily solid bodies. The absorptive power being proportional to the emissive, we can understand (or at least it is no longer altogether perplexing) that the lines of substances whose vapour-density must be considerably greater than that of oxygen or nitrogen should be seen in the solar spectrum, which yet shows no oxygen or nitrogen lines.

Zöllner then presents the following propositions as flowing either directly or indirectly from his calculations:—

1. We cannot conclude from the want of certain lines in the spectrum of a self-luminous star that the corresponding elements are necessarily absent from its substance.

2. The layer in which the reversal of the spectrum takes place is different for each substance, and lies nearer to the centre of the star according as the vapour-density is greater and as the emissive power is less.

3. Under otherwise equal circumstances this stratum lies nearer to the centre as the intensity of gravity is greater.*

4. The distances separating the reversal-strata of given substances, from each other as well as from the centre, are greater as the temperature is greater.

5. Under otherwise equal circumstances the spectra of different stars are richer in lines the lower the temperature and the greater the mass of the star.

6. The difference in the intensity of different dark lines in the spectrum of the sun and other stars does not depend only on the difference between the absorptive powers (of the corresponding elements), but also on the different depths at which the reversal of the spectra in question takes place.

Zöllner closes his paper by dwelling on the great importance of distinguishing between the respective influences of temperature and pressure on the spectra of gases and vapours. He points out the possibility that, when examining the spectra of electric discharges through rarefied gases, the pressure might be kept constant by an emission of gas before each discharge; and thus the means be obtained of determining the effect of temperature alone. He notes, however, that the results presented above could not be *importantly* affected by any change in the *estimated pressure* at which the hydrogen-spectrum *becomes continuous*, since, corresponding to limits of pressure proportioned as 1 to 10, the limits of the resulting temperature are proportioned as 1 to 1½ only.

THE MICROSCOPE.—HOW TO CHOOSE AND HOW TO USE IT.

(Continued from page 532.)

We do not propose any rigid order of sequence in our further notes upon the microscope, but we will endeavour to take the several pieces of apparatus as they appear to stand in the order of desirability. To this end we will allow ourselves considerable latitude in our interpretation of the word *accessory*, and include therein all apparatus not supplied with an ordinary student's microscope. And the question we will set ourselves to answer shall be, What extra apparatus, and in what order, would you recommend to a student?

I think we may place the polariscope in the first place, partly because whether we do or no the student is tolerably sure to do so, and partly because in proper hands it is an invaluable instrument of research. In the form most commonly applied to the microscope the polariscope consists of two parts—the polarizer and the analyzer. These are precisely similar in construction and may (provided their fittings admit) be interchanged at pleasure. The polarizer and also the analyzer may consist of a rhomb of Iceland spar, or a thin plate of tourmaline or of herepathite (sometimes called artificial tourmaline). On account of its cheapness and freedom from colour, as well as its greater freedom from danger of accidental damage, the Iceland spar is generally used, and in the form known as Nicol's prism. Instead of the spar as a polarizer thin plates of glass may be used, but as they do not permit of rotation readily their disadvantages are great. The polarizer fits into the stage from beneath, and it is well if a bayonet catch or some simple appliance be arranged to hold it firmly in position. The prisms are fitted into a collar, which rotates easily by a milled head, unless the stage be an elaborate mechanical affair, when special arrangements are made to receive the prisms. The analyzer may be fitted either immediately above the objective, in which position there is some loss of definition, or above the eye-piece, in which case there is a considerable loss of field. In general work the former position is the best. In any case the prisms should be made capable of rotation with exact centering. If it be desired to carry the

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nowhere near the sun; they become asteroids—the gap of 157 millions of miles now separating the nearest asteroidal orbit from the sun being seemingly as of no moment whatever. It cannot be too plainly insisted on (this projection theory having so often been a stumbling-block) that while the bursting of a planet into fragments which eventually pursue independent orbits, or the projection of a body from a planet so that that body eventually follows an independent orbit, may be conceived (at any rate) as possibilities, the central body of a system cannot possibly project bodies in such sort that they can travel in independent orbits around him. I do not say that the two former suppositions are one whit more acceptable than the latter. There are abundant reasons for doubting whether a planet could burst in the way according to which the formation of the asteroidal zone has been explained. Nor have we any reason for believing that eruptive action on any planet could expel a body far enough to free it from the control of the planet, and enable it to follow an independent orbit around the sun. But we can conceive such things, precisely as we can conceive (without believing) that the sun might project a body beyond the orbit of Neptune. What we cannot conceive, without forgetting the essential principles of dynamics and the law of gravity itself, is that a body projected to any distance from the sun could ever be found travelling on an orbit which at no point approaches the sun.—R. A. P.

* All the quantities dealt with in equation V. are positive. Differentiating we get—

$$\frac{d\sigma}{dt} = \frac{b\,p_h}{t_q}\,(a+t)^{q-2}\left[(q-1) - q\,\frac{(a+t)}{t} - \frac{b\,m\,r\,h}{(r+h)t^2}\,(a+t)\right]\varepsilon^{\,bm\frac{rh}{(r+h)t}}$$

An expression which is obviously negative since $(q-1) - q\,\frac{(a+t)}{t} = -1 - q\,\frac{a}{t}$, and the third term within the square brackets is negative.—R. A. P.

* Against the supposition that such gases as oxygen, hydrogen, and nitrogen can under any circumstances assume the liquid or solid condition, it has been objected that all the gases which can be liquefied exhibit under pressure a departure from the law that elasticity varies with density; whereas other gases exhibit no appreciable departure from that law, even under the greatest pressure yet applied. But it is known that in the cases of the liquefiable gases the departure from the law increases in a marked manner as liquefaction is approached. It follows, therefore, that the appreciable departure from the law under ordinary pressures only proves that the pressure necessary to produce liquefaction bears a measurable ratio to ordinary pressures. It gives us promise, that is, of being able to liquefy such gases,—a promise justified by the event; and conversely, all that is shown by the absence of any such departure from law in the case of other gases, is that the pressure necessary to liquefy them vastly exceeds any yet applied. The fact is sufficient to discourage any hopes we might have formed that such gases could be liquefied by us; but by no means proves that they cannot, under any circumstances, assume the liquid or even the solid form. As a parallel instance, we can conceive that no means would avail to produce variations of temperature many degrees on either side of the freezing point. In this case certain peculiarities noticed in the expansion of water with such variations of temperature might lead the experimenter to infer that iron or gold, which exhibit no such peculiarities under changes of temperature, cannot be liquefied. The conclusion would be erroneous, as probably is the above inference respecting gases.—R. A. P.

* If r be the radius, s the specific gravity of a star supposed uniform, the intensity of gravity at its surface varies as $s\,r$.—R. A. P.

analyzer above the eye-piece either tourmaline or herepathite should in all cases be preferred to Iceland spar. The price of a good polariscope and fittings adapted for a student's microscope varies from 30s. upwards. A selenite of some kind is almost a necessary accompaniment of a polariscope. Sometimes a thin film (to give red, yellow, or blue, according to fancy) is fixed in a collar and made to rotate with the polarizer. But this is a barbarous arrangement. In all cases the film of selenite should be mounted on a glass or in a brass slide, and some means adopted by which it may be removed from the field at pleasure without disturbing the object. It is also convenient to have three films giving different colours set in the same frame, their axes of polarization being in the same plane, that a series may be tried without trouble. A very efficient selenite stage has been described in a recent number of this journal, the price, however, is past a joke to most.

Having obtained the polariscope, the student, if he be a worker and use his ¼" much, will find that he needs a steady and pure light such as is thrown upon the field by what is known as the achromatic condenser. This is optically little other than an objective of ½" or ¼" focus made capable of approximation to the lower surface of the slide under view. It is a somewhat expensive piece of apparatus, costing from 30s. upwards. Mr. Brooke recommends a Kellner eye-piece in the place of the usual short focus objective. In any case the student may remember that he can always use his ½" objective as a condenser for his ¼", and so on. In this case he need only purchase fittings which need not be very costly. Mr. Collins has, within the last few years, introduced a new condenser, which he calls the Webster. From what we hear of it it seems a most efficient affair, especially in connection with his adjusting diaphragm.

Mr. Swift has also introduced a popular and complete condenser, of which, as it is a perfect *multum in parvo*, we give a somewhat detailed description:— "It comprises an achromatic condenser of 90° angular aperture (this is suitable for all objectives from the 2in. to one-fifth), tinted ditto for correcting the yellow rays of artificial light, rack-and-pinion motion for focussing, a most effective spot lens, parabola, large diaphragm, carrying rotating cap—into this cap are fitted three discs for test stops—small diaphragm of apertures, polarizing prism, selenite diaphragm with two selenite films and clear aperture, and oblique light shutter for illumination with low powers.

"The optical combination is made with an angle of 90° or 120°, the former for objectives to the one-fifth of an inch, and the latter for those of ¼in. There are two 'field lenses,' one of uncoloured glass for use with daylight, the other of a blue tint of sufficient depth to correct the yellow rays from an ordinary paraffine lamp, so desirable in long-continued study with artificial light. The condenser is attached to the stage of the microscope and held in its place by a bayonet catch, and the focus adjusted by a milled head with rack and pinion. The sliding frame has an open space and two spots, made central by a spring catch, and of a suitable size for the 2in. and 1in. objectives, for dark ground illumination. The advantage of having these stops immediately beneath the lenses is very apparent in the much darker field that is obtained; their value also in this position is greatly enhanced by being able to use them in conjunction with the polarizing prism and selenite films, thereby bringing out in bold relief such balsam-mounted objects as the palates of the Mollusca. The rotating cap can be removed with the greatest facility and other stops substituted in the place of those (three) supplied with the instrument, as the nature of the test under examination may require. The use of the oblique light shutter and the small diaphragm of apertures are too obvious to require explanation.

"With the exception of the frame of stops all the appliances are carried on the large diaphragm, and are brought into position by simply rotating that wheel until stopped by its spring catch.

"If required, a parabola for dark ground illumination with high powers is made to fit into the place of the optical combination."

The writer of the paper published in the "Transactions of the Royal Microscopical Society" (new series, No. 51, July, 1868, p. 110), claims for this condenser the following advantages, viz.,—

"1. It can be used with marked advantage with objectives from 2in. to ¼in.

"2. The remarkable daylight softness produced by the tinted field lens when used with artificial light; also dispensing with the use of blue lamp chimneys.

"3. It is a very effective spot lens, and dark ground illumination with polarized light.

"4. An almost indispensable requisite for polarized light when using high powers with the object mounted in fluid.

"5. And not least important, the ease and rapidity with which the changes from ordinary to oblique, and plain or coloured polarized light with the other combinations I have named, can be made."

Professor Beale recommends Lealand's Gillett condenser, but we have not space here to enter into a discussion of the respective merits of different makers of apparatus. It must suffice for us that we glance at every important accessory and give enough details to enable our readers to ask for what they want.

Our student will now probably seek to increase his "power." He can do this by the addition of a *draw-tube* to his instrument at the cost of a few shillings, but unless his lenses are very good this plan is not to be recommended. The draw-tube in connection with an erector (for rectifying the inversion produced in the apparent position and movement of objects when they are viewed through a compound mirror) is, however, most useful, as it enables the observer to get a range of from four linear to 100 linear with an 8-10ths objective. Or he may add a C, D, E, and F eye-piece to his instrument, gaining in power approximately 1, 2, 4, &c. But the better plan is to get a C and then to add to his objectives first a ⅛", 1-12th, 1-20th, or 1-25th to 1-50th, as he is able. But he will probably stop at 1-12th, and seek other accessories.

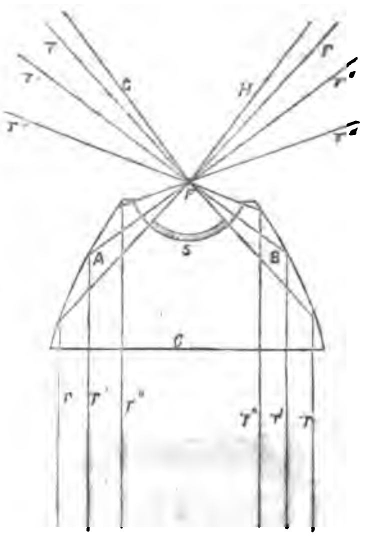
The first thing will most likely be a mechanical stage,—that is, a stage capable of movement in all directions by means of milled heads. Their forms are legion, every maker appearing to have his special type. Let our student see that whatever form he purchases possesses the power of concentric rotation and that the amount of movement can be read off accurately by a scale. He will now want a Maltwood's finder, a very simple and inexpensive arrangement for enabling a person to register the position of any object in the field. It consists merely of a slip of glass whereon is photographed a series of numbers in squares thus—

11 24	12 24	13 24
11 25	12 25	13 25

A little "stop" is placed at one end of the stage against which the end of the slide is placed. when any object of special interest is found the slide containing the object has to be removed and the "finder" placed in its stead and the numbers in the field read off and registered. It is obvious that the reverse process is simply to work the stage until the finder now comes into the field, remove the finder and place the object slide on the stage when the desired object will be found in the field. The price of a Maltwood varies from 5s. upwards. Substitutes have been proposed for the Maltwood, but the latter is so simple and inexpensive that we need not trouble to examine these.

Every observer ought to draw and measure his objects, but as this subject will come before us in another paper we will simply mention the names of the apparatus commonly used for these purposes. For measuring, either the stage micrometer or the eye-piece micrometer is used. For drawing, a camera lucida (a prism properly set), a neutral tint reflector, known as Beale's neutral tint, or a small disc of steel.

We have omitted to mention the spot lens—a simple and inexpensive, but very efficient means for procuring what is known as the dark ground illumination. This apparatus consists merely of a lens of moderate focus with a spot of black paper on its centre to stop out all rays except those which pass through the periphery and converge at so oblique an angle upon the object that were it not for its refraction they would not enter the object-glass at all. Certain objects, such as diatoms, are seen by this mode of illumination brilliantly illuminated on a black ground. Mr. Wenham has introduced what is known as Wenham's paraboloid reflector. It may be easily understood by reference to Fig. which represents it in section A B C, and shows that the rays of light, r r' r'', entering perpendicularly at its surface, C, and then reflected by its parabolic surface, A B, to a focus at F, can form no part of the largest pencil of light admitted by any of the object-glasses, and represented by G F H; but an object placed at F will interrupt the rays and be strongly illuminated. A stop at S prevents any light passing through direct from the mirror, which is more adapted for high powers than the spot lens. Indeed, the latter cannot be used with what are properly called *high* powers.



The celebrated diatom prism which has recently caused such a sensation does not require any explanation beyond this, that it is a right-angled prism fitted either to the stage or on a stand, and that its great advantages are that it enables us to obtain a beam of parallel rays of such intensity and in such direction as we require. The goniometer for measuring the angles of crystals we need not describe, as a well-constructed mechanical stage will serve *most* of its purposes. Neither will we do more than mention Amici's prism for obtaining oblique light; and several other accessories but seldom used must be entirely passed over.

For "opaque" illumination we may use either the parabolic illuminator known as Crouch's but made also by several makers, or the side reflector, or with very high powers Messrs. Beck's patent illuminator, whereby the objective is made its own illuminator by a most ingenious contrivance. The cost of all these is comparatively trifling. It strikes us very forcibly that we have spoken of nearly all accessories appertaining to the microscope proper. In our next we will hurry through such things as processes and mounting materials. If any reader wishes further information respecting any apparatus mentioned in this paper, perhaps the editer will allow him to ask any question he chooses. H. P.

P.S.—In my last article I appear by some oversight to have said that a *fair* English 1" objective could be purchased for 50s.; I should have said 30s. I am pleased to learn that a London maker is selling a tolerably fair 1" for the astonishingly low price of 12s. As my caution to our readers appears to have been misunderstood by some of the makers, I may, perhaps, be allowed to say that nothing was further from my intention than to reflect upon that most painstaking section; I merely wished to advise our readers to *make* as much as possible and to buy as little as possible. It is only just to our opticians to say that they are always willing to help the amateur to save his pocket if he will trust himself to them.

ELECTRICITY—ITS THEORY, SOURCES AND APPLICATION.

By J. T. Sprague.*

(*Continued from page* 531.)

159. THE SINE GALVANOMETER.—When a magnetic needle is removed from its normal position the force with which the earth's magnetic action tends to replace it is proportional to the sine of the angle of deflection. The deflecting force of a galvanic current has its greatest effect while parallel with the needle, hence if the current is made movable and follows the needle it moves till it can move it no further, these two forces balance each other, and it is evident that the force of the current is proportional to the sine of the angle the needle then makes with the magnetic meridian. The action of galvanometers based on this principle is more uniform than that of the tangent instrument, because while the sine of one degree is the same as the tangent, that of 90 degrees is 1, the same as the tangent of 45 degrees, and the sines gradually diminish in proportionate length, instead of, as in the case of the tangents, increasing so rapidly as soon to become almost useless as measures of action. But, on the other hand, their action is very limited, as the force should not be able to deflect beyond 90 degrees. A sine galvanometer, therefore, to be of any extended use, should be made with connections enabling each successive turn or layer of wire to be brought into circuit.

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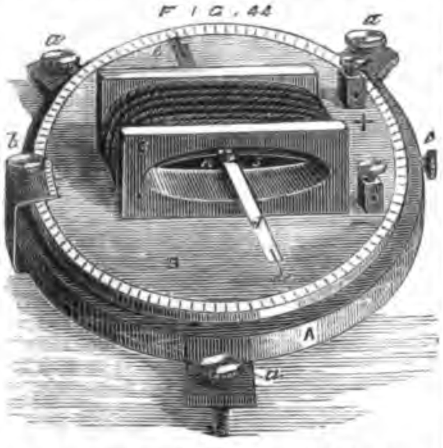
* "Sigma."

Fig. 44 shows the construction in its simplest form. A is the stand mounted on levelling screws *a*; to its bottom is fixed a brass spring *b*, with a clamp screw; its middle corresponds with the central line, and its edge is graduated as described, section 156, in the tangent galvanometer, so as to divide the degrees; in the centre is a strong brass point on which turns freely and smoothly the circle B, which is the base of the instrument itself; its edge is graduated to degrees, and *c* is a handle by which to move it. On it is fixed C, a wooden frame on which is wound the wire; *n s* is the needle, which in this instrument should be heavy and highly magnetized and 4in. to 6in. long, fitted with agate centre to diminish friction, and having fixed to it at right angles a light aluminum or other indicator with a line marked on its middle; *e* is a point fixed to the stand on the line of 90 degrees; + and − are the binding screws. As before stated, to make a really useful instrument, there will be required several of these for different lengths of wire, or a commutator to serve the same purpose; and it would be more convenient also to have the binding screws on A, so as to remain fixed, and communicating by means of springs pressing on metallic bands on B, which would convey the current to the wire; but these are modifications readily devised, which cannot be shown on a figure, or without complicated diagrams unsuited to the scope of these papers. The indicator *d*, may be so short as to pass into the coil or stops provided to arrest the needle, and a glass cover should be provided to keep the needle from being affected by wind and otherwise protect it.

FIG. 44

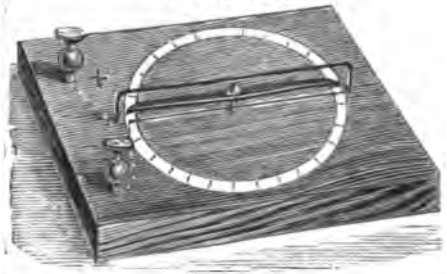


To use the instrument it is placed in the magnetic meridian with *e* pointing truly to the line on *d*, and the zero or 0 on the circle at the middle line of *b*, or if not, then the deviation is to be noted and applied to the final result. The connection is now made, and B turned round till *d* again rests opposite *e*; the angle through which B has been moved gives by its sine the proportionate value of the current, and by constructing a table and making one or two trials, as explained for the tangent instrument, the actual values may be obtained once for all. Of course if the current is powerful it may carry the needle round the whole circle, but it is evident that if it goes over 90 degrees the observation is useless, and the instrument too powerful, and hence the necessity for the power to use only one or more turns of the wire, for each of which lengths a special column will be needed in the table for the actual value based on experiment with that length.

160.—Ordinary galvanometers are of more simple construction, but give no definite information. It is, however, quite easy to obtain the real value of their deflections, by once carefully comparing them with a sine or tangent instrument. The process is to connect one of the screws with the positive pole of a constant battery, such as a Daniel or Grove, the other being connected to one screw of the other galvanometer and through it to the negative pole of the battery. The instruments should be so far apart that their needles do not mutually affect each other. A table of degrees and their values being prepared, the degree marked by the instrument to be tested is entered opposite to that shown by the standard instrument; by increasing the length of the connecting wires and using fine German-silver wire, these deflections may be reduced gradually, and by thus bringing the needle to zero and noting each stage a table is constructed, which will always give the value of the deflections of the instrument, providing the same needle be always used with it. For convenience it is best to note upon the face of each galvanometer the side to which a current deflects the needle, or, if several instruments are possessed, it is still better so to arrange the connections that all deflect the same way—for instance, if the screws are on the sides of the zero line, make the north pole always turn to the side connected to the positive pole of the battery. Columns V., VI., and VII. in the table, p. 530, are the relative deflections taken to the nearest degree of three of my galvanometers, as an example of this mode of valuing them.

161.—Fig. 45 shows the simplest possible form, consisting of a mere rectangle of stout wire encircling the needle. The lower branch should be let into the wood frame, or even be on the lower side, so as to allow the graduated arc to be on the wood, and the needle should either curve down or be provided with a wire prolongation to come close to the graduation; if the rectangle is made more open than is shown many turns of wire may be used without hiding the needle, or it may be fitted with an indicator, as in Fig. 44, and the graduation commence at right angles with the needle. Columns V. and VI. in the table present the action of exactly such an instrument—VI. being that of a single turn of No. 10 wire, V. that of the same continued with a number of turns of No. 18 fitted with a 3in. needle. It will be found, on trial, that these deflections bear no traceable relation to each other, though it is probably a combination of the tangent and the sine of the angles varying at each point, and consequently they are nearly equal for the first 20° or 30°, in V. 4° being equivalent to 1° on the tangent instrument, *i. e.*, 28° = 7°, and in VI. 1° equivalent to about 2¼°, but after this the value of the degrees increases in a much lower rate than in the tangent galvanometer.

FIG. 45



162.—For many purposes it is common to arrange the needle in a vertical plane mounted on a central pivot, in which case the needle is double, one working inside a coil, as in Fig. 44, the other with its poles reversed working outside. Such an instrument—which is, in fact, the needle telegraph instrument—has its uses, but its indications cannot be relied on; they vary with the varying magnetism of the needles, because the resistance to motion is not the magnetism of the earth but the extra weight of the lower parts of the needles; the chief advantage is their instantaneous action, as the needle does not vibrate as in the horizontal form, and their ready visibility from a distance. Col. VII. gives the action of such a vertical instrument made to form part of the circuit of a plating cell, as it has very little resistance of its own, and of course is able to be placed in any position and glanced at at any time to see that all is right. The table shows one of the evils of this form in the sudden jump from 19° to 28°; this is due to some little irregularity in the friction of the mounting, or, perhaps, a slight bend in the wire on which the needles are mounted, defects almost inevitable, but which render the instrument of little value for real measurement.

163.—When very feeble currents are to be measured, the resistance of the magnetic needle is reduced by rendering it nearly *astatic*, that is, without tendency to fixed position; this may be accomplished by placing above or below, at the proper distance, a bar-magnet whose action is opposite to that of the earth, so that the two nearly neutralize each other; it is, however, more commonly done by securing two similar magnetic needles on a wire at right angles to them, with their poles in opposite directions; the nearer equal the two needles are the less the resistance, and one of the needles working within the galvanometer coil and the other outside the whole of the reactions tend to turn the combined needles in one direction. Such an arrangement it is however almost impossible to make perfect, and it will, therefore, always deflect further to one side than the other with equal currents; also the actions continually vary with the altering magnetic conditions, and therefore it is an indicator rather than an actual measurer of currents.

164.—To obtain the most perfect results from a galvanometer its resistance should be about equal to that of the rest of the circuit, and, therefore, instruments with short thick wire, or with great lengths of very fine wire, either separate or combined in one, are usually employed. There is, however, a plan by which a galvanometer may be made widely available—viz., by providing means for sending the whole or part only of the current through the wire, the rest going through "derived circuits;" in this case the instrument is made with a considerable length of fine wire suitable to the examination of a feeble current; if a German-silver wire *of exactly* the same resistance be now arranged *in the stand*, so that by the insertion of a metallic plug, *or by* any convenient commutator, it may form a complete connection or path for the current, this will divide itself equally through these two roads, and the indication of the galvanometer must be doubled because it is due to only half the current; by several such wires only a tenth or a hundredth of the current may be made to act on the needle, and thus the instrument may be made available for strong currents. There will, however, always be a source of error in the different heating effects and consequent changes of conductivity, which is the reason why German-silver wire should be used, as its conductivity changes less with the temperature than that of simple metals.

(To be continued.)

THE WORLD: ITS FORMATION AND ANTIQUITY.

By Arthur Underhill.

(Continued from page 551.)

Chapter VIII.

ABOVE the Silurian, and below that most valuable and most interesting of the geological groups, the Carboniferous, lies a series of strata commonly known as the Devonian or Old Red Sandstone system.

As the name implies this group is eminently sandy (*arenaceous*), consisting principally of sandstones, sandy shales, and schists, and a species of limestone, called cornstone, from the fact of its being a kind of calcareous conglomerate. The ruddy appearance which more or less pervades the greater portion of the group is caused by the presence of peroxide of iron, which, formed by the action of the water upon the iron veins of the previous epoch, was held in aqueous suspension, and finally deposited, together with the detritus, in the form of a new system. The Devonian group, as usually met with, consists of the following strata.

Upper Series.

1. Yellow sandstones and shales, with fossils of aquatic and land plants and fishes.
2. Limestones and schists, with shells and remains of crustaceans.

Middle Series.

3. Coarse ruddy conglomerates and red sandstones, with plants and remains of fish.
4. Red sandstones and conglomerates, green shale, and limestone (cornstone); few fossils.

Lower Series.

5. Rusty sandstones and conglomerates with flagstones and shales; few remains.

6. Dark flagstones and schists, with remains of molluscs, fish, and crustaceans, also of plants aquatic and terrestrial.

The physical features of the system show that it was for the most part formed from the deposits of a shallow tidal sea, the ripple-mark being very well and clearly exhibited. The fossils are principally marine, and in the case of animated beings solely so. *Fuci*, or seaweeds, and sedgelike plants (*juncites*) were numerous in the ocean of that day, and the huge tree-ferns (*adiantites*), now inseparable from a warm climate, then flourished throughout the world. Among the animal kingdoms, the fishes reigned supreme; ichthyolites (*ichthys*, a fish; and *lithos*, a stone), as the organic remains of fishes are called, exhibited in this period a far greater degree of perfection than those of the preceding epoch. We find within this time-honoured tomb of solid rock the remains of these scaly inhabitants of the seas of innumerable ages ago, who, overtaken by the inexorable fate which awaits all living creatures, have been gradually buried to the depth of ten thousand feet. Among these "ancient mariners" are to be seen several curious creatures, of which the *Cephalaspis* (shield-headed), Fig. 1, the *Pterichthys* (winged fish), somewhat resembling a tortoise with a tail, and the *Diplacanthus gracilis*, Fig. 2 (graceful double-spine), are specimens. One peculiarity is remarkable in the fish of this period, viz., the shape of their tails, which are *all* of a *heterocercal* form as it is called, that is to say, they were not symmetrical. Thus in Fig. 2 the tail is heterocercal, but that in Fig. 3 is termed *homocercal*, or symmetrical. The present race of fishes are nearly without exception homocercs, thus showing an entire change in marine animals. The above are of course merely specimens of the denizens of the sea who flourished in the waters of this epoch, and of which the total number of genera was twenty-six, which were *all* new creations, and of which thirteen genera were peculiar to this system and perished upon its termination. A great quantity of molluscs and radiates were also in existence, many being new creations, and some quite confined to and distinctive of this group.

FIG. 1

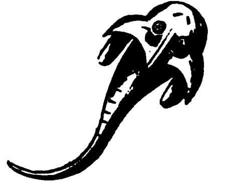


FIG. 3

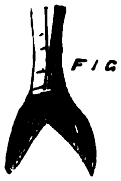
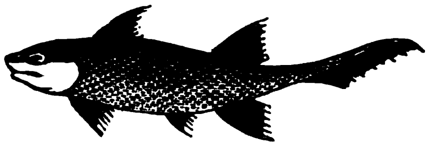


FIG. 2



The temperature of the globe was then uniform, the same fossils being found in the Devonian strata wherever it occurs. In the now frigid plains of Russia and the warm and balmy moors of Devon, the same old plants, the same remains of then existing races of animated life appear, and the tree-fern flourished as luxuriantly in the frigid zone as it does now in the torrid regions of the tropics. The chief cause of the convulsions which attended this period was the irruption of Trappean rocks, which appear in intimate association with the Old Red Sandstone formation, in the form of greenstones and felspar porphyries. Little granite is found however, and it appears from this that the granitic period had by this time given way to the Trappean, as the latter has since done in favour of the volcanic. These irruptions considerably vary the aspect of the localities in which the system occurs, but, as a rule, it is somewhat tame, yet here and there forming rounded hills and vales of much quiet beauty. The appearance of the land during the Devonian epoch must have been of a verdant character: covered with forests of the graceful and majestic tree-fern and other now tropical plants, whose quiet and silent shades, undisturbed even by the hum of insects or the warbling of the winged songsters who now people every grove, suggest to the student musing on the scenes of countries a hundred centuries old, a delicious yet awful calm, awakened only by the quiet rustling of the fern-leaves in the forest or the dull roar of the surf upon the beach. Such a prospect forcibly calls to mind that beautiful passage in the work of the younger Pliny:—

> *O mare! O littus verum secretumque Μουσειον! quam multa invenitis! quam multa dictatis!*
>
> Thou solemn sea and solitary shore, best and most retired scene for contemplation, with how many noble thoughts have ye inspired me!

(*To be continued.*)

ELEMENTARY SCIENCE.[*]

By the Rev. E. Kernan, Clongowes College.

(*Continued from page 557.*)

Application X.

Inclined Plane.

THE subject of the screw propeller may be closed by a few words on the *technicalities* of the propeller, its utility, its history. The "technicalities" contain a number of terms of every-day use which should be familiar. *Pitch of the propeller*, is the "pitch" of the screw (the height of the plane) of which it (the propellor) is a portion. The *Great Eastern*, for example, has a propeller of "37ft. pitch," that is, the propeller is a *portion of a screw*, the pitch of which (in one complete *turn*) would be 37ft. *Length* is the portion cut off of the screw, the useful part; about 1-6th, as above.

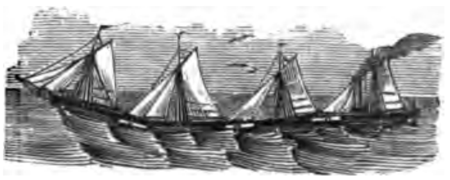
The "length" is, therefore, measured by a straight line along the "boss," and parallel to its axis. *Diameter* is the length from the end of one arm to the end of the *opposite arm*, or the double *length* of one arm, where the arms are not opposite. The *Great Eastern* propeller has a diameter of 24ft. *Area* is the area of the circle described by the points of the *diameter*. The area of the propeller is therefore that of a circle, the plane of which is at right angles to the *shaft* of the propeller, and represents the resisting surface of the water. *Blades* are the arms of the propeller. Here it may be well to note that the *area of the blades* is not the same as the area of the propeller: in the area of the blades the *slanting surface* is considered. *Slip* is the loss caused by the yielding of the water. Theoretically the ship should advance as much as the "pitch" requires—in the *Great Eastern*, for example, 37ft. Practically the ship *does not advance* to the full amount of the "pitch;" the water always yields. This loss or "slip" varies with the "build" of the vessel, with the shape of the propeller, and from accidental circumstances. *Negative Slip* is when the vessel is *going quicker* than the "pitch" of the propeller requires, *i.e.*, when the ship advances at each turn over a space *greater than the pitch*, Suppose the *Great Eastern* to advance 40ft. at each revolution of the screw,—this state of things is called the "negative slip," and, so far from being useful, the propeller is only retarding the progress. When, therefore, "negative slip" is discovered, it is time to stop the engines; their action is pure waste. It is evident that some external force—wind, currents, &c.—is able just now to do more for the ship than its propeller. Negative slip is indicated in the "engine room" by an arm against which the shaft of the propeller presses when doing useful work. When this index is not consulted there may be an *apparent* negative slip caused by the "pitch" of the propeller increasing temporarily from the pressure against the water.

The *utility* of the propeller is shown by mentioning its advantages over other means of motion. For all sorts of ships its machinery takes less room, and can be placed lower down in the "hold." The shape required for quick sailing vessels is not spoiled; the propeller may be used only as an auxiliary in calms, &c. When not acting it can be removed or otherwise prevented from injuring the speed. For merchant-ships the machinery may be in the "stern," leaving ample room for cargo. For war-ships the propeller is out of sight, can with great difficulty be injured by shot; much more space, too, is left clear for the armament.

As regards the question of "speed" only, the screw has not yet attained to what the paddle-wheel *can* effect.

Though not very specially belonging to the propeller, this seems the best place to introduce a curiosity which appeared some time ago in the Mersey,—the "jointed ship." The object of this ship is to avoid the waste and expense consequent on the multiplied machinery of several vessels lying idle during the discharge of cargo. For this purpose the "connector" is made up of three or more *separately complete* ships, joined together, and driven by the propeller of the last, Fig. 102.

FIG. 102

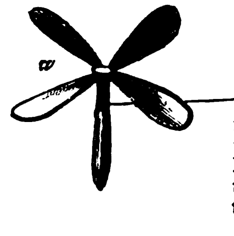


When this compound ship has arrived at its discharging wharf, the machinery part is detached and goes off to seek "another train." Or it may happen that the *parts* of the "connector" have different destinations to which they are duly conveyed *before the engine leaves*. By this means one ship with a propeller does the work of several ships, as regards the moving power.

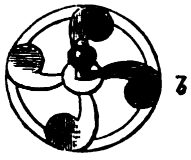
The *history* of the propeller is quickly told. Now that it has proved such a success there are many laying claim to the invention. It is said that the propeller has been used in China for ages, and during the last century suggestions of it are to be found. The following facts are certain. In 1802, a Dr. Shorter used a screw to propel a boat. The same idea was again brought forward in 1813, by Mr. S. Brown, C.E., London,[*] who in 1825 had a large ship moved by a screw. There are strong claims made for Mr. John Swan, but the date of his invention, 1824, seems to decide against him. These facts were not much noticed for some years—the paddle-wheel absorbed all attention, when steam was applied to ships,—and it was not till 1837 that a real practical propeller was brought forward. In that year Ericsson, a Swedish engineer, and Smith, an English amateur, had a small steamer built, 45ft. long, which was propelled by a screw. The success of this little ship was perfect. Notwithstanding, the Lords of the Admiralty refused all encouragement to Ericsson. In 1839 a second screw-steamer was built, which also proved a success; but still the Board of Admiralty declining his offer, Ericsson left England in disgust, and followed his second vessel to America, there to develop his invention. The next year (1840), Smith and others ventured on a larger scale; the *Archimedes*, 232 tons and 80-horse power, proved beyond all doubt the practical efficiency of the screw as a propeller. The success of this vessel, at length decided the Admiralty, and they ordered a vessel to be built, the *Rattler*, with the propeller of which the *shortening experiments* were carried. From this date the screw came more and more into favour, and it is now to be found in every class of ship, from the largest man-of-war, ocean-steamer, or sailing vessel, to the smallest pleasure yacht.

Screw App. V.—Aerial Navigation.—Some years ago (1863), a company was formed in Paris to carry out the ideas laid before a brilliant assembly by M. Nadar, who expressed himself most confident that now indeed had been discovered the true means of directing a body moving in the air.[†] The principle on which the new discovery depended was, that to be *directed*, a body should be *heavier* than the medium in which it floats. Rejecting the balloon therefore as quite unfit, the inventor proposed to raise the vehicle into the air by means of screw-propellers. The scientific toy, four vanes, Fig. 103, spun by a cord (*a*), or spring (*b*) rising into the air, was the *point de depart* of the *auto-locomotion aerienne*, of M. Lalandelle. On a very small scale successful models were shown to the assembly; nothing, however, practically useful has come before the public as yet.

FIG. 103



Sub. App. III.—The Leech Propeller.—Some years ago, under the above title, a propeller was invented, the action of which was to be that of the leech when swimming. The propeller was a flat pointed "band," extending, in a hollow



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[*] All rights reserved.

[*] English Mechanic, Vol. IV., p. 220.

[†] *Cosmos*, Vol. XXIII., p. 141.

chamber, from stem to stern of the ship. An undulating motion, communicated to the "band," produced a series of inclined planes, which incessantly changing position, would propel the ship at a very high speed. This invention seems not to have succeeded.

PROBLEMS.—From the great length to which the Applications have extended, the student cannot but be impressed with the importance of the laws of forces "applied to a point," and may have been anxiously wishing for some exercises by which to fix them in the mind. Problems could not well have been introduced—at least, in a book—up and down through the Applications; and now even so much space and time has been taken up with the mere necessary development of principles, that a good long series of problems, such as ought to be given, would be, perhaps, too great a delay. A few, therefore, just to recall the general principles of this section, and to put those who may wish it in the way of explaining the exercises abundantly provided in books on statics.

QUESTIONS ON THE LAWS OF OPPOSITE FORCES.—**PROB. I.**—A ship is held safely in ordinary circumstances of wind, &c., by a single anchor. Explain—by "forces to a point," and "*opposite*."

PROB. II.—Why is it necessary sometimes in great storms to throw out a second, a third anchor, and even to get up steam to work ahead (paddle or screw) slightly?

PROB. III.—A suitable anchor is able to resist the drag of the largest ship. How then is it possible *ever* to draw up the anchor firmly held below, and is there not sometimes danger of the chain breaking?

PROB. IV.—A net is to be fixed in the narrow side passage A of a river (Fig. 104) the current of which has a force on the net of five tons. A small bank, B, terminating a shallow in the river, will just safely bear one ton of stones, in a box; a rope from which to the net makes an angle of 12° with the direction of the current. Required, the direction and intensity of a force, Q, on the bank sufficient to keep the net in position.

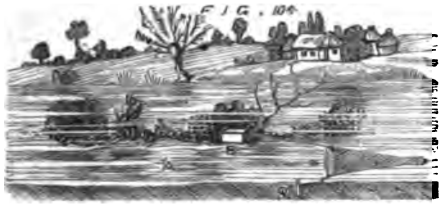


FIG. 104.

PROB. IV.—A large lamp, weighing 25 cwt., is to be hung midway between two rocks at either side of a wide river. The top of the rocks form an angle of 100° with the spot where the lamp should be. Required, the *necessary* strength of the two ropes which will hold the lamp—no question of winds, &c.

PROB. V.—Why does a ship held by a single anchor swing round with the wind, tide, &c., and hold a direction *exactly opposite* to any one of these, if that one be *alone* in action? What would be the direction *more or less*, if a strong current cross the wind at an angle of 50°? and in this latter case, what element should be given to make it possible to have an *exact* answer?

PROB. VI.—Has a horse, drawing a canal boat, more power with a short or long rope, the weight of the rope not being taken into account? Would as much power be required *in* the boat—suppose a propeller to be used—as is exerted by the horse from the bank?

QUESTIONS ON THE INCLINED PLANE.—**PROB. I.**—A block 50 tons weight, length of plane 500ft., height 30ft. Required the power necessary for equilibrium, when the rope may be disposed parallel to the length. Show how the principle of "virtual velocities" is here exemplified.

PROB. II.—A ship 500 tons weight is to be drawn up an inclined plane 100ft. long, 20ft. high. The power at command is only equal to about 50 tons, and cannot be increased. Still the ship *must* be raised without being unladen. What is to be done?

PROB. III.—A single storied house, Fig. 105, is built upon the side of a hill, and the foundations, A B dotted lines, are *slanted* as the hill. The house having stood solidly for years, two stories (according to the original plan) are added to it. Is this house *now* in any danger, and why? Can any precautions be taken against danger?

PROB. IV.—Wedges of wood driven into stone split the stone when they have been wetted. Is this a wedge action or not? and why? Show in diagram the direction of the forces.

QUESTIONS ON THE SCREW.—**PROB. I.**—Does the increase of *breadth* in the thread of a screw increase its power?

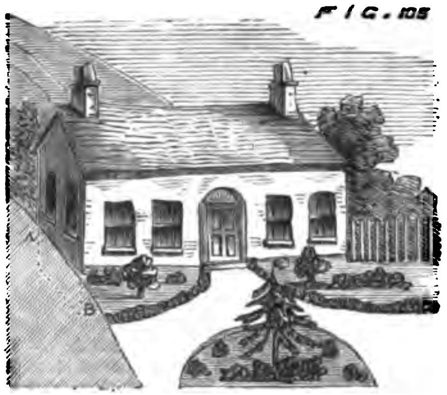


FIG. 105.

PROB. II.—What is the effect of cutting a thread of the *same* pitch as *a* (Fig. 106) on a larger cylinder, *b*? Show clearly the answer from the principles of the inclined plane.

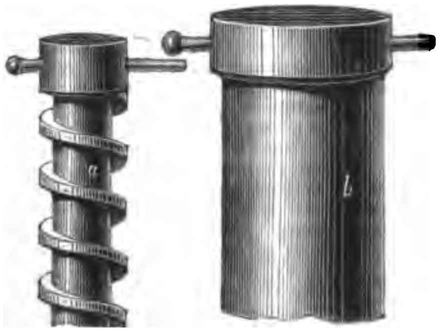


FIG. 106.

PROB. III.—How does a screw-ship move backwards? Explain the action fully. Can a single propeller make the ship move in a curve? and how must a double screw—"twin screw"—act for this effect?

PROB. IV.—A grain of seed of the sycamore tree, Fig. 107 (*a*), when falling to the ground is in a state of rapid rotation (*horizontally*), the same frequently occurs when two grains are joined (*b*). Explain by screw action. Show in diagram the decomposition of the gravitation force.

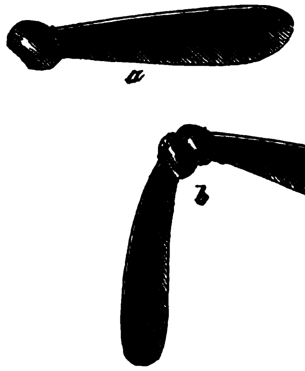


FIG. 107.

END OF SECTION I.

THE SWARMING OF BEES AND THEIR METAMORPHOSES.

THE question has often been asked, Is bee-keeping profitable? and numbers are endeavouring to solve the problem by practical experience. Many cottagers now mingle pleasure with profit and keep a hive or so of bees, and even in London these useful and industrious insects are often to be seen in the neighbourhood of gardens. Costing but little for food, and making use of almost anything for a hive, they demand only slight attention, and are thus well adapted as an amusing recreation for the labouring population. There is one point connected with bee management which has always been a subject of dispute—viz., the method of swarming, and whether swarming or non-swarming bees are the more profitable. The latter point would seem to be settled, as we find a writer saying:—After making many trials we can state that in good seasons for honey, a good early swarm will, at the end of the season, weigh more than a hive that has never been permitted to swarm at all. A swarm put into an empty hive is doubtless placed at a great disadvantage, and apparently will never both fill its hive with [illegible] and gather as much honey as the old one [illegible] full, weighing perhaps 30lb. or 40lb. But [illegible] little; the swarm that is far behind during the [illegible] ten days, afterwards rapidly gains upon the [illegible] and generally overtakes it when they are [illegible] about 70lb. or 80lb. each; the young one [illegible] ahead, at the rate of 2lb. for 1lb. And, [illegible] great superiority of the first swarm over [illegible] which did not swarm, there are the mother [illegible] probably a second swarm, weighing by the [illegible] the season from 40lb. to 80lb. each.

The author accounts for this by saying the stimulus of an empty hive makes the [illegible] harder. He goes on to say that in the [illegible]ing mode of management the queens become [illegible] die; and at the time of the death of a queen [illegible] is a loss sustained. The hive in which [illegible] without eggs for three weeks, or there[illegible] ordinarily the young queens are not [illegible] about ten days after the old one dies, and it is [illegible] days more before she begins to lay. [illegible] the risk of the loss of the whole, for if a [illegible] dies when she is not laying, the bees cannot [illegible] a successor.

A writer in the *Maine Farmer* (U.S.), describes a successful method of swarming bees:—

"First, for queen rearing I select from a [illegible] noted for its superior activity and working [illegible]ties, two or three frames, one or two of a brood [illegible] the proper stage, and one of honey, with enough bees to maintain the necessary degree of heat, which I place in an empty hive and cover with flannel, which retains the heat. In this nucleus I find usually six to ten perfect queen cells, if I have enough bees and plenty of brood in the right stage. About the eighth day I take from as many stocks, less one, as I have cells, *bees*, *honey*, *and brood*, and form other nuclei, *one for each cell, which I* insert carefully in each, *being sure to put the cell in* the centre of the brood, *that it may be discovered* and protected. Let these second nuclei stand twenty-four hours before the cells are inserted, else the bees, unconscious of their loss, may destroy them. This I had to learn by experience.

"To make my new swarms, I divide my bees and combs as near as possible, one-third of the bees in one hive and two-thirds in another, which last I place upon a new stand, but the combs equally. By using the queen and bees that were taken from the same hive and divided, it is not necessary to cage the queen or use other methods which may disturb the day's work, and by using a fertilized queen nothing is lost by waiting to rear one. I never divide without either a queen, or, in default of one, a capped cell, which saves much valuable time."

As regards the various metamorphoses of bees, some careful observations have recently been made in Switzerland according to which the development of queens, drones, and workers proceeds as follows, in the ordinary temperature of the hives in spring and summer:—The egg hatches on the third day after being laid. The queen remains in the larval state in the open cell, five days, the worker five days, and the drone six days and twelve hours. In spinning the cocoon, the queen spends one day, the worker one day and twelve hours, and the drone three days. After spinning the cocoon, the queen remains a larva two days and sixteen hours, the worker three days, and the drone two days and twelve hours. After changing, the queen remains in the nymph or pupæ state four days and eight hours, the worker seven days and twelve hours, and the drone nine days. Hence, from the capping of the cell to the issuing of the bee, the queen usually requires eight days, the worker twelve, and the drone fourteen days and twelve hours—making, from the laying of the eggs to the emerging of the perfect insect, the normal period of sixteen days for the queen, twenty for the worker, and twenty-four for the drone. This period, however, is occasionally hastened or retarded by the peculiarly propitious or unpropitious state of the weather or the temperature of the hive; and the term has been found to vary, the queen, from the 15th to the 22nd day; in the worker; from the 19th to the 26th; and in the drone, from the 23rd to the 28th day.

MANUFACTURE OF PORTLAND CEMENT.

PORTLAND cement was introduced to public notice under a patent by an Englishman nearly fifty years ago; and we have hitherto possessed a partial monopoly in its production, inasmuch as we have fortunately inexhaustible beds of the raw material from which it is made, and an abundant supply of fuel necessary for their economical manufacture. It is strange that under these conditions French engineers should have obtained the start of their professional *confrères* in this country, and that they should have been the first to demonstrate by experiments, and subsequently by the erection of magnificent harbour works on their seaboard, the valuable properties of this excellent constructive material. We may date the *extensive* employment of Portland cement in

England from the commencement of the metropolitan main-drainage works. During the last fifteen years the manufacture of Portland cement has gone on steadily increasing, until at the present day we find that little short of 400,000 tons per annum are made in the county of Kent—the centre of cement manufacture—irrespective of the productions of many minor factories in different parts of the country.

The chemistry of the setting of Portland cement is by no means so well understood as it ought to be. There is no doubt, however, that, like the hydraulic lime and natural cements, it is, chemically speaking, a double silicate of lime and alumina; silicic acid is generated by the hydration of the cement, and forms insoluble salts with the lime and alumina bases. It is a curious fact that Portland cement hardens more rapidly when salt water is employed. According to Schweitzer, 1,000 grains of sea-water in the English Channel contain 27·060 grains of chloride of sodium; soluble silica has a known preference for alkaline bases, and it is not impossible, when the cement is hydrated with sea-water, that the chloride of sodium is decomposed, the silicic acid of the cement combining with the sodium and oxygen of the water, and forming thereby a silicate of soda, or a species of crude glass.

Portland cement is of two classes, which, for the sake of distinction, may be termed "Engineers'" cement and "Plasterers'" cement. The former is the more costly; it is usually described by manufacturers as "best heavy tested;" it weighs from 112lb. to 120lb. to the bushel, is slow setting, and of great strength; the latter is a light cement, quick setting, and of inferior strength when compared with the other. It must be understood that our remarks apply exclusively to "Engineers'" cement.

Portland cement is made from chalk and alluvial clay; the factories on the banks of the Thames use white chalk, those on the Medway grey chalk; the latter is probably preferable, inasmuch as it contains large quantities of silicious matter. Mr. Read, in his treatise on "Portland Cement," says that "the present and safest proportions, provided both chalk and clay are selected free from sand, are four parts of chalk from the Medway (grey), or three parts of Thames (white), with one of clay by measure." These materials are placed in mills of simple construction, each having a circular pan, 6ft. in diameter and 2ft. deep, in which two "edge runners," 4ft. 6in. in diameter, are kept continually going; a constant stream of water flows into the pan, and as the "edge runners" revolve, the chalk and clay are thoroughly ground, and, being thus converted into a fluid state, they filter through a band of fine brass-wire gauze fixed to the side of the pan, and flow through wooden "launders" into tanks or settling reservoirs. One wash-mill will feed four tanks, each of which is about 100ft. long, 40ft. broad, and 4ft. deep. When one of these has been filled in the manner just described the same process is applied to the others in succession. About three weeks after the tanks are filled the whole of the materials will be precipitated, the clear water being drained off in the mean time through a small weir in the brick side of the tank; the residuum is a plastic mixture of the consistency of "putty," and not much unlike it in colour. The next process is to convey this precipitate from the tank to the "drying floors," over which it is spread in a layer about 6in. thick; each floor is 40ft. by 30ft.; it consists of an outer skin of boiler plates resting on a series of brick ovens and flues. The object of this arrangement is to render the plates sufficiently hot to effect the rapid desiccation of the water from the superincumbent layer, a process generally accomplished in about twelve hours. The materials having thus been thoroughly dried are ready for conveyance to the kilns. The "charge" consists of alternate layers of coke and raw materials, the burning generally occupying thirty-six hours. When the contents of the kiln becomes sufficiently cool, the "clinkers," or cement stones—for the mixture has now assumed that form—are drawn and removed to a floor where the larger pieces are broken, and the whole of the burnt materials are then conveyed to the hoppers of the grinding-mills, where, passing under rapidly revolving horizontal burr-stones, they are ground into an almost impalpable powder. The cement issues from the mill at a temperature of about 160°, and the now manufactured material is wheeled away, and spread in a layer from 2ft. to 3ft. thick over the floor of a cool shed; it is subsequently packed in casks or sacks for conveyance from the works. The essential conditions for the manufacture of good Portland are: 1, The chalk and clay should be thoroughly mixed in the wash-mills, and the fluid materials delivered by "launders" over the *entire* area of the settling tanks. 2, The contents of the kilns ought to be burnt equally throughout. 3, The burnt materials should be ground very fine. 4, After coming from the mill the cement should be spread over the floor of a shed, and allowed to remain there for *at least* a fortnight previously to being packed into casks or sacks.

The strength of Portland cement increases as its specific gravity increases; the tensile tests are usually made with briquettes the standard size for the neck being 1½in. by 1½in.; and it must be understood that all experiments referred to have reference to the weight necessary to sever 2¼ square inches of neat cement.

It appears from Mr. Grant's valuable paper, read before the Institution of Civil Engineers in December 1865, that Portland cement gains from 20 to 30 per cent. in strength by setting under water; it is usual, therefore, to place the test briquettes in water, after gauging, and to allow them to remain there until they are to be tested. The following table has been compiled from a recent series of experiments; it shows the average tensile strength of Portland cement as compared with the natural cements; the test blocks were of standard size of 2¼ square inches, and placed in water as before described:—

	Weight per bushel.	Breaking weight two days old.	Breaking weight four days old.	Breaking weight seven days old.
	lb.	lb.	lb.	lb.
Portland cement	119	808	914	1024
Roman cement	76	200	240	280
Medina cement	66	250	313	318
Cement de Zumaya .. (Spanish)	94	306	..	409

The *Builders' Trade Circular* vouches for the accuracy of these figures.

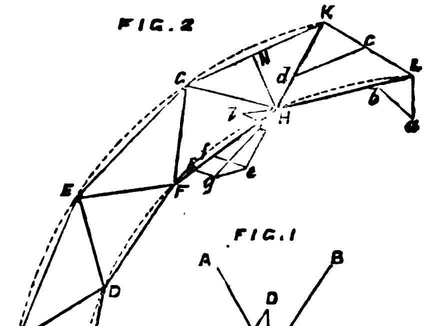
Mr. Grant's tables show conclusively that the strength of gauged Portland cement increases with age; from his experiments it appears that the breaking weight of test blocks, one week old, one year old, and two years old, are as 1, 1·5, and 1·62. The ultimate maximum tensile strength has not as yet been ascertained; experiments are, however, being conducted periodically with a view to determine this important point. Mr. Grant gives the average tensile strength of cement weighing 119lb; to the bushel as 777lb., whereas we give it as 1024lb., the excess of the breaking weight as recorded by us may probably be accounted for by improved manufacture since Mr. Grant's experiments were made.

Portland cement now forms an important item in the list of our manufactures, but even now its valuable properties are not as fully appreciated as they deserve to be.

WROUGHT IRON CRANES.—III.

(*Concluded from page 537.*)

OUR two preceding articles on this subject were confined solely to a practical description and illustration of the ordinary method of constructing wrought-iron cranes, and we reserved for a third and concluding article the question of their theory and scientific analysis. It has been already stated that mathematical formulæ and algebraical equations are not suitable for those particular examples of construction in which the different parts are inclined to one another at angles which not only vary among the parts themselves, but are also dissimilarly inclined to the horizontal. An example of our meaning is given in Fig. 2, which represents a skeleton elevation of a wrought-iron bent crane. In practice, the outer and inner flanges are curved as shown by the dotted lines, but they are considered theoretically to consist of a series of straight lines joining the several points where they are connected with the diagonal bars forming the web. These points may, in reality, be either pins or rivets, but bearing in mind to what tremendous jerks and vibrations cranes are subjected, there would not be any particularly valid reason for employing the former kind of attachment. After a time, pins must work loose; rivets never do. To determine the strains upon the crane represented in Fig. 2, which is supposed to be loaded only with a weight at its peak L, we start from the fundamental principle that governs the distribution of strain upon two separate members inclined at different angles to the horizontal, and acted upon by the same weight—to speak dynamically, by the same force. The principle, which it is necessary thoroughly to understand, will be best explained by a reference to Fig. 1. Let A C, B C, be two bars inclined to the horizontal line F G at angles respectively of 60° and 45°, and supporting a weight W at their junction C, which let us take equal to 1 ton. By the method of resolution of forces, construct the triangle C D E, and make C D = 1 ton. Draw D E parallel to B C, then D E will equal the strain upon B C, and E C that upon A C. If these strains be measured off upon a scale of two tons to the inch, which is the scale upon which C D is drawn, they will be found to equal respectively 0·50 and 0·71. It is not difficult to prove that these values are in the ratio of the cosines of the angles which the bars make with the horizontal line F G. By the principles of trigonometry we obtain in the triangle C D E the proportion D E : E C : : sine E C D : sine E D C. But the angle E C D is the complement of the angle E C F, which in the diagram was made equal to 60 degrees; similarly, the angle E D C is equal to the angle D C B (Euclid, prop. xv., book 1), which is the complement of the angle B C G, which is equal to 45 degrees. As the sine of any angle is equal to the cosine of its complement, if we call the strain upon the bar B C = E D = S, and that upon A C = E C = S^1, we have $S : S^1$: : cosine 60° : cosine 45°. Substituting the values of these in the equation, we find 0·5 : 0·71 : : 0·50000 : 0·70710, a sufficiently close approximation to prove the accuracy of the diagram.



A similar method is employed in deducing the strains upon the crane in Fig. 2, with the exception that, as we proceed, the resolution of the different forces becomes rather more complicated, but not to such a degree as to hinder any one from mastering the subject with care and attention. At the same time it is not to be supposed that a mere casual perusal of our article is sufficient to enable our younger readers to comprehend the matter thoroughly. Far from it. They must study—not merely read—it, and work out for themselves the diagrams to a conveniently large scale. For the sake of simplicity, we will suppose that there is a weight of one ton only at the point L, in Fig. 2. The advantage to be derived from this is that when once the strains due to a weight of one ton have been ascertained, all that is necessary to obtain those on another crane similar in design but loaded with a different weight is to multiply them by the constant ratio between the original or standard weight and the one in question. It must not be forgotten that any alteration in the design of the crane, such as changing the radii of either the inner or outer flanges, or the angle of inclination of the bars, will altogether vitiate the calculation. To return to our diagram in Fig. 2. Let L *a* equal one ton, supported at the front L. How does this produce strains differing in character and intensity throughout the whole structure? In the first place, the weight being supported at the connection of the two bars K L and L H must strain both of them, compressing the latter and extending the former. The parts in compression are shown by thick black lines, those in tension by fine ones. From the point *a*, draw *a b* parallel to the bar K L, meeting the chord of the part L H of the lower flange in *b*. Then, measured on the same scale, *a b* will give the strain upon L K, and L *b* that upon L H, and they are respectively equal to − 1·3 and + 1·05 tons. The sign minus denotes a tensile strain and + a compressive. Leaving this latter strain alone for a moment, let us trace the further action of that upon L K. This is obviously transferred to point K, where it acts upon G K and K H, extending the former, and compressing the latter. Upon K L, plot off K *c* equal to *a b*, equal to the strain upon K L; draw *c d* parallel to K G, meeting K H in *d*. The lines *c d* and K *d* will give the strains upon G K and K H respectively, and will be found equal to − 2·15 and + 1·85 tons. Following the strain upon K H, it is transferred to the point H, where it pulls upon the bar G H and compresses H F. If there were no other force acting upon the point H, nothing more would be required to find the strains upon the members G H and H F than to proceed as before. But there is the strain upon L H, equal to L *b*, to be taken into consideration, and how it also affects the bars acted upon by the strain upon K H. It will be seen on inspecting the diagram that it compresses H F, and also compresses the bar G H, which is, on the contrary, stretched by the strain brought upon it from K H. But it has been frequently mentioned that when a bar or part of a structure is acted upon by forces or strains of both tension and compression, the actual strain is the algebraical sum of the two. Thus if a bar have a tensile or minus strain of 7 tons, and a compressive or plus strain of 4 tons, then the actual resulting strain is (+ 4 − 7) = − 3 tons. This is just what occurs in the present case, and we thus see how important it is to remember these fundamental axioms. The bar G H is acted on by a tensile strain in the direction of K H and a compressive one in that of L H. It is the difference, therefore, of these two which is the strain really affecting the bar.

There are two methods of resolution by which these strains on G H and H F may be determined.

MECHANICAL MOVEMENTS.

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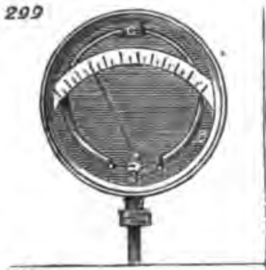

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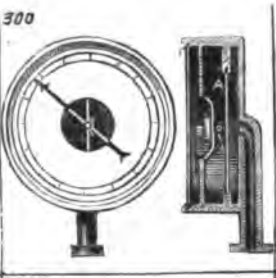

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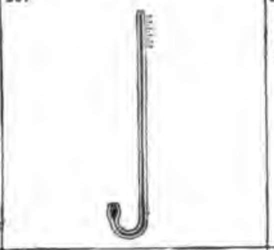

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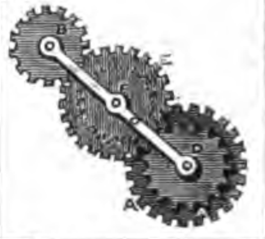

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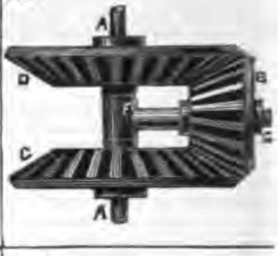

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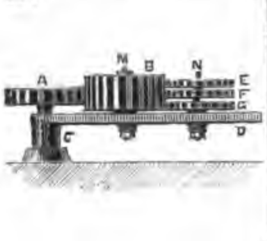

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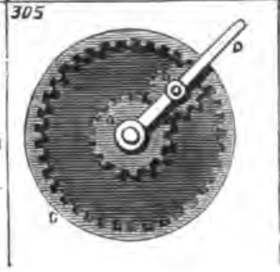

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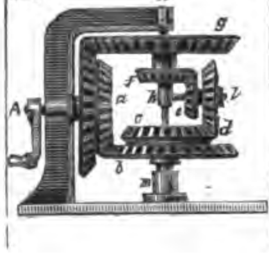

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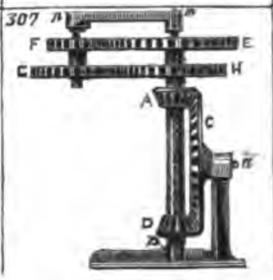

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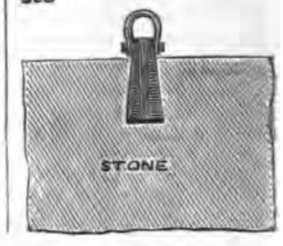


One is by proceeding as has been already done, taking care to take the algebraical sums of strains of a different character where they are so, and the other to first find the resultant of the two original strains, and then completing the diagram of forces. Let us consider the former method first. Produce K H to *e*, making H *e* = K *d* = strain upon K H. From *e* draw *e f*, parallel to G H. Measure *e f* and and *f* H, and these will represent the strains upon the bars G H and H F, due to that transferred to the point H by the bar K H, and will be − 1·0 and + 2·4. Now for the other strains, produce L H to *l*, making H *l* equal L *b* equal the strain upon L H. From *l* draw *l n* parallel to G H, and *l n* and *n* H will be the other strains upon G H and H F, and will scale + 0·5 and + 0·63 tons. Summing up, we obtain the total strains upon these parts of the crane to be as follows:—Upon G H (−1·0 + 0·5) = − 0·5 tons, and upon H F (+ 2·4 + 0·63) = + 3·03 tons. By the second method, the resultant of the strains of K H and L H must be first ascertained. Produce K H to *e* as before, draw *e g* parallel to L H, and equal to L *b*. From *g* draw *g h*, parallel to G H. Then *g h* will be found, on measurement, to equal (*e f* − *l n*) = − 0·5 and *h* H to equal (H *n* + H *f*) = + 3·03 tons. At the point G there are also two forces acting—namely, the strain due to the bar G H and that to K G. The resulting strains can easily be determined upon the parts G E and G F by either of the methods we have just investigated. We cannot spare space to go through every strain, nor is there any necessity, as the determination of the others is simply a repetition of what has been already done. Those who desire to thoroughly understand this operation must make a good large diagram of Fig. 2, and work out the whole problem for themselves, taking care to tabulate the strains upon each bar separately, so as to perceive how they accumulate from the free to the fixed extremity of the crane.

Although this method of calculating strains is perfectly accurate enough for all practical purposes, yet, as it is a consecutive one, it is advisable to check the strains in the flanges at intervals. This may be readily done by very simple formulæ. For example, the strain upon the bar K G has been found by the diagram to be equal to − 2·15 tons, and it may be checked as follows. It is manifest from the principle of moments that the strain at any point multiplied by the leverage with which it acts, will be equal to the weight at that point, multiplied also by the leverage with which it acts. The strain on the bar G K acts with a maximum leverage of N H, equal to 3·5 feet, whereas the weight at L acts with the horizontal leverage of H *a*, equal to 7·9 feet. If S be the strain required, L its leverage, W the weight, and L′ its leverage in the general formula, $S = \frac{W + L'}{L} = \frac{1 + 7\cdot 9}{3\cdot 5}$. From which we obtain S = − 2·2 tons, which checks the accuracy of the calculation by diagram. Great care must always be taken in calculating by diagram, as there is always a tendency for errors to accumulate. One false step at the commencement, if it is not perceived, is perpetuated in all the succeeding operations, and would ultimately cause a very serious difference in the correct values. But by using the method of moments to check the results, no such accumulation can occur, and one is enabled to perceive, as the working out of the diagram proceeds, that the calculations are rightly performed. One or two checks of this kind should always be introduced, as, if the whole operation is effected first, and the strain upon the last flange not found to be correct, the whole work must be gone over again to discover the error.—*Building News.*

MECHANICAL MOVEMENTS.

(*Concluded from page* 536.)

299. Aneroid gauge, known as the "Bourdon gauge," from the name of its inventor, a Frenchman. B is a bent tube closed at its ends, secured at C, the middle of its length, and having its ends free. Pressure of steam or other fluid admitted to tube tends to straighten it more or less, according to its intensity. The ends of tube are connected with a toothed sector-piece gearing, with a pinion on the spindle of a pointer which indicates the pressure on a dial.

300. Pressure gauge now most commonly used. Sometimes known as the "Magdeburg gauge," from the name of the place where first manufactured. Face view and section. The fluid whose pressure is to be measured acts upon a circular metal disc, A, generally corrugated, and the deflection of the disc under the pressure gives motion to a toothed sector, *e*, which gears with a pinion on the spindle of the pointer.

301. Mercurial barometer. Longer leg of bent tube, against which is marked the scale of inches, is closed at top, and shorter one is open to the atmosphere, or merely covered with some porous material. Column of mercury in longer leg, from which the air has been extracted, is held up by the pressure of air on the surface of that in the shorter leg, and rises or falls as the pressure of the atmosphere varies. The old-fashioned weather-glass is composed of a similar tube attached to the back of a dial, and a float inserted into the shorter leg of the tube, and geared by a rack and pinion, or cord and pulley, with the spindle of the pointer.

302. An "epicyclic train." Any train of gearing the axes of the wheels of which revolve around a common centre is properly known by this name. The wheel at one end of such a train, if not those at both ends, is always concentric with the revolving frame. C is the frame or train-bearing arm. The centre wheel, A, concentric with this frame, gears with a pinion, F, to the same axle with which is secured a wheel, E, that gears with a wheel, B. If the first wheel, A, be fixed and a motion be given to the frame, C, the train will revolve around the fixed wheel and the relative motion of the frame to the fixed wheel will communicate through the train a rotary motion to B on its axis. Or the first wheel as well as the frame may be made to revolve with different velocities, with the same result except as to the velocity of rotation of B upon its axis.

In the epicyclic train as thus described only the wheel at one extremity is concentric with the revolving frame; but if the wheel, E, instead of gearing with B, be made to gear with the wheel, D, which like the wheel, A, is concentric with the frame, we have an epicyclic train of which the wheels at both extremities are concentric with the frame. In this train we may either communicate the driving motion to the arm and one extreme wheel, in order to produce an aggregate rotation of the other extreme wheel, or motion may be given to the two extreme wheels, A and D, of the train, and the aggregate motion will thus be communicated to the arm.

303. A very simple form of the epicyclic train, in which F, G, is the arm, secured to the central shaft, A, upon which are loosely fitted the bevel-wheels, C, D. The arm is formed into an axle for the bevel-wheel, B, which is fitted to turn freely upon it. Motion may be given to the two wheels, C, D, in order to produce aggregate motion of the arm, or else to the arm and one of said wheels in order to produce aggregate motion of the other wheel.

304. "Ferguson's mechanical paradox," designed to show a curious property of the epicyclic train. The wheel, A, is fixed upon a stationary stud about which the arm, C, D, revolves. In this arm are two pins, M, N, upon one of which is fitted loosely a thick wheel, B, gearing with A, and upon the other are three loose wheels, E, F, G, all gearing with B. When the arm, C, D, is turned round on the stud, motion is given to the three wheels, E, F, G, on their common axis, viz., the pin, N; the three forming with the intermediate wheel, B, and the wheel, A, three distinct epicyclic trains. Suppose A to have twenty teeth, F twenty, E twenty-one, and G nineteen; as the arm, E, C, D, is turned round, F will appear not to turn on its axis, as any point in its circumference will always point in one direction, while E will appear to turn slowly in one and G in the other direction, which—an apparent paradox—gave rise to the name of the apparatus.

305. Another simple form of the epicyclic train, in which the arm, D, carries a pinion, B, which gears both with a spur-wheel, A, and an annular wheel, C, both concentric with the axis of the arm. Either of the wheels, A, C, may be stationary, and the revolution of the arm and pinion will give motion to the other wheel.

306. Another epicyclic train in which neither the first nor last wheel is fixed. *m*, *n*, is a shaft to which is firmly secured the train-bearing arm, *k*, *l*, which carries the two wheels, *d*, *e*, secured together, but rotating upon the arm itself. The wheels, *b* and *c*, are united and turn together, freely upon the shaft, *m*, *n*; the wheels, *f* and *g*, are also secured together, but turn together freely on the shaft, *m*, *n*. The wheels, *c*, *d*, *e* and *f*, constitute an epicyclic train of which *c* is the first and *f* the last wheel. A shaft, A, is employed as a driver, and has firmly secured to it two wheels, *a* and *h*, the first of which gears with the wheel, *b*, and thus communicates motion to the first wheel, *c*, of the epicyclic train, and the wheel, *h*, drives the wheel, *g*, which thus gives motion to the last wheel, *f*. Motion communicated in this way to the two ends of the train produces an aggregate motion of the arm, *k*, *l*, and shaft, *m*, *n*. This train may be modified; for instance, suppose the wheels, *g* and *f*, to be disunited, *g* to be fixed to the shaft, *m*, *n*, and *f* only running loose upon it. The driving-shaft, A, will as before communicate motion to the first wheel, *c*, of the epicyclic train by means of the wheels, *a* and *b*, and will also by *h* cause the wheel, *g*, the shaft, *m*, *n*, and the train-bearing arm, *k*, *l*, to revolve, and the aggregate rotation will be given to the loose wheel, *f*.

307. Another form of epicyclic train designed for producing a very slow motion. *m* is a fixed shaft upon which is loosely fitted a long sleeve, to the lower end of which is fixed a wheel, D, and to the upper end a wheel, E. Upon this long sleeve there is fitted a shorter one which carries at its extremities the wheels, A and H. A wheel, C, gears with both D and A, and a train-bearing arm, *m*, *n*, which revolves freely upon the shaft, *m*, *p*, carries upon a stud at *n* the united wheels, F and G. If A have 10 teeth, C 100, D 10, E 61, F 49, G 41, and H 51 there will be 25,000 revolutions of the train-bearing arm, *m*, *n*, for one of the wheel, C.

308. A better form of the "Lewis" than that given in fig. 293, for which we are indebted to our correspondent "Theta."

MESSRS. BAEYER AND EMMERING are investigating the nature of Indigo with a view to its artificial preparation. Their researches are apparently suggested by the success of Messrs. Graebe and Liebermann with respect to Alizarine.

FRICTION.—XI.

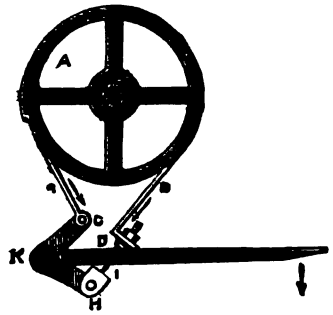
By C. Draper, A.B., L.C.E.

(*Continued from page* 514.)

Frictional Brakes.—The first of these which we shall describe is that which consists of a flexible band embracing an arc of the circumference of a wheel or drum. A brake of this description is very frequently attached to cranes, hoists, windlasses, &c., in which the weight when raised, were the pressure exerted by the labourer on the winch relaxed for a moment, might descend with destructive velocity. Numerous fatal accidents have thus occurred through want of sufficient brake power and through negligence of the workmen in letting go the handles before the brake was applied. When, however, a brake of sufficient power is attached, the simple pressure of the hand or foot upon the end of the lever is able to arrest the weight at any point, or suffer it to descend safely and slowly as required.

Fig. 29 represents an arrangement of brake in which the pressure is applied by the foot. A is the cast-iron brake-wheel, the circumference of which is recessed to receive a wrought-iron band B; the ends of this band, C and D, are attached to the ends of the short arm of a bent lever C H E, whose fulcrum is K, one directly by a pin *c*, and the other by means of an adjusting screw I, so as to regulate the length of the band. When E is pressed downwards by the foot, C and D are moved in the directions of the arrows, thus tightening the band upon the wheel. Now, before the wheel A can revolve, it must overcome the friction developed by the pressure between A and B; and since A is fixed on the same shaft as the winding drum, or other shaft of the machine, it must control the action of the whole.

FIG. 29



Frequently the brake-wheel is cast in one with the spur-wheel on the barrel-shaft, as shown in Figs. 30 and 31, which represent in elevation and plan another variety of friction brake, in which a number of blocks of wood *a a a* are attached to the iron strap, so that the rubbing surfaces are wood and iron, and any worn pieces can easily be replaced. The best woods for this purpose are elm, beech, and oak, as they offer considerable resistance to crushing.

FIG. 30

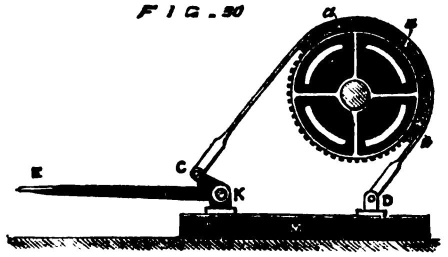
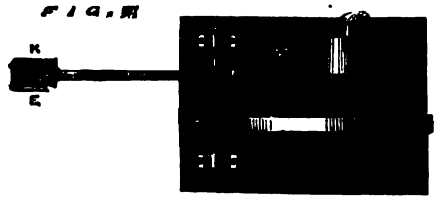


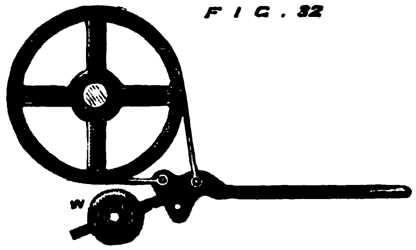
FIG. 31



In this brake, one end of the strap D is attached to the framework of the machine M, and the other to the end C of the short arm of a bent lever E K C, whose fulcrum K is also attached to the framework M. Although the brake-wheel is often fixed on the same shaft as the winding barrel, it is frequently fixed on the same shaft as the winch, for the reason that this shaft has a greater velocity than any other, and therefore, by the principle of virtual velocities, a pressure on a wheel on this will have the same effect as a pressure on a wheel of the same size on the barrel-shaft greater than it in the proportion of the velocity of the latter to that of the former. If by the nature of the machine the barrel tends to revolve in the direction of the arrow, it is clear that the end D of the strap will suffer a greater tension than the end C; the lever should therefore be attached to the end C, and not to D; for if it were attached to D we should have to exert a greater pressure upon E to produce the same effect upon the friction-wheel.

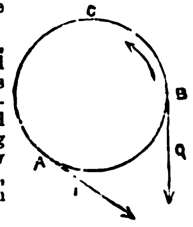
Fig. 32 represents the form of brake adapted to hand pressure. A balance-weight W is shown, the object of which is to counterpoise the weight of the brake-lever, which otherwise would cause a tightening of the band and create friction when not required.

FIG. 32



To find the amount of friction developed between the strap and wheel consequent upon a given force P being applied to one end of the strap. In Fig. 33, let A B C be the wheel, and let P and Q be the tensions of the band at A and B respectively; when the wheel is on the point of rotating in the direction of the arrow Q will be greater than P, and the relation between them is

FIG. 33



$$\frac{Q}{P} = 2{\cdot}7183^{\frac{\mu a}{r}},$$

where μ is the coefficient of friction between the band and wheel, a the length of the band in contact with the wheel, and r the radius of the wheel. For a proof of this formula the reader is referred to Rankin's "Applied Mechanics," page 617, and for an elementary proof to Todhunter's "Mechanics for Beginners," page 183.

As the wheel is on the point of revolving within the band in the direction of the arrow, the force overcome at the circumference of the wheel, supposing the band fixed, must be equal to the friction between the band and wheel; and this friction is manifestly equal to the difference between Q and P. Calling the friction F, we have $F = Q - P$; substituting in this the value of Q from the above equation, we have $F = P\left(2{\cdot}7183^{\frac{\mu a}{r}} - 1.\right)$

In the above formula, as $\frac{a}{r}$ is the circular measure of the angle of contact of the band, we see that if P remain constant the friction depends upon that angle, and is independent of the radius of the wheel. We also see that as the arc or angle of contact increases in arithmetical progression, the ratio of Q to P increases in geometrical progression, so that by increasing the arc we very rapidly increase the mechanical advantage of the brake.

Example 21.—In a ten-ton crane, let the following be the proportions of the wheelwork:—Two toothed wheels, 4ft. 8in. and 3ft. diameters; two pinions, 7in. and 6in. diameter; diameter of barrel measured to centre of chain, 12in.; diameter of brake-wheel, which is fixed on the winch shaft, 2ft.; arc of contact of strap and wheel, 4ft. 6in.; lengths of the arms of the brake-lever, 1 : 7. Calculate what force must be applied to the handle of the brake-lever so as to allow a weight of ten tons just to descend, if the coefficient of friction be taken as $\frac{2}{9}$.

Here the ratie of the weight to the force to be overcome by friction at the circumference of the brake-wheel is $\frac{56 \times 36 \times 24}{7 \times 6 \times 12} = 96$, that is, a force of $\frac{10 \times 2240}{96} = 233$lb. nearly, at the circumference of the break-wheel is sufficient to just arrest the descent of the ten tons weight. Now this 233lb. must be the value of the friction F, so that substituting for μ, a, and r their numerical values $\frac{2}{9}$, $4\frac{1}{2}$, and 1, we must have

$$P = \frac{233}{2{\cdot}7183^{\frac{2 \times 2}{9 \times 2 \times 1}} - 1},$$

but $\frac{2 \times 9}{9 \times 2 \times 1} = 1$, so that $P = \frac{233}{1{\cdot}7183} = 135{\cdot}6$lb. This reduced in the ratio of 1 : 7 will give the force at the brake-lever handle, that is, the required force is 19·37lb.

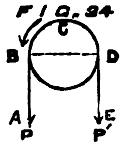
The values for μ, a, and r have been so chosen as to give $\frac{\mu a}{r} = 1$, in order to save calculation, for *any* values of them; however, the value of $2{\cdot}7183^{\frac{\mu a}{r}}$ can be easily calculated with the aid of a table of logarithms.

Although in example 21 we have supposed that the end of the strap which suffers the greater tension to be attached to the framework of the crane, still the most usual arrangement is that indicated in Figs. 29 and 32, where both ends of the strap are connected to the brake-lever. The reason for this arrangement is, that for a given movement of the lever the strap is tightened twice as much as when one end is fixed to the frame, for manifestly if the short arms of the lever be equal, each point of attachment of the strap to the lever is moved to the same extent.

To calculate in this case the pressure on the lever handle required to produce tensions P and Q on the ends of the strap, let a and b denote the lengths of the perpendiculars from the fulcrum, upon the directions of the strap; let c be the length of the long arm of the lever, and W the required pressure on the lever handle; then, by the principle of the lever, $P \times a + Q \times b = W \times c$. W is thus found, knowing P or Q; for when P or Q is given the other is found at once, since $Q - P = F$ the given friction.

Let A B C D E, Fig. 34, represent a cord or band passing over a wheel B C D; let equal weights P P′ be suspended from A and E; the arc of contact between the band and wheel will clearly be a semicircle. Now, if the wheel or cylinder B C D be supposed fixed, in order to cause the cord to slide in the direction of the arrow, we must increase P to such an amount Q, that $\frac{Q}{P} = 2{\cdot}7183^{\frac{\mu a}{r}}$. Let now the same cord and weights be hung over a wheel of the same material, B′ C′ D′, but of twice the diameter, Fig. 35; then since the angle $\frac{a}{r}$, or 180°, remains the same in each case, the cord will just commence to slip in the direction of the arrow in this case also.

FIG. 34



In Fig. 36, let B C D be the same cylinder as in Fig. 33, and let the cord on one side, instead of hanging vertically, be led horizontally over a pulley H; the value of Q now, according to the formula, when it just causes P′ to ascend, will be but one quarter the value of Q in Fig. 34; the arc of contact in Fig. 36 being 90°, or one half that in Fig. 34, being in accordance with a consequenc of the above formula, that as the arc increases in arithmetical progression the mechanical advantage increases in geometrical progression.

FIG. 35

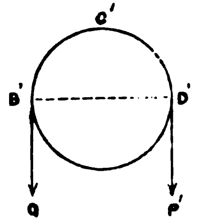
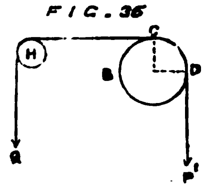


FIG. 36



This explains the astonishing advantage gained by coiling a rope round a mooring post. For example—suppose that the coefficient of friction be such that a man pulling the end of a rope which is passed once round a mooring post with a force of 25lb. can equilibrate a tension of 200lb. on the other end of the rope, by coiling it twice round he can resist a tension of 1,600lb.; and by coiling it three times round a tension of 12,800lb., or 5¾ tons nearly. For 25 : 200 : : 1 : 8, therefore 8 is the ratio of the geometrical series, and we obtain the force for the second coil by multiplying 200 by 8, which gives 1,600; and for the third by multiplying this again by 8, which gives 12,800, and so on for any number of coils. For the same reason, one man by exerting a small but constant tension, can take in a cable as it passes from the winding barrel of a windlass or capstan, although the other end of the cable may suffer great strain, provided the cable takes several turns round the barrel before it leaves it.

(*To be continued.*)

A NEW TEST-PAPER.—From *Cosmos* we obtain the information that M. Böttger has produced a new test-paper which is highly sensitive towards the alkalies and alkaline earths. The reagent is a magnificent colouring matter, obtained from the leaves of the well-known plant, *Coleus Verschaffelti*, upon digestion for twenty-four hours with absolute alcohol, to which a few drops of sulphuric acid have been added. The paper is prepared for use by the usual process. The colour is a splendid red, which passes more or less rapidly into a fine shade of green, by the action of the alkalies or the alkaline earths. It is far more sensitive than turmeric; it is unaffected by carbonic acid, and will indicate the presence of the least traces of the carbonates of the alkaline earths in water. A moistened strip of the paper, when held at the opening of a gas jet, immediately assumes a green colour if ammonia be present.

THE VALUE OF GELATIN AS FOOD.

THE general appreciation of articles of food more or less exclusively gelatinous, such as isinglass, jellies, cod sounds, calves' feet, cow-heel, calf's head, &c., was a few years since denounced by some persons as an error; and, in opposition to the general experience and common sense of mankind, they maintained that gelatin and gelatinous articles of food were of no value whatever, and that the benefit of, say, half a pint of strong calf's-foot jelly solely depended on the tablespoonful of wine which it did or did not contain.

The grounds on which this extraordinary opinion was based were chiefly twofold; firstly, that gelatin is not found in the blood; and, secondly, that an animal fed on nothing else than gelatin speedily dies of starvation. The absence of gelatin from the blood does not prove that it is not nutritious. Milk is the model food, the only substance expressly created for the nourishment of animals, and which has no other use in the economy of nature. Now the albuminoid, or flesh-forming substance, in milk is the curdy matter, or casein; no one can deny its value, except perhaps the persons who say that gelatin is not nutritious; for casein, like gelatin, is never found in the blood. If we turn to the latest, and certainly the most exhaustive, treatise on physiology which has been recently published, namely, that of Marshall, we shall find that the value of gelatin is thus stated:—"Gelatin is not found in the blood itself, but when digested is converted into a gelatin-peptone, and so becomes absorbed as we have seen, but in what state is not yet known. Nor is its destination in the nutritive processes of the body certain. Either it may serve for the direct nutrition of the gelatin-yielding tissues, or—and this is very probable—it may by itself, undergoing oxidation, conserve other more important tissues, and at the same time maintain the temperature of the body. Its efficacy, as administered in jellies, &c., in cases of sickness, especially indicates its importance as an article of diet."

Dr. Edward Smith, F.R.S., in the fourth edition of his valuable "Practical Dietary," states that gelatin "exists very largely in the skin, horn, hoofs, tendons, and bones of animals, and in a less amount in the flesh. Hence we obtain it from calves' feet and cow-heel when boiled for that purpose, from the shin and other parts of beef when prepared for soup, and from bones which have been broken and boiled for many hours in water. Whether, therefore, as jelly or in soup, this substance is largely eaten; and yet it is affirmed even to this day that it is innutritious, and therefore worthless as food. My own experiments have proved that gelatin, like albumen, is transformed within the system, and leaves the body as urea, and hence it must have played its part in nutrition; but whether its nutritive value is quite equal to that of albumen, is another question. I believe gelatin to be a valuable food, and every one knows that, with the addition of wine and other substances, it is a very agreeable one. It is however, very probable that it is not an economical food as it is ordinarily prepared, but it may be cheaply obtained in soup from bones."

I now come to the second so-called argument by which the uselessness of gelatin is attempted to be maintained. It is said that an animal fed on gelatin dies rapidly of starvation and inanition. This is perfectly true; but the fact is, that no simple substance given alone will support life. The most nutritive materials, such as albumen, fibrin, gluten—to say nothing of such substances as starch or sugar—all equally fail to support life when given alone. Good wheaten bread will support life any length of time; but separate the starch, gluten, and other constituents, and give them singly, and, if the argument above adduced holds good, you could prove each of these substances to be totally without value as food, as neither will support life when used alone. I believe that this false opinion respecting the valueless character of gelatin arose from some experiments on the feeding of convicts in some of the French prisons. They were supplied with a very small quantity of gelatin in place of other articles of food, and soon showed symptoms of starvation. The fact that dogs, though they die rapidly when fed on perfectly pure gelatin, will live any length of time if kept on soft bones, which consist almost exclusively of gelatin and bone earth, is a convincing proof that the gelatin is a valuable article of diet.—W. B. **Tegetmeier**, in the *Food Journal.*

ENAMELLING LIQUOR BARRELS.

OWING to the extensive trade in liquor the demand for barrels is constantly increasing, and the growing scarcity of oak timber renders it necessary to find some substitute. This want is likely to be supplied by the process of enamelling, some observations on which are made by Mr. Krupsi in a German periodical from which we translate the following:—

Up to the present time, these barrels have been made of oak-wood, but as this article becomes rarer and more expensive, it became necessary to find a substitute. Iron has been proposed, but, though these have the advantage of greater durability and safety from leakage, there are many disadvantages—such as their greater weight, their liability of getting out of shape, the expansion and contraction by heat and cold, thus having a larger capacity in summer than in winter, and, finally, their expense. These disadvantages are so great that there is no likelihood of iron taking the place of wood in the manufacture of barrels for this purpose.

In Russia, where, with the exception of the western provinces, casks of oak-wood are obtained with great difficulty, a substitute has at last been discovered, and quite a trade is done in barrels of pine and deal, enamelled on the inside. The enamel prevents the liquid from coming in contact with the wood, and fills the cracks and prevents leakage. These take the place of oak barrels for many purposes, especially for lager-bier barrels. They are mostly bound with wooden hoops. The enamelling is done as follows:—The barrel is made and hooped, leaving out the bung stave, through this aperture the enamel is applied to the inside and then the bung stave is put in, in the ordinary way. The enamel is made of thirty-three pounds of carpenter's glue, three pounds of finely ground and sifted gall-nuts, six pounds of pulverized and sifted glass, and five pounds of sifted cement or fine unslacked lime. The glue is softened with sweet milk instead of water, and boiled down quite thick, then the powdered gall-nuts are added, and the whole boiled for half an hour, then the glass-powder, and lastly the lime is thrown in. When these ingredients have been thoroughly mixed, five quarts of good linseed-oil varnish is added, and the addition of a few pounds of sulphur is also desirable. It is then boiled until it is sufficiently thick, being well agitated all the time to prevent the glass and cement from settling at the bottom. When boiled sufficiently the kettle is immediately placed in ice, which causes the mass to solidify rapidly, so that the undissolved particles will remain in a finely-divided condition in the glue. The enamel is used in a semi-fluid state, and it is best not to prepare very large quantities at once, though it can easily be rendered fluid by heat when it becomes hard.

The casks to be enamelled must be perfectly clean and dry, and just before putting on the enamel they should be heated by burning a little alcohol in them. Three coats are given, each one being allowed to dry before putting the next one on. In the case of very large barrels it is necessary to have the bottom well supported, as, when full, the bottom, if not supported, will give way a little, and the enamel not being elastic will crack, which will cause the barrel to leak.

Liquors placed in enamelled barrels will not be coloured or changed in taste by the coating, as is the case with oak barrels, which, when new, invariably turn the alcohol brown. This enamel, however, will not stand water, therefore when the barrels become dry they must be allowed to float on the water instead of putting water in them.

A NEW SPHYGMOSCOPE.

IN the *Centralblatt* of the 25th of June, M. Landois gives an account of a new sphygmoscope, which so far differs in construction from those that have been hitherto suggested, that the movements of the pulse act on a column of gas, the undulations of which can be recognized by the movements of the flame resulting from the ignition of the gas as it issues. M. Landois observes that the nature of the dichrotic curve or secondary elevation in the pulse so commonly depicted has not as yet been satisfactorily determined; some believing it to be a real undulation, others that it is to a certain extent an artificial curve, and due to a kind of recoil of the instrument. None of the tracings obtained by the various forms of instruments hitherto suggested, are free from this peculiar undulation, whether we take the mercurial column, as in the instrument of Chelius; the column of water, as in that of Naumann; the elevation of a lever, as in that of Vierordt; or, lastly, a spring, as in that of Marey. The instrument suggested by M. Landois appears, says the *Lancet*, to be a small metal chamber, the edges of which fit closely on the wrist or elsewhere, whilst a small space is left between the skin and the inside of the chamber through which either ordinary gas or hydrogen is transmitted from a gasometer at a very low pressure. The gas issues by a capillary glass tube attached to the other extremity of the chamber, and can easily be ignited. It is interesting to find that the movements thus rendered visible agree precisely, both as regards the principal curve and the secondary undulation, with those exhibited by means of Marey's sphygmograph.

WATERPROOFING STONE.—At the recommendation of Professor Abel, Chemist to the War Department, the process invented by Messrs. R. Gay and Co., of Alton, Hants, for waterproofing and preserving stone and other buildings, is, by order of the Office of Works, to be applied to portions of the decayed stonework of the Houses of Parliament.

LETTERS TO THE EDITOR.

[We do not hold ourselves responsible for the opinions of our correspondents. The **Editor** respectfully requests that all communications should be drawn up as briefly as possible.]

*** All communications should be addressed to the **Editor** of the **English Mechanic**, 31, Tavistock-street, Covent Garden, W.C.

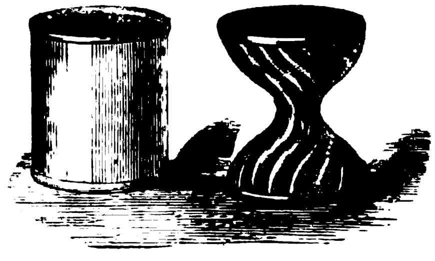
All Cheques and Post Office Orders to be made payable to J. **Passmore Edwards**.

"I would have every one write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks: a vice from whence great inconveniences derive their original."—*Montaigne's Essays.*

*** In order to facilitate reference, correspondents, when speaking of any Letter previously inserted, will oblige by mentioning the number of the Letter, as well as the page on which it appears.

ASTRONOMICAL, MECHANICAL, AND OPTICAL.

[817] Sir,—The diaphragm described and figured by Mr. H. W. Reveley, p. 540, in answer to the query "Unit" (4495), p. 502, is ingenious enough, and effective; but it is *not* the "Iris Diaphragm," which is of much more simple construction. It merely consists of two brass rings connected by an india-*rubber cylinder* of their own diameter. By twisting *one of these round* it is perfectly obvious that the cylinder *will assume an* hour-glass figure; and it is *equally apparent that* the aperture may be entirely closed *if the twisting be* sufficiently continued, or that upon allowing *the tube* to assume its original form the whole aperture of the rings will be available. The annexed sketch shows



the principle of this arrangement. The details may be studied by "Unit" in the stage of R. & J. Beck's large microscope should he be able to obtain access to one of those instruments. I would venture to point out to Mr. Gould (235), p. 518, that I gave a perfectly straightforward answer to his question in my letter (47), on p. 395, in the only *practical* form in which it admitted of a reply, and that without any reference, proximate or remote, to what he calls "the tenuity of his own cerevisia." As a matter of fact we have no right to assume that the air at the equator, or anywhere else, moves merely as a rigid shell attached to the earth's surface; but conceiving for our present purpose that it does, Mr. Proctor has very clearly laid down the conditions of the problem to be investigated in his communication ([illegible]), p. 540. I may be, however, permitted to say that we have really no experimental data as to the influence of the air on shot sufficiently perfect to justify us in employing them, otherwise than tentatively. If Mr. Gould be fond of integrating, and cares to obtain the "Mécanique" of M. Duhamel, he will find ample material of the best available sort to assist him in his investigations.

In this connection, too, I must ask "M. L." ([illegible]), p. 518, to forgive me for saying that the trade wind does not blow *at* the equator at all, but north and south of it,—the region of calms and rains, or what sailors call "the doldrums," extending for some six degrees of latitude, and travelling north and south with the sun and with the trades themselves. I would further observe that your correspondent's idea of a ball which is to be projected 3,970 miles, reminds me a little of the story of the Cambridge undergraduate, who being asked in an examination paper to explain the theory of putting a cup into a pie, did so quite correctly, but added, somewhat needlessly, by way of a rider, that "the cup must not be more than 32ft. high." I happen to have heard a few hundreds of guns fired in my lifetime, but should certainly, with my experience of ordnance, shy one which was guaranteed to project a ball to the height of half the earth's radius. I have nothing to add to what Mr. Proctor (257), p. 540, has said to "Etudiant" (251), p. 522. Like Mr. P., I wait for more definite data.

Your engraver, in his reproduction of my drawing of Saturn on p. 529, has made the inner, or crape, ring C very much too light, in fact, has engraved it of the same tint as the outer one A. Any one who wants a facsimile of my original sketch had better darken this inner ring with Indian ink until it is just fairly distinguishable from the black sky between it and the body of the planet.

"R. T." (260), p. 540, may make the requisite table of Algol's variations for himself when he has once caught it at its maximum, by remembering that those variations are performed in 2d. 20h. 48m. 55s. It only remains as a fourth magnitude star for some 15m. or 20m. I have not the most distant idea when its next mimimum is to take place, and could only ascertain it in a way equally open to "R. T." himself, that of watching the star until I saw it begin to diminish. A very rudimentary acquaintance with the doctrine of probabilities will show that the odds are very heavy indeed against Algol being caught in its wane at any particular time; and that nothing but repeated and sedulous watching, undertaken with that sole object is likely to be rewarded.

I have no doubt whatever, that the undulation observed by the friend of "α Ursæ Minoris" (4516), p. 526, was referable to a current of heated air rising from the house roof of which he speaks. The ground, trees, or houses, all radiate heat rapidly into space on a clear night, and the rippling of the limb of the moon or a planet, when at a small altitude, is one of the commonest of all common appearances. The owner of the stand need not accuse it of unsteadiness in the absence of better evidence than that referred to.

I shall not condescend to argue with Mr. Firth (279), p. 545. My faculty of prevision being strictly limited I am utterly unable to conceive what I shall say "thousands of years' hence." What I did say, and what, with or without Mr. F.'s leave, I shall continue to say, was, that on the 1st July, 1870, the sun was in the constellation Gemini. Were I about to continue so childish a discussion (which I certainly will neither waste your space nor your readers' time in doing) I might ask Mr. Firth "on what page of the 'Nautical Almanack' it is *stated* that the sun is in" any sign of *the zodiac* on the 1st July, 1870? (Since writing this sentence I have seen Mr. Proctor's very kind letter (290), p. 568. With reference to this it is only necessary for me to say that if my unpretending "Notes" satisfy a man of his great and admitted eminence, I need not distress myself much as to the effect they produce upon such a critic as Mr. F.)

Mr. Preston (288), p. 546, is quite right about the phenomena of diffraction being exhibited irrespective of the employment of any telescope. This is a subject of very considerable interest, and might, I think, be profitably treated in these columns. Diffraction phenomena are very beautiful, and may be exhibited with little or no apparatus. With regard to your correspondent's other observation about keeping his disengaged eye open while observing with the telescope I may just say that a little practice will enable any one to dispense with a shade or covering of any description. I never close my unoccupied eye while employing the telescope or microscope, but only *attend* to the image in the one engaged at the instrument. From use I can so abstract this image as to cease see—or rather perceive—anything with the other eye; albeit, of course, a picture must exist on its retina wholly differing from that with which my mind is absorbed.

Mr. J. T. Hill (4588), p. 550, will do good rather than harm by blackening with a *dead black*, the interior of any telescope tube, terrestrial or otherwise, the less light lost by internal reflexions obviously the more will pass through the lenses.

I am unable to give any definite answer to the question or questions propounded in (315), on p. 570, by "D. W." By very far the greatest proportion of meteorites are most undoubtedly cosmical; but of course it is *possible* that volcanic stones might be projected during a tremendous eruption to a sufficient height to enable them to be carried for some considerable distance by a rapidly moving current of air, and a stray specimen or specimens of terrestrial origin might thus fall, apparently from space, but in reality from no very enormous distance above the earth's surface. This is however (though, as I have said, possible) exceedingly improbable. Literally, nothing is known as to the cause of the chemical constitution of these strange bodies. I do not remember to have heard or read of Professor Newton's theory; but with reference to the late Professor Brayley, while fully recognizing the excellence of the old adage, "de mortuis nil nisi bonum," I am constrained in candour to say that no deference was ever paid to his opinions, nor was he ever held to be an original investigator at all.

The difficulty of "Hesperus" (4654), p. 574, will vanish when he reflects that the "Elements of Occultation" of Saturn, to which he refers, as given on p. 452 of the "Nautical Almanac" for this year, have reference to the *geocentric* places of the moon and planet. In the particular case to which his question relates, if he were situated at the centre of the earth he would see the moon pass quite clear to the north of Saturn without occulting him at all; but (the horizontal parallax of the moon amounting to some 59′ 6″ at the time of the conjunction) were he to go up north to Greenwich, she would be apparently depressed so considerably as to cover the more distant planet. If "Hesperus" will turn to p. 539 of the "Nautical Almanac," he will find an easy and intelligible description of the table which has puzzled him.

If "T. W. C." (4698) will turn back to p. 323 of your current volume he will find a sketch and description whence he will be able to construct quite as good a spectroscope as it is within the capacity of an ordinary amateur to manufacture. If, however, he will take my advice he will go or write to Mr. John Browning, of 111, Minories, London, who will do infinitely better for him than he can possibly do for himself.

A FELLOW OF THE ROYAL ASTRONOMICAL SOCIETY.

ORIGIN OF METEORITES.

[318] SIR,—"D. W." (letter 315, p. 570) asks a question of enormous difficulty; one on which it is difficult to offer anything more than a mere opinion. Clearly, if Professor Brayley and others have guessed rightly in supposing the earth to have been formed by the aggregation of meteorites, a theory as to the origin of meteorites involves an opinion as to *the origin of the origin of our earth.*

I cannot believe that meteors formed part originally of larger masses, notwithstanding the very remarkable evidence founded on their structure and the occasional presence of organic matter in their substance. My reasons for not so believing are founded purely on dynamical considerations. I can scarcely imagine any circumstances under which a portion of a large mass could ever become free to travel on an independent orbit.

The whole question is, however, immensely difficult, and most of the views hitherto presented are only tenable by aid of a very energetic forgetfulness of a portion of the evidence. RICHARD A. PROCTOR.

COURTEOUS CORRESPONDENTS, MELTING GLUE, BLACKING BRASSWORK, SILVERING CLOCK-DIALS.

[319] SIR,—Allow me to say that the letter of "Sigma" in the ENGLISH MECHANIC for Aug. 26, must express the feelings of many worthy contributors who give their time and special knowledge for the benefit of all who like to ask questions, and many who would be able to give much useful knowledge are often deterred by the way that others treat their endeavours to impart information to them. All who ask questions should remember that an answer, however humble or incomplete, comes from one who wishes to oblige another whom he has never seen, and of whom he expects nothing but a kindly acceptance of the proffered aid. I feel fully assured that many more would answer the numerous questions, which involve a vast amount of useful information to many others of your readers than the questioner thinks, if a kind word were always substituted for a harsh one. And let me call the attention of your readers to the list of Unnoticed Queries; every one should look this over and refer to the queries he may think himself able to answer, and if he can answer any let him do so, and he may be sure that some one will be thankful even if the querist is not. And now to set a good example and be practical as well as theoretical, I will try to answer a few questions. First, 4602, as to properly melting glue. No one can do this except in a proper glue-pot, which is an outer and inner vessel—the outer to contain boiling water, and the inner the glue. To attempt to melt glue in a saucepan or single vessel over the fire is simply useless, and leads to burning the glue; but supposing we have a proper glue pot, I find this to be the most convenient plan of managing. When I have done with the glue I add some of the boiling water from the outer vessel to the glue, so as to make it too thin for use. I then put it away till wanted again, and I find that by the time the water in the outer vessel is boiled, the glue in the inner is ready melted and the proper thickness for use. If the glue is put away without the addition of some water, it dries and becomes hard, and takes some time to dissolve, and this will specially apply to small quantities of glue, which amateurs are most likely to keep for their use, and when used only at long intervals.

And now as to Query 4576. The black brasswork of microscopes, &c., is obtained in the following manner, which I have seen done many times:—Take lamp-black,—say about a thimbleful—and put it on a flat stone or smooth slate; add four or five spots of gold size, and well mix with a pallet knife, or any flat or weak-pointed knife, and if it does not make the whole about as thick as putty add a spot or two more of gold size; well mix. The less gold size there is the better, so that the lamp-black just sticks together; if too much gold size be added, the effect will be a bright black and not a dead black. Now add some turpentine, about twice its own volume, to the whole, in a small vessel, and mix with a camel-hair brush, and apply to the brass-work: it will dry in a few minutes. Put on as little as possible, so as just to cover, and do not attempt a second coat; and if that will not do there is something done wrong; a little practice will soon decide how much turpentine to apply. If there be too much the black is apt to rub off; if not enough, the black will look streaky when dry, and not a dead, that is dull, even black.

4299. SILVERING CLOCK-DIALS.—Take a tablespoonful of cream of tartar (the best), and add about as much nitrate of silver (in crystals) as will lie on a shilling, dissolve in a very small quantity of water, and make it all into a thick paste,—in fact, only just wet the cream of tartar, for if it be too thin with water the dark deposit complained of by "E. H." will appear. No metal of any kind must be brought in contact with it during the mixing. A beautiful effect on the clock-dial greatly depends on the regular emery-clothing of the brass plate. There should be no scratches seen before the plate is silvered, the grain or the marks of the emery cloth should be very regular and all one way; the emery cloth should not be too fine; the paste of cream of tartar and nitrate of silver to be rubbed on with the clean fingers. VULPECULA.

BATTERIES.

[320] SIR,—Thanks to John Legg and "R. M." for the information, and (with your permission) I shall be glad to see in the MECHANIC the sketch John Legg kindly offers.

As a new subscriber, I begin to feel out of my element when I read "Sigma's" answers (pages 501 and 546) to my very first query, but cannot help thinking that the amount of space occupied by his two letters addressed to myself would have completely answered my query (4450), and also furnished information to the numerous new subscribers who must have become readers through the incorporation with the MECHANIC of other journals, and who may perhaps not feel disposed to buy the back numbers.

I find that I do not stand alone in my opinion that "Sigma" might be a little more explicit (316, page 570). He addresses us as if we were *all* philosophers, and, in my opinion, thereby detracts greatly from the value his writings would otherwise possess. I am still of opinion that his description of the sulphate of lead battery (page 482) would be insufficient to guide any one to make one, and as "Sigma" intends ultimately reproducing his papers in the form of a book, I should think he would be only too glad to invite criticism or receive suggestions. However insignificant the queries on this subject may appear to "Sigma," they evidently interest some one, for of what use are all the stores of learning in our scientific libraries to the individual if he cannot find *there* the knowledge he is in quest of?

M.R.C.S (A New Sub.)

IRIS DIAPHRAGM.

[321] SIR,—I am greatly indebted to Mr. Reveley for his reply and sketches, also to you, Mr. Editor, for the engravings in the last number. But I am afraid the diaphragm there described would not meet my wants. I think I have seen one made use of in an American photographic lens, which would be nearer what I want, but I have entirely forgotten its construction, and should feel exceedingly obliged if Mr. Reveley, or any other of our talented friends, could supply me with a drawing or description of an iris diaphragm, which could be applied in front of the object-glass of a telescope and reduce the aperture, *retaining the circular form* or nearly so, from 6 or 7in. to 2in. diameter. Or perhaps some friend could suggest another description of screen or diaphragm, which would accomplish the same object without being unsightly or clumsy? At the same time, however, I should prefer, if possible, a circle expanding or contracting iris diaphragm. UNIT.

WINDOW CLEANING.

[322] SIR,—Amongst the numerous inventions applicable to the saving of labour there has not yet appeared one—which is a real necessity—for sparing the lives of women servants. The article needed is a wooden hand and arm, to hold a cloth and move to clean the outside panes of glass in bedroom windows. In the country women servants constantly do this, and sit on the sill holding by the window frame, with the body outside. Can it be difficult to arrange an instrument to work upwards, downwards, and to the right and left, so as to clean the glass and spare the risk of life and limb by the common act of the neat tidy housemaid? The inventor would find remuneration. Every mistress would rejoice to possess what would do the work and spare her from anxiety. Tidy servants never will take warning or obey if ordered not to sit outside the window. ISLE OF WIGHT.

HEIGHT OF CLOUDS.

[323] SIR,—Referring to the letter of your correspondent, Mr. J. Steel, under the above title, in your columns of August 26, I beg to say that I have no doubt the phenomenon which he has very clearly described was a modification of the Aurora Borealis. In former years I have seen many of these luminous arches, whose appearance exactly tallied with his account, and whose real nature was evident from their progressive changes or their connection with some other simultaneous form of auroral display. The earliest mentioned in my note-book was a very fine white one, very generally observed on September 29, 1828; the most remarkable, a crimson one on February 18, 1837, which I have described as "one of the most wonderful and awful spectacles I ever beheld." A brilliant moon, upwards of thirteen days old, prevented its being more generally noticed, or it might have occasioned wide-spread consternation among those who were ignorant of its true character. In all probability the luminous clouds in the old observations of Magnan and Riccioli may have had a similar origin.

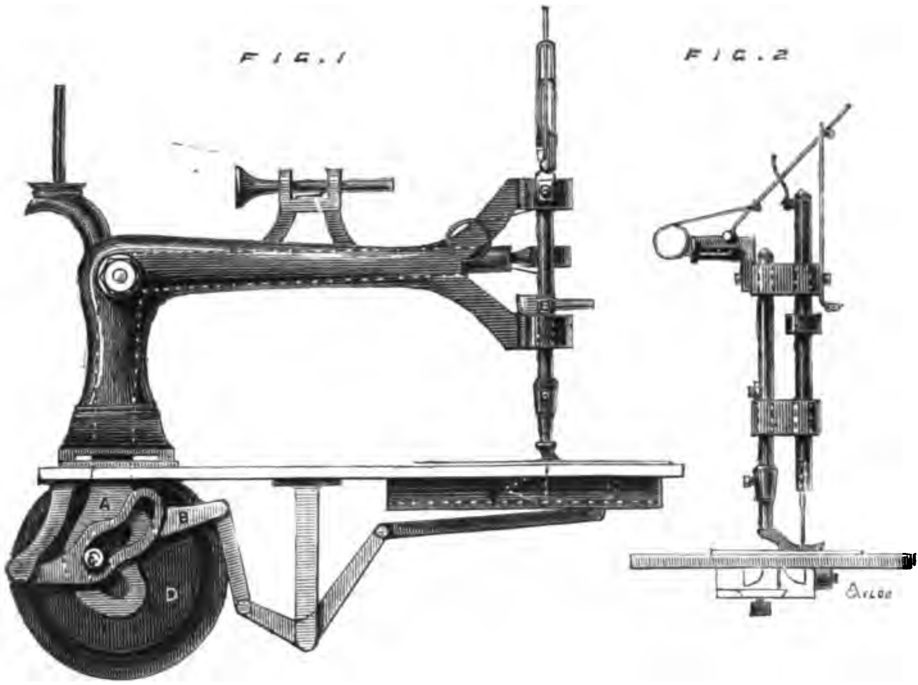
T. W. WEBB.

PROPELLING A VESSEL BY A WINDMILL.

[324] SIR,—In the year 1828 I built a small vessel about 4ft. long, and launched her on the Blackwater in Ireland. She certainly did go *head to wind*, and pretty fast too, and for a considerable distance. After this, I read in the *Courier* newspaper of such a vessel having been successfully constructed in America. But the new power of steam having beaten her, I never heard more of her. I believe that a vessel with two masts would go head to wind, in spite of the friction mentioned by "W." R. J. MORRISON.

THERMOMETERS.

[325] SIR,—I have for some months sent *Scientific Opinion* my observations of a thermometer 2ft. below



SEWING MACHINES.

the earth's surface and its variations. I *fancy* these last have some connection with earthquakes. In July 1870, 1st and 2nd, my thermometer at 8 a.m., marked 57°, on 3rd, 4th and 5th 56°; on the 2nd, there was an earthquake at Santorin. On the 6th July, my thermometer was again 57°. On the 3rd to 6th August my thermometer was 61°; on the 6th there was an earthquake in Greece; on the 7th to 19th it was 60°, since then lower.

My *fancy* is the sun acts as an electro-magnet on the metallic mass in our interior.

THERMOMETER IN AUGUST.

	1870.			1869.	
Aug.	1—2	60°	Aug.	1—4	59°
„	3—6	61°	„	5—12	58°
„	7—19	60°	„	13—17	57°
„	20—21	59°	„	18—20	58°
„	21—26	58°	„	21—24	57°
			„	25—26	58°
„	27—30	57°	„	27—28	59°
			„	29—30	60
„	31	56°	„	31	59°

C. J. B.

IMPROVEMENTS IN SEWING MACHINES.

[326] SIR,—I believe many sewing machines are cast aside as useless from the want of a little care and judgment on the part of the makers. In the first place, if it is necessary for the needle to dwell while the shuttle passes through the loop, it is equally necessary for the shuttle to dwell to allow the needle to take up the thread, and both be released at precisely the same time to procure good sewing.

The above drawing represents a machine made for the shuttle to be always on the move, and never gave satisfaction. To perfect this machine has been the work of my leisure hours. Fig. 1 shows the needle and shuttle cams, and links connecting with the shuttle carrier, both driven by the pin and rollers C; in disc D, on the opposite side, is the stitch cam, and driving pulley; A is the needle lever; B is the shuttle cam. By the above means (Fig. 2) I have obtained the Howe action; and that is, as soon as the shuttle has passed through the loop, it dwells until the needle has about ⅛in. to rise; the shuttle then moves forward. By that means, top and bottom thread are on equal strain, and the sewing is alike on both sides. I think the above sketches and explanation will be sufficient for all amateur sewing machinists to understand.

J. HARPER.

STEAM PRESSURE.

[327] SIR,—In English works and papers on the steam-engine, whether condensing or otherwise, I observe that the writers very seldom when speaking of steam pressures, add, whether such are to be understood as being in *excess of the atmosphere* or starting from *a vacuum*. On the Continent the statement is always at once made comprehensible by qualifying those pressures as above the atmosphere or from zero, *i.e.*, from a vacuum.

Perhaps, however, when by English writers not otherwise expressed, the pressures are *invariably* understood as from a vacuum.

Cologne. A. W. E.

READINGS FROM THE GLOBES.—XI.

[328] SIR,—It is a popular notion that the sun rises in the east and sets in the west, and this is by no means lessened by Dr. Watts's lines, "When from the chambers of the east, his morning race begins," &c., and it is true, in a general sense, that the sun does rise in the chambers of the east, but only on two days of the year does he rise exactly east and set exactly west—namely, March 21 and September 23, when he is crossing the equator. On all other days of the year he rises and sets either to the north of the east and west or to the south. Now, the number of degrees that he rises from the east point is called his rising or ortive amplitude, and the number of degrees that he sets from the west is called his setting or occasive amplitude. The meaning of amplitude is largeness, and this term is applied to the rising and setting sun, because he is apparently larger at this time than at any altitude. Amplitude, then, is measured by a great circle of the horizon, and as the pole of every circle is 90° away from it, its pole is in the zenith, and the degrees are reckoned from the east towards the north or south point. If, for instance, the sun rises 20° to the north of the east, his rising amplitude is said to be 20° to the north. Closely allied to amplitude is azimuth, which term has also reference to the points of the compass, and it differs from amplitude in two things—in being used when the sun is at any altitude, and in being reckoned from the north towards the south, or from the south towards the north. Azimuth is also measured by an arc of a great circle on the horizon, whose pole passes through the zenith. Amplitude is generally employed by nautical men to find the variation of the compass, for we are so accustomed to associate the east with the rising-point, and the west with the setting, that it seems more natural to take his distance therefrom than from the north. Its utility is obvious, for to ascertain the variation of the compass is important in order to determine the correct course, whatever may be the destination. If we wish to ascertain this for any particular place or spot where we may happen to be, we must find by the magnetic needle upon what point of the compass the sun rises, and then compare this with its true place of rising as found by the globe or solar tables, and the difference will be the variation of the compass. Thus, for instance, we find by the globe that on June 21 the sun's rising amplitude is 40° to the north of the east, but by the magnetic needle it would be found to be 20° to the north of the east, consequently the magnetic north must be 20° nearer to the west than the true north, and the variation of the compass must be 20° to the west. Again, as the magnetic north is different in different parts of the earth, of which a fuller account may be seen in Mr. Proctor's papers on page 472, Vol. X., it sometimes becomes necessary to ascertain its variation at other places. Suppose it to be in latitude 32° south and December 22, the sun at this time has just entered Capricorn, and the true setting amplitude by the globe is found to be 35° from the west towards the south. It is required to find the variation of the compass when his setting amplitude as taken by the magnetic needle is exactly south-west, or 45° from the west towards the south. We find by comparing the two that the observed amplitude is nearer to the south than it ought to be, consequently the magnetic needle veers from the north towards the west, and the quantity which it veers is the difference, or 12°, hence the variation of the compass by this observation was found to be 12° to the west. The sun's azimuth, however, is his distance from the north or south point at any time of the day or at any altitude, and since this is measured by an arc of a great circle on the horizon just as amplitude, only from different points, we must make the quadrant of altitude, which represents a great circle, pass from the zenith, the pole of the horizon (see page 372) over the sun's place, and we shall find the azimuth marked on the second circle of the horizon. Thus, suppose we wish to find out by the globe the sun's azimuth at London on May 1 at ten o'clock in the morning, we must elevate for the latitude, screw the quadrant to the zenith, put the sun's place at ten o'clock, and having passed the quadrant over the sun's place, we shall find the azimuth to be 136° from the north. The same is used to find the variation of the compass, and navigators are generally well versed in the methods employed for this purpose. By means of the globe we can find it sufficiently near for practical purposes, but if greater accuracy is required we must make use of what has been termed the astronomical triangle, which we shall have occasion to notice afterwards. It is necessary to observe here that when the sun is in the equinoctial, his azimuth to the inhabitants of the equator is exactly 90°, or due east and west, the whole time he is above the horizon. This may be demonstrated by placing the globe in the position of a right sphere—that is, with the two poles in the horizon; but when his declination exceeds the latitude in the torrid zone his azimuth will be the same twice in the morning and twice in the afternoon; for, let the latitude be [illegible] north and the declination 23½°, the azimuth [illegible] from the north towards the east at 6.15 and [illegible] a.m., and in the afternoon also his azimuth will be [illegible] same. This also is apparent from the globe; elevate for the latitude, make a mark upon the sun's place, and pass it under the quadrant screwed to the zenith, and it will be found that this is the case. Should we wish to verify the azimuth and amplitude by the formula in trigonometry, we must take the complements of the latitude, the altitude, and the declination. These will be the three sides of a spherical triangle, from which the angles may be found (see page 472). In this case the colatitude will be 76° 30', the coaltitude 33° 5', and the codeclination 66° 30', which will give us the azimuth 67°. The globe, when properly arranged will show the triangle as in Fig. 2, where P A is the colatitude made by the brazen meridian, A Q the zenith distance or coaltitude made by the quadrant, P Q the codeclination made by the meridian passing through Cancer, and the angle A, or azimuth, will be measured by an arc of the horizon, H O.

T. S. H.

FIG. 1

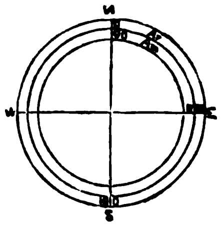
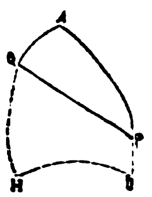


FIG. 2



PICRIC ACID, AURIC CHLORIDE, ETC.

[329] SIR,—Your querist (No. 4604), "S. H. R." cannot detect the presence of picric acid in beer, as to do so requires the possession of some manipulative skill in qualitative analysis. It is a pale yellow acid obtained from carbolic acid, and its solution is of a persistent pale yellow colour and intensely bitter taste.

I am afraid Mr. H. Vincent (query No. 4579, page 550) will not be able to obtain a very satisfactory reply to his query. From the experiments of Drs. Angus Smith, Taylor and Riessi, it would appear that air contaminated by being breathed to such an extent as to contain 4 per cent. of carbonic acid, would prove instantly fatal, and 8 per cent. ultimately fatal. On the other hand 4 to 5 per cent. of pure carbonic acid produced no apparent effect.

Taking everything into consideration, if after an explosion of fire-damp the percentage of carbonic acid should be as high as from 12 to 14 per cent., it would produce almost instant death, while a percentage of from 7 to 9 per cent. would cause insensibility and afterwards death.

"Young Photo's" queries (Nos. 4621 and 4623) admit, however, of a definite answer to each, though he does not expressly state the condition of his gold. Still I conclude it contains copper, and possibly silver, which must be separated by one of the following methods:—

Dissolve the gold in boiling aqua regia, made by mixing two parts of nitric acid with ten of water and three parts of hydrochloric acid. Then neutralize the solution with ammonia, and add excess of sulphide of ammonium. Filter and precipitate the gold with hydrochloric acid.

Dissolve the gold in aqua regia, neutralize with potassa, and precipitate, with a dilute solution of protosulphate of iron, the gold. This precipitate must be collected and washed well with acetic acid and then water.

Or, after dissolving in aqua regia, evaporate down to near dryness, and re-dissolve in water, finally precipitating the gold with excess of ammonic carbonate, which must be collected and washed well with, first a dilute solution of ammonic carbonate, and then water.

The product obtained by the method which may be adopted, must be dissolved in a mixture of one part of nitric acid, three parts of hydrochloric acid, and five parts of water, and the whole evaporated to dryness in a water-bath. (This may be easily constructed by suspending a test-tube in a beaker full of water, kept boiling.) It is then to be re-dissolved in water, and again evaporated down, and re-crystallised.

To convert the silver in his cyanide bath into the nitrate (No. 4623), let him add excess of hydrochloric acid to it, and boil for a short time; filter, and wash the precipitate well. Boil this precipitate, with a strong solution of pure potassa, until it is entirely converted into a dense black powder, which is to be thoroughly well washed. Dissolve this in pure nitric acid (dilute) and after crystallizing, re-crystallize. This method will yield him quite pure nitrate of silver.

Seeing that fluorine is a normal constituent of the bones, teeth, and some juices of animals, it is of necessity included in the list at Kensington, that "E. L. G." (4625) refers to. It is also an essential, though minute, constituent of most soils, and is also contained in many manures, as "superphosphates," &c. It is likewise essential to the silicious coatings of the calcareous and siliceous-calcareous plants. Urban.

ON THE LINK MOTION AND SLIDE VALVE.

[330] Sir,—In query 4460, August 5th, Mr. Thomas Watson says he encountered several difficulties in reading a letter of mine on the "Slide Valve," in a late number of the English Mechanic, and he says he wants an accurate description of the slide valve itself, with a definition of the words, "lap," "lead," and "travel."

I find that in order to give Mr. Watson all the information he asks for, and to enable him to understand the drawing of the link motion which I append, it will be necessary to begin at the very beginning of the matter; and in order to do so I will take as a familiar subject for illustration and description the link motion and slide valve of an ordinary passenger locomotive engine, as in actual use, and show how and upon what considerations the proportions of the parts are arrived at.

The cylinders of such an engine are 15in. diameter and 20in. stroke, and its area is 176¾, say 177 square inches, and from this area we derive all the dimensions of the ports and valve in the following manner.

The area of the steam port is made equal to one-twelfth of the area of the cylinder or 14¾, say 15 square inches, and the length of the port is equal to three-quarters the diameter of the cylinder or 12in.; the breadth of the port is the quotient produced by dividing its area (15) by its length (12) = 1¼in. The exhaust port is the same length as the steam port, but is double the breadth, = 2½in. The breadth of the bar between the ports is equal to the breadth of the steam ports, 1¼in. It is sometimes made narrower, *but it is bad practice to do so.*

Fig. 1 is an elevation of the ports and valve. A A are called the *admission edges*, and E E the *exhaust edges* of the steam ports.

FIG. 1

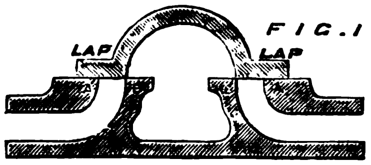


FIG. 2

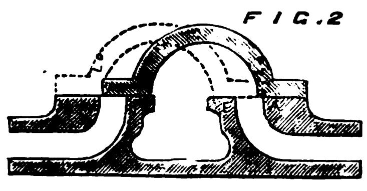
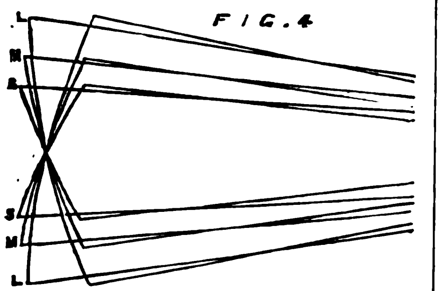
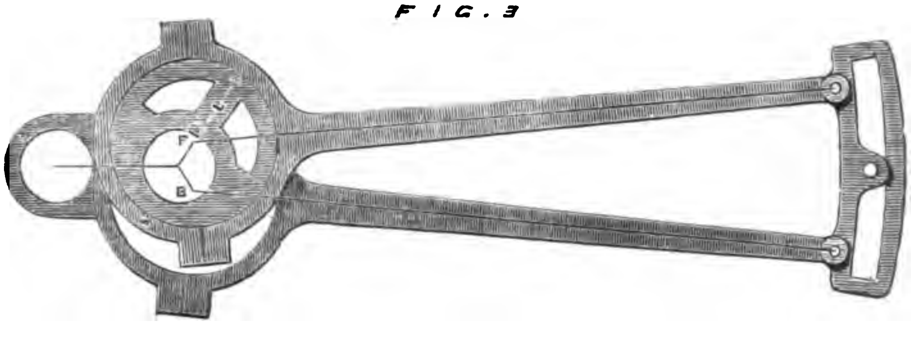


FIG. 4



The slide valve may be described as a shallow rectangular box in plan, with a flange all round its open mouth. The breadth of this flange on two of the opposite sides called the "ends" of the valve, is of no consequence at all, as it does not in any way affect the performance of the valve, and merely does duty as a bearing surface to prevent the steam from escaping under the valve, and in valves such as I am describing this flange is about 1¼in. wide; but the breadth of the flange on the other two sides, called the "faces," is of the greatest importance, as it is that which governs the admission of the steam to the cylinder and determines the throw of the excentrics and their position on the shaft. It has a certain amount of influence also in determining the lengths of the link and excentric rods, but its influence on these is not absolute, but subordinate to considerations of space in the engine, and the judgment and experience of the designer.

FIG. 3



The "travel" of the valve is the length of its excursion to and fro, and it is not necessarily equal to the "throw" of the excentric, for in valves moved by the link motion their "travel" is variable and under the control of the engine-driver, who can at any moment alter its amount, whilst the throw of the excentric is of course constant. The proper amount of the travel of the valve is 3½ times the breadth of the steam port. In the present case it is 1¼in. × 3½in. = 4⅜in. the travel of the valve, and that is the greatest travel the gearing should give it. In stationary engines, when the valve is moved by one excentric, whose rod is connected direct to the valve spindle, the throw of the excentric and the travel of the valve are equal; but if a "rocking shaft" and "levers" are introduced between the excentric and the valve, then the travel of the latter may be either equal to greater or less than the throw of the former, according as the lengths of the levers are proportioned.

The "lap" of the valve is the amount which its "faces" project or "lap" beyond the "admission edges," A A, of the steam ports, when it is laid evenly over them, as in Fig. 1. *The amount of the lap is equal to one-fifth of its travel*, and in the present case it is ⅞in., which is one-fifth of 4⅜in.

The "lead" of the valve is the amount of opening which is given to the port for the admission of steam to the cylinder when the crank is on the "dead centre" (see Fig. 2), in which the dark lines show the position of the valve when the crank is on the outer dead centre pointing from the cylinder, and the dotted lines show its position when the crank is on the inner dead centre pointing towards the cylinder (the crank is supposed to be at the left-hand side of the figure). The lead in both positions is shown at L° and L′, and *its amount is equal to one-fifth of the lap*, or nearly 3-16in.

A valve of the above proportions—viz., 4⅜in. of "travel," ⅞in. of "lap," and 3-16in. of lead, *or lap one-fifth of travel, and lead one-fifth of lap*—whether driven by the link motion or by a single excentric, will cut off the steam from the cylinder when the piston has made 80 per cent. of its stroke, and will allow it to exhaust at 94 per cent., and this holds universally true, no matter what the *actual dimensions* are, so long as the above proportions are maintained.

I believe I have now answered all Mr. Watson's questions with regard to the slide valve and ports, so I shall pass on to the consideration of the "link" and excentrics.

There are several different varieties or patterns of link in use, but I do not intend in this letter to enter into a general description of them, or a discussion of their several merits and demerits, farther than what is necessary to giving a full description of the engine I have taken in hand. In this engine the link used is the pattern shown in Fig. 3, which is an elevation of the link motion complete. The most important dimension about the link is its length, which is measured from centre to centre of the pins which connect the excentric rods to it, and there is no "rule absolute" for even this. The length of the link *per se*, is a vague, unmeaning dimension, and cannot have any definite, positive, or specific meaning attached to it, except when taken in connection with the length of the excentric rods, for any given link may be said to be too long or too short, and may possess all the bad features of these two opposite conditions, according to the length of rods to which it is connected; but when its length is made equal to three times the throw of the excentric, and the excentric rods are from twelve to fourteen times the throw, a very well proportioned link motion is the result; and in the motion I am describing, Fig. 3, the length of the excentric rods is twelve times the throw, or 4ft. 4½in., and the length of the link is three times the same, or 13⅛in.

The crank shaft is 6in. diameter where the excentrics are fixed, and the excentrics are 13⅜ in. diameter, and their throw is 4⅜in. (the throw of any excentric is equal to the excess of its largest side over its smallest side, measuring from the surface of the shaft to the circumference of the excentric). In the present case the large side L is 5⅞in., and the small side S is 1½in., the difference, 4⅜ in., being the "throw" or the amount of motion it imparts to its rod and the end of the link. The "excentricity" of the excentric is the distance which its centre is from the centre of the shaft, and it is of course equal to half the throw. The nature of the "lineal advance" of the excentric was explained in my last letter, and I need not go over the same ground again so soon; its amount in the present case is 1 1-16in., equal to the "lap" of the valve added to the "lead" which it has *when in "full throw."*

As to the movement of the link itself, it is a curious compound, made up of the motions received direct from the excentrics, which is a definite amount, and of a certain quantity, caused by the crossing of the rods, which is indefinite, and depending upon their length: in the present case it happens to be ⅝in., or 5-16in. on each side of the "mean distance point" (see my last letter). The motions of the two ends of the link are *not* opposite (as insisted on with incredible perversity and unaccountable stupidity by a late writer in your columns), for during a considerable portion of each revolution of the crank the two excentrics and the two ends of the link move in the *same direction*, and in the present case this unanimity of motion, so to speak, continues during 65°, or more than one-third of each half revolution, and the exact amount of motion of this link is 4⅜in. at the ends, and 2⅞in. at the middle; ⅝in. out of this 2⅞in. is due to the crossing of the rods, and the remaining 2¼in. are due to the lineal advance of the excentrics.

The "lead" of the valve when in full throw—receiving its motion from the *end* of the link—is 3-16in., and when in the "middle gear," receiving its motion from the *centre* of the link, the lead is ½in.

When the link is made much shorter than three times the "throw," the angles it assumes in working are so great, and its deviation from the perpendicular when in its extreme positions so considerable, that a great amount of "slippage" takes place between it and the "valve spindle block" or "link block," and a very irregular and imperfect motion is transmitted to the valve, for the motion of the valve is derived from that part of the link with which the block is in contact for the time being, and if the block—owing to slippage—comes into contact with different parts of the link during the stroke, the motion of the valve cannot be otherwise than irregular, being compounded of the motions due to different parts of the link.

On the other hand, when the link is made much longer than the above proportion, although the angles it assumes are less and its movements easier and more graceful, yet an evil which is not very conspicuous with the short link becomes greatly aggravated, and that is the derangement of the "lead" of the valve occasioned by the crossing of the excentric rods, which increases rapidly as the length of the link increases; but as that subject was treated at length in my last letter I shall not introduce it here, but shall refer Mr. Watson to that letter for all information on that part of the subject. Fig. 4 shows the angles and attitudes assumed by the short, the medium, and the long links, when in their extreme positions. The excentric rods are twelve times the throw of the excentric, which is 4⅜ in.; the short link S S is two throws long, or 8¾in.; the medium link M M is three throws long, or 13⅛in.; and the long link L L is four throws long, or 17½in.

It is at once evident that the long link is much better calculated for giving motion to an object which is constrained to move in a straight line (as the valve spindle head is) than either of the others, because it is more nearly at right angles to the direction of motion of that object, and because the arc described by its end in working being a portion of a larger circle, with an equal chord, the versed sine—which represents the slippage—is less, and therefore the long link would be the best link were it not for the great derangement of the "lead" occasioned by it. However, if the motion is not required to cut off the steam earlier than about five-eighths of the stroke, which is mostly the case with screw-boat engines and goods locomotives, the derangement of the lead is not much felt, as in cutting off at five-eighth stroke the "link block" is not near the middle of the link where the derangement is at a maximum, diminishing thence to the end where it vanishes. It might, therefore, be assumed that the long link is the best, as it has other advantages besides those mentioned, for it is easier to reverse the engine with it, as it does so more gradually and has less friction than the short link, and it also offers—owing to its greater length—increased facility for a more minute and accurate subdivision of the grades of expansion.

We are now in a position to go to work in designing a link motion for Mr. Watson's "road-steamer," and, what is better, to understand the principles which govern that operation. The cylinder is 3 3-16in. diameter, but to avoid ugly fractions let us call it 3¼in., and the corresponding area is 8·29 square inches, one-twelfth of which is ·69 square inch, = the area of the steam port. The length of the port is three-fourths of the cylinder's diameter, or 2·43in, and its area divided by its length gives ·28in. for its breadth, and for that of the bar between the ports also. The exhaust port is double the breadth of the steam port, or ·56in. The exhaust edges, E E, of the steam ports are 1·12in. apart, and that is also the breadth of the cavity of the slide valve, and the length of the cavity is the same as the ports, 2·43in. The "admission" edges, A A, of the steam ports are 1·68in. apart. The travel of the valve is equal to 3½ times the breadth of the steam port, or ·980, and its "lap" is one-fifth of that, or ·196in., and when the valve is laid evenly over the ports its "faces" project ·196in. beyond them, so that the total breadth of the valve is 2·072in., say 2 1-16in. The lead of the valve is one-fifth of the lap, or ·039 = about 1-32in. full throw.

Fig. 3 will answer as an elevation of the link motion also, the throw of the excentrics is equal to the greatest travel of the valve, or ·98in.; their centres, F and B, are, therefore, ·49in. from the centre of the shaft whose diameter I have taken at 1¼in., the small side S of the excentrics I have made ½in. wide, and that added to the throw gives 1·48in. for the width of the large sides L, hence the diameter of the excentrics is 3·23in., and their thickness may be made 1in. I suppose I need not tell Mr. Watson that the mere diameter of the excentric has nothing whatever to do with its throw or excentricity, as the diameter may be increased or reduced without making any alteration in its throw, and the size I have prescribed for it is merely what I should myself consider suitable for his engine.

The "lineal advance" of the excentrics is equal to the sum of the "lap and lead," or ·235in.; this link is the same pattern as that in Fig. 3, and its length from pin to pin of excentric rods is equal to three throws, or 2·94in., say 3in. even; the length of the excentric rods is twelve throws, or 11¾in. nearly; the motion at the ends of this link is ·98in., and at its middle it is ·562in. or 9-16in.; the lead of the valve when in full throw is ·039in., and when in middle gear it is ·085in.

If I have not been sufficiently explicit in the foregoing description to enable Mr. Watson to construct a link motion for his "road-steamer" I shall have much pleasure in answering any further questions he may ask.

James Baskerville,
Manager, City Foundry, Limerick.

UNNOTICED QUERIES, Etc.

[831] Sir,—Having looked over the list of Unnoticed Queries I came across some I had not noticed, I therefore send you answers to them.

Magnetic Queries (4232, F. Peel).—The total intensity of a magnet is that force which brings a needle to a position of equilibrium when disturbed. The total intensity is capable of being resolved into the horizontal and vertical intensity. The vertical intensity tends to make the needle dip under the influence of the terrestrial magnetism, and when one end of the needle is loaded, the vertical intensity of the north and south end counteract each other. The horizontal intensity tends to make the needle recover its position when displaced from equilibrium under the influence of the earth. The resultant of these two forces is the total intensity, from a knowledge of which the other values can easily be trigonometrically determined. Secular variation is that disturbance which is gradually taking place, and which takes centuries to complete; thus, before 1663, the variation at London was to the east; at that year and a few years before it stood at the geographical meridian 0°, from then it gradually went west till 1818, when it stood at 24° 41′; from then it began steadily to return, and is now about 20° W. As regards the magnetic curves, F. Peel can imagine those which occupy the field of a bar-magnet, making allowance for a spherical field, instead of a flat one, as is the case in most illustrations; he can also compare them with Sabine's chart of isoclinic lines.

Associate in Arts Degree (4269).—Every candidate is required to satisfy the examiners in:—1, English Grammar, including Analysis; 2, English Composition; 3, Arithmetic; 4, Geography; 5, English History. Questions are set in Faith and Religion; one portion of this section is, however, optional, if any objection is raised on conscientious grounds. The optional subjects are divided into four sections, of which the candidate will be required to satisfy the examiner in two. A, English History, Literature, Economy, and Law, with Physical, Political, and Commercial Geography. No candidate will pass if he does not show a fair knowledge of one division. B, Latin, Greek, French, or German, at the option of the candidate; C, Mathematics, Geometry, Mechanics, and Hydrostatics; D, 1, Electricity, Magnetism, Light, and Heat; 2, Chemistry, including practical analysis; 3, Animal and Vegetable Physiology; 4, Geology and Mineralogy. No one passes who does not show a fair knowledge of one of these divisions. Candidates can also be examined in Drawing and Music. No one is admitted over eighteen years of age.

Chemical (4270).—Carbonate of soda mixed with finely divided charcoal may be distilled in an iron retort, the neck of which dips under paraffine. Caustic potash may be neutralized with tartaric acid, and the dry salt projected into a red-hot crucible; the black mass is mixed with a small quantity of charcoal, and treated as above in the case of sodium. In the case of sodium, Deville recommends the following mixture:—Dry carbonate of soda, 717 parts; charcoal, 175 parts; chalk, 108 parts; to be intimately mixed and calcined before placing into the retort. Magnesium may be procured by dissolving the caustic magnesia in hydrochloric acid, and adding 6 parts of salt to every 4 of magnesia used; evaporate to dryness and heat in an iron crucible with metallic sodium.

Testing Gold (4275.)—Dissolve in aqua regia. If the solution has a blue or green colour, copper is present; if there is a white residue upon adding water it is alloyed with silver; if there is a precipitate with a blue or green coloration, copper and silver are present together with the gold.

Alabaster Glass (4284).—I am afraid "J." would not be satisfied with his results if I were to give him a method of glass analysis. I will do so if he particularly wishes it; but I should advise him, if he wishes for correct results, to place the specimens at once into the hands of a professional analyst.

Effects of Carbonic Acid (4599).—When carbonic acid is inhaled it produces spasms of the glottis, which prevents the poison from entering the lungs. A candle will not burn in a mixture of four volumes of air to one of this gas, and the proportion that will not support combustion will not support life. A candle may burn in a mixture of carbonic acid and air, and yet not support life. Six volumes of air to one of acid would quickly act as a narcotic poison, for if sufficiently diluted it passes the glottis and enters the lungs.

Picric Acid (4604).—Picric acid, also called carbarotic and nitrophenisic acid as well as trinitrophenol, being in reality a substitution alcohol, is phenol (carbolic acid) in which three hydrogen atoms have been replaced by nitroxyl; the formula is $C_6H_3(NO_2)_3O$. It may be prepared by acting upon carbolic acid with fuming nitric acid and afterwards purifying the product. If present with colouring matter, this latter must be precipitated with sub-acetate of lead and the acid taken up with ether. Its solutions are intensely yellow. Its lead salt is soluble in water and explodes on heating. The potassium salt is sparingly soluble in water and behaves as the above. Picrate of ammonia deflagrates only when heated, and solutions of the acid possess a high yellow colour and an intensely bitter taste.

Fluorine (4625).—If "E. L. G." will turn to the analysis of bones in Simon's "Medical Chemistry," he will find every analysis is marked by the presence of fluorine, and if found in *every* sample surely it ought to be regarded as a normal constituent. Small quantities, even traces, ought not to be despised; nuclei, which cannot be discerned by the naked eye, determine the crystallization of supersaturated solutions.

Chloride of Gold (4621).—If the gold is only alloyed with silver, place in a flask, cover with aqua regia, and digest at a moderate temperature on a water bath; when dissolved, filter and evaporate to dryness (well washing the filter) on a water bath. If the gold is alloyed with copper, dissolve in aqua regia, neutralize with carbonate of soda, and add ferrous sulphate solution. The gold is precipitated as a fine powder, which must be collected and re-dissolved in aqua regia and evaporated to dryness on a water bath.

Nitrate of Silver (4622). — Take the plating solution, evaporate to dryness, mix with carbonate of soda to moderate the action, and heat in a clay crucible, gradually increasing the heat until the silver is completely reduced. Take the silver and dissolve in nitric acid, evaporate to dryness, re-dissolve in water and crystallize.

South Kensington Examination Papers (4640).—I shall be most happy to supply your triple subscriber, "J. B. H.," with a set of the above papers if he will write to me through you. They are not yet to be obtained through the publisher.

George E. Davis.

EQUIVALENTS, PAINTING CISTERN, Etc.

[832] Sir,—I have not long been a subscriber to this journal, but, by the kindness of an old subscriber, I have for some time been a reader, and desire to say that as such I have derived much useful information and considerable pleasure, in return for which, it is my intention to give answers to such questions as I am able. It will also be my pleasure, if requisite, to ask questions of other correspondents. (One I have already asked, 4483, p. 502, to which I hope, if not a complete answer, a partial one will be sent.) I will now endeavour to answer a few queries.

(4537.)—Equivalents.—The question of "MaO Co_2" seems rather out of place. As no doubt you have in some previous number given a full list of elements with their equivalents it would therefore be a folly to reinsert the list. I shall recommend "MaO Co_2" to get "The New and Old Notation of Chemistry," by S. W. Rich, price 1s., which is a list of elements, and the more important compounds, 217 in all, with their symbols, and equivalents according to both the old and new notation, or any new book on chemistry.

(4560.)—Painting Cistern.—"Cistern" has not stated whether the paint shelled off alone, or whether it was forced off by a scale of the oxide of the iron, which I suspect to be the case. If so, "Cistern" may paint again with safety, it will not shell off. I am engaged where most of the work done is ironwork, all of which has to be painted. Experience has taught that it is necessary to let the surface of the iron oxidize first, scrape off the scale of oxide and then paint. The paint will not again shell off. If the water in the cistern is for drinking, it would be much better not to paint at all, it being dangerous to have paints which contain lead in communication with drinking-water.

(4519.)—Tender Feet.—I would advise J. T. Hill to bathe his feet frequently in strong salt and water if sea water is not available.

(4492.)—Raising Water.—If time permits I will make a sketch and answer this next week. Psi.

BOILER POWER.

[833] Sir,—I beg to submit the following in reply to query No. 4550, August 19.

Boiler Power.—Boilers of this class usually evaporate about 2·7lb. of water per hour per effective square foot of heating surface; the *grate* surface being in the proportion of 1 : 22 of the effective heating surface of boiler; and the fuel consumption (coal of good quality) at the rate of 9lb. to 9½lb. per square foot of grate surface.

The boiler in question presents a *total* heating surface of about 758 square feet; of which, however, about 88 per cent., or say, 666ft. is *effective*.

On the foregoing assumptions, the boiler will evaporate 666 × 2·7 = 1798·2lb. of water [illegible] *per hour*, and supply, therefore, 324·9 cubic feet of *steam* of 40lb. *absolute* pressure per square inch per *minute*.

The boiler *power* will, therefore, best be determined by exemplifying what this amount of steam [illegible] capable of doing. Assuming then a condensing engine of $26\frac{28}{32}$in. diameter of piston; the latter moving at 300 lineal feet per minute, we shall have a ratio of expansion of 1 : 4, and an average pressure (after deducting one-tenth of steam volume for loss in passages, &c., and 3lb. per square inch for imperfect vacuum) of 20·862lb. per square inch of piston area, and—

$$\frac{(26\frac{28^2}{32} \times 0{\cdot}7854) \times 20{\cdot}862 \times 300}{33000} = 107{\cdot}5$$

indicated *horse-power*. The proportion of *useful effect* to indicated thus arrived at is usually assumed at 0·5 for this size of engine, so that the *effective* power of the boiler thus developed, would be 107·5 × 0·5 = 53·75 horses. (Some large boiler manufacturing firms of my acquaintance would call this a 60-horse boiler.)

This (53·75 h.p.) gives per *effective* horse power per hour, 12·4 square feet of effective heating surface, 5·15lb. of coal, and 33·4lb. of steam—results which if actually attained in this case, might be considered sufficiently satisfactory. It is, doubtless, possible to get more work out of this boiler by *harder firing*, and indeed, instances are reported, where, with Lancashire boilers of nearly same dimensions, as much *as 5·75lb.* of water have been evaporated per *square foot of effective* heating surface per hour—burning, however, nearly 22lb. of coal per square foot of (same proportioned) grate surface. Such results are not attainable in regular practical boiler working, and cannot, therefore, be estimated upon if economy and durability are objects sought after. Indeed, the figure of 5·7lb. is *twice* that of instances of practice in Cornwall; there, however, balanced by a greater percentage of "duty" in the engine proper.

It would, doubtless, be a great boon—and I trust these few imperfect remarks will lead to its realisation—if various correspondents having the opportunity of experimenting upon the evaporative capacities of steam boilers of various types, or already, perhaps, in possession of summaries of results—would carry out and kindly publish them for the benefit *of all, and especially* of those less favoured, in "our" *journal*, along with such "notes" of peculiarities of construction, &c. as would enable a fair comparison with each other being made. There is especially wanted a more complete and wide-spread knowledge of the evaporative capacities of a class of boilers now much in demand—viz., *semi-portables* of the *vertical* and *horizontal* type, consisting of:—1. The vertical and horizontal fire-tube (multitubular) boilers; 2. The vertical cross water tube boilers; and 3. The *vertical* "Field" tube boilers, all with *internal* fire-box and grate, and employed now, especially those of the latter class in powers up to 80 horses. For fair *comparison*, however, with the older and simpler type of boiler—the cylindrical with hemispherical ends, evaporating about 6½lb. of water per 1lb. of coal—as the most simple form to start from, the use of the blast nozzle should be discarded, and the usual means of securing the requisite draught—the chimney—alone employed. For the same reason cold feed should be used, or if used hot, it should be duly accounted for.

On the continent it is usual to allow for semi-portable "Field" boilers with *normal* draught by a chimney about 20ft. high, 14½ square feet of heating surface, and 0·55 square feet of grate surface per *effective* horse power; and if this type of boiler, as repeatedly asserted, is capable of evaporating 6lb. of *water per foot of heating surfaces per hour*, without intensifying the draught beyond that naturally attainable by 20ft. of chimney; the quantity of steam thus raised, and that, too, at a pressure of 5 to 6 atmospheres from *zero* should give out in a good *non*-condensing engine even a very much larger increment of power than *one* horse. It is evident, therefore, that more information is wanted, and I doubt not but that your esteemed correspondent Mr. Olrick will be both able and willing to supply it; at all events, in respect to "Field" boilers—the more so as not only have the results at Oxford been (seemingly) unfavourable as regards this type of boiler, but because there is also not wanting men, both engineers and others, who utterly deprecate their employment. Then, again, as to *vertical* fire-tube (multitubular) boilers there is a *great* discrepancy in regard to their stated efficiency. Some English makers assume as little as 11½ and others as much as 18½ square feet of *total* heating surface per *effective* horse power—in the one case claiming the vertical surfaces of tubes *above the water line* equally with those below; and in the other, putting the upper surfaces out of the question, as of no *evaporative* power whatever. For this class of boiler it is usual on the Continent to allow 17½ square feet of *total* heating surface per horse power (effective) with steam at a pressure of 6 and 7 atmospheres from *zero*.

I think, sir—and this must be my excuse for occupying so much of your valuable space—that you will agree with me that there is wanting some *practical* data upon the evaporative capacities of surfaces, as applied in the various forms of boilers now principally in use; and I doubt not but that many others would, equally with myself, be much benefited by such data being supplied through the medium of your estimable journal. E. W. A., Cologne.

PHOTOGRAPHS.

[334] Sir,—"T. A." [271], asks Mr. Proctor to explain what he calls "two curious photographic phenomena." As the gentleman referred to may not happen to be a practical photographer I write hoping to prevent him from seeking a solution of the problems by assuring him that the first of the "phenomena" only exists in imagination, and the second, if real, only shows that his chemicals decrease rapidly in sensitiveness.

"J. W." [282], speaks of a method of accelerating exposure by allowing red light to fall on the plate. Many plans of producing a partial fog and calling it softness have been proposed, and some of them even patented. Among others that of lining the camera with white, and of exposing the plate to a weak light, but they have only served as sources of amusement and wonder.

"Young Photo" (4621, 4622), had better precipitate his silver with hydrochloric acid, and sell it to a refiner, who will give him nitrate of silver, if he desires, in exchange for it. If he attempt to evaporate and fuse it he *might* blow up the neighbourhood, as fulminating silver may easily be formed in electroplating solutions. He may dissolve his gold in aquaregia (nitric acid, 1 part; hydrochloric acid, 3 parts), and evaporate to dryness on a sand-bath under a chimney, but he will do better to sell his gold and buy the chloride; nitrate of silver and chloride of gold, the former especially, being sold for the merest fraction over the intrinsic value of the metal contained.

"Amicus," (4616) should get Newth's "Natural Philosophy." W. E. D.

THE SATELLITES OF URANUS.

[335] Sir,—Allow me to express my thanks to Mr. Proctor—[257] page 540—for so promptly taking up this question. I very much regret that I am not now able to quote the exact words of Mr. Lassell, my extracts from the "Monthly Notices" being only the substance of them. I have notes to the effect that in 1851-2 the positions were as stated on p. 522 of the English Mechanic; the apparent ellipse of the orbits being as 8 to 6 (Vol. XII.).

In the papers by Mr. Dawes containing a discussion of Lassell's and O. Struve's observations (Vol. VIII.) the major axis of the orbits was assumed to be Pos. 10° and 190° in Nov., 1847.

I now see that Humboldt refers to "Astr. Nachr." No. 493, for Mädler's account of the ellipticity of the planet.

It would be too much to expect Mr. Proctor to examine these papers for one inquirer only, but if he were induced to do so from his own interest I am not certain that he would not be repaid. I am more certain that he would be helping an Etudiant.

FOCUS.

[336] Sir,—When the rays of light which pass through a double convex lens are converged to a point, or what is generally called the focus (see F, in diagram 1), how can it be said that a picture is produced in that focus, inverted or upside down, seeing that the rays which are so converged do not intersect or cross each other, but merely meet or centre in one spot? Practically I find, however, in order to obtain a clear and distinct picture, it is necessary that the lens or screen, it matters not which, should be shifted so as to increase the distance between the two, as in diagram 1, where C, B, A are the rays received on the screen, some distance beyond the focus F; it can be seen at once, therefore, that these lines having crossed each other, that then, and not until then, does the picture become inverted. How can it be said, with respect to the eye and vision, that to see distinctly, or that a distinct picture should fall on the retina, the focus should centre on it, as in diagram No. 2, B? I maintain that it would be indistinct, and not inverted; what is meant, therefore, by the focus falling on the retina, and how can it be reconciled with long and short sight? Again, if a screen with a small hole permit the rays of light reflected from some distant object, such as a cross A in diagram 3, to pass through it, it will be perceived that the lines intersect each other at the opening B, crossing each other and passing on to C. I ask where is the focus? Is it at this opening, or where the picture falls on the screen D? Perhaps some of your kind readers will help me, with, at the same time, that indulgence for my ignorance, which is so necessary in answering the inquiries of others. E. O. S.

FIG. 1

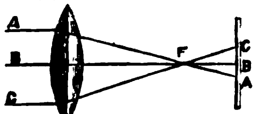


FIG. 2

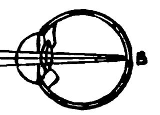
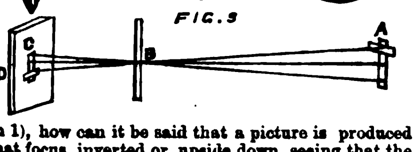


FIG. 3



TOBACCO AND SNUFF AS PREVENTIVES OF CONSUMPTION.

[337] Sir,—At the recent meeting of the British Medical Association at Newcastle, a paper was presented by Dr. John Murray, on the above subject, to which I wish to call the attention of "our" readers. Dr. Richardson, some years ago, in a lecture on the effects of tobacco-smoking, pointed out that the greater number of the patients in our hospitals for diseases of the chest were non-smokers, and he accounted for this fact, if I remember rightly, by saying that the bronchial membranes of smokers were covered by a coating of mucus, which, he argued, protected those delicate tissues from the effects of our damp atmosphere. Whether this be true or not, Dr. Murray has now come forward as an exponent of the advantages of snuff-taking as a preventive of catarrh; and, by a process of inductive reasoning, he arrives at a conclusion that smoking and snuff-taking are preservatives against, if not cures of, bronchitis and phthisis. He states that an habitual smoker seldom or never dies of consumption, and he further declares that he has seen the progress of consumption arrested by practising the habit of snuff-taking. The reasons given by Dr. Murray for this emphatic expression of opinion are as follows:—"By titillating the lining membrane of the nostrils, snuff acts as a powerful derivative and counter-irritant, and its use will tend to preserve the more important and susceptible pulmonary mucous membrane from evil. The sneezing which succeeds the unaccustomed application of the errhine, or agitates even an old and seasoned nose when a new titillant is tried, and the cough which is induced when, by chance, some of the lighter particles get into the throat, may be of some avail in effecting the elimination of albumenoid matter (the precursor of tubercle) from the lungs—ere it has had time to fill the air-cells and minute bronchi, and coagulate—in like manner as sea-sickness is believed to do. The majority of medical men, when recovering from a common cold, will take a pinch, in order 'to speed the going guest.' If good to expedite the departure of a cold, I have no hesitation in affirming that it will be better still as an expedient in altogether preventing the catarrh."

It is believed, that in tobacco and snuff manufactories, the workmen do not suffer from any disease which tobacco can be said to occasion, but, on the contrary, the employés seem to have an immunity from typhus fever, consumption, and cholera. The majority of the State physicians of France agree in believing that employment amongst tobacco is instrumental in preventing consumption, and may even restore consumptives to health. As regards the effects of tobacco-smoking there is still much that requires elucidation. Does the empyreumatic oil or the nicotine affect, in any way, the health of the smokers? Tobacco is supposed to be repulsive to the uninitiated system because sickness and nausea invariably follow the "first pipe;" but then again so is the motion of a vessel at sea, which generally brings on vomiting. In the one case something may be said to be imbibed (or infumed) into the system; in the other there is nothing of the kind, unless we are to suppose that the fresh air is the cause of the sickness. Who, therefore, shall say that tobacco must be injurious because the system repels it at first? Many persons cannot partake of some species of shell-fish without nausea and sickness supervening, and instances are on record where such a simple repast as roast mutton invariably caused "alarming symptoms." But surely no one can say that either mutton or shell-fish is, *per se*, repulsive to the human stomach? One fact is generally overlooked by the opponents of tobacco in relying too confidently on the supposed antagonism of the system to smoking, as exhibited after the first pipe, viz., that novices do not understand the method of smoking, and so probably pump the smoke into their stomachs. Of course, no habitual smoker ever does that.

It is acknowledged by all smokers that tobacco-smoking acts upon them as a sedative, and enables them to perform heavy mental labour without that nervous prostration which otherwise is its invariable concomitant. Many of our great mathematicians and literary men are, or were, great smokers; and I know but few hard-working members of the press who are not habitual smokers. Sir Isaac Newton, Charles Dickens, and Mark Lemon were all great smokers, whilst Professor Masson, Mr. *Punch*, *Fun*, and others too numerous to mention, are all well-known patrons of the "weed." It is said by some anti-tobacco men, that smoking is an insidious poison, weakening the brain and destroying the stomach of its devotees. I ask for proofs. Take the great Teutonic nation, notorious for its inveterate habit of smoking. Are Germans weak, either in brain or body? Do they invariably die young? Or, rather, are they not a nation of deep thinkers? No one can say they are deficient in muscle. Of course, smoking carried to excess is a dangerous habit; but then, the same applies to eating, and in fact, to everything else. What we really want to know is what sort of tobacco is the best, and what kind of pipe most effectually removes the poisonous properties which tobacco is said to contain. There can be no harm in removing the nicotine, if possible; though whether it is really absorbed in sufficient quantity to do any harm is exceedingly doubtful. It is more than probable that cheap tobacco is extensively adulterated, and it is quite possible that whatever evil effects are laid at the door of the "fragrant weed," may be traced to the action of the substances with which it is mixed or prepared. Saul Rymea.

TO "SIGMA."

[338] Sir,—I have been a diligent reader of "Sigma's" papers on the different kinds of battery, but have not been able to avail myself of the valuable information contained therein to the extent I had hoped for, from my previous ignorance of the subject. I shall feel much obliged if "Sigma" will, as opportunity offers, explain to me a few difficulties which I will state. I don't know how many liquid grains there are in one pint, therefore I have not been able to make up a nitrate of soda solution, which I was anxious to do. In the nitric acid table (p. 266) the number of atoms in a pound decrease with the gravity, but in the fourth column the number of atoms appear to increase for the first three figures. In the above table aquafortis is treated as a weak nitric acid.

Does "Sigma" know anything of the article made to be used for all ordinary trade purposes as dipping aquafortis, which is composed of certain proportions of brown oil of vitriol, and nitrous acid, as they call it in the trade? It is a bright brown fuming acid, and a smaller proportion of it is used than of the oil, if I am correctly informed. Would not such an article give worse results than the acid mentioned in the table?

A few words as to the selection of an instrument to take the gravity would be very acceptable. At the risk of being thought very dull, I must confess I have not been able to master as yet the table on page 340; but if "Sigma" will give the quantity of nitrate of soda and of acid, to make, say a pint of solution, and the number of fluid grains in the same, I think, with this additional help I shall succeed.

I certainly should not venture to ask so much, did I not recollect that probably there are others whose only source of information on many subjects is our much loved Mechanic, and who, like myself, after honest effort have not reaped all the benefit those papers can afford. H. K.

HORSE POWER.

[339] Sir,—I am much obliged to "R. D." (4531) for his kind reply to above query, and find that our views coincide in respect to sections 1 and 2 of query, *i.e.*, that the pressures in boiler, *when stated as in excess of the atmosphere*, are to be assumed as *wholly* effective in non-condensing engines, whilst in *condensing* engines the force of the vacuum has to be *added* to these pressures. Thus, for a clear understanding of the case, let the steam pressure in a given boiler be 60lb. in *excess* of the atmosphere (75lb. from a vacuum), the gross theoretical horse power of a *non*-condensing engine (full pressure throughout the stroke being presumed) will be expressed by either of the following formulas:—

$$R = \frac{f\,s\,v}{33000}$$

or,

$$R = \frac{f\,(s' - p)\,v}{33000}$$

in which R is the gross theoretical H.P.; f, the cross sectional area of cylinder in square inches; s, the excess force of steam over the atmosphere, per square inch; s', its *total* force per square inch from a vacuum; p, the atmospheric pressure per square inch; and v, the velocity of the piston in feet per minute.

Under same assumptions and values, the gross theoretic horse power of *condensing* engines would be expressed by either of the following formulas:—

$$R = \frac{f\,(s + p)\,v}{33000}$$

or,

$$R = \frac{f\,s'\,v}{33000}$$

In regard to section 3 of query (Compound Engines), the answer of "R. D." is not quite so explicit. Although the reply is satisfactory *as far as it deals with the question*, it does not go to the full extent of the inquiry, *i.e.*, does not explain how the *power* of an engine of the given dimensions and data is estimated. I agree with "R. D." that the ratio of expansion is as 1 : 4, and that the mean steam pressure is 36lb. per square inch *in excess of atmosphere*, but I desire to know,—and it is this point upon which I trust to be enlightened,—*upon what areas this mean pressure takes effect*. Does it operate with its mean force upon *both* the pistons *equally per unit of surface* or only upon *one*, *i.e.*, upon the largest?

I have noticed in a scientific work, that the power of a *compound* engine is the same as a *single cylinder* engine of the same dimensions as the *low pressure* cylinder, and working with the same initial pressure of steam and the same ratio of expansion.

If this be so the gross theoretical horse power of engine particularized in section 3 (see also corrections in No. 283, page 548) would be:—

$$\frac{(26^2 \times 0{\cdot}7854) \times (36 + 15) \times 330}{33000} = 270{\cdot}75 \text{ H.P.}$$

It would seem to me, however, more correct to deal with *each* cylinder *separately*, *i.e.*, calculating the power of each part of the machine for itself, and adding together the two resultants for the total power. Perhaps, "R. D." will kindly work out the example in *both ways*, by which the correctness or otherwise of the statement as to the size of low pressure cylinder forming the basis for estimate of power, would be demonstrated.

In conclusion I would further take the liberty of inquiring, What percentage of the *gross theoretic power* obtained on the basis of the foregoing formulas as applied to the *three several classes* of engines (single-cylinder condensing, single-cylinder non-condensing, and compound-condensing) may be safely assumed as effective from off their respective crank-shafts in the form and character of *useful available* power? Of course good construction and finish pre-supposed.

A Working Engineer.

SCREW POWER.

[340] Sir,—I wish to submit to the scrutiny of the gentlemen who have recently been writing in the English Mechanic on the subject of screws and inclined plane, the following result, which I have arrived at theoretically, as to the most economical angle for the thread of a screw, but which might, at first sight, seem to contradict the commonly-received idea that the finer the thread of a screw the greater its mechanical power. Now, although if it were possible to to do away with the friction of a screw, there would, theoretically, be no limit to its power, yet as the friction of a screw absorbs a very large proportion of the power applied to turn it round, it becomes a question as to how many times it is necessary to turn it round to produce a certain effect, and as that number of times is dependent on and inversely proportional to the pitch of the screw, the question resolves itself into a consideration of the angle at which the thread of the screw is to be cut to produce the best result.

The simplest possible form in which we can present the screw with a view to this investigation is represented in Fig. 1, where the screw is itself fixed, and the nut with the weight attached is supposed to be moved round by a cord stretched horizontally and falling over a pulley with an experimental weight hung to it. And that is the form that an apparatus for determining this question experimentally would probably assume.

Now for the matter according to theory:—Let angle B A C (Fig. 2) = i = inclination of thread of screw, and B C = H = pitch of screw; O P direction of power applied, O W direction of gravity of weight to be lifted; O V drawn perpendicular to A B, and angle R O V = ϕ = angle of friction of smooth iron on smooth iron; and suppose these pressures and R O the resistance of plane to be in equilibrium when the mass O is just about to slide up the plane, then

$$\frac{P}{W} = \frac{\sin(i+\phi)}{\cos(i+\phi)} = \tan(i+\phi)$$

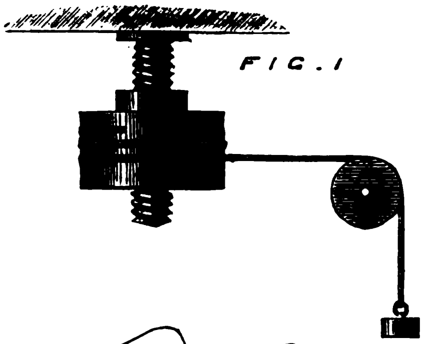
$$\therefore\ P = W\tan(i+\phi)$$

$$\text{and } AC = H\cot i.$$

Now, in raising the mass O through a distance equal to B C, the power P has to move a distance equal to A C, or the whole work done will be

$$P \times AC = W\tan(i+\phi)\,.\,H\cot i$$
$$= WH\tan(i+\phi)\,.\,\cot i$$

which has to be made the smallest possible, or, which is the same thing, making $\tan i\,.\,\cot(i+\phi)$ a maximum.



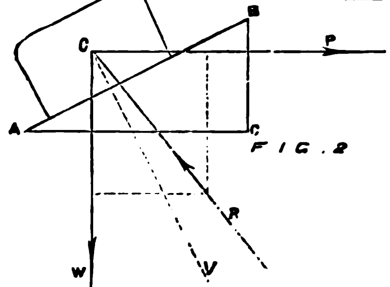
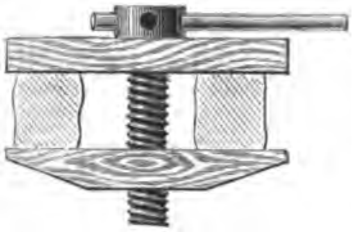


FIG. 3



Now, without treating your readers to the differentiation of this small expression, I may state simply that the result is that when $\frac{I}{P}$ is a maximum, then

$$i = \frac{\pi}{4} - \frac{\phi}{2}$$

or that is to say that the most economical angle for the thread of a screw is 45°, minus one half of the angle of friction, which depends on the nature of the substances composing the screw and nut, and which for (say) a steel screw and wrought-iron or brass nut we may take roughly at 10°, so that we get a screw inclined $45° - \frac{10°}{2}$ or 40°.

As the differentiation mentioned above is a long one, occupying nearly a whole side of letter-paper, and some of the steps being too long to be got into the space, even when written length wise of the sheet, it becomes desirable to adopt the simpler plan of approximation, with the help of a table of tangents, in which way of doing it it comes out thus:

First suppose $2 = 30°$ and $\phi = 10°$
then $\tan i\,.\,\cot(i+\phi) = \tan 30° \times \cot 40°$
$= {\cdot}577 \times 1{\cdot}19 = {\cdot}686$

Next suppose $i = 50°$, then $\tan i = 1{\cdot}19$ and $\cot(i+\phi) = {\cdot}577$ which gives the same result as before, so that the proper value of i probably lies somewhere half-way between the two.

Therefore, lastly, let $i = 45°$, then
$\tan i\,.\,\cot(i+\phi) = {\cdot}839 \times {\cdot}839 = {\cdot}704$
and this seems obviously a maximum without trying any more values, from the consideration that, as the tan and cot vary simultaneously, the largest possible product of the two would certainly be a square, which this is.

The illustration that I give above of the probable form an experimental apparatus would assume is by no means a practical one; in fact I can hardly imagine a case in which it could be applied to any useful purpose; but the usual manner in which the power of a screw is applied is by the screw working through a fixed nut, as in a letter-copying or ordinary house-press, or else as in a smith's vice.

Fig. 3. Take for instance Fig. 3 as a type of the ordinary application of a screw. Not considering the rate or pitch of screw, let us take account of the friction. Now bearing in mind that the amount of friction depends for the same material solely on the pressure, and that all the rest of the calculation is a mere matter of leverage, it becomes obvious that the friction on the under side of the head of the screw—as it is exerted on an annular plane, whose mean diameter is greater than the mean diameter of the screw thread—takes more power to overcome it than the friction of the screw-thread itself does (unless, indeed, the nut fits the screw very tight, which is considered by workmen to be perfection of work, but is on a par with many other absurd ideas that workmen have), and the broader the collar under the head the more loss through friction. Hence, as it is inevitable that much more than half the power applied to this arrangement, as compared with No. 1, is utterly thrown away, it becomes desirable to reduce the number of times that the screw has to be turned round, or else to reduce the diameter of the screw and its collar with a view of decreasing the distance from the centre of the screw at which the resistance acts; and this is done either by retaining the same diameter and increasing the pitch of screw, or else retaining the same pitch and reducing the diameter, which increases the angle of thread, or else a judicious mixture of the two. Also to reduce the friction of collar, make its diameter as small as possible consistently with strength, either making it press on its extremity (pointed if possible), as in a letter copying-press, or by making the collar in the form of grooves as is sometimes done with propeller shafts, recollecting that twenty gooves that fit properly, not tight, have no more friction than one. I believe that there is hardly an application of the screw, except for bolts, in which this plan of very high pitch would not tell advantageously, particularly for planing machines, lathes, and screw presses; the velocity of action being modified when necessary by the application of wheels and pinions, as is done in a crab, or crane, or screwing lathe; and I believe there would be much greater economy of power from the less number of times the screw itself would revolve, than there would be loss through the additional gearing. Of course to turn a high-pitched screw round *once* requires more force or a longer lever than a low-pitched one, but it requires doing so much less frequently.

A screw of 40° rises 8⅜in. with a circumference of 10in. or a diameter of 3¼in., or say the rise of the thread is about 2½ times the outside diameter of the shaft, which appears extravagant, but I have screws of 45° actually in use, so there is no question about their working or sticking. I wonder whether the same would hold good with propellers? I believe it would with 43°?

J. K. P.

BICYCLE RIDING.

[341] Sir,—Notwithstanding all that has been written on the experience of various riders, the fact is that the performance of the bicycle can be reduced to a simple sum in arithmetic. The driving wheel seldom reaches 3ft. 6in. in diameter, but assuming such dimensions, and acknowledging that the driving wheel must inevitably measure the length of road passed over, it must make 560·7 revolutions to accomplish one mile. The action of the crank requires the legs of the driver to make the same number of strokes for the same distance, and to cover seven miles, seven times that number will be required, and to perform that distance in one hour, 65·1 strokes per minute must be made, or rather more than one full stroke per second. This rate of motion is impossible to many, and very few could keep it up for any length of time. Therefore the statements of 8 or 10 miles an hour as having been performed must be entirely fabulous, or executed on a descent, when no action is required, for we all know, unfortunately, how easy it is to go down hill.

The greatest fallacy of all is the proposal to put more than one driver upon a velocipede, for neither two nor fifty on one machine could increase the speed 1in. per hour. Two drivers do not divide the labour, they double it. The only means of giving the velocipede a commercial value is to cause the driving wheel or wheels to revolve with a velocity at least fourfold that of the legs of the driver.

Henry W. Reveley.

AN ENGLISH MECHANIC MICROSCOPICAL SOCIETY.

[342] Sir,—The thought has occurred to me, Would it not be a famous plan to have an "English Mechanic Microscopical Society"? I believe there are a great many more amateurs in this very interesting science than we, perhaps, suppose, all of whom would no doubt be glad of any little help that might be afforded them by better hands if they only knew where to find them; besides which a society so formed would be one of the best means of disposing of our duplicate slides. I am not sure that the plan I am about to propose is the *best*, but I think it a *good one*.

Let all those interested in microscopy send their names to the editor to be published on the "Micro." page. I then propose that the person whose name stands first, whom I will call A. shall send list of duplicates (bearing his name at top) to B.; at bottom of same sheet A. might write any question he wishes to ask or make known any idea of his own. In not more than two days after receipt of same by B., he shall add another sheet, bearing his name, list of duplicates, answer to A.'s questions, and anything else of interest, and forward same to C., who will send it to D., and so on to last member, who will send the whole on to A. A. shall then take away his first sheet and add new one at end. B. to do same, &c. This list may always be sent from one member to another for a penny by book-post. The best way to fasten sheets together in proper order will be with one of the patent paper fasteners so generally used.

A. A. F.

VARIOUS VARIETIES.

[343] Sir,—I fancy your querist, "Melting Point" (No. 4536), will find some difficulty in obtaining an exactly correct answer to his query, as the data necessary does not, I believe, exist. Even if it had been obtained for one sample of paraffine melting at 109° Fahr. and 128° Fahr., to all probability it would differ in another.

To all practical purposes, though, the melting points may be assumed to be about 115° Fahr., 114° Fahr., and 113° Fahr.

The acid solution of phosphate of lime referred to by Mr. Young in his letter on page 568 is a sulphuric acid solution of phosphate, and is also known as superphosphate.

With reference to the degree of Twaddell's hydrometer equal to 53° of Baumé's, is, taking Franceour's division, exactly 98°. If it would be of any use to him, I will, if possible, forward to him an approximate rule for converting Baumé's into Twaddell's degrees.

I find "An Exhibitioner at the Royal College of Chemistry" states, on the authority of Professor Huxley, that "15 to 20 per cent." of carbonic acid gas "may be breathed without producing any immediate evil effects, provided the quantity of oxygen is increased in a like proportion."

I do not know from whence the above was taken, certainly it may be from some such little work as his "Elementary Physiology," in Macmillan's series; but though I remember casually looking through that work, yet I do not remember any such statement. Perhaps, though, your correspondent, "An Exhibitioner at the Royal College of Chemistry," will state his authority for giving that as Professor Huxley's opinion. As it stands it is almost too indefinite for even Professor Huxley: for reading it literally and increasing the oxygen in the same ratio or proportion as the carbonic acid gas has been, we should have to imagine an atmosphere containing some thousands per cent. of oxygen, which is considerably worse than three halves to an whole, and more than I can manage. If we are simply to increase the oxygen only to some 80 per cent., we can hardly be said to have so done, seeing we have increased the carbonic acid some hundredfold. Dr. Taylor, too, has found that a mixture of equal volumes of oxygen and carbonic acid produces death.

Dr. Angus Smith categorically contradicts the assertion that 4 per cent. of pure carbonic acid produces any apparent effects, and that from personal experience (*Proc. Royal Com.*, 1864).

That possibly picric acid *might* be detected by the two extremely simple tests detailed by an "Associate of the Royal School of Mines," on page 578, is undeniable; but that it *would* be so done I should hardly care to so gravely affirm. Accordingly I think an "Associate" might have so far exercised his ingenuity as to have at least found some little more decided and certain test than those: acknowledging freely though the difficulty in so doing, due to the very small proportion of picric acid present.

The test of "Crow Trees," described on page 578, is a very neat little reaction, founded on the production of a picramate; but in its practical value, hardly better than those of an "Associate of the Royal School of Mines," for the very infinitesimal amount of picric acid present in beer, and the very complex constitution of that liquid, would render it hardly more trustworthy than as an indication that picric acid might be present.

With all due courtesy I should commend to your energetic correspondent, Mr. Boord, a little care in reading queries; as of course I can but ascribe to his having very carelessly indeed read a "Young Photo's" query his very incorrect and misleading answer, that might easily cause much annoyance and expense to a "Young Photo." If I am unfortunately wrong in my supposition, and Mr. Boord did read the query with all care and attention, then I am sure Mr. Boord will accept my apologies, and excuse and kindly pardon my mistake. In that case he will allow me to assume the only other supposition, and ascribe his lapse into error to an imperfect acquaintance with the various reactions he writes concerning; so, doubtlessly he will excuse my setting matters right.

In his answer to "A Young Photo" (4622), he gravely directs him to precipitate with common salt the silver from his solution of cyanide of silver in cyanide of potassium. Now, as a matter of fact, chloride of sodium produces no precipitate whatever in a solution of the cyanide of silver in cyanide of potassium—a fact that has been known ever since Professor Ittner discovered the salt. If Mr. Boord will refer to any work on chemistry, as Fownes' or Professor Miller's, as he might almost have done before replying, I have some idea he will find it prominently stated that metallic chlorides produce no precipitate in solutions of cyanide of silver in alkaline cyanide. Also, Mr. Boord seems quite unaware that, as Professor Rammelsberg was first to ascertain, chloride of silver is very readily soluble in cyanide of potassium, which of itself would, in my idea, effectually prevent any precipitation. If Mr. Boord would so far oblige by referring to some little work, as Professor Fownes' "Manual," or Dr. Miller's "Elements," I am most decidedly under the impression that he will find the same stated therein, and which, had he but thought fit to take the trouble to refer to, would have possibly prevented his falling into so flagrant a blunder. Lastly, if I have not already troubled him too much, will he again oblige by referring to some work, and I have some idea that he will find stated therein that chloride of silver is soluble in excess of chloride of sodium.

The consequences of Mr. Boord being, as we must assume, ignorant—no, unaware of these very simple facts, and of his not having seen fit to take the immense trouble to refer to such simple sources as might have enlightened him, is that his answer to "A Young Photo," on p. 578, is erroneous and useless *ab initio*. That Mr. Boord will regret having written a wrong answer is to be supposed, and that he will regret having given an erroneous reply to your correspondent, "A Young Photo," is certain.

Perhaps I have quite mistaken what "An Associate of the Royal School of Mines" intends "A Young Photo" to obtain in his answer to query No. 4622, p. 578; but if your querist, "A Young Photo," thinks he will obtain by it pure nitrate of silver he will be sadly disappointed.

Let "Paddy" (No. 4676), boil well his precipitate with strong caustic potash, and dissolve as much as possible in dilute nitric acid; dilute with water, filter and precipitate with sodic chloride. Collect and wash well the precipitate, boil with pure strong caustic potash, until converted into a dense black powder. This is to be dissolved in nitric acid and evaporated to dryness in a water bath; dissolve in water and crystallize; re-dissolve, neutralize with ammonia, and re-crystallize.

Mr. Proctor, I fancy, is explaining a mere supposition and unknown circumstance. Urban.

CURIOUS QUESTION.

[344] Sir,—Not being satisfied with F.R.A.S.'s" rejection of my views (see pp. 450 and 491), and Mr. Proctor having ignored them altogether, I sent the correspondence to Mr. Alexander Herschel, and I forward you his answer. In the face of so strong an authority will those gentlemen revise their views and criticise my confessedly imperfect mathematics?

T. S. Usborne.

"My dear Usborne,—If fixed vertically upwards from the earth *in vacuo*, a projectile *would fall westwards* from its point of projection.—I remain, yours very truly, Alex. Herschel.

"Collingwood, Hawkhurst, Aug. 29, 1870."

THE PARIS DEFENCES.

[345] Sir,—There must be an error in the statement (p. 560) that "the distance from the Boulevard to the enceinte continué averages about 1,093 yards." This may be probably the *smallest* interval anywhere between the *Barriéres* (not boulevards) and the enceinte. The Barriéres are the very irregular, approximately oval, line of roads at which the shading on p. 560 terminates; including about four times the area of ancient Paris as defined by its Boulevards. These form a far more circular, or rather decagonal circuit, tolerably traceable in the plan, except on the S.E.; nowhere, I believe, so little as two miles behind the outer glacis; and it is remarkable that they either enclose or touch every monumental or public building of any dignity, with the sole exception of the Arc de l'Etoile, which alone stands on the line of Barriéres. The zone between these two circuits, known as the Faubourgs, is certainly more densely and, in the northern half, more loftily built, even than the central city, and more solidly and handsomely on the whole than perhaps any town in the world; but nearly all is private, except a few inferior churches and the railway termini. Then we must remember the Parisians have far better refuge from bombardment than cellars or sewers; among the bones of their ancestors, in the quarries whence all the noble material of their city has come, undermining its whole southern half. E. L. G.

AN "ENGLISH MECHANIC" SOCIETY FOR BRISTOL.

[346] Sir,—A few of your Bristol subscribers are desirous of emulating the example of some of the other large towns in forming one of the above societies here. We should be glad to receive the names of those readers in Bristol who could join us. W. Johns,

6, Park-row, Bristol.

ELECTRO-MAGNETISM.

[347] Sir,—Two things appear to have escaped the thoughts of "Thinker." 1. That the power produced, in any form, heat or motion, by a given chemical action, has been found always proportional to the number of *equivalents* (or what Dalton terms "*atoms*") of matter, combined or set free. Now, as the equivalent (or "atomic weight") of carbon is the lowest of any but that of hydrogen, while that of zinc is rather high, they are held to be as 6 to 32. This would imply that the oxidation of 32lb. of zinc in a battery can yield no more power than the burning 6lb. of coal. But, secondly, he must have overlooked that every pound of zinc he oxidizes or combines has first had to be deoxidized or set free from combination, by an expenditure of coal, for no zinc is found in a free or uncombined state, as all coal is. The native oxide, or sulphuret of zinc, has first to be decomposed by an equivalent power (yielded by the combination of something else, usually native coal and native oxygen). The zinc has to be separated from those very elements, oxygen or sulphur, one or both, to both of which "Thinker" must recombine it in his battery, its whole power-yielding value to him depending on this previous artificial separation from these elements. He is, therefore, as it were, proposing to compete with an engine by the power of the water that this very engine has pumped up for him. E. L. G.

THE FLUTE AND FLUTE PLAYING.

[348] Sir,—Since the begining of last month I have been so much occupied by various matters that I have been entirely deprived of the pleasure of reading the English Mechanic, and it is only this day, 5th Sept., that I have seen in your number of the 5th August, two letters on the flute, one signed by Mr. T. Cridland, and the other by "Flautist," and the latter, addressed to me. I will furnish the information the above two gentlemen ask for. The instruction book that Mr. Cridland wants to know about, is by John Gunn. It is an excellent work, but it is long since out of print, it was published by the author, towards the close of the last century, and I find that the quotation is from Sir J. Reynolds, "Academical Discourses," A.D. 1776. "Flautist" is quite right in supposing that there is an especial fingering for many of the upper notes on the Siccama flute. I beg to inform him that he can get a printed scale for that instrument of Messrs. Chappell & Co., New Bond-street. Henry Chapman.

VINE CULTURE.

[349] Sir,—I have an old and vigorous vine that covers the lower half of the back of my house, which faces the west. Last year a few branches turned the corner and ran along the northern wall of my garden, and this year there are several fine bunches of grapes on them, while there are none on the house.

This induces me to encourage its extension along the wall and to check its growth on the house by keeping it topped. The young branches not having been properly attended to, have grown very irregularly, sometimes in clusters of half-a-dozen, an inch apart, and I "would fain lay knife aboard," right and left, but that I fear, without proper advice, to take off the wrong shoots.

The only books on the subject I can refer to deal only in generalities, and do not make the matter clear to me. I therefore appeal to some of your readers to help me; and as it would be difficult to explain my case without drawing, I will begin from the beginning and plant a young shoot from my own or some other vine, and ask for such instruction as will carry me on to the first crop of grapes. This will enable me to treat the old vine properly at the same time.

The wall is 10ft. high, faces due south, and is exposed to the sun from 10 till 3.

What I wish to know is

1st. Will white or black grapes be preferable?

2nd. When should the cuttings be taken and how much of them planted?

3rd. What kind of mould should they be put into at first, and what kind of subsoil should they have to strike down into?

4th. Should they be struck in pots or in the places they are henceforth to occupy?

5th. What should be the future treatment after they are in the ground? In Vino Veritas.

REPLY TO "A CUMBERLAND MINER'S APPEAL."

[350] Sir,—If not too late, I will give a little advice to "Cumberland Miner" (p. 307), so that he may avoid the distressing accidents he speaks of. The whole cause is in the use of the pricker, which I had imagined quite obsolete years ago, and all the replies have given palliatives, only they have not gone to the root of the matter. My advice is, throw away the pricker, and use the patent safety fuse—not the gutta-percha fuse, which I grant you, is expensive. The patent safety fuse is only 4½d. a coil of eight yards; and if required in damp places, use the fuse with tape wound round the outside, called by us here tape fuse. This is 6d. the coil, but much superior to the ordinary fuse. We have used this fuse at the slate quarries in this neighbourhood for the last twenty years, and have never had an accident in the blasting during that period. The fuse will be found less expensive than the pricker, as the hole left by the latter must be primed with fine sporting powder. The pricker is only fit to be put into a museum as a relic of the dark ages. Wishing the "Cumberland Miner" success with this fuse, I beg to subscribe myself, Timothy Burstall.

THEORETICAL.

[351] Sir,—I have no objection to Mr. Proctor enacting the part of scientific policeman, and checking me in statements that appear to him erroneous, if the duty is fairly and courteously executed. It is difficult to judge the motives prompting the acts of others, and I fancied there was more of the spirit of counsel defending a client right or wrong, than was consistent with a philosopher seeking natural truth. It seems from the letter (No. 241, p. 564), that I was mistaken in this surmise, and therefore hope Mr. Proctor will pardon the suspicion. But he is also wrong if he thinks me altogether unacquainted with the writings of other men on the subject of light. I am as well aware as he can be of the discordance between my views and theirs, and will explain to him in a few words the reason of the difference. The prevailing belief is, that the powers and activities of material substances result from the action of properties they inherently possess. This is not my belief, and in dissenting from that doctrine, I think myself able to advance irrefutable proof of, its fallacy. Indeed the questions I have already propounded, both to Mr. Proctor and "F.R.A.S.," were introduced for the purpose of showing the impossibility of accounting for certain natural phenomena by the prevailing theories, although readily explicable by the theory I have framed, as also others still more recondite.

I shall not now dwell farther upon this subject, having at present little leisure to work it out, but I hope shortly to show Mr. Proctor another theory of the cause of the zodiacal light, which I think he will own was not considered in his paper. T. A.

ASTRONOMICAL MATTERS.

[352] Sir,—I am glad to see that Mr. R. A. Proctor has given Mr. Firth a few words of advice, which I hope he will profit by. Mr. Firth ought to be well acquainted with the fact that it is almost impossible to avoid errors in printing scientific matter, and especially in cases where the writers have not had proofs. Let us hope that your correspondent will see the folly of his recent endeavour to find fault with one who is really deserving of our warmest thanks. In reply to "Young Amateur" (4670), the planet Saturn is situated between Ophiucus and Sagittarius. If, on any fine evening, he will look towards the south-west sky, he will not fail to perceive a star shining with a very steady light, and much brighter than any others in its vicinity. The planet will not be high above the horizon.

The solar spots have recently appeared in great numbers. I was much surprised, on examining the disc two or three days ago, to find that there were enormous groups visible in the north hemisphere. It is probable that one or more of these groups has now passed off the disc, but there is no doubt that the sun's photosphere is in a very disturbed state, and we may therefore expect to see numerous large and well defined *maculæ*.

A Member of the Observing Astronomical Society.

INDUCTION AND MEDICAL COILS.

[353] Sir,—Mr. Coffin [304], p. 567, is quite correct in his idea (which I have frequently stated), that for medical use the induced current of the primary wire is more valuable than the more intense shocks of the secondary, though these have also their value in some cases. The plan of construction given by me in last volume furnishes both, and carries the current of the primary into the secondary and secures a current always in one direction, a matter of great importance.

In reply to the questions. A Rhumkorff coil could be used as suggested, taking care to leave the secondary circuit open, and disconnecting the condenser and providing an additional conductor and screw from the end of the primary within the break, but it would not be a wise process as a special coil is a very simple matter. A certain amount of force would be absorbed by the secondary wire even when open, but it would be small. I think that the magnetic effect on the core would be increased by increasing the middle layers, but am not certain. At all events it is unnecessary for medical use, as quite sufficient effect can be obtained from a single cell by even layers. My own coil, made as described, gives action with a single Smee cell, varying from such a current as might be passed to stimulate the most sensitive organ, up to one which would set a strong man screaming. Sigma.

CHASSEPOT.

[354] Sir,—We see now and then in the papers statements regarding the supply of the rifle bearing the above name to the French. The first remarks on the subject that came under my notice were about a month ago, to the effect that 50,000 of these rifles sent to France in the spring of the year were so many reasons for Napoleon III. deciding to make war. From the neighbourhood of Finsbury was stated to be their origin. This morning too, Sept. 3rd, I see in the *Times*, in Mr. Muntz's letter, that Count Palikao stated that 40,000 had been sent from this country and more contracted for. I think I can reconcile all these statements thus. A firm somewhere near Finsbury did have a contract for say 50,000 rifles for the French; and early this year, when the time was expired for completing the whole order, they had done only, say 40,000, and the French Government then told them that they might discontinue making more, as they thought they had enough. This accounts for the 40,000 delivered, and more said to be contracted for. This occurred before the second week in March, though how much before I cannot say. It is absurd to suppose that an order for 40,000 rifles came over, and was supplied *out of stock* since the declaration of war. I should think few makers kept in stock many specimens of such a Beestly rifle as a chassepot. Also the rifles were not wholly made here. The barrels, sword bayonets, and scabbards, came from France; they were "actioned" here and went home again to be stocked, so that although the French may have and undoubtedly did get a superior quality of workmanship in this small number (a mere fleabite compared with the whole quantity their army carries) yet had these 40,000 been entirely instead of one-half made in London, that would have had but small influence on the exact time when Napoleon III. thought proper to declare war.

The above agrees too with Earl Granville's statement that no rifles have been sent to France *since* war was declared.

A friend of mine in the course of an interview with the Emperor on another subject, three or four years ago, was asked what he thought of the chassepot, and told H.I.M. that in his opinion the chassepôt was the worst military arm in Europe except the needle gun. And I am quite of opinion that the Snider is the best, and amply good enough for any soldiers in the world. I have made breechloaders myself before now, and studied the matter a little too. J. K. P.

EXTRACTS FROM CORRESPONDENCE.

◆

KEEPING VARNISH BRUSHES.—A correspondent of the *Hub* writes: The following method of keeping brushes may be of interest to painters. Should any dirt collect in the brush while varnishing, or the brush drop on the floor, which will happen sometimes, then clean it out well in varnish, and before putting it away in the keeper fill the brush full of varnish, and in time the dirt and dust will all settle to the bottom. By cleaning it with turpentine, which is a very volatile substance, you will draw all dust and dirt up to the tin of the brush, and when using it next time it will all work out, and in many cases spoil the job. Every brush should be well dipped in varnish before putting it back in the keeper. I have used brushes now for eight years, and never had them in turpentine.

PARIS GREEN.—A correspondent says:—"Of itself I do not think Paris green is a difficult paint to manage, but it is of a delicate shade which is easily affected by outside causes. It is a good and permanent colour, but the drawback of its changing, which is so commonly experienced, is generally due to the varnish used over it. This can be proved very easily. I have a panel before me which was painted with this green eighteen months ago and varnished, and now it is of a very dark and dirty shade. But by pumicing it until the varnish is removed I find the colour beneath it is still of the original shade almost precisely. As with several other colours, the continued beauty of Paris green depends very materially upon the paleness and purity of varnish which is used over it. Paris green needs more than ordinary care in mixing, from the same reason that its shade is so easily changed. I mix it with white lead, and grind as stiff as possible in oil and a little japan gold size. As it quickly settles it should be stirred frequently during application, and should be worked as rapidly as possible, the whole panel being laid on and not touched again, otherwise it will give a streaky appearance."

AN AMERICAN SALT-MINE.—The *Patriot*, of San Jose, California, gives the following account of the great mine, or rather plain, of salt which lies about eighty miles N.W. of Austin, in Nevada territory, and not far distant from the railway. The mine is thirty miles long by about twelve or thirteen miles broad, without any break or interruption. The surface presents the appearance of a frozen lake with a light sprinkling of snow over it; the first stratum of salt is from twelve to fourteen inches in thickness, beneath which is a layer of argillaceous mud of a uniform depth of two feet; and under this again is the principal layer of salt, the thickness of which has not been ascertained, although a shaft has been sunk to the depth of several yards. The salt of this main stratum is described as being hard as quartz and clear as glass; it is also stated to be remarkably pure, containing only 5 per cent. of soda. The world will not want salt for a time at any rate.

REPLIES TO QUERIES.

*** In their answers, Correspondents are respectfully requested to mention in each instance the title and number of the query asked.

[3942.]—MAKING BUTTER.—See, under the heading of "Useful Notes," page 26, present volume.—Sergius.

[3949.]—"GUAYANA," OR GUIANA.—I find I have misconstrued what "Bernardin" said; I therefore apologize. In answer to "E. L. G.," who points out my error in omitting the *a*, I cannot acknowledge that such is an error, since greater authorities do not use it. I must certainly say, in my opinion, that the word is *long*, not *short*, as introducing such a letter would make it. The Rev. Thomas Milner, M.A., in his "Gallery of Geography," writes it as *Guiana*, and Stieler's "Hand Atlas" gives *Guyana*, so I wrote it both ways, although I do not myself think the substitution of *i* instead of *y* correct. The word, as the Rev. Thomas Milner says, "is derived from the aboriginal tribe *Guayanoes*—a form of *Wai-ini* a small tributary of the Orinoco." There does not exist at the present time any republic, but I find that such territory has merged into the Venezuelan Republic, as spoken of by your correspondent "E. L. G." While in Brazil last year, I made enquiries respecting these three dependencies, and was informed that Don Joao (Quinto) had given them to the three Powers after which they are named for some services, but for what my informant did not say. No one who has been residing in Brazil, or on the South American Continent near the equator, can say it is healthy for Europeans.—J. G.

[4002.]—MUSLIN.—Aquilla (my better half) informs me that some colours may be restored to muslins or cashmeres very easily by simply washing them in buttermilk.—Aquillus.

[4208.]—ADULTERATION.—This query of J. Moody, if consigned to the limbo of the "unnoticed," will be so for the contrary reasons to the usual ones; in fact because too important, and too continually cropping up on every side. He must remember not only Mr. Bright's eternally memorable dictum that adulteration, false weights, and measures, and so forth are "a form of competition;" but (as is plainly implied) they form that particular sort of competition by which Mr. Bright's "nation" (or the two mobs that we dignify with that name) have resolved to try the experiment of living. The world is, in this century, to be enlightened on the possibility of thus living; and so grand an experiment must not be interrupted. Mankind must see it carried out *a outrance*. A querist put exactly J. Moody's question last year, in July, in *Public Opinion*, and I, happening to see it, replied to this effect, that there neither is nor ought to be any means of detecting or publishing names of such traders as he and J. Moody complain of. It would be unjust if there were, for they are not offenders. They do but act as *we* force them. If there be wrong-doers, it is not they who adulterate *tea* by putting in what ought not to be in tea; but those who adulterate *mankind* and the "nation," by creating therein classes of beings that ought not to be. It is not shopkeepers, but the shopkeeper-*makers* that are answerable. Perhaps I hardly make this clear, but enough for the querist to rejoin immediately that when he "wrote the other day on *our commercial system*, it was not with a view to complain of it as a whole," and so we parted. He may (or may not) have understood the *fact*, that he and each one of us must either attack and fight it *as a whole* (in what way, I will readily explain if any one wishes to know), or accept it *as a whole*,—with adulteration, short weight, cheating of the blind, and all its other features. Let none dream there can be any neutral here. He *must* be the system's soldier or its enemy. It is because this begins to be seen by many, I think, that we hear less and less of querists like J. Moody. They see, and silently choose their side.—E. L. G.

[4209.]—WATER-WHEEL.—This cannot be answered without knowing approximately the quantity of water falling per minute. "J. Royd" might see from statements repeated in almost every number of the English Mechanic that to yield a horse-power, the weight falling 5ft. must be 6,600lb. (or about 660 gallons) per minute. —E. L. G.

[4232.]—UNNOTICED QUERIES ON MAGNETISM. —The horizontal intensity is that of the directive force in a common compass-needle—*i.e.*, one balanced *after* being magnetized—its tendency to swing back when disturbed horizontally. Vertical intensity is that wherewith a dipping needle, or one that was balanced on a horizontal axis *before* being magnetized, returns to the local angle of dip, when disturbed therefrom in a vertical plane, up or down. Both are measured, or their strength at different places compared, by counting at each place the oscillations made per minute by the same needle; just as local amounts of gravity are compared by the numbers of oscillations per day of the same pendulum. The needle shows the magnetic forces to vary over the globe like gravity, but to far greater extent and very irregularly. The horizontal force vanishes at the earth's magnetic poles, the compass there having no directive power; but the vertical intensity is there a maximum, as also the dip. Secular variation is the change observed in any of these data in a century; or the term expresses merely *time* variation as distinguished from that of locality. Four kinds, at least, of magnetic curves exist all over the globe, and are slowly changing. 1st. Those through places of like declination (or direction of the compass relatively to the meridian), and these roughly resemble meridians. 2nd. Those of equal horizontal force. 3rd. Of equal inclination (or dip). And 4th. Of equal vertical force. And of the three latter all resemble wavy parallels of latitude.—E. L. G.

[4246.]—GLYCERINE FOR COD-LIVER OIL.—We have many better substitutes for cod-liver oil. Although patients increase in weight while taking it, they rapidly fall back if it is discontinued for only a short time.—Medicus.

[4251.]—PAINT FOR AQUARIUM.—Common paint answers very well for the aquarium, but you must varnish when dry, with a weak solution of shellac in spirit, the painting you have done outside.—Medicus.

[4265.]—TRANSPARENCIES.—For these, prints on a close thin even-surfaced paper should be [illegible] Colour on the right side of the picture with moist [illegible] colours, apply strong *even* washes and use the [illegible] as sparingly as possible. As the pictures are to be [illegible] by transmitted light, they will require deeper [illegible] To determine the exact depth will require practice. [illegible] should be kept very clear. Prepare a solution of Canada balsam (not too thick) in rectified oil of turpentine, coat the face of the coloured picture rapidly and evenly with this cement, taking care that no parts are left *untouched* by the brush, and immediately apply to the glass which must be scrupulously clean, press it closely and carefully, *expel all air bubbles* or the [illegible] will be irrecoverably spoiled. When the cement has become hard and dry (about thirty hours will [illegible] this) varnish with the best picture copal. Fine [illegible] hair tools should be employed for the cement and varnish. The following are the proper colours:—[illegible] madder, pink ditto, yellow lake, Italian pink, [illegible] umber, burnt sienna, brown pink, Prussian blue. [illegible] shades of purple may be made with the madders and blue, also in green with the yellows and blue, and [illegible] and the browns. The madders may be enriched by adding little burnt sienna as in draperies, &c., in this case, shade with madder mixed with burnt umber. Vandyke brown is a useful colour in transparent painting. Use a little ox-gall with the water in colouring, and [illegible] gum and dust.—Sable.

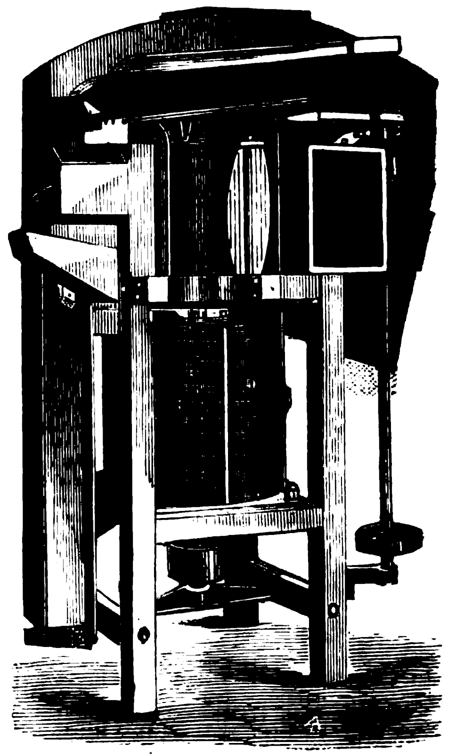
[4288.]—FORCE-PUMP FOR IRRIGATION.—Small portable force-pumps are made by most pump-makers. They are very useful for watering flower or kitchen gardens. They will throw from 30 to 40ft. Price about 30s. Names of makers can be found in "The Directory" and in the advertisement pages of "our" journal.—Sergius.

[4361.]—METHYLATED SPIRIT.—I beg leave to contradict most emphatically the statement of "T. L. H." that "as a rule all the tinctures now sold in chemists' shops are prepared with the methylated spirit, and many of such tinctures are for internal application." There could be no greater mis-statement, or greater display of ignorance on the part of "T. L. H." than this. No respectable chemist would ever dream of making tinctures for internal use from methylated spirit, and if he did so he would find them unsaleable. Moreover, the use of methylated spirit is now strictly prohibited in the manufacture of any medicine for internal use, except ether and chloroform. This is on account of "cleansed spirit" having been sold by some unscrupulous druggists among the poorer classes as a stimulant, under various names. Methylated spirit may be used for liniments, &c., for external use, and where cheapness is an object with the purchaser there can be no objection.—Henry James, Pharmaceutist, Woolwich.

[4383.]—THREE COINS.—Though I am no judge of coins, I fear there is a misprint in W. J. Eggleston's reply to "Hastings." Should not "London" (first word, fourth line) be "Londonderry"? "John Ervin at ye ferry of Londonderry."—Aquillus.

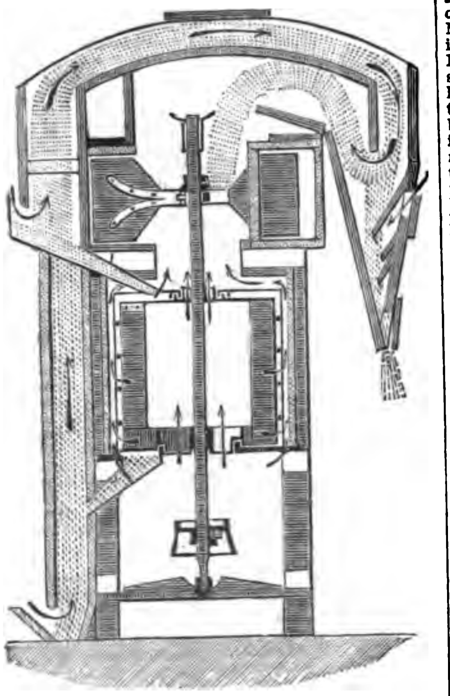
[4293.]—MILLERS.—In reply to the query of "J. S. H.," I beg to send the following description of Howes, Babcock, & Co.'s "Eureka Smut and Separating Machine," one of which we have been using for some time, and find it far surpasses any other machines which we have hitherto tried for cleaning Ghirka or other kinds of wheat. Cut No. 1 is a perspective view, one section of the outer casing being removed. It represents, on the right, the screenings dropping from the separator, and on the left, at the bottom of the machine, the discharging of grain. No. 2 is a sectional view, showing an internal arrangement of the machine. The direction of the arrows represents currents of air, created by the action of the fan through the separators and different parts of the machine, for separating the grain, collecting the dust and other impurities, and discharging them out of the mill. On the left showing the wheat entering

FIG. 1



through the first separator, passing through the scourer, and discharging through the second separator at the bottom. It has two suction separators—one before the scourer for separating from the grain chaff and smut balls, or other light substances, the other, after cleaning the grain from remaining impurities after being scoured (each acting independently of the other), depositing two kinds of screenings, one taken from the wheat before it is scoured, the other after, and both cleansed from dust and chaff, and ready for market. The scourer is constructed on the smooth surface principle, and therefore is not liable to break the wheat, which is a great drawback to rough surface machines. If ordered they attach a shaking shoe, as seen in cut No. 1, the first screen of which is for the purpose of carrying off any impurities larger than the grains of wheat. The second screen separates the sand, seeds, &c. With this shoe the machine forms a complete grain cleaner of itself. With regard to fixed *v.* balance rhynds I should think the increasing scarcity of the fixed rhynds will be answer enough, being almost entirely superseded by the balance.—Sergius.]

FIG. 2

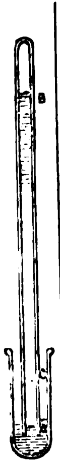


[4409.]—FOUL AIR.—It is a most mischievous error to suppose that wherever a light will burn a man can live. A candle would burn to its end in plenty of gaseous mixtures that would be *instant* death to any warm-blooded animal entering them. No man should be allowed to descend into a well, a liquor-vat, or any place left for many hours without downward outlet, till a bird in a cage has been lowered for some minutes and drawn up alive. The only reason why ascending into an untried upward well, or place without upward outlet, is less dangerous than descending an untried downward receptacle, is because light gases have a far more active diffusive power than heavy ones. It is providential that carbonic acid, the commonest by far of all irrespirable ones, is heavier than air of the same temperature, but comes from all its ordinary sources, as animals' lungs and combustion, heated enough to rise at first. The above accidents arise from the comparatively rare cases where it is produced cold. The ordinary warm carbonic acid, nearly as fast as it can accumulate against roofs or ceilings, must cool and descend, so as to be quickly spread and diluted. Still, no lantern, from a lighthouse to a policeman's bull's-eye, is made without perfect upward drainage, for its continual outflow. Indeed, every lantern maker knows that not one would be saleable without it. No particle of air can enter any lantern twice. In all our dwellings, on the contrary, and most public buildings, the ceilings are the most perfect arrangements that could possibly be contrived for retaining and forcing all foul air to be breathed over and over again as many times as possible.—E. L. G.

[4415.]—CURIOUS PROBLEM.—According to the answers received from various sources it would appear that an "irresistible" force cannot co-exist with an "immovable" body and *vice versa:* in other words, these terms are incorrect, and as definitions of things which have no existence should be crossed out of the dictionary, or at all events become obsolete. To avoid such a conclusion my *alter ego* suggests that an "irresistible" force coming into contact with an "immovable" object would "make a hole through it!"—Saul Rymea.

[4474.]—HORSE POWER.—"Vertumnus" (p. 548), gives to my mind rather a curious rule for finding the horse power of a cylinder. May I ask him if the stroke is not worthy of some little consideration. To illustrate this I will take his example, viz., a 6in. cylinder; it may have 9in. stroke as in a locomotive or 4½in. as in a screw engine, and by his rule the two cylinders are of exactly the same power, whereas in reality the 9in. is exactly double the power of the other.—G. W. A.

[4481]—THE BAROMETER "DIFFICULTY."—I was aware that standard barometers have a movable scale ending downwards in the point mentioned by "A. M. W." (p. 571), and by thus separately measuring the difference of level at every reading, we eliminate the effects of any inequality of bore in different parts of the tube or cistern. But if this is expected to be done with every barometer, as "Exhibitioner at Royal College of Science" implies (p. 548), I call it a most "clumsy" expedient, not meaning by that term *inaccurate* but *inartificial*, or in the sense that we call it clumsy of Chinese water-carriers to inherit the contrivance of a yoke to which they append a bucket of water at one end and a stone at the other, and are said to have organized as stout a resistance as if they were Manchester or Sheffield unionists, against the innovation of balancing one basket by another. Let A be the present level of mercury in a simple rigid cistern, and B in the tube, 30in. higher. Suppose the surface A to be nine times the area of B. Then if the top were opened, both surfaces would come to the level C, three inches above A. Now, if the makers expect me to bring "the fluid in the cistern always to the same level when an observation is made," I beg to tell them and "Exhibitioner," I prefer the less troublesome course of obliterating their scale, and making a directly usable one, by dividing the 27in. from C to B into 30 *nominal* or *scale* inches; in short, figuring every 9-10 of an inch above or below B as an inch. If they object that the tube or cistern are not parallel-sided, I say they ought to have been so practically and that their not being so is most "clumsy."—E. L. G.



[4484.]—BUNSEN'S BATTERY.—"An Old Subscriber" will find the easiest mode for cutting his carbons is to fix his carbon in a vice and cut it down with a hand-saw. The saw will cut about twelve, then will require re-sharpening.—A. J. Jarman.

[4495.]—GOLD SHELLS.—These may be made by rubbing up gold leaf with thin gum water and spreading upon shells. The gum used for this and colour grinding should be the finest white gum arabic dissolved in distilled water. The palate knife should touch this and all the mineral colours, especially the vermillion, as little as possible. Beware of dust in all such operations.—Sable.

[4501.]—SEWING MACHINES.—As "J. G.'s" reply (if he gave one) to "H. W." has escaped my notice I will see if I can be of assistance. As well as I can judge, the fault is still a badly-regulated tension of the upper thread. "H. W." should *gradually* increase the tension till the loops vanish, or good thread breaks. His remarks read as though his machine had no tension attachment, else the hole in the cotton-reel would have no need to be made smaller. If this is the case, "H. W." might manage to increase the tension by giving the thread one or more turns round the thread guide. "H. W." had better not take his machine to pieces till he knows it better, or he may spoil it altogether. If regulating the tension does not make it all right, let him see if the brush has been pressed in on the hook too tight—this would *split* the brush and make it useless. Or the pin at the end of the rod which drives the rocker may have worn loose, and if so, it may be made right by giving the screw an extra turn. P.S.—I hope "Practical Man" will soon let us hear from him with the promised information about sewing-machine construction.—Aquillus.

[4504.]—ELLIPSES.—The common trammel (or elliptical compass) has been described and figured several times in the English Mechanic, better than by T. W. Boord in this number (p. 548). Thus, in vol. VII. alone, I find it rightly figured by "Novice Barnsley," p. 193, as well as the still simpler mode of striking ellipses by foci and cord, *three times* given, pp. 148, 149, 214; and a third method on a wholly different principle, p. 452. Moreover the "connecting-rod" oval that our present "J. K. P." patronizes, is there also confounded with an ellipse, or an "ellipse in perspective," pp. 237, 323, and its first introducer, Thomas Arnall, even calls his instrument for striking it an "elliptograph." "J. K. P." must surely see that if it be *ever* egg-shaped, it must *always* be unsymmetrial and a more complex curve than the ellipse, however, long his connecting rod. In fact, it is an oval of the fourth order, while ellipses and all conic sections are of the second, the same order as a circle. T. W. Boord's figure of the trammel has been made puzzling by the printer inverting it, but is also wrong by having the arms of the cross unequal; and an attempt to disguise the inherent defect of that instrument which is, that owing to equal length of grooves being required each way, you cannot strike any ellipse with a minor axis less than the width of the cross, nor can you strike one much wider than the instrument, nor so long as twice its width. In fact, only ellipses of small excentricity can be drawn by it, and the larger the less elliptic, by suppressing one arm, however, or rather halving the entire cross, we can draw any ellipses not exceeding its width, however narrow, by half at a time. "J. K. P." says this is necessary with Cowper's Ellipsograph, which I do not know. I greatly doubt the possibility (without very complex machinery) of striking any of more than small excentricity with ink and a drawing-pen; though it is perfectly easy with pencil. The drawing-pen introduces difficulties that I long ago, though constantly drawing ellipses, decided to regard as not worth solving.—E. L. G.

[4511.]—WEIGHT OF BALL.—The length of wire that can be drawn out of a ball of iron, may be found without reference to the weight, by dividing twice the cube of the diameter of the ball by three times the square of the diameter of the wire. If diameter of ball is 7", and diameter of wire ¼", we have

$$\text{length of wire} = \frac{2 \times 7^3}{3 \times (\frac{1}{4})^2} = \frac{2 \times 7 \times 7 \times 7}{3 \times 1{\cdot}16}$$
$$= \frac{2 \times 7 \times 7 \times 7 \times 16}{3}$$
$$= 3658\tfrac{2}{3}\text{in.} = 304\text{ft. } 10\tfrac{2}{3}\text{in.}$$

The weight of an iron ball may be ascertained by multiplying the cube of the diameter in inches by ·136 for cast iron, and by ·146 for wrought-iron. These foctors are obtained by multiplying ·5236, the constant used in obtaining the cubic contents of ball, by ·26 and ·28 the weight of a cubic inch of cast and wrought-iron respectively.—William Moor, jun.

[4515.]—FELT HATS.—I cleaned my felt hat with spirits of turpentine and a soft sponge, and by rubbing gently *with* the grain of the felt.—Aquillus.

[4516.]—ASTRONOMICAL PHENOMENON.—This was doubtless occasioned by a current of hot air rising from the roof.—Unit.

[4519.]—PHOTOGRAPHY.—Ordinary shellac dissolved in spirits of wine makes a good and cheap negative varnish, to be poured on to the warmed plate the same as collodion. Or the hard spirit varnish, made for carriage painters, diluted with twice its quantity of spirits of wine, is good.—Unit.

[4521.]—EXTRACTING HONEY FROM THE COMB.—The method I adopt is to stretch a coarse strainer over the top of an earthen pan, open the cells of the comb with a knife, and cut the comb into pieces. Then place it on the strainer, when it will drain into the pan beneath perfectly clear. This is the most simple and the most perfect plan I know of.—Winner.

[4535.]—HORTICULTURAL.—"G. H." in pruning gooseberry and currant bushes must be guided by the strength of the soil. At any rate, all main branches that crowd one another should be thinned out, and only as many left as the root can supply. After reducing the main stems, take each one separately and cut the side shoots down to spurs about an inch long, of course removing all weak and spindling shoots.—Saul Rymea.

[4539.]—CHIMNEYS.—In reply to the inquiry of Mr. Moody in your journal of the 19th inst. (query 4539), I beg to give him below the principal dimensions of a very elegant and efficient chimney-shaft erected for four (eventually for six) boilers of about the same size each as those described by him. The chimney is built of brick; foundation and plinth four =, and equal-sided; shaft octagon, in horizontal section. The foundation is 26½ft. deep, forming an equal four equal-sided prism of 14ft. 8in. side. The plinth is 19ft. 8in. high by 11½ft. side. The shaft is 92ft. high from top of plinth, so that the total height from ground-level is 111ft. 8in. The width of flue at base is 59in., and at top 39½in. The thickness of masonry in plinth is 39½in. and in the shaft at lower end 29½in., and at top 10. Plinth and shaft is cagped with hewn freestone. The canal from boilers leading into base of chimney is immediately under ground-level, and is 5ft. 6in. high by 4ft. 1in. wide.—E. W. A., Cologne.

[4541.]—EMBROIDERING MACHINE.—There is a machine special for this, but very dear. There are attachments for the same purpose to some makes of "Wheeler & Wilson," also to "Singer's," and perhaps the "Weed," and the "Howe." Bradbury's W. W. makes, so I understand, six different stitches; ranging from single thread chain stitch to *eight* thread embroidery. Seller's W. W. uses up to *five* thread embroidery stitch. I consider the "Gulph" *treadle* the best chain stitch machine. Perhaps it would suit "A Braider," but chain stitch is *not* embroidery stitch.—Aquillus.

[4545.]—SECRET CODES.—In compliance with the request of "Argus," I send you the clue to the "secret code" upon which I commented in your columns in No. 278. To take the simplest case, let us suppose that the suspected word is the first in the cipher, and is believed to be BEACH; the corresponding letters in the cryptograph being ULOTU.—We proceed as follows:—1st. Write down the alphabet in order as far as the lowest letter in the word—*i.e.*, as far as H—and draw under it as many parallel lines as in the suspected word. 2nd. On the first line place U under B, on the second L under E, on the third O under A, on the fourth T under C, and on the last U under H—*i.e.*, the cypher letters, one in each line, under the suspected letters. 3rd. Complete these lines in retrogradealphabetical order towards the left as far as the column under A, and the first column gives the key. Thus

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A B C D E F G H &c.
T U &c.
H I J K L &c.
O &c.
R S T &c.
N O P Q R S T U &c.
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Showing the key-word to be THORN. In the secon
case, suppose that the word is not the first, or that th
sentence begins "The beach." Our first, second, and thir
trial will fail, but the fourth will produce this result—
cipher being SRTJV—

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A B C D E F G H . . .
R S . . .
N O P Q R . . .
T . . . . . .
H I J . . . .
O P Q R S T U V . . .
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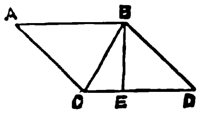
which gives RNTHO as key-word, which by an eas
transposition becomes THORN. If the known word b
longer than the key-word, the latter will repeat itsel
thus THORNTHO; if shorter, we must guess at th
rest of the key, but *we can always obtain as many consec*
tive letters of the key as there are in the known word. I ma
be told that this plan is slow when the word is containe
in a long sentence, and that it may be defeated by usin
as key a set of letters having no meaning. To the fir
I reply that my object is only to show that with patienc
the code is not secret; to the second, that no uncon
nected series of letters can be retained in the mind lon
with certainty, and that if a note be made of ther
security, the great merit of the system, is lost, as th
word may fall into the hands of others. Allow me
add that I have invented a little instrument whi
enables any one to write cryptographs almost at the ra
of ordinary writing, and to read them without putti
pen to paper, of which, if the subject still retains i
terest, I will send a sketch, with full permission for a
one to make for private use, or for sale, as I am mere
acting *en amateur* in the matter. And as I have tak
upon myself to disclose the secrets of other plans, I b
to subjoin two very short specimens for practice—t
one founded on the principle that I have tried to elu
date, the other upon the same principle, with a modi
cation which I have introduced. I may say that the k
word in each is a very common word, and I will gra
that the word JONES occurs in both. If any broth
cryptographer on discovering my plan will kindly co
municate his method he will oblige me and doubtl
interest your readers. I should add that in neith
cryptogram have I transposed the alphabet, omitted a
letters, or introduced signs without meaning, all
which methods require two copies to be kept, a fa
objection—

1st Cryptogram.	2nd Improved Do.
YMNSAUMJSHDXSYG	KUOPFCQASMTLGPFY

[4616.]—**PROBLEM.**—I am sorry that time will not allow me to work out the problem proposed by "Amicus" fully; but I will make all clear for him to do so. He must not be afraid of large complicated numbers and expressions. The question is solved more easily by trigonometry, yet as it is taken from "Newth's First Book," I imagine the algebraical solution to be what "Amicus" requires. Thus:—Let the diagonal C B of the the parallelogram A B C D represent in magnitude and direction the resultant of two forces A C, C D, acting upon a point C at an angle of 135°. Let A C = C D. Let C B = 100lb. It is required to resolve C B into its components. From B draw B E at right angles to C D meeting the latter in E. Because A C B = 135°, A B D = 135°, and C A B + C D B = 90° But as they are equal C D B = 45° In the triangle B E D, the angle B E D = 90°; E D B = 45°, and therefore, D B E = 45°, *i.e.*, Euc. i. vi., B E = E D.



Let x = length B E, then x = length E D.

and Euc. 1, 47, $\sqrt{2x^2}$ = length of $BD = x\sqrt{2}$,

or, "Wormell's Mechanics," the hypothenuse =

either side $\times \sqrt{2}$, $\therefore BD = x\sqrt{2}$;

but $BD = CD$ (const.), $\therefore CD = x\sqrt{2}$

and $CE = x\sqrt{2} - x$.

By Euc. 1, 47, $BC^2 = CE^2 + BE^2$,

i.e., $100^2 = (x\sqrt{2} - x)^2 + x^2$.

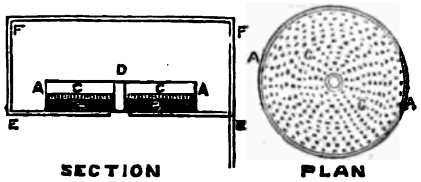
"Amicus" can solve this equation, and getting the value of x or B E, he can multiply by $\sqrt{2}$ to get B D, or

$x^2 + x^2 = BD$.

P.S.—I do not think our friend will ever get such a difficult problem in the "London University Matriculation Papers."—C. H. W. B.

[4618.]—**MANAGEMENT OF BEES.**—I agree with Thos. Poulton, that letters on bee culture would be very interesting, and I trust not inappropriate to your columns. If he would fill a wide-mouthed bottle with water *or bee food*, tie some fine muslin over the mouth, and quickly invert it, he will find none will escape after the bottle is inverted, and will at once see the principle of the feeding bottle. The bees suck the food through the muslin from the bottle, as it is inverted over the hole on the top of the hive. Sometimes the bottle is inverted on perforated zinc, allowing it to be removed and replaced, without the bees escaping through the hole at the top.—Astron.

[4618.] **BEE MANAGEMENT.**—In answer to Thos. Poulton, there are several ways of feeding bees, but I believe the best feeder is the simplest, viz., a round zinc pan, as per sketch.



SECTION PLAN

A, zinc pan; B, honey, or sugar and water; C, floating board, perforated with numerous holes; D, entrance for bees; E, top of hive; F, super or working hive. There is a piece of wood, which fits into it and floats on the sugar and water, perforated with numerous small holes through which the bees insert their proboscis, and get nutriment without getting their feet, legs, or wings sticky. The feeder is placed on the top of the hive, and the bees ascend through the centre. Of course this is used with the humane or depriving system, other than which no amateur or any other bee-keeper should use. With this hive, which is as inexpensive as any, and which any youth with a little ingenuity can construct for himself, the little bees will produce more honey, and afford a constant and highly interesting study, for any time the bees could be seen at work through the glass doors. As far as expense goes bees can be kept in an old wooden barrel, providing it is clean, and put in proper position, &c. The simple square box hive, with two or three working supers, is a very good one, and gives very little trouble to the bee-master, and a strong healthy swarm will work three supers during the honey season. Should my brother readers require any further information on bees and beekeeping I shall be glad to aid them in every way I can if they will ask through your columns.—Frank.

[4618.]—**MANAGEMENT OF BEES.**—Feeding-bottles for bees are on the principle of the fountain for bird-cages. They are readily made. Get a wide-mouthed glass bottle—a pickle-bottle, I usually have—nearly fill with syrup, have a piece of canvas and tie on the mouth as if you were tying down preserves, only don't have the cloth two thicknesses. The hive is supposed to have a large hole in the top, on this place a bit of perforated zinc, holes about the size of the head of a pin. Carefully turn the bottle of syrup upside down on this zinc. No more syrup will leave the bottle than what the bees will readily take up. See J. W. Pagden's pamphlet on bees, To make syrup I buy West India sugar, 4d. per lb., to every pound I add half a pint of water, boil for *a few minutes*, say, five minutes, when cooling stir in a pinch of salt and a few drops of rum. On the 11th July, I had a swarm too late in my district to do any good. I hived it into a box 12in. square, 9in. deep, commenced feeding, each night giving a bottle of syrup, about a pound and a half, and on the 27th of July the box was full of beautiful comb, having used 12lb. of sugar. In feeding, mind and don't spill any of the syrup, and be sure to cover the bottle, so that no bees can get to it, or you will have much fighting and so loose your stock.—J. Lee.

[4621.]—**CHLORIDE OF GOLD** may be made by dissolving the metal in one part nitric acid by mixing two parts hydrochloric acid.—New Subscriber.

[4621.]—**CHLORIDE OF GOLD.**—If "Young Photo" mixes one part nitric acid and two parts hydrochloride acid in a beaker or bottle and cuts the gold into small pieces will dissolve sooner. The deep yellow solution thus obtained yields by evaporation, yellow crystals of the double chloride of gold and hydrogen soluble in water, alcohol, and ether. N.B. Place the dish containing solution of chloride of gold over the mouth of a pan containing hot water, so as to evaporate the acid off.—Omega

[4621 and 4622.]—**CHLORIDE OF GOLD AND NITRATE OF SILVER.**—For replies to these queries see G. E. Davis's letter in this number.

[4622.]—**NITRATE OF SILVER.**—"Photo" must precipitate all the silver out of his solution by the aid of hydrochloric acid. After standing a day or so, pour the water off, and get a clay crucible and mix the white precipitate (from solution) with charcoal and carbonate of potash, and place the crucible in a well-urged fire. You will obtain a pellet of silver, which must be dissolved in nitric acid and solution crystallized in a water bath.—Omega.

[4624.]—**"YOUNG JOBBER."**—The selection of a pendulum spring for a watch is regulated according to circumstances, namely—a verge watch requires one kind, a lever watch another kind, the duplex different again, and the horizontal again differing from the rest. Presuming that he requires a pendulum-spring for the *lever* watch, proceed as follows:—Select, or make, a pendulum spring to suit the size required, that is, that the spring is such diameter that the outer coil lies nicely between the curb-pins and free of the stud when the eye of the spring is exactly central with the potence hole. Let the spring contain about twelve to fourteen turns there is no recognized rule, to determine the length of wire or number of turns chosen by springers. All they have to avoid, concerning this part of the matter, is that the turns are not too close to each other, nor too open. A good kind of spring will have its turns the distance apart of four times the thickness of the wire of which it is made; the length of which will very much depend upon the size of the watch. In all probability the average length may be 5in. to 6in. Next find by counting the train of wheels—or by the old spring—how many vibrations per minute—or half minute—the balance must perform, then secure the spring to the pendulum collet, attach it to the balance, hold the outer end of spring firmly by the tweezers, and while the lower pivot of balance rests slightly on a piece of glass cause the balance to have rapid motion by striking one of its arms, that motion may continue for 90 or 100 seconds, during which time count how many vibrations the balance performs in the time required, say half a minute. Thus the springer is guided in the selection of a pendulum spring.—Seconds Practical Watchmaker.

[4625.]—**FLUORINE.**—This element must certainly be reckoned as one among the normal constituents of the human body, though it only exists therein in a very small quantity. It is alway found in the teeth, more especially in the enamel, as well as in bones, particularly fossil ones. It also exists in minute quantity in most animal and vegetable products, in water, both salt and fresh, and in most rocks. There is, consequently, no difficulty in seeing how a supply of this element is sustained in the human body.—Trinitrophenic.

[See also G. E. Davis's letter.]

[4627.]—**LEATHER DISCOLORATION.**—"G. A. G." being in the leather trade, should know that gallic acid, one of the products of tanning, in contact with iron and moisture produces common ink. His moulds and stamps should be made of brass or boxwood.—H. W. Reveley.

[4627.]—**DISCOLORATION OF LEATHER** is caused by the iron press. All iron liquors or sulphate of iron will blacken leather. The proper way to make impressions is to get your impression made in white zinc metal, ¼in. thick. which should fit in a groove, made to receive it Fig. 1, in the top part of the press, and before using it should be taken out and made warm, and then slid back into the groove again. Two pieces of flat white metal, cut at an angle and screwed to the top part of the press, Fig. 2, would make the grooves.—S. Scholefield.

FIG. 1

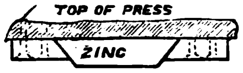
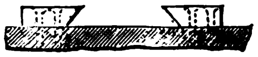


FIG. 2



[4628.]—**INTENSITY COIL.**—In answer to "W. J. P.," I have made a coil from instructions given by "Dyer," and except that I have made mine only half the size "Dyer" gives, in every other respect I kept to his instructions, and had not the least difficulty whatever. When I connect the coil with two point-cells of a Daniell's battery, the shock is so strong that none of my friends dare take hold of the handles.—J. D.

[4629.]—**MANGANESE BATTERIES.**—I regret that I have, from other business, overlooked two queries in your last issue, in which my name occurs, until now. I have to state that my battery is simply the Leclanché, but without the accumulation.—W. H. Stone.

[4632.]—**WEIGHT OF BALL.**—Ralph Williams in this query makes it appear that my former answer is characterized by two errors. But I am pleased to say that I am not accountable for either of the (apparent) errors. I think that "R. W." himself is accountable for the first one, and the printer for the other. In the first place "R. W." *points* out that he thinks I have missed a *point* (I presume he means a decimal *point*). If so I beg to *point* out to him that the said *point* will be found *behind* the figure 7 in my former answer, and not *before* it, as *he* places it, which makes all the difference—7·854 being made to stand as ·7854. In the second place the printer has misplaced a decimal *point* in connection with the weight of wire, ·5, or half a pound, being made to appear as 5lb. I thought "R. W." would discover the error when he knew that the weight of the wire was half-a-pound. He will see that dividing by five and dividing by point five, give different results. Perhaps a little explanation will assist "R. W." in comprehending the rule (which I hope is not too simple). Of its correctness I can entertain no doubt after twenty years' almost daily experience. The rule to obtain the weight of round bar iron is as follows: Multiply the square of diameter by 2·618, which is the weight in lbs. of a lineal foot of round iron, 1in. diameter. In working out the weight of a foot of ¼in. round wire for my former answer, I found that it involved several places of decimals. I therefore took the weight of a yard, which, coming so near to half a pound, made the process very simple. On referring to Penn I find that he gives the weight of 3ft. of ¼in. round iron as ·49; Spon gives ·51. I take the mean and say ·5, which is sufficiently approximate for all practical purposes. Of course I had to multiply the weight of a foot by three to obtain the weight per yard. Or else (which was more simple) multiply by the weight of a yard of round iron 1in. diameter, which is 7·854. I did not attempt to split hairs, as I inferred from "R. W.'s" first query that he only wanted a rule whereby he could obtain the weight of *round* iron in the shape of *round balls* and *round* wire, so I gave the weights in *round* numbers. I may now inform "R. W." that the ·146 made use of to obtain the weight of a wrought iron ball is the weight of a wrought iron ball 1in. diameter. So that the cube of any sized round ball multiplied thereby will give the weight in lbs. I think I have now said enough in explanation of the rules and the reasons for the rules, and think that if "R. W." will try again (bearing in mind these corrections) he will succeed to his own satisfaction. It is scarcely necessary for me to work the sum now. But I do so with pleasure, hoping thereby to satisfy "R. W." Weight of ball 7in. diameter. $7^3 \times \cdot146 = 50\cdot078$. Weight of a yard of ¼in. round wire $\cdot25^2 \times 7\cdot854 = \cdot490{,}875$ For simplicity I take the weight as ·5. Therefore

$$\frac{50}{\cdot 5} = 100.$$

If "R.W." will invest 2s. in a little book published by Charles Fox, Paternoster row, viz., "Penn's Tables," showing the weight of round, square, and flat iron, brass, copper, I think he would be pleased with the same and find it a cheap two shillings' worth. Does not J. Nash find his weight too heavy for a cubic foot of cast iron? Most authors give it as 450lb. This will account for the 8lb. difference between my weight and his of a 7in. ball.—Ferrum.

[4634.]—**ELECTRIC CLOCK.—TO "ELECTRO-MAGNET."**—I may add that the clock is equally unoriginal, being a Swiss patent, exhibited in the last Paris Exhibition. I heard of it from my friend Dr. Grabham, of Earlswood, and procured one through his instrumentality. The English patent has been bought by Mosely, of Covent Garden. The only points to which I wished to draw attention were the mode of making the battery and the remarkable permanence of the action.—W. H. Stone.

[4635.]—**CAKE COLOURS.**—Procure a small slab and muller of glass, and grind the powders into a smooth stiff paste with equal parts of isinglass size, and thin gum water; compress into squares as closely as possible, and dry with a very gentle heat. Old crumbling cake-colours, may be powdered very finely in a biscuit-ware mortar, and sifted through fine muslin, and ground up as above, omitting the gum water in the medium. If the powders are rubbed up with honey (*despumated*) to the consistence of thick cream, they answer admirably as *moist* colours.—Sable.

[4640.]—**SOUTH KENSINGTON EXAMINATION PAPERS.**—If "J. B. H." sends direct to South Kensington for the examination papers, they will be sent to him by secretary, Science and Art Department. He will have to pay for them, 6d I think.—C. H. W. B.

[4648.]—**TWO COINS.**—The upper one is a PAXS penny of William I., possibly one of the 12,000 or so found on the property of a Mr. Dunn, of Beaworth, in Hampshire, in the year 1833. The obverse is PILLELM REX (William King), and on the reverse is "OCMUND ON SUDE," Osmund being the moneyer's name, and Cude the place of coinage, Southwark. The letters PAXS in the angles of the cross, by some, considered to be an abbreviation for "Pax sit," a not improbable expression of hope for peace in the troublous times of the Conqueror (v. Ruding). The lower coin is a sixpence of Philip and Mary, date 1554. Value depends on condition.—T. W. Boord.

[4650.]—**FRENCH LANGUAGE.**—I think "Ollendorff's Method" would suit "Patty" very well.—G. W. A.

[4652.]—**TONING BATH.**—I have used the following for the last four or five years, and know of none superior for rich purple tones:—30grs. acetate of soda, 10oz. water, 5grs. carb. of soda. This to be mixed some hours before wanted, and chloride of gold sufficient to tone the prints in hand added just before required for use. The bath works quickly hot and slowly when cold. I always prefer it hot, and the solution may be used over and over again, *ad libitum*. I may also add that for the last three or four years I have always used nitrate of potash in my sensitizing bath in the proportion of 2 of silver to 1 of potash, and obtain richer tones and more glossy prints by so doing:—2oz. nitrate of silver, 1oz. nitrate of potash, 20oz. water, neutralized by a little carb. of soda. I never have any "old" bath. I use it up until there is not sufficient to float my paper, and then add fresh.—Unit.

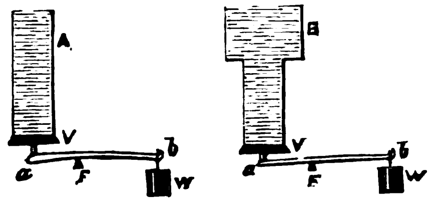
[4653.]—**SUNDIALS TO SHOW CLOCK TIME.**—Wishing still to leave this problem to your readers' ingenuity for a month, I will only give the querist of p. 574, at present, the information that should enable him to solve it. 1. Astronomical.—The "Meridian of mean time," or that line in the apparent heavens which contains the place of the sun's centre at every 12 o'clock, may be plotted by attending to the two columns, in any almanac, of equation of time and sun's declination. It has the form of a long italic 8, so leaning across the true meridian as to touch the northern tropic about 1¼ minutes (of an hour) west, and the southern about 1¼ minutes east thereof. This leaning slowly increases, and will for many centuries; but the inequality of the two loops is decreasing, having been at its maximum six centuries ago, when the 8 was last upright. The leaning is alternately to the right and left, for about 6,000 years each; but each loop is alternately largest for twice that period; and the southern has been largest ever since Adam's time, when they were last equal. The widest bulge of that loop is now somewhere about 15° of S. declination, and that of the smaller loop, 20° N. The crossing of the curve on itself is some ¼ minute west of the meridian, and about 10° N.; and its four crossings of the meridian are at some 9¼° and 10¼° N., at a point *very* near the northern tropic, and at one still nearer the southern. I expressly renounced the showing of true clock time for a few days of midsummer and midwinter, namely, when the sun's declination exceeds the last-named two points. I should add that the indications of all dials within half an hour of sunrise and sunset, will always be vitiated by refraction, and the scale should never extend to those hours. 2. Optical.—The solar shadow of every object is bordered by a *penumbra*, whose angular width equals the sun's apparent diameter, and the theoretic shadow's boundary (as it would be cast by a star occupying the place of the sun's centre) is half-way between the edge of pure shadow and full light. But while the former of these is always perceptible, the latter never is so with accuracy. Therefore the shadow boundary to be used practically in dials must always be that of pure shadow, which is within, or less than, the theoretic shadow by half the sun's diameter at the time.—E. L. G.

[4654.]—OCCULTATION OF SATURN.—"Hesperus" will find no difficulty in interpreting the *Nautical Almanac* account of this phenomenon if he will refer to page 164, where he will find that the horizontal parallax of the moon on September 30th is about 59′. This is the maximum amount by which the moon's apparent place in the heavens may be shifted from her place as supposed to be viewed from the earth's centre. Further, her semi-diameter on September 30th is more than 16′, so that even though Saturn were 75′ (*i.e.* 59′ + 16) from the moon, supposing both to be viewed from the earth's centre, he would be occulted as seen from some parts of the earth's surface. He is actually about 56¼′ from the moon, southwards, at the time of conjunction; so that, as seen from stations having more than a certain northerly latitude, he will be occulted.—R. A. Proctor.

[4654.]—OCCULTATION OF SATURN.—Without examining the *Almanac*, it seems pretty plain that "Hesperus" must have overlooked the *moon's parallax*. The elements he quotes, are doubtless given for the earth's centre, not Greenwich; and apply to the place where the bodies will be vertical. The *Almanac* does not predict an occultation *there*, but at Greenwich, which is quite possible while their *geocentric* distance is as great as he states; the moon's horizontal parallax being greater, and Saturn now never much above our horizon.—E. L. G.

[4655.]—MANGANESE BATTERIES.—TO "F. H. B."—I protect my connections from corrosion with a small plate of platinum foil under the copper. I understand, however, it is possible to prevent corrosion by making the carbon very long, so as to project some inches from the solution, and painting a thick band of shellac varnish round the projecting part between the fluid and the binding screw.—W. H. Stone.

[4664.]—PRESSURE OF WATER.—The pressure per square inch on the bottom is the same in each case. The pressure of a fluid on the bottom of its containing vessel depends on the depth of the fluid and not on the form of the vessel. "Holbeck" may demonstrate this for himself in the following manner:—Take a plane tube A, and to the bottom fit a water-tight valve, V. This may be pressed up by means of a lever, *a b*, as shown in the sketch. F being the fulcrum and W the weight. Water must now be carefully poured in till the valve just begins to open and the height of the column of water noted. Now perform the same experiment with a tube of the form shown in the sketch B, the bottom of which has the same area as that of A, and let the valve be pressed upwards by the same, or a similar lever and weight; on pouring water in, the valve will just begin to open when the height of the column is the same as it was in A.—Exhibitioner at Royal College of Science.



[4664.]—PRESSURE OF WATER.—No difference, of course. It is the most elementary fact in hydrostatics.—E. L. G.

[4664.]—PRESSURE OF WATER.—In reply to "Holbeck," the pressure per square inch at the bottom of each pipe is exactly the same, namely, about 5·29 lbs.—Thomas J. O'Connor.

[4665.]—PROBLEM.—α. Call the regular length of journey x minutes. The train proceeded regularly 60 minutes, then stopped for 30, and had to do the remainder, which would regularly have taken $x - 60$, at three-quarter speed which occupied $\frac{4}{3}(x - 60)$—The whole took, we are told, $x + 110$ minutes. Hence (A) $90 + \frac{4}{3}(x - 60) = x + 110$. Next, had the train proceeded 90 minutes right, and stopped for 30, it would have had to do what usually takes x 90, at three-quarter speed, requiring $\frac{4}{3}(x - 90)$ and these times, we are told, would have made $x + 100$. Hence (B) $120 + \frac{4}{3}$ $x - 90) = x + 100$. Rejecting the figures common, to both sides, equation (A)

becomes $\frac{4}{3}$ $(x - 60) = x + 20$; and

(B becomes $\frac{4}{3}$ $(x - 90) = x - 20$. Their half sum is

obviously $\frac{4}{3}$ $(x - 75) = x$; so that $x = 300$.

β. From $\frac{1}{2}x + 30 + \frac{1}{3}x = x + 80$ by merely omitting the 30 common to both sides $\frac{1}{2}x + \frac{1}{3}x = x + 50$, whence $\frac{1}{6}x = 50$, and $x = 300$, as before. So that the β information is correct, and sufficient alone, with none of α, to determine that the regular length of journey was five hours.—E. L. G.

[4668.]—LATHE.—TO "TOMETER."—You ought to be a pretty good judge of what you are able to do. A great deal more is required in lathe making than a mere knowledge of turning. As to price, the £100 and the £25 lathes are probably each worth about its price—*plus* profit. You want an amateur's lathe, that is, one fit for a gentleman's use, and seem to think that you can get it somehow at the price of one that an apprentice would be set to work at. Do not, pray, make a 4½ lathe: nothing less than 5. I should get the bed cast and planed and fitted on to standard, and fly-wheel and treadle fitted complete as a first start, and I reckon to get that well done will take £11 more or less for a 5in. You can add a leading screw at any time after all the rest is complete, and the bearings for screw may be cast on or screwed on afterwards as you please. And all the above work I should entrust to Wilkinson, and nobody else. You can get a 5in. lathe of Whitworth with sundry chucks for £90. One of Muir's for less than that, and one of Smith, Beacock, Tannett, for a little more than half Whitworth's price.—J. K. P.

[4668.]—THE LATHE.—Perhaps "J. K. P." will pardon me for answering a question addressed to him. I do not think £25 at all an adequate price for a lathe such as "Tometer" describes. If he wants a good lathe and has not the money handy, he might borrow it, and, as he says his time is his own, he could easily earn the interest of the money advanced, and so gradually pay off the debt.—G. W. A.

[4672.]—KITE.—The kite would certainly not act as "W. J." describes, for suppose it to be suspended in the air as he proposes, and to be inclined at an angle, say of 45°, which would be about the proper inclination; then the wind pressing on the inclined kite would act in two ways, it would tend to drive it along horizontllay and it would also tend to drive it up perpendicularly, and as these two forces would be equal, and supposing there be nothing to oppose or diminish either of them, the utmost the apparatus could do would be to move in the direction of their resultant, or in other words it would move up from the earth in the direction of the wind at about an angle of 45°. But seeing that the weight of the kite and its appendages would diminish the force of its upward tendency, and that no opposition whatever would be offered to its horizontal motion, the practical result would be, that though it might possibly rise up into the air, it would, at the same time, move along with the wind at a much more rapid rate. In order that any apparatus may beat up to windward, it is necessary that it should have something to hold on to, in order to prevent it drifting to leeward. A boat beats up into the wind because its length gives it a firm grip on the water, and a kite will beat up to windward (as indeed all kites do when they rise up from the earth) provided it is held by a string to prevent it going with the wind. A kite could no more work up into the wind without being held by a string, or some equivalent contrivance, than a lever could be used without a fulcrum. The apparatus "W. J." describes would drift hopelessly along with the wind.—W.

[4676.]—NITRATE OF SILVER.—Refer to replies to query 4622 in last number.—T. W. Boord.

[4676.]—NITRATE OF SILVER.—The sediment from "Paddy's," salted "slops" is *chloride of silver*. His best plan is to collect the sediment in a large bottle, and when full, sell it to a chemist, together with all his old filter and draining passers, or get the chemist to convert them for him into nitrate.—Unit.

[4678.]—BOURNE ON THE STEAM ENGINE.—In reply to Thomas Watson no better work than "Bourne" is at present published on the steam engine. "Main and Brown on the Steam Engine" is also a very good work, but it treats principally on the marine engine.—Thomas J. O'Connor.

[4689.]—PEDOMETERS.—The motion of the body in walking causes the vibration of a short weighted arm or pendulum which acts upon a small toothed wheel, geared into another connected with the index.—Unit.

[4691.]—POWER OF ENGINE.—According to the rule to which "R. W." refers, the power of his engine at 30lb. pressure would be ⅓ horse power, thus,

$$2 \times 2 = 4 \div 12 = \frac{4}{12} = \frac{1}{3} \text{ h. p. of engine,}$$

therefore three times the given pressure, or 90lb. per sq. in. would be necessary to enable the engine to work up to 1 horse power. With respect to the thickness of boiler plate, I must refer "R. W." to some practical boiler maker, whose advice will be safer than mine, for 90lb. is an unusually high pressure. If possible, it would be far better to use an engine with a 3in. cylinder, since then, the pressure need not be more than 40lb., the expense of boiler being, of course, proportionately reduced.—Vertumnus.

[4698.]—BICHROMATE BATTERY.—The plates are usually about ⅜in. or ½in. between the faces. The resistance of the solution is so small that I think very little powder would be lost, and greater constancy be obtained, if they were 1in. apart. The plan for connecting (given under the heads of "Carbons" and this battery in my papers) is the best possible—viz., electrotyping the top of the plate and soldering.—Sigma.

[4701.]—CLEANING COINS.—Caustic ammonia will clean silver coins. Much more harm than good is likely to result from attempting to clean coins of any value.—T. W. Boord.

[4706.]—PHOTOGRAPHY.—"In a Fix" has overdosed his washings with salt. *A very small quantity of salt* is sufficient; too much undoes it all. "In a Fix" had better put all his future washings into another mug and try to precipitate the silver by adding a little of the *over-salted* washings to it instead of salt, and so gradually use it up. Unit.

[4709.]—PROCTOR'S TELESCOPE STAND.—The dimensions of the stand figured at p. 17 of my "Half-hours with the Telescope," can be gathered from the fact that the telescope was of the size mentioned by "Turton"—that is, 4in. in aperture and 5ft. in focal length. I do not recommend the stand as [illegible] figured. The toothed wheel and quadrant are too expensive; and, again, the legged part of the stand should be higher in proportion. The great toothed quadrant should be replaced by a semicircle without teeth; a cord carried along the circumference of the semicircle and making a turn round the [illegible] the endless screw in my figure, serving to give a continuous motion in altitude. In like manner a cord round the circle *c*, with a turn round the [illegible] the crown-wheel, would give the continuous motion in azimuth. The figure is really a picture, with very slight modifications, of a telescope I used in [illegible] at Marlborough School. The crown wheel I [illegible] from a part of the appurtenances of a [illegible] I also filed and set the endless screw, and a [illegible] of work I made of it, more by token. The [illegible] wheel working in the crown-wheel was made by breaking a knitting needle into four equal parts and tying these (!) parallel to each other round [illegible] a rod. The instrument, when thus completed, was a singular combination of the expensive and the commonplace; but the knitting needle and the [illegible] arrangement worked well all the same; and the [illegible] of having the two handles, which give the altitude and azimuth motions, always in the same fixed and convenient position, was such as to make one [illegible] instrument was an alt-azimuth.—R. A. Proctor.

[4718.]—BEES.]—They will pass in and out through such a hole as you describe, provided you connect the entrance of their hive with it in such a manner as to prevent their escape into the room where the hive is kept. Move them at night, and in the morning they will take the bearings of their new locality before commencing their labours, so as to be able to find their way back again. For feeding in winter, use a syrup made of white loaf-sugar, boiled down with water, about a pound to a pint.—T. W. Boord.

[4721.]—FOSSILS.—"H. U." ought most certainly to find some fossils in the locality between Cromer and Hunstanton. The Tertiary system is *very fully developed* in that neighbourhood, and amidst the Crag of the Pliocene group he may chance to come upon the remains of small mammalia analogous to the mouse, also teeth and bones of placoid fishes, and *corals*, and shells of innumerable species; marine plants are *likewise to be* found. The strata consist of marine *and lacustrine* deposits of shelly beds of sand, clay, and *yellow loam, and* flinty shingle, generally resting *on the chalk system*. "H. U." should wander into *any gravel pits or quarries*, &c., and closely scrutinize *every* rock near *which he* comes; he should also provide himself with a hammer for the purpose of detaching specimens. The chalk or Cretaceous system lies immediately below the Tertiary and is rich in shells.—Arthur Underhill.

QUERIES.

[4725.]—SHORT-SIGHT.—Could any of your scientific readers give me a little advice under the following circumstances? I am very short sighted, so much so, that I am unable to recognize a person ten yards distant, which is very inconvenient for my daily occupation. I am 21 years of age, and my sight has gradually got shorter since 14. Is it prudent to wear spectacles (I have a great horror of them), I have heard they strain the eyes and otherwise prove injurious.—Moses.

[4726.]—HOROLOGICAL.—TO "NOBODY."—Thanks to "Nobody" and others for their kind replies to my queries, No. 4,128. I never had the pleasure of reading such a welcome communication before as that of "Nobody's" on watch jewelling; and allow me to tell him I found it practical to the letter. Will that gentleman kindly inform me how to turn in a new verge, and also how to fit a balance wheel to a verge watch, naming tools to be used in the same, and oblige?—Compensated Balance.

[4727.]—TO "OMEGA."—I am very much pleased with the results given by "Omega" in his paper on Slater's iron cell. Would he kindly inform me where I can obtain nitrous acid at 4d. per lb., and also nitrate of soda at 1½d. lb.? I should very much like to know the results obtained with his 36 cells.—A. J. Jarman.

[4728.]—TO "SIGMA."—I am glad to hear that "Sigma" is going to compile his present papers into a book. Undoubtedly it will be about the best work on electricity. The iron that contained 65 per cent. of carbon was a piece of common cast-iron gas-pipe. I would like "Sigma" to inform me how zinc can replace sodium in a solution of sodium chloride, as he asserts it does; while in one of his former papers he says that zinc cannot replace sodium in a solution of sodium chloride, and I think so too.—A. J. Jarman.

[4729.]—TO MR. PROCTOR.—Mr. Proctor says α Arietis is visible in a 3in. Will he say what is the angular distance and magnitude of the components? Does Mr. Wray use a cement, liquid or solid, as a concave lens in his glasses?—Aquæ Solis.

[4730.]—NAIL MAKING MACHINE.—Can any correspondent inform me what would be the cost of a machine to make cut nails, and how many different sizes one can make, and also what power is required to work one?—Nail Maker.

[4731.]—TO "SIGMA".—I shall esteem it a very great favour if "Sigma" will inform me whether soaking a portion of a carbon plate with paraffine, to prevent absorption of liquid, as suggested by him some time since, would not have an injurious effect upon its conductivity.—Dædalus.

[4732.]—GAS-TAR.—Would "Sigma," or any reader kindly inform me how gas tar is prepared, so that its alcoholic solution would form an emulsion with water.—Domino.

[4733.]—BRONCHITIS.—Can any of your readers inform me of a cure for bronchitis? I am much troubled with it, especially when I walk a distance in a hurry, the tubes get full of mucous, and expectorati on is the only relief; at times the mucous is streaked with blood. I bathe the throat and chest with cold water frequently, and have found it a great benefit, but the disease or trouble is never away, and is annoying.—Omega.

[4734.] REMOVING WRINKLES FROM PRINTS.—Will a brother subscriber inform me how I can remove wrinkles out of a coloured print? The print is fastened to the back of the frame with gum or some other adhesive substance, but in places it is drawn from the back and rose up in wrinkles.—Winner.

[4735.] PEARL OYSTER-SHELLS.—Can any one tell me where the above are to be purchased and the price?—Thos. Fletcher.

[4736.] BALANCE IN VERGE WATCHES.—Will any of our watchmaking brothers enlighten one desirous of gaining knowledge as to the best way of uprighting the balance in verge watches when the cock and potence holes are worn and want refilling, or have been refilled, and left with balance leaning on one side? What I want is the best and easiest method of setting out the holes so that they shall be perfectly perpendicular, as I find frequently that watches which have been so repaired fail in this essential point.—Cheek-ache.

[4737] BLOWPIPE.—I wish for some information upon the practical use of the blowpipe. I possess one 10in. in length of brass, and can manage to braze small articles such as watch hands, &c., but when I attempt to solder new joint or pendant on watch case with silver solder it results in a miserable failure. I use a common tallow candle, or in place of which I use a small benzine lamp filled with benzoline. Then I place a little powdered borax on the joint, or whatever it may be, with the silver solder on the top, then placing the article in my left hand I direct the blowpipe and flame with my right hand upon the work, and blow till the borax is melted and the silver also, which has been laid on in a strip, which runs into a small round globule glittering and dancing beneath the heat of the flame. This is all that I can attain. The fault appears to be that I cannot obtain sufficient heat in the article to be brazed to enable it to take the solder (but I may be wrong), although I may blow till my cheeks ache and my eyes start. Is the fault in the blowpipe, the candle, or lamp, or want of oxygen in the breath, or where is it? I know that such work is done daily, and hope to receive instruction through your columns.—Cheek-ache.

[4738.] GEOLOGICAL.—There is a matter which has puzzled me much, viz., the "cause" of the intervening strata, or the sandstone rocks, which is found between the different coal beds. In other words, if the vegetation of the coal bed periods has been caused by the heat of the sun and seasons, what has been the "cause" of the sandstone periods?—Veritas.

[4739.]—COLOURING SIZE.—As no correspondent has answered my query, 4317, page 490, can any one tell me what to put into the size to make it a very pale blue, as I find by putting indigo into the size it makes it a green?—John Bury.

[4740.]—CONTACT BREAKERS.—Will "Sigma," or some fellow reader, describe the contact breaker of the large coil at the Polytechnic (or any other) that counteracts the destructive action of the spark?—R. N.

[4741.]—DISSOLVING INDIA-RUBBER.—Would some one inform me how to dissolve india-rubber, so that it will mix with oil and turpentine?—Rubber.

[4742.]—STEREOTYPING IN A SMALL WAY.—I have had many attempts at stereotyping in a small way, both by the paper and plaster of Paris processes, but have always partially failed. Having read, here and there, about electrotyping, I have thought of trying that process, and now wish to know whether, by taking an impression in gutta-percha or plaster of Paris, I could get a slight deposit of copper upon either of them sufficient to print from. After having obtained the battery, is the process more difficult or open to failure than stereotyping? What would be about the price of a battery sufficiently powerful to coat a surface of, say, 7in. by 4in. of music stereo, which I have obtained by a new process, and desire to prove? I should feel greatly pleased if some of your numerous correspondents would answer me.—George.

[4743.]—HEM-STITCHING MACHINE.—Can any reader give me any information as to the construction of the hem-stitching machine, or how I may get to see the specification of the patent?—Aquillus.

[4744.]—GUN-COTTON.—Will any kind reader of our paper inform me how the above is made? I have tried equal parts of nitric and sulphuric acid; poured over cotton wool, it turned a brownish colour, and some became like jelly, and after a thorough washing failed to be explosive?—Experimentalist.

[4745.]—STARCH.—What substance can be used with the above to give linen a fine gloss, such as you see on collars, &c., in shops?—Tidy.

[4746.]—SCREW CUTTING.——I should be very glad if our kind correspondent "J. K. P." would give me some information on the screw-cutting lathe. I have a four-foot lathe with back gear and slide rest, the bed flanged same as ordinary screw-cutting lathes, and saddle to fit. What I want to know is what form of nut he would advise me to use? Being only an amateur, I do not want a complicated affair. I have had a screw cut for the lathe, but no nut for it. The pitch is ¼in. square thread. Would he advise me to have a split nut or solid nut with bevil wheels to work with handle at the front? I see that he has sent some useful information on the lathe, which encourages me to ask him to do me and my fellow readers a great favour.—Joseph Moseley.

[4747.]—GLASS BURNING.—I am afraid Mr. Ashton will think me very *dense*, but I venture to ask him for a diagram of his brick furnace, described at page 476, also for replies to the following questions:—What is the medium used for painting on the colours? Is it necessary to submit the painted glass to the action of heat after laying in each separate shade, *e. g*, as in flesh tints, draperies, &c.? The painted glass is directed to be placed between layers of quicklime,—will not the lime mingle with the colour during fusion, and injure its evenness and transparency, what kind of fuel is most suitable? Will the red protoxide of copper yield a good ruby colour, and oxide of manganese a good amethyst?—Sable.

[4748.]—ELECTRO-MAGNETIC BATTERY.—Will some kind reader inform me how to construct the above so as to produce a strong magnetic current? any valuable hints will be acceptable.—Bering.

[4749.]—CARBOLINE.—Would "C. D. C." be kind enough to state where I can obtain carboline, and at what price per gallon?—A. J. Jarman.

[4750.]—SOFTENING AND PURIFYING WATER.—I should be glad if some correspondent could tell me where I could get a description of "Clark's patent for softening and purifying water," as mentioned by Dr. Frankland in his report to the Registrar-General for the month of July, and referred to in your number for August 19th, p. 182.—J. C.

[4751.]—TAPS AND DIES.—In the English Mechanic for August 5, W. Reed asks (4484) "if he can make left-handed taps and dies from a set of taps and dies for right-handed work," and on the 19th "Semper Paratus" replies that he can; "he has only to work them the other way or backwards." Will "Semper Paratus" please say if he has succeeded in producing serviceable tools by this means *alone*?—T. W. Boord.

[4752.]—DIFFERENTIAL CALCULUS.—Will some one show me how to do this sum? It is in "Woolhouse's Differential Calculus," p. 27:—

$$\text{If } u = \frac{(a^2+x^2)^{\frac{3}{2}}}{x^3} \quad \text{then } \frac{du}{dx} = -\frac{3a^2}{x^4}\sqrt{a^2+x^2}$$

F. P.

[4753.]—GERANIUM PROPAGATION.—Will a brother reader give me a few hints how to slip these plants, and whether or not I am to put anything to the bottoms of the slips?—J. E. Clay.

[4754.]—DRESSING SKINS.—Will any reader kindly inform me how I can dress into mats such skins as sheep, deer, and dog?—Tawer.

[4755.]—CONICAL WINDING DRUMS.—Will some brother reader kindly give some particulars respecting the construction and working of conical or spiral drums as applied at collieries for drawing coals, and state what conditions are to be observed in order to ensure their safe working?—W. M.

[4756.]—CONSTRUCTING MAGIC-LANTERNS.—Can any of your numerous readers inform me how to construct a magic lantern; where the lenses may be procured, the prices of such, or how to grind them; and material required for such purposes?—A. Storment.

[4757.]—GAS PRESSURE GAUGE.—Will any one give me an explanation of a gas pressure gauge?—Alex. Ogilvie.

[4758.]—FRESHWATER FISH AND FISHING.—Being an ardent follower of "Old Izaak" and "the *gentle* craft," I always read with interest "A. T.'s" replies to questions. Can he inform me of any places near London where good fishing can be had on payment of a small fee; or where permission can be obtained on writing for the same? The great drawback we workers in town have is the difficulty of finding spots near at hand where, in our few hours stolen from toil, we can seek recreation at once harmless, healthy, and amusing.—Piscator.

[4759].—POLISHING WALKING-STICKS, Etc.—Will any of our numerous contributors kindly tell an amateur the best polish to use for walking-sticks, umbrella-sticks, &c?—Whitethorn.

[4760.]—EXPANSION OF STEAM.—1. In Spon's "Dictionary of Engineering" under this head, page 428 (article "Boiler"), it is stated that "the dual logarithm of a given number can be calculated without the use of tables in a few minutes." As my table of hyperbolic logarithms goes only to the number of ten, I should be glad, having to calculate the mean pressure of steam corresponding to a ratio of expansion of 1 to 17·47, to have *the rule* as to dual logarithms explained, so as to be able to employ it (?) for *any* ratio of expansion. 2. Not being up in logarithms, would any kind brother reader give me a table of *hyperbolic* logarithms of numbers from ten upwards to twenty, and also explain how the hyperbolic logarithm of a number and fraction (or decimal fraction) of a number *between* units and fractions of units in table is determined. *Example:* Let the number be 4·70. The next *lower* number in table is 4·50 (4½), for which the hyperbolic logarithm 1·5040774 stands, and the next higher, 4·75 (4¾) for which the hyperbolic logarithm 1·5581446. I want to know how I am to find the hyperbolic logarithm of No. 4·70. 3. What is the *rule* for finding the *end* or ultimate pressure of steam (not the mean) for any given degree of expansion? Does the pressure decrease *exactly* in proportion to the increase of volume?—A. W. E.

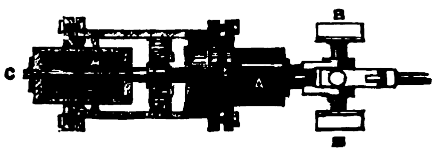
[4761.]—SLIDING RULE.—I wish to know how the scales, or rather the divisions, are laid down, that is, set out on the sliding rule, for working proportions, areas, divisions, &c. Information will greatly oblige.—Robert Bridgart.

[4762.]—DISPLACEMENT OF SHIPS.—Would Mr. W. Felton give a sketch of his model, and how it is divided, for computing the displacement of ships? As models are generally made of wood, will the rule hold good for iron ships?—G. B. D.

[4763.]—SOLDERING BRITANNIA METAL.—Now "J. B——h," having examined the recipe as described by "Sergius," cannot understand the composition of bell metal, thinks it may do very well for iron and brass, but is afraid to use it for Britannia metal. The latter being so soft, whilst bell metal so hard. "Sergius's" reply would oblige.—J. B——h.

[4764.]—BRONZING COPPER URNS.—Can any of your many readers inform me of a simple way of bronzing urns for hot water, chiefly used on the tea-table, value about £5 each, colour very dark copper colour.—J. B——h.

[4765.]—PISTON AND PRESSURE.—A represents a cast-iron cylinder fastened to the piston-road as shown, and working through the bottom of the steam cylinder in the same manner as an ordinary horizontal engine. I will suppose the engine to be an expansive one. Now in my plan the piston, having its full surface exposed to the steam, must, when the ports are open, have the same pressure on it as though the cylinder A were omitted. So far all right, but when it (the steam) is cut off, will the amount of steam contained then expand and do the same amount of work, as an engine without the cylinder A? I think it will, because of the piston allowing its full area to receive the pressure; but would like to know if there are any rules to determine the force of my argument.—One.



[4766.]—STAUNCHING TIMBER JOINTS.—I would feel much obliged by any reader informing me as to the best material for staunching the joints of a canoe (timber-built, of course). Is marine glue used for the purpose, and if so, how prepared for use?—Antares.

[4767.]—MODEL PADDLE-STEAMER.—I am making a model steamer (paddle), about 7ft. long, and wish to fit air compartments to prevent immersion; will some kind reader inform me how to do it, and what to make them of?—T. K.

[4768.]—POLISHING PLASTER OF PARIS.—Would you or some of your numerous readers inform me how to polish plaster of Paris?—A Two Years' Subscriber.

[4769.]—CIVIL SERVICE EXAMINATIONS.—Can any reader give me information respecting the alteration in the Civil Service? Why the examination is done away with, and what course of study it involves? I shall feel much obliged for any information on the subject.—J. M. C.

[4770.]—FIXING PRINTS ON CARDBOARD.—I have a quantity of prints I wish to affix on to cardboard, and should be obliged if any of your readers would favour me with a recipe for a paste or cement for fixing them and the best method of doing so.—T. E.

[4771.]—FLUX FOR BRASS, GUN-METAL, &c.—Will some kind reader inform me what flux is used for brass, gun-metal, &c., and how? In running the metal into a mould I find it leaves a crust hanging from the crucible, and however smooth the mould may be it turns spongy, and not solid, therefore very often of no use. The flux, I think, clears it in a great measure.—Lilliputian.

[4772.]—HERB BEER.—Will some reader of the English Mechanic give me a receipt for making cheap herb beer?—Anxious.

[4773.]—CAUSE OF THE EARTH'S REVOLUTION. Can you give me any idea what causes our earth to revolve? I can understand it being set in motion, but why does it go on, as far as we can judge, at the same rate for at least thousands of years? Call me, if you like—A Moke.

[4774.]—THE AILANTHUS.—Will some of your correspondents kindly give me some particulars of the Ailanthus silkworm? I wish to breed a few. 1. When does the egg hatch? 2. How long before the larva becomes a chrysalis? 3. When does a chrysalis hatch? 4. Where is the plant to be procured upon which it feeds? 5. Where can I procure some eggs? I have seen the names of other silkworms but do not know where to look for them, but shall be glad to have particulars of one or two of them also.—A Constant Reader.

[4775.]—LUMPS ON HORSES.—Will any of your readers kindly inform what they consider the best cure for small lumps on horses, commonly known as "heat weals," and what to apply when they break under the collar?—A Groom.

[4776.]—LATHE.—Your correspondent T. W. Boord, gives the numbers on the division plates of lathes by different makers. It would interest many to know the size and pitch of the screws on the respective mandrels, and whether the same gauge is adapted for "ornamental lathes" as for those for general use; also the diameter of the dividing wheels and pulleys of each lathe. I presume the lathes referred to are 5in. centre.—Amateur Turner.

[4777.]—LINK MOTION.—I am surprised to see "R. W. B.'s" question (4581), after the very clear and intelligible papers by Mr. Baskerville on the subject. May I ask Mr. Baskerville to explain a sentence in the last paragraph but one in his last letter about the stationary link as applied to the locomotive? He says it requires "a length altogether out of the question in a screw engine or a locomotive." To what extent the word *properly* applies I know not, but there are a large number of engines running on the London and North-Western, and London, Tilbury, and Southend Railways with this motion.—G. W. A.

[4778.]—DENTISTS' CEMENT.—Can some one inform me how the cement that dentists use in fixing the teeth in the metal is made?—X. L.

[4779.]—HOLTZ'S ELECTRICAL MACHINE.—Will "Sigma," or any other correspondent give a description of *Holtz's* electrical machine, or state in what work English or French, the same may be obtained?—A Revenue Officer.

[4780.]—TEMPERING STEEL NEEDLE WIRE.—Will any one inform a brother reader how to harden and temper fine steel needle wire in 30 or 40in. lengths?—An Old Subscriber.

[4781.]—SUSTAINING BATTERY.—Could "Sigma" or any other electrical reader give me a description of the battery used for working Tyer's railway block signals? It has been described to me as a box containing eighteen stoneware cells, and at the bottom of each cell there is something very bright like mercury, this is all the information I could gain on the subject. I am very anxious to learn what this battery is, and how long it will remain in action.—Code.

[4782.]—TOMATO SAUCE.—Can any reader give me a simple recipe for making the above sauce?—Bon Vivant.

[4783.]—CONVEYANCE OF WATER.—How much power can be utilized from a supply of water conveyed 150 yards in 1¼in. piping with a fall of 12ft.? What is the best means of gaining that object,—combining the attainment of the greatest percentage of power with simplicity and efficiency? Suppose a turbine that is propelled by the water being simply thrown against wings and buckets (without collecting the water in a chamber as in an engine for instance) is used, what horse-power or fraction of horse power could thus be gained, and should the water be allowed to flow out of the full size pipe, or should the end be contracted, and if contracted what would be the best size of outlet?—J. Johnson.

[4784.]—STEREOTYPING.—Will any reader kindly inform me of a plan of making the moulds for stereotyping, so that they can be used immediately they are made, the moulds I make (of starch and whiting) having to stand some time to get into condition?—Amateur Stereotyper.

[4785.]—BINDERS' TOOLS, Etc.—Will "Ab Initio," or some other contributor, be good enough to tell me where I can obtain a binders' pattern-book of rolls, &c., as I have applied to many houses and cannot get one? Will "Ab Initio" also be good enough to state in what Nos. of our Mechanic, I shall find his recipes for staining leather, &c.?—L. J. W.

[4786.]—IMPRESSION OF FERN LEAF.—Will some kind reader inform me as to the best method of taking the impression of a fern leaf?—Inquirer.

[4787.]—SPEAKING TUBES.—Having witnessed the laying down of a galvanized iron speaking or whispering tube, the bore of which is 1in., and length 600ft., the completion of which turned out a failure, I am anxious to learn as to the best material for such a purpose, and to what length it is possible to go, so as for each communication to be distinct.—Inquirer.

UNNOTICED QUERIES.

In future, if any query remains unanswered for four weeks, we shall insert the number and subject of the query in this list, where it will remain for two weeks, if not previously replied to. We trust our readers will look over the list, and send what information they can for the benefit of their fellow-contributors.

Since our last "E. L. G." has answered 4208, 4209, and 4232; G. E. Davies, 4232, 4269. 4270, 4275, and 4284; "Vulpecula," 4299; "Sergius," 3942, 4288, and 4293; "Medicus," 4246, 4251; "Sable," 4265.

4308 Model Mills, p. 430.
4310 Destructive Soap Powders, 430.
4311 Emigration, 430.
4312 Rocking Chair, 430.
4315 Cleveland Ironstone, 430.
4317 Sizing, 430.
4326 Polariscope for Lantern, 430.
4327 Want of Pressure, 430.
4331 Stone for Trinkets, 431.
4332 Black Glass of Antimony, 430.
4333 Lancashire Black, 430.
4337 Hollow Candles, 430.
4338 Draught Furnace for Smelting Lead Ore.
4339 La Crosse, 430.
4343 Windmill for Working Lathe, 431.
4345 Cracked Boiler Plates, 431.
4346 Concertina, 431.
4349 Heating House with Hot Air, 431.
4350 Barometer, &c., 431.
4351 Case for Ferns, 431.
4352 Weaving, 431.
4354 Copper Medal, 454.
4357 Coil, 454.
4360 Galvanizing Nails, 454.
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4366 Insects in Water, 454.
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4372 The Hautboy, 454.
4374 Printing, 454.
4405 Shell Gold, 455.
4406 Supposed Ancient Painting, 455.

USEFUL AND SCIENTIFIC NOTES.

THE BRITISH ASSOCIATION.—The following sectional arrangements of the British Association are now announced:—A—Mathematical and Physical Science (in the Crown Court, St. George's Hall: President—J. Clerk Maxwell, F.R.S.L. and E.; Secretaries—Prof. W. G. Adams; W. K. Clifford; Prof. G. C. Foster, F.R.S; Rev. W. Allen Whitworth. B—Chemical Science (in the Royal Institution, Moore Street): President—Prof. Henry E. Roscoe, PhD., F.R.S., F.C.S.; Secretaries—Prof. A. Crum-Brown, F.R.S.E., F.C.S.; A. E. Fletcher, F.C.S.; Dr. W. J. Russell, F.C.S. C—Geology (in the Concert Hall, Lord Nelson-street): President—Sir Philip de Malpas Grey Egerton, Bart., M.P., F.R.S., F.G.S.; Secretaries—W. Pengelly, F.R.S., F.G.S.; Rev. H. H. Winwood, F.G.S.; W. Boyd Dawkins, F.R.S., F.G.S.; G. H. Morton, F.G.S. D—Biology (in the Reading Room and Lecture Room of the Free Public Library): President—Prof. G. Rolleston, M.D., F.R.S., F.L.S.; Vice-Presidents—John Evans, F.R.S., F.G.S., F.S.A.; Professor Michael Foster, M.D., F.L.S.; Secretaries—Dr. T. S. Cobbold, F.R.S., F.L.S.; Thos. J. Moore; H. T. Stainton, F.R.S., F.L.S., F.G.S.; Rev. H. B. Tristram, LL.D., F.R.S. E—Geography (in the Small Concert Room, St. George's Hall): President—Sir Roderick I. Murchison, Bart., K.C.B., D.C.L., LL.D., F.R.S., F.G.S.; Secretaries—H. W. Bates, Assist. Sec., R.G.S.; Clements R. Markham, F.R.G.S.; Albert J. Mott; J. H. Thomas, F.R.G.S. F—Economic Science and Statistics (in the Council Chamber, Town Hall); President—Prof. Jevons; Secretaries—E. Macrory; J. Miles Moss. G.—Mechanical Science (in the Civil Court, St. George's Hall): President—Charles Vignoles, C.E., F.R.S., M.R.I.A., F.R.A.S.: Secretaries—P. Le Neve Foster; J. T. King.

DISINFECTANT FOR SCARLET FEVER.—A homely, but apparently most useful, method has been communicated to us (*Food Journal*) for disinfecting houses and rooms in which cases of scarlet fever have occurred. Dissolve saltpetre up to the point of saturation, and in the solution soak several sheets of coarse blotting paper, which must be allowed to take up as much as they can, and be afterwards dried. Carefully close every door, window, and chimney of the affected room, and let the prepared blotting paper be lighted and smoulder itself out. This is of course not intended to supersede the use of Condy's fluid, the value of which in every household where there is sickness is sufficiently well known; but we have heard of such success in checking the spread of infection by means of the saturated paper, and it is moreover so easy of trial, that we gladly publish the information sent to us.

THE ADVANTAGES OF SCIENCE.—Chemistry, therefore, in its highest, and, it may be said, its most theoretical investigations, is most justly to be cultivated by a nation. In an ordinary sense the resources of a nation lie in the growth of its soil, as well as in the minerals which the soil contains, and likewise in the fish of its rivers and of its seas. Holland, limited in its soil, and destitute of minerals, sought in fisheries and in whaling other materials for wealth, which have been the foundation of her shipping and carrying trade. It was, however, by the applications of science that Holland, in a less progressive age than this, endowed herself with further resources and constant employment for her population. By a better application of politico-economical doctrines she enlisted skilled labour; favouring the persecuted, she attracted capital; protecting the Jews, she raised her public and private credit as an assured means of providing herself with wealth. Holland, by free trade in corn, was the entrepôt of Europe, and became the great money market. By the prosecution of chemical and mechanical studies, then favourably fostered by the possession of the great book and publishing market, Holland promoted every branch of manufacture, acquiring a supremacy over the world in many departments. If Holland has no longer the monopoly of these advantages, it is because the late war fell heavily upon her; and that other powerful nations, particularly our own, are engaged in the same career, leaving Holland only a minor share.—*Food Journal.*

ANSWERS TO CORRESPONDENTS.

*** All communications should be addressed to the Editor of the English Mechanic, 31, Tavistock-street, Covent Garden, W.C.

The following are the initials, &c., of letters to hand up to Tuesday morning, September 6, and unacknowledged, elsewhere:—

R. M. S., S. & Co., W. Pickering, Dr. T. C. Burton, J. A. Mays, Godwin Emberey, W. Hunter, Timothy Burstall, J. R. T., Magog, Rich. Harvey, R. A. P., W. Pocklington, H. Dolon, W. Kummis, R. Gay & Co., W. M. E., A. B. C., C. B., J. Grafton, R. J. Jones, D. H. Thomas, T. G. A., T. R. P., J. Y. and Son, D. D., W. H. S., Revd. E. H., R. A. Proctor, Jas. Mills, J. Jarman, A. Underhill, E. L. G., R. Evans, J. C. Frank, Feu Follet, Aplanatic, Geometros, Dr. U., J. W. S., R. W., Excelsis, R. P. E., Rev. J. H., S. Wright, Dr. J. B. Lieut. H., B. H. T., Jas. Mills, H. Drinkwater, S. and Co., Anon, Roanoake, Chas. Goodyear, H. C. Sutton, C. Tiesset, W. T. H. Beechey, J. J. B., Beginner, W. J. Eggleston, F. H. Rogan, The Harmonious Blacksmith, W. J., Onus, Thos. Fletcher, An Old Man, Engraver, An Attic Worker, J. W. T., T. D., H. B. M., Boniface, Pater Familias, J. B. Fenby, Geo. E. Davis, F. A. B., Salt, Tometer, G. S. Walsden, Thos. Wood, Nat, Wahsrof, W. D., H. Dolan, A Contributor, A Publisher's Clerk, R. E. H. Goffin, T. P. Barkas. Suffolk Amateur, Operator, George Stedham, W. E. Yates, Ed. Sharpe, J. T. M., Amicus, Pace, J. W., Yarmouth Bloater, J. B., E. T. S., W. T. Laber, J. T. W., F. P. P., Student, Improver, E. V., D. Jacob, J. Brown, Black Country Joe, L. M. N., T. Storey, J. Nash, J. Thomas, George, Dœdalus, A Poor Clerk, Judas, B. W. J., C. F., Wood, C. B. T., O. P. Q., R. N., George Hardy, Rev. E. Kernan, Oliver Cromwell, W. Greenwood, Amateur Astronomer, J. W. G., F. G. A., Liliputian, Young Phrenologist, E. M., Eli Green, J. T. H., W. B.

"Coal Measure Fossil," by T. P. Barker, next week.

"Speculum Working," by J. P., next week.

The Bicycle.—Jas. Smith, E. Hamley, E. T. J., and others have written letters in vindication of bicycle riding. All speak of the journeys they have gone on the bicyle with remarkable ease.

The Phantom Wheel.—We have received several more letters in answer to the "Harmonious Blacksmith," all showing, from practical experience, that that correspondent was wrong in stating that these wheels lacked rigidity.

Holiday Time.—Though it is holiday time when many correspondents are enjoying themselves by the seaside, on the river, or on the moors, correspondence flows into our office in a continuously increasing stream. Let it flow on. The larger the postmans bundle the better we are satisfied, and the richer will be the contents of every succeeding number. An unusually large number of letters, queries, and replies are necessarily postponed till next week.

H. O. asks to whom application should be made for employment as Clerk of Works under the Turkish Government. We should think to the Turkish Embassy, Bryanston-square, London.

"Mounting for the Microscope" by Achromatic, next week. Please send name so that a paper may be sent.

Eustace Hinton Jones on "Organs and Harmoniums," next week.

J. T. H.—The half-penny postage system will begin on the first of October next.

J. H. S.—For prices of timber and other building materials see the "Timber Trade Review" weekly in the *Building News.*

Accessories to the Microscope next week.

F. F. C. says, "I much regret that in writing about my dislike to the flute, I should have made use of expressions which have excited the indignation of a clergyman." "F. F. C." says his reverend censor is more guilty than himself in perpetrating the fault he himself condemns.

Lex, who does not send his address, is mightily offended because we did not insert his answer to "R. P.," whom he charged with "deliberate equivocation" and "gross ignorance," and like a petulant child who breaks the toy he does not understand, he ceases to be a subscriber. He says "the loss you have sustained by not publishing my letter is small (five subscribers), but if other letters are similarly treated you will ultimately awaken to a sense, &c." We shall continue to treat absolutely discourteous correspondents in the same manner, if we lose five or five thousand subscribers, as we know very well that we should get 10,000 more subscribers in their place.

F. Jordan.—A puff nevertheless.

A. M. Keays.—We can't say. Have nothing to do with doctors who advertise questionable works.

J. R. M.—See Needham's "Starter for Sewing Machines," p. 232, this volume.

J. R. K.—The number was sent. We cannot be responsible for Post-office losses or irregularities.

J. M.—The query appeared and was answered.

T. W.—Crocus is the commercial name of a polishing powder made with oxide of iron.

Chemicus.—No; it was M. Sobrero who discovered the properties of nitro-glycerine, but M. Nobel, the Swedish engineer, first brought it into notice for blasting purposes.

Courteous Correspondence.—We have referred above to a letter from "Lex." How different is the following from a correspondent whom "Lex" abuses:—

Sir,—I feel very sorry that any part of my letter on "Handwriting" should have given offence to "Lex" or any other correspondent (see "Answers to Correspondents," p. 576). I have frequently been contradicted in your columns on matters which I have known to be true, and after writing an angry reply, have destroyed it, rather than yield to my *tempter* or *temper*. Your valuable pages should be the storehouse of accumulated thought and experience, not a receptacle for angry feeling. May every reader take the same pleasure that I do in extending the circulation of the English Mechanic.—Scriptor.

Compensated Balance.—"Seconds Practical Watchmaker" has promised to contribute an answer to query.

Mr. Gibbs.—We don't know the address.

Jones.—See reply about "Adept," in "Notices to Correspondents" last week. To second query about H. Willis, No.

Steel.—Your query on "Soldering" has been answered again and again. What metals?

Dr. Maclaren, Blairgowrie.—An American publication.

Constant Reader.—If you made your siphon aquarium before the one at the Workman's Exhibition was patented, you may sell yours, or as many of the same kind as you like.

W. Herd.—Don't know the address.

H. Boon.—Nothing is charged for the insertion of queries of course.

F. H. Roberts.—Apply to the Secretary of the English Mechanics' Scientific Society, Working Men's College, Manchester.

Astron.—Nearly every number in Vol. X. contains letters on telescope construction. Those that will most likely suit you are 236, 238, 240, 243, 244, 245, 247. All of those can be obtained of the publisher.

D. Hoffmann.—This sign (‡) is known to all printers, type-founders, and bookbinders as a "double dagger."

J. T. Rowlands.—Apply for the specification at the Patent Office. None of our readers are likely to know anything about it, unless they have already purchased the specification.

G. Harvey.—The dials of the clock at the Houses of Parliament are 22ft. in diameter.

Old Cramlington.—Try the furniture creams given on p. 525, (4459). Most oilmen sell them ready mixed.

N. V.—The subject of sewing machines has been almost exhausted in our columns. See Vol. X, pp. 262, 326 Vol. XI., pp. 90, 112, 157, 211, 231, 280, 375.

J. H. Gray.—See a recipe in Vol. X. p. 56.

G. P.—No. "Systole" means literally "a bringing together," and is used by medical men to denote that action of the heart which *expels* the blood, whilst "diastole" means "a placing asunder," and is used to explain the contrary action, as when the blood *enters* the heart.

G. B. D.—"Weight of ball" answered by several correspondents previously. Please supply numbers to replies in future. By so doing you will save us much labour.

W. S. Husk.—The "unclaimed prizes" were not transferred when the *Mechanic* was incorporated with the English Mechanic.

Duffer.—The suggested articles on brass would no doubt be instructive and acceptable.

B. E. Loddy.—The writer of the articles on the "Workman's Exhibition" went to the war as a special correspondent of a morning paper. Like many others he was arrested and imprisoned. He has, however, returned, and probably will resume his criticism on the exhibition. The price of the catalogue is 6d.

Thos. Marshall.—As you wrote saying the reply was incorrect it was destroyed.

Trinitrophenic, who answers two queries in to-day's impression, says, "He shall be happy to answer any other questions relating to chemistry."

W. E. D.—Exchange advertisements were made 6d. for two reasons. 1, to establish a uniformity of price, and 2, to act justly, as many people were continually trying to get "for sale" advertisements in the exchange column.

S.T.P.—Yes. The whale belongs to and forms an order of the class Mammalia. You are perfectly correct in calling it a "sea-animal." The class Mammalia includes all animals which suckle their young.

J. B. M.—Mountain soap is a mineral, soft to the touch, which assumes a greasy lustre when rubbed, and falls to pieces in water. It is found in the Isle of Skye and in Bohemia. Analysis shows it to consist of 44 parts silica, 26·5 alumina, 20·5 water, oxide of iron & lime 0·5. It is known by the same name in both French and German—*savon de montagne* and *Bergseife*.

The English Mechanic
AND
MIRROR OF SCIENCE AND ART.

◆

FRIDAY, SEPTEMBER 16, 1870.

RECIPROCAL GEOMETRY.

By J. Beverley Fenby, C.E., M.I.M.E.

IT very frequently happens that those who have to make geometrical calculations for practical purposes are at a loss for the proper formula for some particular case, and are therefore under the necessity of referring to a pocket-book for something which they require. No matter how retentive the memory of any engineer, or how thorough his training, it is impossible for him to carry all necessary formulæ in readiness by memory alone, hence the need of some form of pocket-book. In many cases, however, there is some reciprocal relation existing between that which he has "at his fingers' ends" and that which he does not at the time remember, which would, if known, obviate all doubt. Some time back, a draughtsman employed under the writer had to deal with a problem in the designing of some machinery, involving the calculation of the cubic contents of a spheroid. As to the proper mode of performing this calculation, the draughtsman—though a very well informed, and withal industrious youth—was evidently at sea, for, after looking for some book, which he failed to find, he applied to the writer for the requsite formula.

Inquiry elicited the fact that he was perfectly well informed as to the method of finding the contents of a sphere, and also that he had on more than one occasion worked out the problem as regarded the spheroid, but without noticing any special relation between the two. The writer of this memoir, in place of giving him the formula for the spheroid as an isolated one, gave him a comparison between the contents of the *cube*, *parallelopipedon*, *sphere*, and *spheroid*. With these relations he seemed much struck, and expressed his surprise that such reciprocity in geometry was not pointed out in every work on the subject. Further researches on this subject brought to light the fact that not only were standard treatises silent on the subject, but that very well-known men actually, at first sight, denied that the alleged reciprocity existed. The fact that men accustomed to performing calculations had, in so many cases, missed the very beautiful principle of reciprocation which runs through geometry naturally aroused the writer's attention, and led to the compilation of the following notes on the subject. Before commencing to explain the reciprocations hereafter stated, it may be well to state that it is not supposed that any original discovery is here embodied, but merely that practical men have overlooked a fact that would materially lessen the labour of calculation, as applied to geometrical figures, such as constantly crop up in practice. It must, therefore, be clearly borne in mind that this little memoir is intended solely to aid practical men in performing calculations, and not as an exercise for mathematicians.

The geometrical figures to be treated of are (1) the square; (2), the oblong; (3), the circle; (4), the ellipsis; and the solids directly derived from them—namely (5), the cube; (6), the parallelopipedon; (7), the sphere; and (8), the spheroid; and the object aimed at is to show how the mode of calculating each of these figures is reciprocally related to all the others, and thence to prove that it is easier to remember them as a group very closely related than to take them disjointedly, as is done in the ordinary text-books. To the proposed mode of consideration, it may be objected that the eight figures enumerated belong to *three* branches of geometrical science, namely 'plane geometry, the geometry of solids, and conic sections. As an abstract question, this is undoubtedly true; but in practice these three branches are promiscuously mixed; and, as we only propose to deal practically with them, we think no valid objection exists to treating them in their reciprocal relations; the more so as a just comprehension of their affinity to each other will very materially help the student in understanding their properties and, therefore, in appreciating each in its just place in the three great branches of geometry.

Having stated these premises, let us proceed to the consideration of the square. The square is a rectangle having all its sides equal, and its area is found (commonly) by *squaring* one of its sides. Taking the square A B C D (Fig. 1), it is evident that if we multiply *two* of its sides — say A B × B C, we shall get the area, just as we should by squaring any one side; and, in fact, the rule for *squaring one side* arises merely because all the sides are equal. That this is the case is evident when we come to consider the oblong or rectangle A B C D, Fig. 2., for here we *must* take two adjacent sides, as A B, B C, though the oblong differs only from the square in having its opposite sides equal to each other, but wanting the equality of the whole four. If now we take the case of a circle—inscribed for the sake of illustration in a square—we find that the area is obtained by multiplying the two diameters of A B and C D together (Fig. 3.), by which we obtain the area of the circumscribing square, and then reducing the product by multiplying by the factor ·7854; which in effect reduces the area of the square *a b c d* by the sum of the parts A *n* C, C *b* B, B *d* D, and D *c* A, the excess of the square over the circle. Inasmuch as the two diameters A B and C D are equal, this rule is commonly given as though only *one* diameter were multiplied by itself or squared. The consideration of the ellipsis will render this self-evident. To find the area of the ellipsis in Fig. 4. the diameter A B is multiplied by the diameter C D—by which we obtain the area of the oblong *a b c d*—and this area is reduced by multiplying by the factor ·7854, so as to deduct the sum of the parts A *a* C, C *b* B, B *d* D, and D *c* A; that is the excess of the area of the rectangle over that of the ellipsis.

Fig. 1

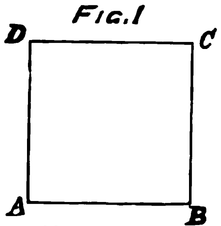


Fig. 2

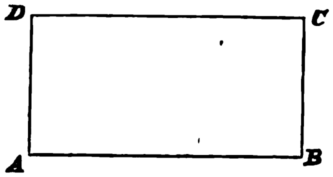


Fig. 3

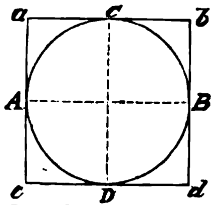
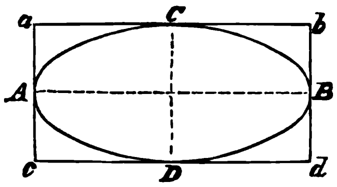


Fig. 4



If the reader has carefully followed the cases given he will easily perceive that we have shown that the area of the square and that of the rectangle are found by identically the same process, namely, by multiplying *two* adjacent sides together. He will also perceive that the area of a square circumscribing a circle is first calculated to obtain the superficial contents of the circle, and that the latter area is simply ·7854 of the former.

Further, it is observable that the area of an ellipsis is deduced from that of the circumscribing rectangle by multiplying by the factor .7854. The results, then, which we have arrived at may be stated as follows:—First. The area of the square and that of the oblong are obtained by identically the same process, namely, the multiplication together of two adjacent sides; *the squaring of one side in the case of the* SQUARE *being an accidental consequence of the equality of all its sides, and in no way affecting its properties as a rectangle.* Secondly. The area of the circle is deduced from that of the square, and the area of the ellipsis from that of the rectangle, simply multiplying by the same factor, namely, ·7854. *Hence the square is to the oblong as the circle is to the ellipsis, as regards area; and to calculate these* FOUR *figures it is only necessary to remember* TWO *facts, namely, the multiplication of two adjacent sides*—or the diameters at right angles—*and the factor* ·7854. If, therefore, the student will impress these simple reciprocal relations upon his memory he will perfectly master four very useful facts in practical geometry.

Passing from the consideration of these four plane figures to that of the solids derived from them, we find the same beautiful laws of geometrical reciprocity to hold good. From the square is derived the cube, and its solid contents are found by cubing one of its sides. For our present purpose we will consider the cube on the same principle as that on which we considered the square, that is to say, we will take its area from the multiplication of *three* of its sides, thus A B × B C × B G, Fig. 5. We will then take the parallelopipedon, which is derived from the oblong, and taking the three sides A B × B C × B G, as in Fig. 6, we have the contents by exactly the same process as for the cube. Following out the principle we started with we find that, as the cube is generated from the square and the parallelopipedon from the oblong, so are the sphere from the circle and the spheroid from the ellipsis. Further we find that the contents of the sphere are capable of deduction from those of the cube, and those of the spheroid from those of the parallelopipedon. Let Fig. 7 represent a sphere inscribed in a cube, and Fig. 8 a spheroid in a parallelopipedon.

Fig. 5

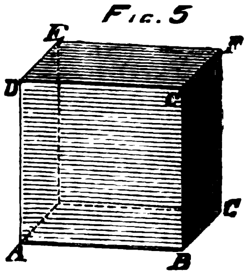


Fig. 6

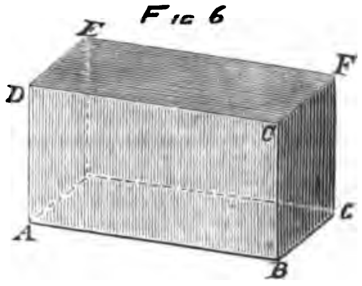
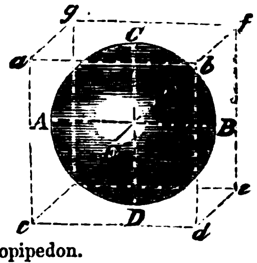
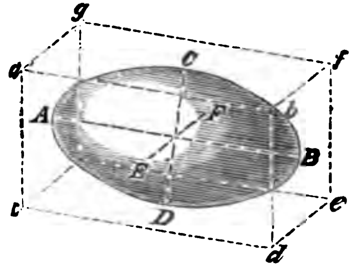


Fig. 7



To find the solid contents of the sphere A C B D we will conceive the *three* diameters A B, C D and E F to be multiplied together. The result is evidently the solid contents of the circumscribing cube, and the multiplication is equivalent to the process of cubing the diameter of the sphere on the side of the cube. The excess of the contents of the cube over those of the sphere is reduced by multiplying by the factor ·5236, which practically *turns* off the corners of the cube. Extending the analogous processes to the next case, that of the spheroid, we find precisely the same rule holding good. To find the solid contents of the spheroid, A B C D, Fig. 8, the ordinary rule is to multiply the stationary diameter A B by the square of the revolving diameter C D, and then by the factor ·5236. This is equivalent to multiplying the stationary diameter A B by the two diameters C D and E F; the latter beir

Fig. 8



right angles to each other. This process gives us the contents of the parallelopipedon *a b c d e f g*, and the reduction of this by the factor ·5236 used as a multiplier gives the contents of the enclosed spheroid. In Fig. 8, a prolate spheroid is shown, but the principle holds just the same with the oblate spheroid.

The relations we have traced may be thus summarized:—

Firstly. Consider the square and the oblong merely as rectangles, and for the area multiply two adjacent sides together *(these two being equal in the square)*.

Secondly. Remember the factor ·7854, and for circle or ellipsis multiply *two* diameters at right angles (observing that these are equal in the circle, and that the major and minor are to be taken in the ellipsis); the area—which is that of the circumscribing rectangle—will, when multiplied by the factor, give that of the circle or ellipsis, as the case may be.

These two cases embrace the four plane figures of which we are treating—namely, the SQUARE, OBLONG, CIRCLE, *and* ELLIPSIS.

Thirdly. To find the solid contents of any cube or parallelopipedon multiply any three sides which give the length, breadth and thickness, and the product will give the result required.

The CUBE *only differs from other* PARALLELOPIPEDONS *in having* ALL *its sides equal.*

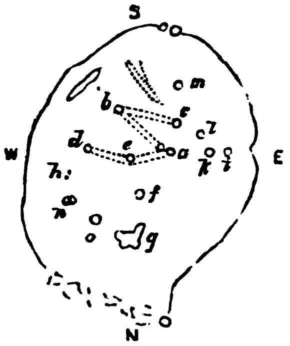
Fourthly. Remember the factor ·5236, and, for the solid contents of the sphere or spheroid, multiply three diameters together; observing that in the sphere all these are equal, while in the spheroid *two* only are equal, and these are of necessity revolving diameters. This multiplication gives the contents of the circumscribing cube or parallelopipedon, and the reduction of the result by the factor ·5236 used as a multiplier will give the contents of the sphere or spheroid.

It will therefore be seen that precisely the same mode of calculation may be traced through these eight cases, thus: For the plane surfaces named two dimensions are multiplied together—namely, length and breadth, and for the solids denoted these are further multiplied by the thickness. That for the circle and ellipsis the factor ·7854 is used as a means of reduction from the rectangle corresponding; and for their solids, the sphere and spheroid, the factor ·5236 as the measure of reduction from the cube and parallelopipedon. When once these reciprocal relations are mastered it is only necessary to burden the memory with the retention of the TWO factors ·7854 and ·5236 to be completely master of the areas and solid contents respectively of EIGHT of the most important figures in practical geometry. To be thoroughly *au fait* at calculating these eight figures is thus a very simple acquirement, but not the less useful to the practical man; and yet what proportion of the total number possess this knowledge, ready at a moment without any book for jogging the memory? If called upon for an answer it must be confessed very few; in fact most look upon the ellipsis and spheroid as very recondite figures to deal with. The present little memoir has been written with the aim to show that it is not an abtruse question to deal with any of these figures. Beyond this its intention does not reach; it is in fact a purely simple and practical synopsis of the points touched upon, and if it should help any of the readers of the ENGLISH MECHANIC to a ready ease in dealing with the calculations treated of, its purpose will be fulfilled.

TELESCOPIC WORK FOR MOONLIGHT EVENINGS.

By W. R. Birt, F.R.A.S.

ON the southern border of the *Mare Nectaris* (V of Webb's index map) when the moon is about five days old, will be found an object appearing immensely like a *bay*, indeed any one of the bays on our own sea coasts—Torbay, for example—will furnish a fine terrestrial analogue. The name of this object, 372 of Webb, is *Fracastorius*. Surrounded on the W., S., and E. by a high mountainous border, the enclosed surface is separated from that of the *Mare Nectaris* by a range of very low hills, which appeared to Mr. Ingall (who observed them on the morning of July 17, 1870, with a dialyte of 5¼in. aperture, powers 196, 236, and 768) as if the soft mud (?) of the *Mare Nectaris* had flowed and almost covered some high mountains there, and had rounded off the asperities as if they had been washed with it. Mr. Ingall adds, "this is somewhat romantic, but I express my ideas as they came to my mind."* From these low hills on the N., and from the interior bases of the mountain border, the surface of *Fracastorius* gradually rises so as to form a slightly convex floor, which culminates in what has hitherto been considered as a small central eminence or peak, but ascertained by Mr. Ingall, on the morning before-mentioned, to consist of two craterlets, which, for easy reference, may be designated *a*. These craterlets are interesting, inasmuch as from them, in a S.W. direction, a line of very minute craterlets (appearing in ordinary states of the atmosphere and in smaller instruments as a streak of light) extends to a craterlet *b* on the S.W. part of the floor, which I observed with the Hartwell Equatoreal on Sept. 13, 1862. From this latter craterlet another chain of minute craterlets extends to a craterlet *c*, south of the pair *a* already mentioned. This craterlet I observed on July 11, 1865. In addition to these objects Mr. Ingall ascertained the existence of another craterlet, *d*, on the W. part of the floor, similarly connected with the pair *a* by a chain of minute craterlets, interrupted by a larger craterlet *e*, first seen by Mr. Ingall on July 17, 1870. So far as I am aware these minute crater chains have not hitherto been detected. Clefts have been observed within the interiors of lunar plains surrounded by mountain borders, but these in *Fracastorius* are so analogous to the well-known crater chains W. of *Copernicus*, that further observation of them is extremely desirable, especially with large instruments.



There are two features of interest on the floor of *Fracastorius*—viz., a line of craterlets a little E. of the centre, and another a little E. of the W. border. These appear to be two nearly parallel lines of eruption, except at their S. ends, where they converge to a crater on the S. border of *Fracastorius*, given by Beer and Mädler, seen by me on July 11, 1865, and by Mr. Ingall on July 17, 1870. The first line of eruption consists of five craterlets, the southern one *m* seen by me Sept. 13, 1862, and by Mr. Ingall July 17, 1870. The next is the craterlet *c*, already mentioned, the third and fourth the pair *a*, and the fifth is a craterlet *f*, seen by me July 11, 1865, and by Mr. Ingall July 17, 1870. It is given by Beer and Mädler. The direction of this line is nearly N. and S., and it terminates with a low mountain *g*, with at least three peaks, which I observed in 1862, 1863, and 1865, and Mr. Ingall in 1870. It would appear that between this mountain and the low hills forming the north border, indeed close upon them, is a somewhat shallow crater, seen by me on Sept. 22, 1868, and again on April 5, 1870. The second line of eruption consists of four craterlets and two spots of light *n*. The craterlets are *b*, *d*, and a pair of minute craterlets *h*. This line is terminated by *two* spots of light *n*, as seen by Mr. Ingall, on July 17, 1870. These spots I have usually seen, 1862, 1863, and 1865, as *one*, which is described in my earlier observations as "a round-topped table-land." On Sept. 21, 1868, there was certainly not the slightest appearance of a hill or table-land, no bright side, no shadow. On the 22nd Sept., 1868, I recorded "a round white spot is plain." July 1, 1865, Mr. Grover described the object as "a crater." Mr. Ingall, July 17, 1870, speaks of it as a doubtful object, which appeared as a double-light spot having no shade. Between the mountain *g* and the spots *n*, is, in Mr. Ingall's drawing, July 17, 1870, a hill *o* answering to the "round-topped table-land" mentioned above in appearance but not in position. Mr. Ingall depicts three pairs of craterlets, the pair *a* of medium size, the pair *h* very minute, and a larger pair *i* and *k* on the E. part of the floor, rather widely separated and hitherto unrecorded. Between these and the craterlet *c* is a smaller one *l*, also unrecorded. The appearance of *Fracastorius* on Rutherford's photograph of March 6, 1865, is extremely interesting. The dark tint of the *Mare Nectaris* has penetrated the interior of the floor; indeed the material of this portion seems to be of the same nature as that of the surface of the adjoining *Mare*, continuing its outline on the S., while the connection of the two dark surfaces is interrupted by the N. border of *Fracastorius*, which is of [illegible] reflective power. A somewhat short rill near the S.W. border, given by Mr. Ingall, completes this description of the floor of *Fracastorius*, a very interesting lunar formation, which is [illegible] to afford results bearing as much on important selenographical questions as those obtained by the study of *Plato*, if its craters' spots and markings be observed with the same assiduity as has characterized the observations of *Plato*.

MOUNTING FOR THE MICROSCOPE.

By "Achromatic."

IN laying before the readers of the English Mechanic some articles upon mounting for the microscope I must beg to apologize to the other writers on the same subject for seemingly treading on their heels. In treating this subject I shall speak of the apparatus required in conjunction with the method of mounting the object which may be under discussion, hoping by these means to avoid all ambiguity as to what instruments, &c., are required. And here I may mention that most of the apparatus and a great many of the instruments can be very effectively manufactured at home, as also can innumerable little knick-knacks, the same designed by the ingenious microscopist, to suit occasions resulting from his method of treatment, which as he gets more practised will be found, in all likelihood, to considerably differ from that of a brother in the art.

In treating insects in my first chapter, the advanced state of the year *must be my excuse*, and let me remind the beginner *that he should* lose no time in gathering specimens for future treatment.

Chapter I.

PREPARATION OF INSECTS.

Insects, like hares, have to be caught before they are "cooked," and this fact makes it imperative for the microscopist to make little excursions into the country (if he can), into a town garden, or even into his cellar, and in fact anywhere where insects most congregate. And then the insect having been caught has to be killed, and for this nothing is more handy than a pocket death-bottle, made thus:—

To Make a Death-Bottle.—Having chosen a large mouth stoppered bottle of a size to suit, clean it well, then drop into it three or four good-sized lumps of potassic cyanide (half an ounce of this salt will be quite sufficient for a large bottle), cover completely with dry silver sand, and on the top pour a plaster made of plaster of Paris mixed with about half its bulk of silver sand. Pour a thickness of this from half to three-quarters of an inch; when "set" firm cover over the surface of the plaster with a piece of loose blotting or filtering paper, cut so as to nearly fit the bottle. This is a perfect death-bottle.

Besides this, I should recommend a smaller one to be made, small enough to be carried about on the person at all times. This will be found extremely useful and convenient, for any little insect that we may come across during the day can be immediately consigned to oblivion without the least trouble; and in this way our supply of insects will be found to be greatly augmented.

The insect being now killed, should be passed on to the next stage—that of the potash—supposing that it is to be mounted whole; if, however (as is more generally the case), it is to be dissected, a proper book should be consulted, to ascertain what parts are the most desirable for preservation, and then the insect being dissected, in accordance with this knowledge, these parts, as with the whole insect, are to be immersed in caustic potash.

But to dissect, certain instruments are required. Of these I think the scissors *must* be purchased, but small dissecting knives can be made by grinding sewing needles to an edge, and then nounting them in conveniently sized holders of cedar or other wood. Of course these knives can be made of any size or shape to suit convenience.

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* Although Mr. Ingall's analogy of soft mud, &c., is not likely to be accepted by astronomers, nor is it put forth as supporting any theoretical view, it certainly expresses the idea of "invasion from the *Maria*," which is fully borne out by the appearances presented by all such formations as *Fracastorius*.

In addition to the knives, plain mounted needles of various degrees of fineness, a few of them being bent (the bending should be done to suit circumstances), will be found extremely useful, and indeed necessary.

The potash used in this stage should be made in the following way:—

To prepare Potash for the Microscope.—To the **liquor potassæ of the pharmacopœia** add its own **bulk of water.**

It **will be found in practice convenient to have** various bottles of potash of **different** strengths to suit the texture of the different subjects for preparation; generally three are sufficient.

The time that an object should be left in the caustic potash is a matter best determined by practice, but a little consideration will be found of great service, it being kept in mind that this alkali, while it dissolves **flesh and fatty matter, leaves horny matter unacted upon.**

The subject having been left in the potash for a time sufficient to extract all fat, &c., is immersed in as pure water as possible for four-and-twenty hours, the water being changed from two to four times during that period.

The object being taken out of the water should be well brushed with a copious supply of water. The best brush for this purpose is a large camel's-hair brush, costing one penny at any oil-shop. With the brush the future object should be arranged, according to taste, on a clean glass slide, and another clean slide being placed upon it, the whole is placed in some convenient contrivance for squeezing it firmly together. When dry, the object is carefully removed from the slide and immersed in good clear methylated spirit, where it is allowed to remain for three or four days to extract the last trace of moisture. The beginner need not be afraid of the spirit taking the form out of the object. From the spirit the object should go into methylated ether for two or three days, and if there be any bubbles of air in the object, it should be allowed to remain till they disappear. The object should next be soaked in the best refined turpentine for a couple of days; at the end of that time it may be considered fully prepared.

The object may now be mounted, and for this, of course, two glasses and a medium are required. As to glasses the thick slides had best be bought ready cut, the unground ones costing 4d., the ground 8d. a dozen; but if preferred, the thin glass can be bought in sheets and cut at home, and, perhaps, with a small saving; but this saving is so small that it will hardly be found worth the risk of breakage, always incurred by an amateur. The medium for insects is generally Canada balsam, costing 6d. a bottle.

To mount the prepared object a clean slide should be placed on a piece of paper with its own centre marked thereon, and the object being taken from the turpentine, by means of the forceps, is laid over this centre, and all superfluous turpentine is wiped off with a dry camel's-hair brush. A drop of balsam on a pointed glass rod is then let fall upon it, and a thin glass cover, nicely cleaned, is warmed, and being held by the forceps, is allowed to fall on the balsam, one side being more depressed than any of the others; the whole is then gently heated over a spirit-lamp, or a candle, when it will be found that the cover will fall down on the top of the object as the balsam softens by the heat. The cover should then be gently squeezed down with the top of the needle holder, and to keep the cover in its position till the balsam hardens a spring clip should be used. The superflous balsam should not be cleaned away in less than a month from the time of mounting, as it is apt to shrink and so admit air bubbles under the glass cover. This is our mounted object, and if care has been taken ought to be good; no dirt, no bubbles, and no miness ought to be visible. As for its not being erfect, in the sense of complete, that is owing bad manipulation, and is not a fault of the ethod of preparation.

The above process may, perhaps, be considered ng and tedious, but it is really not so; that u have to *wait* a long time for the completion the preparation I admit, but then it does away th all necessity for an air-pump for extracting -bubbles, &c., for with a little care air does not d cannot (by reason of the object, up to the ying process, being filled with some liquid or her) get in. If, however, it does get in a few s extra in the ether will generally drive it out. In this, as in other things, the beginner must remember that it is practice that makes perfect.

(*To be continued*)

THE THEORY OF SUNSTROKE.

Dr. E. VAN DE WARKER, writing in the *New York Medical Journal*, thus explains the cause of sunstroke:—The integrity of the cutaneous function is essential to the maintenance of the equilibrium of the thermal condition of the body. The perspiration is one of the principal avenues of escape for the surplus heat generated by the operations of organic life. While this is true of the body when in a quiescent state, it becomes a cardinal truth when the body is in a state of exertion and exposed to an elevated temperature. The healthy man, when exposed to these conditions, at once perspires, and the temperature of the system is preserved at a normal standard. If this means of compensation between the systemic heat and that of the surrounding air is impaired, heat must accumulate in the system in reciprocal proportion. To use a familiar illustration, the evaporation of perspiration from the surface of the body lowers its temperature in the same manner as the evaporation of water from the surface of heated iron.

When the body is exposed to intense solar heat, the perspiration is the direct antagonist of the sun's rays. When we reflect upon the amount of heat necessary to evaporate one ounce of water, it is easy to see how the arrest of this function may lead to serious or fatal lesion of the vital fluids or nerve-centres. An ounce of water passing from the fluid to the vaporous state receives as much heat as would raise its temperature to 990° Fahr.; or, the quantity of heat required to convert a quantity of water into vapour is five and a half times as much as will raise it from the freezing to the boiling point. The evaporation from the surface of the body of one ounce of perspiration would transmit from the system to the surrounding air all the heat required to accomplish its evaporation. On the contrary, the arrest of this secretion would lead to the retention in the system of the heat otherwise expended in the conversion of it from the fluid to the vaporous state. The other excretory functions being impaired, it would obviously require but a short exposure to an elevated temperature to lead to an accumulation of a morbid degree of heat. This is not an immediate effect; it is progressive. The impairment of function goes on with the impairment of strength. The exhausting march, or the stoking at the furnace, or labouring in the field, is still continued, and, before the victim is aware of it, possibly, the skin has ceased entirely to act. There are now but few avenues of escape for the systemic heat resulting from muscular action, from the oxidation of tissue, or from the hæmal oxidation of normal alcohol present in the lungs, and still less escape from the alcohol the man too often takes to relieve the exhaustion from which he is suffering. In addition to this, from the sun's rays the body is continually absorbing heat, until such a degree of heat is present in the system, that disorganization of the blood results, or the nerve-centres are so oppressed by its presence that insolation (sunstroke) results. I therefore conclude that insolation is the expression of the presence of a morbid degree of heat in the organism dependent mainly on the arrest of the cutaneous function.

The preventives recommended by Dr. Van de Warker, are the wearing of a white shirt over the flannel, if that is dark coloured, covering the neck and chest, and wearing a light straw or palm-leaf hat, with fresh leaves or a wet handkerchief in the crown. The working man should always attend carefully to his diet, and never work exposed to a high temperature while suffering from the calls of hunger. Ardent spirits should be avoided. The violent reaction following over-stimulation is attended with most serious effects when the subject is exposed to a high temperature. When men experience a sense of fulness in the head and of tightness across the chest, with a total or partial suppression of the perspiration, they ought immediately to stop work and protect themselves from the sun's rays until the functions of the body are restored. Persons in infirm health or convalescent ought to take extra precautions when exposed to severe heat.

Sixty-nine thousand one hundred and twenty flowers are wanted for 500 grammes of saffron.

NEW SALT FOR INTENSE ELECTRIC CURRENTS.

M. ETEVE, of Paris, has taken a patent for the composition of a salt for the production of very intense currents of electricity, which he calls double acetate of iron and potash. The inventor claims to remedy the inconvenience arising from nitrous exhalations disengaged from solutions of nitric acid, in the following manner:—The nitric acid is replaced by a salt composed of one part of sulphate of protoxide of iron and one part of nitrate of potash, dissolved in a sufficient quantity of the ordinary acetate of commerce, the solution being aided by a slight heat; the whole is then left to cool and crystallize, and the crystals after being drained, are stove-dried. When the salt is thus prepared, the pile is mounted in the following manner:—In the non-porous vessel is placed a saturated solution of common salt, and a zinc cylinder is introduced, within which is placed the porous vessel containing the charcoal, upon which is poured water containing 30 per cent. of sulphuric acid. In this state the pile will not act, or in an almost insensible manner; but, in order to develop the current, it is only necessary to introduce a few crystals of the above-named double salt, when the current becomes remarkably intense, if not superior to that of the common pile; the current may be easily maintained constantly and regularly by merely adding a few crystals from time to time, and without any nitrous vapours being disengaged. M. Etève believes that his salt is a double acetate of iron and potash, but a writer in the *Moniteur Scientifique* objects to this, and says that if small quantities of this salt are formed, as is probable, with the aid of the acetic acid, the greater part consists of two sulphates and two nitrates of potash and iron. He believes that the activity of the salt in question arises from the fact that the small quantity of the acetate of protoxide of iron, finding itself in the presence of a nitrate of the same metal, becomes peroxidized; heat as well as electricity will bring this about. This is the salt that has proved of so much value in the dyeing of black silk, and which is improperly called nitro-acetate of iron. All who have attempted to reduce nitro-benzine by ferrous acetate know how rapidly this converts nitric acid into ammonia. Gun-cotton may also by it be brought back into the natural state of cotton. It is, therefore, quite natural that no nitrous vapours should be evolved from a pile fed by such salt. Perhaps nitrate of soda might be substituted for nitrate of potash with economy.

THE FLUTE AND ITS VICISSITUDES.

By Sable.

(*Concluded from page 558.*)

THE alleged improvements of the Böhm flute awakened "great expectations" in the minds of flute-players generally; but all pleasant anticipations were at once dispelled by the appearance of the instrument itself, and with few exceptions its introduction was strongly opposed: it was accompanied, too, by a number of new students having little or nothing in common with the staid Nicholsonians, who treated the old flute with contempt, voted it "obsolescent," and answered all opponents with the full, firm tones of the Böhm. This was rather too much for the old flautists, *some* change and remodelling they had expected, *some* fresh difficulties they were prepared to encounter; but here *was* a metamorphosis in which they could recognize nothing of their old acquaintance save its head, and even the fashion of that had been altered: here was a flute to be studied afresh from its very gamut; something to be acquired and something to be forgotten simultaneously: moreover, it was pertinently objected that what had already been so changed and complicated would in all probability undergo further mutation at no distant period. Meanwhile, the new instrumentalists gained ground, and the old stagers, who would not go to school over again, either eschewed the flute altogether or retired dispiritedly from the contest; hence all not *personally* interested in the matter ceased to study the flute, and the popularity of the old favourite at once declined.

The reader is referred to Fig. 1, the Böhm flute, the drawing of which shows the open C natural, or thumb key *c*; the open G sharp key *g* next claims attention, and the open B flat key *b*, acted upon by the lever of the ring *a*, second

FIG. 2

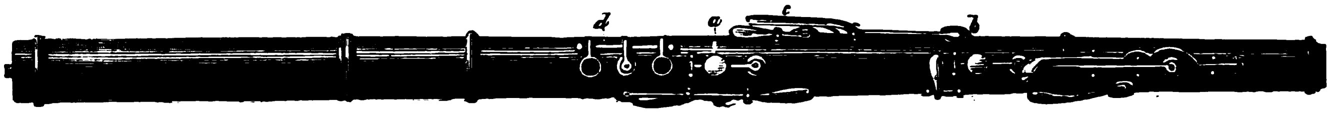
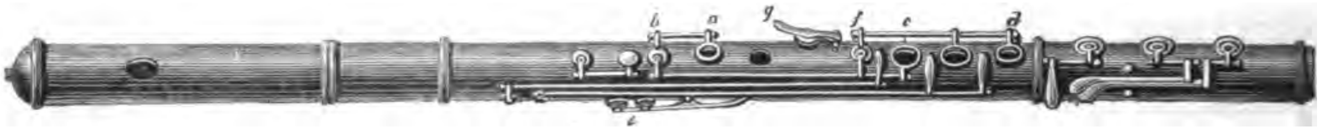


FIG. 1



finger of left hand, also by rod of the ring *c*, first finger of right hand; thus to produce B flat the first fingers of each hand are pressed down; the ring c also closes *f*, the open F sharp key, in fingering *F natural;* and the ring *d*, third finger of right hand, shuts *f* by the aid of the lever in producing *F sharp*. The awkwardness of these B flat and F sharp fingerings to a flautist of the Nicholson school can only be duly estimated in their acquirement. It is scarcely necessary to apologize for the open-keyed system; every flute-player is aware that the tone of the instrument is much improved by keeping the D sharp key open when it can be done (in rapid arpeggios in the chord of F natural, when the F natural key can be "secured"—*e.g.*, as when E and C do not occur in the passage, the increased fulness and freedom with which the flute speaks is very evident, especially in the fundamental octave). Such was the Böhm, or first open-keyed flute, practically useless to those who would or could not begin as upon a new instrument. A carefully-made drawing is given, it having played so important a part in the flute's history, and it is the foundation of that system which has been applied not only to all modern flutes, but to all instruments of its genus. That distinguished professor, the late Mr. Clinton, was one of its earliest and warmest advocates. After comparing its system carefully with that of the old flute, he was so convinced of its superiority that he adopted it himself and recommended it to his pupils; but in doing this he encountered a storm of opposition. "However," he writes, "those who were my most vigorous opponents, after a while became my warmest supporters; and I was confident that the decided superiority of this flute would eventually overcome the prejudice with which it was at first regarded." The open G sharp key, nevertheless, was found to be so troublesome that M. Dorus, of Paris, changed it into a shut one, adding a ring for the left hand third finger. This change was adopted by Mr. Clinton, in 1842, and slight as it was it gave rise to more dissatisfaction and suspicion. Herr Böhm had "astonished the natives" with *his* invention, a Mr. Cornelius Ward, however, surprised both natives and foreigners with a very singular species of flute, and he increased their surprise by assuring them in a pamphlet that on his system facilities were offered by sundry cross and back fingerings: it is true that this flute was *professedly* free from such abominations, but be it ever remembered, that all departures from the old mode of fingering (which is decidedly the best because based upon simple and natural laws) is *practically* a back or cross fingering. Mr. Ward's contrivance had five keys for the work of the left hand thumb, three of which acted on the foot keys; they were in reality apologies for "duplicates," to obtain slurs, &c., not available before, and the result was that neither the old or new were accomplished well; this flute was to dazzle all the orchestras in Europe, but its fame was circumscribed, its existence brief, and it is scarcely remembered. A drawing of this musical curiosity would have been presented, but that it served no useful purpose in flute regeneration. A Mr. Card next presented himself with a flute that was to "make these odds all even,"—it was neither more nor less than a "Böhm" in which the right hand part was altered, while the left remained as before; this died almost in its birth and was soon thrown aside. The next claimant for favour was the flute of Mr. Siccama, B.A., formerly known as the "Diatonic," and it did good service to the cause inasmuch as it reverted boldly and steadily to the old system of fingering; it possessed many advantages over the Nicholson flute, but they were insufficient to displace the Böhm, the Dorus modification of which still held its own both in England and on the Continent. Fig. 2 is an accurate representation of the "Diatonic or Siccama" flute; there are two finger rings at *d* which command the open key between them, by which arrangement the C sharp is much improved in tune and firmness; there is a finger plate at *a* which closes the open key covering the G hole, and at *b* is a similar contrivance for "stopping" the E hole (as both these openings are placed beyond the reach of the finger), which decidedly improves the respective notes. The F natural key is also situated lower in the body of the flute. In this instrument the same theory of equal-sized holes is strenuously maintained, although it is tuned "on strictly acoustical principles." "The weak and ineffective quality of several intervals on the old flute, occasioned by the disproportionate size of the holes, and the inequality of their respective distances, is entirely remedied on this flute, where they are of an equal character throughout and partake of the same firmness and power." "For A an aperture equal in size to the preceding ones,—thus a clear and brilliant A is obtained," &c., &c. Now if all these fine theories be right, dame Nature *must* have made a rare hash of her acoustics! but seriously; it proves what a fascination equal-sized holes have had for flute manufacturers. In the interim, pockets were lightened, and the purse of the exchequer made heavier by the patents granted for all these contrivances; flute players were dissatisfied and undecided, and makers worked up to a great pitch of competition and contention, each one earnestly affirming that his instrument was the "werry identical flute," and all others were "abortions." M. Tulou, of Paris, added another faggot to the fire by substituting *two* thumb keys, one for C natural, and the other for B flat. And now the talented Mr. Carte, in conjunction with Messrs. Rudall & Rose, brought out two new flutes, and in a thoughtful treatise, lucidly stated the fact that the flute's condition was as yet highly unsatisfactory. Mr. Clinton appears to have applied to the patentees of the Böhm flute on the subject without avail; however, he went to Munich to consult with Herr Böhm, who, some little time after, brought over his metal flute with parabola head (like the clarionet) but it did not meet the difficulties in the estimation of the former gentleman. One would have imagined that the Böhm flute, in the hands of a proficient, was all that could be desired, but it was not so; players of moderate capacity, it is true, found a certain ease in getting out the lower notes, but the intelligent student soon discovered the host of evils with which he had to contend; the notes of the third octave were painfully sharp and thin in quality, owing to the largeness of those apertures serving for the time as "vent" holes; the lowest note (C natural) was a very fine one, the D, immediately above it, weak; the whole temperament of the cylinder very unequal; there were several very awkward fingerings, and a deal of work imposed upon the weak fingers. The cylindrical bore was brought forward as a new thing; it was not so; *fifes* and the old flute *a bec* (p. 411) had been constructed so long before; the conical head joint was no novelty, the clarionet and organ pipes were old examples of crocs in the heads of musical tubes. Under these circumstances, Mr. Clinton himself commenced a series of experiments, the result of which was a cylinder flute with the simple and natural expedient of *regularly* graduating the holes. Fig. 3 shows the old cylinder with its equal-sized holes; Fig. 4, the new one with regular gradations. It is true others have declared that cylinder flutes with graduated holes, were made by them prior to the appearance of the "Clinton cylinder," and that the said holes decreased regularly "always one quarter of a millimetre" (about 1-105in.) "in diameter." Be this as it may, such a gradation would have no practical influence on tone or tune, even if it could be accurately marked on the flute's *rounded* surface. It would be beside the purpose to recommend any particular flute, but *if* we are ever to have what has been so patiently and industriously sought, I think we have got it in the Clinton Cylinder; nor are spectacles needed to show us that the natural laws of sound have not been violated; the old system of fingering is retained, and the long cramp F natural key discarded; there is also a means of taking this note with the first finger of the right hand, as on the Böhm; but this involves no alteration in the fingering of the F sharp, or the old fingering of the former.

FIG 3

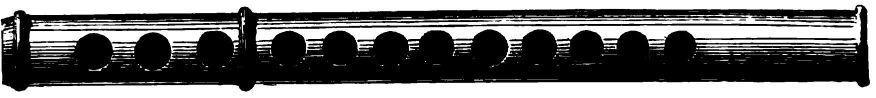
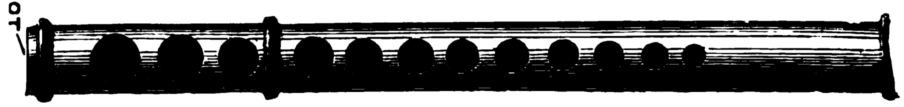


FIG 4



My task is done, and I have to acknowledge the care and accuracy with which my drawings have been reproduced; and I must, *en passant*, express my admiration of the beautiful engravings of machinery, which are constantly given in this periodical. And now I bid adieu to the flautists of the English Mechanic with hearty good wishes both for themselves and our favourite. Although no longer able to use or enjoy *it*, *I have* the satisfaction of knowing they can *do both*. Finally, I entreat all to believe that *I have* kept steadily in mind the motto which heads these papers—

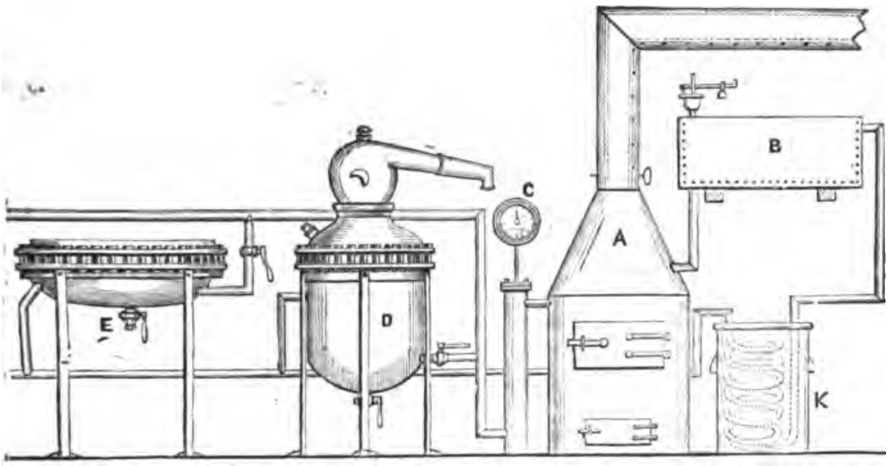
Nothing extenuate,
Nor aught set down in malice.

Errata.—P. 459, 26th line from bottom—for "its read "his." P. 558, 39th line from top—for "1728" re 1828."

The End.

COFFEY'S APPARATUS FOR DISTILLA TION.

As several correspondents have asked for formation concerning Mr. Coffey's rece inventions of apparatus for distillation, evapora tion, &c., we give an illustration of a portion that in use by Messrs. Doulton & Watts, Lambeth. The invention of Mr. Coffey consi in the application of the discovery that a sort paraffine oil may be continuously heated in clo tubes to a temperature of 1100° Fahr.—in oth words, to a temperature at which iron exhibi



COFFEY'S APPARATUS FOR DISTILLATION, ETC.

dull redness,—not only without carbonization or combustion, but absolutely with very little change, and scarcely any pressure whatever. This oil has double the specific heat of water, and possesses high conducting power, so that it not only receives heat readily from the fire, but imparts it readily and equably to the evaporating vessels or other substances with which it is brought into contact. The heat can thus be maintained with the greatest regularity, and at a temperature sufficient to melt lead, distil mercury, generate steam at high pressure, or evaporate the most delicate liquid. Messrs. Doulton have succeeded in producing earthenware evaporating pans and retorts which are impervious to the oil; and in future the distillation of the strong acids may be conducted in perfect safety, without costly platinum retorts, or the direct and dangerous application of heat to glass; whilst the distillation of turpentine, alcohol, and other inflammable fluids may be conducted by the circulation of this liquid heated from a furnace in another building. As the fluid oil is so much more readily heated than water, there is a great economy in fuel, particularly as the surface to which the heat is applied may be almost indefinately extended within the smallest space. We may expect to see the system applied to steamships, to locomotives for the Underground Railway, and indeed to a thousand purposes where freedom from smoke and economy of space are matters of importance; and we would especially direct the attention of architects to its application to the purposes of warming and ventilating public buildings, and particularly hospitals. By circulating this liquid at a temperature of 600° Fahr., it is possible to deliver in a given room six times the amount of heat which the same bulk of water, heated to 200° Fahr., would convey, and this would be done by the consumption of little more than half the fuel. The patentee proposes to use it for cooking, baking, soap-making, oil-refining, and for metallurgical operations, where regular and often high temperatures are required. In fact there seems to be scarcely any manufacture on purpose for which heat is used to which this invention cannot be applied, especially where economy both of fuel and space are considerations to be studied. In the engraving, A represents the furnace, containing a coil of iron piping through which the heating medium circulates; B is a tank or reservoir containing a supply of the heating medium; C is a pyrometer; D is a still, still-head, and dip-arm as applied to Coffey's patent method; E is a shallow pan for evaporation; and K is a stoneware pan for distillation, &c., through which the heating medium returns through the coil to tank B.

STEAM ROAD-ROLLING IN ENGLAND.*

THE steam-road roller has now been more or less in use in Paris for the last ten years. In carrying out their six years' contract with the Paris municipality, the engines of the contracting company there have already rolled down nearly half a million of cubic yards of road metalling. That the interests of the uses of the roads, whether human or equine, are fully served, is evident to the most casual observer amongst the visitors to that beautiful city. Knowing many European capitals, we feel free to say that the Paris roads are unequalled, whether for their regular and smooth surfaces, their precise contours, or their freedom from mud in winter and dust in summer. It has been officially estimated that the diminution in draught due to the steam-rolled surface saves an enormous annual sum to Parisian owners of horses and vehicles. This is easily accounted for when we remember that the draught on loose metalling is five times more than where the stones have been "run in" by the traffic; and that draught progressively rises to this five-fold amount on patches in varying states of consolidation. Apart from equine and vehicular wear and tear caused by increased draught, it continually happens that horses are injured on the loose sharp stones by spraining the joints of their legs; especially on stones of too large a size to be consolidated by the comparatively narrow and light felloes of ordinary vehicles. During this very season we know that more than one wealthy carriage owner proposed to bring actions for damage done in this way to horses passing on the macadamized part of Piccadilly, Still, much as West-end people object to loose metalling, they prefer its occasional appearance to the dangerous slipperiness of stone setts. No rider with any care for his own neck or his horse's knees will, if he can help it, ride over pavement. There are qualities in which a macadamized road must always excel paving. It is cheaper to lay down, it gives a better foothold, and it is free from the fearful noise of paved setts.

At first sight it might be expected that such roads as in Paris must be dearly paid for in maintenance. In England, at any rate, consolidating roads by rolling is looked upon as merely a luxury for parks and pleasure grounds; as it is believed that common vehicles roll roads down at no cost to road maintainers. In all probability, road-rolling was thus regarded when first used in France and Prussia; or, at the most, it was hoped to prevent injuries to horses, vehicles and harness. But the virtue here displayed was found to be its own reward in the form of much saving in maintenance. It was in our own pages that attention was in England first markedly drawn by Mr. Paget to the waste of metalling on unrolled roads, and generally to the great economical advantages of the process. From seven estimates formed at different times, under the most varying circumstances, by different engineers—amongst whom are Field-Marshal Sir John Burgoyne, the engineer of the Seine Department, and Mr. Holmes, the Sheffield borough engineer—an average of 40 per cent. saving in metalling can be proved to be produced by the imperfect process of horse-road rolling as against traffic rolling. Now the experience of the last ten years in Paris, as compared with the experience of the previous thirty years or thereabouts, since horse-rolling was adopted, has shown the French engineers that the steam-rolled roads last twice as long as horse-rolled roads; or, in other words, while the horse-roller diminishes road maintenance by 40 per cent., the remaining 60 per cent. of any total to be expended, when no rolling is used, is itself brought down by one-half where the steam roller is applied.

With such results, and placed, as they have been lately, in a clear light before the public, it would be wonderful if the use of the steam roller—especially as a cheaper and more efficient form than that of the Paris company is obtainable—did not spread even with such conservative local authorities as own. Liverpool, Sheffield, Leeds. Manchester, Birmingham, and Maidstone now actually possess and use steam 'rollers, while the Americans, always eager to take hold of mechanical improvements, are very rapidly extending their employment throughout the States.

After this bare statement of facts there comes the obvious inquiry why the steam roller is not regularly used in London? And this our question has, in fact, been very often asked of late. Intercourse between London and Paris, especially amongst the equestrian, and, therefore, road-judging, classes is too frequent to allow such a capital improvement, in use for years, to escape notice. On the prodigious area of the 1,200 miles of macadamized roads in the metropolitan district alone there must be a wide field for the steam roller. It has been estimated that there are some 22,000,000 of square yards of macadamized roadway, solely within the thirty-eight metropolitan parishes and districts. Taking the districts of Plumstead and Lewisham, which are the furthest from the centre of London, as giving an approximate, in low, measure—in the ratio of the area of their roads to their total acreage—of the proportion of roads to area on the outskirts, it can be calculated that, within twelve miles of Charing-cross, there are more than 40,000,000 of square yards of macadamized roads. Then, many miles of new roads are being every year laid down on the outskirts of this metropolis—the largest in the world—which, according to the estimate of the engineer of the City Commissioners of Sewers, doubles its population every forty years. In fact, there can be little doubt that at least fifty steam road rollers could be profitably employed in London and its neighbourhood.

We have now to ask why London should be so behind Paris, Bordeaux, Hanover, the main cities of the United States, and our own large provincial towns? The answer is to be found in the subdivision of metropolitan administration into districts mostly too small to purchase a steam roller. Even a larger vestry would have to pause before such an expenditure of capital, with its heavy depreciation for wear and tear; it would have to consider the facts that the single roller could not well be used at all seasons, while on the other hand, at some times, more than one could be profitably employed; that a special staff for working, applying, and repairing the roller would have to be kept up, with an attendant increase of responsible duties for the, in many instances, already over-worked surveyors.

Within the last few months a good amount of steam road rolling has been done in London, in at least six different districts, while several others are proposing to try it. Allured by the prospects of saving their heavy annual bills for granite metalling, these worthy vestrymen, each set forming a board perfectly ignorant of, and entirely ignoring, each other's doings, expect that the very first passages will save in metalling. In this they go to the other extreme of confidence in steam rolling, as its full economical effects are only felt after at least a couple of years. Nevertheless, vestries naturally hesitate, for the reasons we have just given, actually to buy steam rollers.

In fact, there simply remains the usual British remedy for British maladministration, decentralization, and administrative supineness—a joint-stock company for steam rolling by contract the roads of London and of other places where a steam roller *en permanence* could not be afforded. In this, even with a centralized administration, the French have been before us, finding it best to have the work done by a company, which, indeed, is yielding good profits to its shareholders. With these views, we are pleased to be able to state that a steam road-rolling company is being formed with every prospect of success. We understand that the committee of the Royal Society for the Prevention of Cruelty to Animals, under the presidency of the Earl of Harrowby, after making vain attempts, extending over years, to introduce steam road-rolling, have, subsequent to an investigation resulting in an expression of warm approval of the objects of this company, rendered substantial aid in setting it on a sound basis.

M. Léon Vaillant has published some interesting observations on the marine animals of the Breton coast.

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* From the *Engineer*.

REVIEWS.

Curiosities of Mathematics. By JAMES SMITH. London: Simpkin, Marshall, and Co.

MR. JAMES SMITH, the Liverpool cyclometer and demolisher of Euclid, has been at it again. Poor Euclid has not been left a toe to stand on. His opponent, pursuing his triumphant career of discovery, now finds that sundry of the propositions of Euclid's Elements "are inconsistent with certain other propositions," and "are not true under all circumstances,"—especially 8 and 13 of Book VI. "are inconsistent with each other;" and though he freely admits "that the three angles of a plane triangle are together equal to two right angles," one is exhibited whose smallest angle is about 2°, and each of the others, whether any reader "can or cannot see it," are right angles. As for De Morgan and modern professors in general, it is absolutely a fact that, "Mathematicians have never discovered that if the length of a straight line be represented" (according to I. 47) "by $\surd 15$, its true length is $3 + 7\text{-}24$ths of $3 = 3{\cdot}875$, and not $3{\cdot}872$, &c., the extracted root of 15" (the dolts!). If any of his present five correspondents "*can't see*" these things, Mr. Smith "*can't help it, but the fact remains* (and in italics) *notwithstanding.*" Moreover, they each and all, in pretending to solve a case under Book I., to which our redoubtable author challenged them—running straight into his trap—"made the ratio between the length of two unequal lines the same as the ratio between the areas of squares on two other unequal lines in the diagram," than which "nothing can be more absurd." Thus he has caught "five blind mice," and dropped them "into a quagmire of geometrical inconsistency, contradiction and confusion."

Alas! however, for those who love to watch the effects of the northern Smith's doughty arm, the net has this time been spread in vain in the sight of his old victim, Professor De Morgan, who is like a chicken of education, too sly to accept the cook's repeated invitations to "come and be killed;" and hence it must be confessed that the above are the chief plums to be picked from our cyclometer's new cake or π. The Liverpool "Catholic Will Case" being very prominent when he was challenging two reverend professors to discuss his "interesting and novel problem" (the ratio of the two segments made by the perpendicular on the longest side of a triangle whose sides are 5, 4, and 3), one of his lay victims, understanding these clergymen, or one of them, had voluntarily entered the lists, and originated the title "*Curiosities of Mathematics,*" thought proper to suggest the following Will Case, as a curiosity involving, like Mr. Smith's, a little ciphering, and more worthy their solution.

A testator left a property to be thus employed, after being turned into money:—His executors were to advertise a request to the Archbishop of the province to answer these three questions. The last chapter of Scripture that contains this phrase, "If any man have an ear, let him hear," ends, he said, with a riddle concerning a name, whose letters, taken as numerals in the arithmetic of that day (which knew of no numerals but the Greek letters), were to notate a given number. Now, as it is plainly implied by the writer of that and succeeding chapters, that to all men of some future time a knowledge of this name was to be *extremely important*, the Archbishop was to be solicited to state publicly, for the general good, these evidently *ascertainable* things: (1) whether the New Testament contains any name,—that is, noun in the nominative case—that answered the said riddle; (2) whether it contained more than one; and (3) what the name, if any, was; or the names, if more than one, were. On his Grace doing so, the advertising was to cease, the remaining money to be laid up six months, and then put at his disposal, for his trouble, unless either of his answers were meanwhile proved false—in that case paid to the persons proving it so. But until his Grace might answer all three, the advertising was to go on till a named sum was expended; after which the same questions were to be put to the Roman Catholic Archbishop alone, with the same conditions; and unless, or until he might answer, their advertising was to continue as long as any money remained. On execution of this will commencing, the Protestant Archbishop set a clerk to work examining in Bruder's "*Concordantiæ Novi Testamenti*" every noun occurring in the nominative; beginning from A, working 8 hours per day; and the average time to find and examine each, was 3 minutes. Meanwhile the daily cost of asking his Grace as publically as the will required was £5. Presently he answers question 1; but before he could answer 2 or 3, though another day would have enabled him, the sum named was expended; so that the inquiry had to be transferred to the Romish prelate. He, guessing that the Protestant had probably used the above concordance, and begun alphabetically, thought fit to set two clerks to work and begin contrariwise from the end, or rather from the last possible noun (as no word containing ψ or ω could answer the riddle, these letters having their numeral meanings too high). As these clerks checked each other (and moreover, were paid by job, instead of the truly British method, by time) their progress was at just thrice the rate of the Protestant's; and presently, without going all through the book, they enabled their master both to confirm the answer given to question 1, and to answer 2 and 3; so that after six months he obtained the disposal of the remaining legacy. *Problem.*—How much of the advertising expense would have been saved had the Protestants obtained it by getting through their work a day sooner?

Of course this needs no more algebra than our friend "Gimel" would tolerate, but the answering would involve the whole of the work that the testator's bribe is supposed to extract from the two prelates themselves.

HOW TO OBTAIN STEREOSCOPIC PHOTOGRAPHS OF MICROSCOPIC SUBJECTS.

AT the conclusion of an occasional half-hour's examination of stereoscopic pictures we have frequently felt tempted to decide that for the future we should take only binocular views of nature. An ordinary photograph, however well taken and however much it may command admiration, is but a picture after all; but when a pair of pictures have been obtained from standpoints differing only a few inches, and are made to coalesce by means of the stereoscope, the representation before the spectator ceases to be a picture; it then becomes a reality—"Seems! nay *is*."

We have sometimes, says the *British Journal of Photography*, for the sake of amusement and effect, taken a binocular picture of a piece of apparently interminable forest brushwood, which as a single picture was simply an unmeaning mass—a sort of pictorial chaos—and have listened with interest to the comments made on the single picture and its hopeless intricacies compared with the laudatory exclamations which greeted its appearance in the stereoscope. If any photographer has attempted to take a view of a well-frequented fishing station when the harbour was filled with boats, he will have obtained the best idea of intricacy and confusion that we can suggest. Some single and stereoscopic pictures of Wick Harbour that we took on one occasion are probably the best specimens of pictorial order *versus* confusion that we have ever seen.

Laying aside the ordinary camera as an agent for obtaining views from nature, we now take up the microscope. What we desire, first of all, to direct attention to is the increased fascination that centres in some subjects when examined by the binocular microscope as compared with the ordinary single tube. The solidity and beauty of these tiny objects when thus viewed are simply marvellous. As is the photographic view of natural scenery when seen *in* the stereoscope and *out* of it, so is the effect conveyed by a minute body when viewed in a binocular and in a monocular microscope. In one the image is a flat picture; in the other it is a solid body. The production of large and perfect representations of the most minute bodies by means of photography is now, thanks to such men as Drs. R. L. Maddox and Woodward, a fact realized by every man of science; but the work in this direction is not complete so long as monocular representations only are made.

A short time ago we were desirous of obtaining an ordinary stereoscopic picture of a small object—the head of a crane-fly. We had previously taken a negative of it about three inches in size, so as to form an object for the magic lantern, but we afterwards considered it desirable to make a *stereoscopic* slide from the same subject. Without dwelling upon the various methods we intended adopting, and our reasons for so doing, we shall now explain the method that we finally adopted, and which yielded results of the most gratifying character. As a prelude to what we are about to say, we may state that any reader who possesses the most ordinary achromatic microscope and a quarter-plate camera may obtain quite as good and successful results as we did.

The object-glass that we employed on the occasion was the lowest power in our possession, viz., one of 2in. in focus. This permitted the whole of the object to be distinctly displayed in the field of the instrument. Having placed the microscope in a horizontal position, and so as to obtain a ray of sunlight on the mirror beneath the stage, we then placed in position the slide to be photographed—with this difference, however, from the ordinary mode of proceeding, that we inserted under *one* end a small wedge tapering up to the thickness of a penny piece. At the eyepiece end of the tube we placed the camera, from which we had previously removed the lens, and having excluded all light except that which was transmitted through the tube, we adjusted the size of the picture by sliding in or out the ground glass, and the focus by means of the rack. In this position we took the first of the binocular negatives. Now removing the wedge from under the end of the slide, we transferred it to the opposite end and proceeded as before. We thus obtained two pictures—similar, yet different. When printed from and mounted on a stereoscopic slide the effect was exceedingly beautiful; it was as if a huge model had been prepared in a translucent material. To heighten the effect we made a transparency on glass, and, by means of chlorising and washing with Schlippe's salt, we converted the image into a fine transparency brown exactly the colour of the original.

There is only one class of subjects that can be effectively represented in the manner we have described. We do not suppose it would be possible to obtain in this way representations of the [illegible] kind of microscopic "game" at which Dr. [illegible] flies, and for this reason:—When operating [illegible] very high powers on difficult test subjects, [illegible] is the thickness of the covering glass an [illegible] of disturbance in the definition (one, however, easily got over), but its inclination at other [illegible] right angle to the axis of the objective [illegible] insurmountable confusion. This, coupled [illegible] fact that high powers are absolutely devoid [illegible] of focus, and therefore that an object so placed [illegible] one part is nearer to the lens than another [illegible] all be sharp, seems to us to prevent this [illegible] from being serviceable when such objects as [illegible] scales and *Naviculæ* are to be photographed [illegible] powers only one-twelfth of an inch.

About two months since a new invention in connection with the microscope was made public, [illegible] which the very highest class of test objects may [illegible] photographed, as they are now seen, with [illegible] stereoscopic effect. The excellent binocular microscope introduced by Mr. Wenham, and now [illegible] known to microscopists, answers only when [illegible] powers are used, being, in consequence of its internal construction (which we need not here describe), quite unsuited for showing any object under an object-glass of short focus. But at the last meeting of the Royal Microscopical Society, Mr. J. [illegible] Stephenson, F.R.M.S., &c., exhibited a new form of binocular microscope invented by him, which, if we mistake not, will soon eclipse every other form hitherto in use, from the original binocular by Wenham to those which, while professedly improvements upon it, still depend upon the same principle.

IMPROVEMENTS IN OPTICAL *APPARATUS*.

A SPECTROSCOPE of a very valuable description has been invented and constructed by Mr. John Browning, F.R.A.S., and has been exhibited at some of the soirées of the Royal Society. An ordinary spectroscope, with a train of prisms, is a difficult instrument to use, because to see each part of the spectrum in perfection the prisms should be adjusted to give the minimum angle of deviation of the particular rays under examination. Thus fresh adjustments of the whole of the optical parts of the spectroscope are necessary to see to perfection each of the different lines of the spectrum. With Mr. Browning's new instrument, whatever part of the spectrum may be in the centre of the field of view the prisms and telescopes are always in the best position for viewing that part of the spectrum. To effect this the prisms and telescopes are mounted upon a hinged framework of bars of brass in such a way that when any line of the spectrum is brought into the centre of the field of view the prisms always stand so that the rays from that part of the spectrum shall be bent by the prisms as little as possible from their original direction before entering the intrument. When this is done the prisms are in the position known to opticians as "the angle of minimum deviation" for that particular line of the spectrum. A spectroscope which thus arranges the prisms automatically is necessarily rather an expensive instrument; the ordinary spectroscope, on the other hand, is very troublesome to adjust. The best instrument for ordinary observers who do not intend to plunge very deeply into the science of spectrum analysis is the "direct-vision spectroscope," in which compound prisms of peculiar construction are enclosed in a straight brass tube, and all the trouble of adjust- frighten young students of mathematics from attack- ment is rendered unnecessary.

Mr. J. L. Lane, of 28, Charles-street, Hatton-garden, has invented a new photographic camera and appurtenances, to facilitate the working of the wet process in the open air by tourists or photographers. His object is to do away with the dark tent or dark box ordinarily used under such circumstances. By Mr. Lane's plan the plate is first coated with collodion in the open air, then it is placed on a peculiar "dipper," a framework made of varnished wood and silver. The handle of this dipper passes through the top of the dark slide, and the plate, after being placed on the dipper, is at once drawn up into the dark slide. The bottom of the dark slide is then fixed upon the top of a vertical wooden case, containing the nitrate of silver glass bath, and all the points of junction are so nicely fitted that no light can reach the plate of the bath. The plate is sensitized by being pushed down, dipper and all, into the nitrate of silver bath, and when it is sensitized it is drawn up again into the dark slide by the handle of the dipper. Then a pause is made that the plate may drain itself, after which a little sliding door closes the bottom of the dark slide, so that it can be removed from the bath, and no diffused light can reach the plate. After exposure a peculiar little jerk is given to the dark slide to dislodge the plate from the dipper, and the fact that this jerk has to be given seems to an observer to be an objectionable feature. The dislodged plate then rests upon the wooden bottom of the dark slide, which is fixed over the developing bath just as it had previously been fixed over the sensitizing bath. When the bottom of the slide is withdrawn the plate falls into the developing solution, and the process of development may be watched through pieces of orange glass fixed in the wooden casing of the trough. Afterwards the picture may be taken out, washed, and fixed in daylight. We have seen a letter from one gentleman who has had a set of this apparatus on trial, and he speaks very well of it, but it requires prolonged experience to prove its real value. Supposing there are no practical objections, it will be very useful as tending to abolish—in landscape photography—such inconvenient and heavy accessories as dark tents and dark boxes.

Some improvements in electrical lanterns have just been made by Mr. Ladd, the optical instrument maker, of Regent-street. The new lamp resembles a vertical cylinder in shape, and it has two "fronts" nearly at right angles to each other, with flanges to carry lenses. When throwing a spectrum upon a screen, electrical lanterns are never placed so as to face the screen, but at an angle, and the prisms in front of the slit bend round the rays of light. Hence, by having a cylindrical lamp with two flanged fronts, the electric microscope may throw direct images upon the screen from the one front, while the prisms may at the same time or afterwards throw a spectrum upon the same screen from the other front without moving the lantern. Moreover, an image of the luminous arc may be thrown by the one front, then its lenses may be covered, and a spectrum of the light from the same arc be immediately exhibited by permitting the rays to pass through the spectroscopic apparatus. This lamp, then, will do the work usually done by two lamps at public lectures, and much time in adjustment of apparatus is at the same time saved by the speaker and his assistants. In the side of this cylindrical lantern is fixed a little tube, with a lens at one end and a piece of blackened ground glass at the other. A small image of the luminous carbon point is thus projected upon the ground glass, so that the lecturer may see that the luminous arc is in exactly the right place, this being a point of considerable importance in using the electric microscope. When this instrument is used a very slight shifting of the elevation of the arc throws the image off the screen. A fine horizontal line ruled across the ground glass serves as a guide to the true position of the luminous arc. Inside the lamp is a common gas jet, so that when it is necessary in spectrum experiments to frequently change the carbon points, there is some light inside the lantern to see to work by. Altogether the new lamp is a very useful instrument to the public lecturer.

One evening, towards the close of the session of the Royal Institution, Mr. Browning exhibited in the library of the institution a spectroscope with one or two prisms of the ordinary construction, but between these prisms and the eye of the observer was a direct-vision compound prism, with outer edges of a circular shape to fit in a tube, the two ends of the prism, however, being of course inclined planes. This prism and its tube could be turned round and round by the hand of the observer. It is plain, therefore, that in one position this direct-vision prism aids the others and produces more dispersion; by turning it round it acts against the others, and produces less dispersion; by taking it away altogether, an intermediate effect is obtained. It follows, therefore, that three different degrees of dispersion are placed at the command of the observer by a simple motion of the hand.

ON PYROMETERS.*

By C. William Siemens, F.R.S., D.C.L.

The mercury thermometer, which enables us to estimate ordinary temperatures with such admirable precision, fails to indicate heats exceeding the boiling point of mercury (500° Fahr.), and although many attempts have been made to produce a reliable high temperature thermometer (or pyrometer) it can hardly be said that such an instrument is now in the hands of the practical metallurgist.

Amongst the attempts which have been made in this direction the Wedgwood pyrometer occupies the first position. It is based upon the peculiar property of fire-clay to shrink permanently when exposed to intense heat, and upon the supposition that the amount of shrinkage in question was proportionate to the intensity of the heat to which the ball of fire-clay had been exposed. The error involved in this supposition becomes at once apparent if we consider that the shrinkage of the ball is caused by the expulsion of water of hydration which must necessarily take place chiefly at one particular temperature. It is proved, moreover, by the very discordant and, in fact, impossible results, recorded in chemical works as being obtained by means of this instrument. Thus we find it stated in Dr. Lardner's popular treatise, that cast-iron melts at a temperature of 17,977° Fahr., and that iron welds at a temperature of 21,000° Fahr., whereas it can be proved that the utmost temperature to be obtained by the combustion of carbon with a blast of atmospheric air cannot exceed 4,600° Fahr., which degree of temperature far exceeds the points of heat to be met with in metallurgical processes, not excepting even the melting point of mild steel, which comes nearest to the maximum point here indicated.

Amongst the other pyrometers that have been proposed from time to time is the air pyrometer, which is limited by the melting or softening point of the vessel confining the air, the pyrometer by difference of expansion of two metals which has lately been brought forward in a compendious form by Mr. Gauntlet, but which cannot be relied upon beyond a point approaching red heat, at which permanent elongation of the metal set in, and a pyrometer by contact of two dissimilar metals setting up an electric current capable of measurement, which, however, is by no means proportionately progressive with increase of temperature.

Another pyrometer has been based upon the well-founded supposition that the specific heat of metallic bodies is the same at various temperatures, and that by measuring the heat of a ball of metal after it has been exposed to the heat to be estimated, a true measure of its intensity is obtained. I have myself constructed an instrument upon this well-known principle, which has found considerable favour with ironmasters in measuring the temperature of hot blast, and for other purposes. It consists of a portable vessel composed of three concentric cylindrical vessels of thin copper-plate, the two intestine spaces being filled, the inner one with cow-hair, and the outer one with atmospheric air, and the two together forming an excellent barrier against loss of heat from the interior of the vessel.

A delicate mercury thermometer is fixed in the interior of the vessel, being protected by a perforated shield, and furnished with a movable sliding scale showing pyrometer degrees, of which one is equal to 50 ordinary degrees. The instrument is accompanied by balls of copper or platinum, which are so adjusted that fifty of them would be equal in thermal capacity to an imperial pint of water. Each ball is perforated by a hole through which a rod is passed in exposing the same to the action of the heat to be measured. Immediately before using the instrument, an imperial pint of water is poured into it, and the pyrometer slide is so moved that its zero point coincides with the top of the mercury column in the thermometer tube. The ball is thereupon exposed to the heat for two or three minutes, and plunged into the water. The mercury will be observed to rise, and the absolute temperature of the place measured is ascertained by adding the reading on the pyrometer scale, opposite the new level of the mercury, to the degrees of temperature indicated by the thermometer before the ball was introduced. In using ordinary dexterity very satisfactory readings may be obtained with this instrument, but its application is limited to the point of heat at which the metal ball employed begins to deteriorate, nor can it be employed for measuring the temperature of inaccessible places.

It has been my endeavour for several years to devise a pyrometer of a more universal applicability, and containing in itself more absolute proof of correctness, and, after a long series of experimental investigations I have succeeded in producing an instrument which I can confidently recommend to the practical metallurgist. It is based upon the peculiar properties of the pure metals to offer an increasing resistance to the passage of an electrical current with resistance of temperature. A platinum wire of known electrical resistance is wound upon a cylinder of fire-clay, upon which a helical path has previously been cut to prevent contact between the turns of the wire. The coil of wires, so prepared, is enclosed within a cylindrical casing of platinum if the temperatures to be measured exceed the welding heat, or of iron or copper if lower temperature only requires to be measured. The two ends of the coil of wire are brought out endways, and are attached within the protecting tube to thicker leading wires of copper, insulated for a short distance by being passed through pipe-clay tubes, and further on by india-rubber, or gutta-percha, terminating at the measuring instrument, which may be placed at any convenient distance. This latter is of peculiar construction, its characteristic feature being that the usual calculations necessary in determining electrical resistances by the Wheatstone or other methods are dispensed with, and a reading in degrees of a large scale is at once obtained by so placing the index lever that the electrical current, generated in a small battery and passed through the measuring instrument, including the platinum wire of the pyrometer, produces a deflection of the galvanometer needle. These degrees do not themselves express the temperature, but the temperature they represent is expressed by a table of reference, which accompanies each instrument. The pyrometer coil itself, with its protecting casing, may either be fixed permanently at points, the temperature of which ought to be ascertained from time to time, or it may be introduced into a furnace through a door or aperture for only a minute or two, which time suffices to obtain a reading of the instrument. The latter is the only practicable method where the temperature to be measured approaches a welding heat which would in time destroy the protecting case of platinum or any other material; whereas, the former method of fixed coils will be the most convenient for measuring the lower temperature of drying or annealing stoves, or of the hot blast supplied to blast furnaces. At iron works with a number of hot blast stoves, a protected coil may be fixed within the hot blast tube leading from each stove towards the blast furnace, and the leading wires from each of these coils be brought into the office where the measuring apparatus would be placed. By such an arrangement the temperature of the blast of each stove of the furnace could be measured and noted at frequent intervals by a clerk without leaving the office, and very perfect record and control be thus obtained. The correctness of this instrument depends solely on the ratio of increase of electrical resistance in the platinum wire, with increase of temperature. This rise is considerable, the resistance being increased fourfold by an increase of temperature from the freezing point to about 3,000° Fahr. The ratio of increase is, however, not uniform, but follows a parabolic law which I have ascertained by a series of careful observations embodied in the table, and which form the subject of a separate communication to the Royal Society. I wish it to be understood that, in developing these principles, I have been animated solely by a desire to fill up a blank in the means at our disposal to carry on metallurgical inquiries with such a degree of certainty as could not hitherto be realized, without seeking for any commercial reward through the Patent Office or otherwise.

[The paper was illustrated, and the pyrometers mentioned exhibited.]

IMPROVEMENTS IN POWER LOOMS.

Among recent improvements in power looms that of Messrs. Davies and Yates, of Manchester, which we this week illustrate, must take a prominent place. This invention, which is patented, consists in an improved "positive letting-off" and "swell motion," which, besides other advantages, are applicable to any existing loom or fabric woven. In ordinary looms the letting-off is effected by means of weights and levers, which require almost constant attention and have to be altered as the diameter of the beam becomes less; the constant vibration of the weights being destructive to the loom, and causing many of the warp threads to break. The principal advantages of this improvement in the letting-off motion consist in it being entirely self-regulating, so that when the warp is once set it requires no attention till the whole length is finished. It also acts as a vibrator in regulating the tension of the warps during the shedding and beating home of the weft shot, and by this means lengthens the duration of the healds and reeds. By this process a more perfect and uniform cloth is produced, while greatly economizing both power and labour. The inventors calculate that, in average work, 150 per cent. will be saved in healds and reeds, while the breakage of the warp threads will be reduced fully 200 per cent. The objects effected by the new swell motion are a reduction of the driving power, a lengthening of the duration of the shuttle, and the production of an even pick with great accuracy. Several manufacturers have tested the improvements and expressed their entire satisfaction with them, and looms fitted with them can be seen in operation daily at the premises of the inventor, 35, Back George-street, Manchester. On referring to the illustrations the letting-off motion is seen in Figs. 1, 2, and 3; Fig. 1 representing a back elevation of the loom, having adapted thereto the improved arrangement of letting-off apparatus. Fig. 2 represents a transverse sectional elevation of the loom, having the improvements applied, showing the position of the apparatus when the "sley" is on; its front centre beating home the weft shot. Fig. 3 represents a detached view similar to the last, showing the position of the apparatus of the warp beam at the time the shed is closed.

In these figures, a is a rod forming the fulcrum of the levers $b1$ $b1$, supported by the bracket secured to the framing c of the loom immediately above the flanges of the warp beam d. The upper or shorter levers b b carry or support a rod e passing under and supporting the warp threads, as they pass from the beam d of the lower or longer levers $b1$ $b1$, carrying a rod f that lies against the yarn of the beam and passes under the last fold or lap of the warp ends. The upper levers carrying the rod e are supplied with projecting brackets g g which support adjusting screws and nuts h h. The lower end of the screw underneath the bracket g is connected to a rope or chain k, which passes first around the drag pulley of the warp beam, then under a carrier pulley l connected to the lower frame of the loom below the warp beam; after which it passes onward

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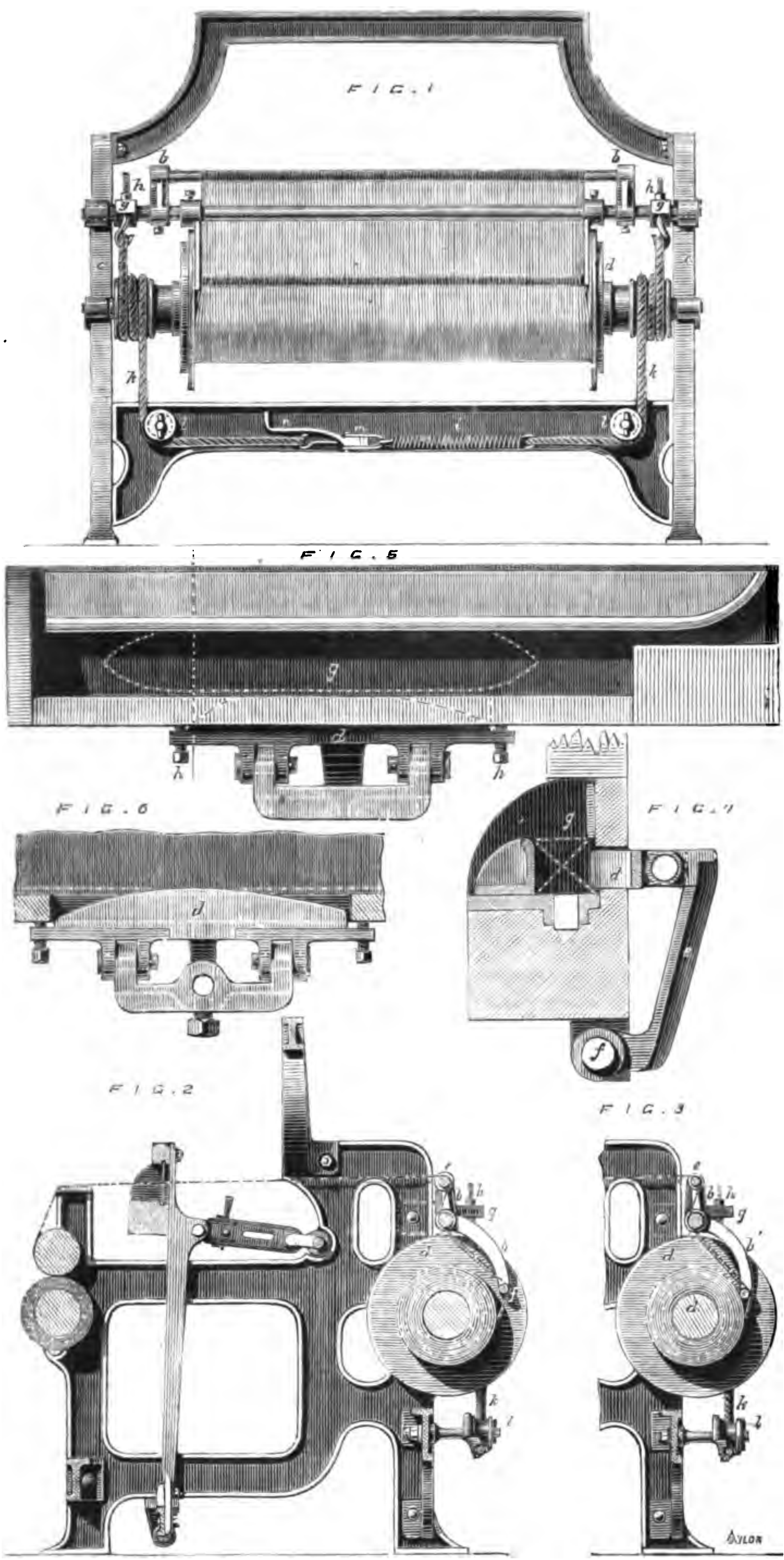
* Paper read before the Iron and Steel Institute at the meeting in South Wales, September 6, 1870.



IMPROVEMENTS IN POWER LOOMS.

and is attached to one end of a rod connected to one end of the reversible lever n, the fulcrum of which is secured to the link m forming part of a helical or coiled spring i. This spring is the medium or connection between the ends of the two ropes or chains k k. The opposite end of the spring from reversible lever is attached to a rope or chain which passes, in a similar manner to the one already described, around the opposite drag pulley of the warp beam to the adjustible screw h.

The tension of the warps is first adjusted by the nuts and screws h h, which tighten up the ropes or chains k k, passing around the drag pulleys of the warp beam d connected to the coupling spring i. The action of tightening up these ropes or chains through the medium of the nuts and screws h h is continued until the required tension of the warp is obtained. When the tension is obtained and loom in action, the beating up of the sley closing in the weft shot (at which time the sley is on its front centre as shown at Fig. 2) drags forward the top rod e, thereby causing the beam to exert a pressure upon the warp threads; this gives an excess of tension to the same at the beating home the weft shot and effects [illegible] the cloth under manufacture. On the return of the sley (Fig. 3) the upper rod or bar e inclines by reason of the action of the spring i and the medium of the ropes or chains k k, thereby the lower rod f against the beam to become [illegible] so as to reduce its tension upon the warp, simultaneously with which the ropes or chains on the drag pulleys of the beam are also eased; this allows the necessary quantity of yarn to be drawn easily from the warp beam sufficient for the pick, and the healds to open the shed without strain or tension upon the yarn. Again, as the diameter of the beam becomes reduced with the delivery of yarn therefrom, the lower tension rod f is in contact with the passing warp threads gradually nearer the beam, thereby effecting during the delivery of the yarn a proportionate reduction of tension on the spring forming the coupling between the ends of the ropes or chains k k. When it is desired to let back the warps, a temporary release is given to the spring through the medium of the lever n, which, when pulled over into a position the reverse of that shown at Fig. 1, relieves the spring i; the original tension being readily obtained on recommencing weaving by placing the bar in its original position.

Figs. 5, 6, and 7, relate to the new swell motion, and consist in forming the same of an inclined construction which increases its distance in the box from the part where the shuttle first enters, and also for supporting and maintaining the swell in the orifice or opening in the back of the shuttle-box independently. Fig. 5 represents a plan view of the shuttle-box showing the position of the swell in relation thereto. Fig. 6 represents another modification of the swell and its supporting brackets, having an adjustment for giving more or less inclination to the swell in the box, and Fig. 7 represents a transverse section of the same.

In these figures d is the swell supported by the brackets or arms e secured to the stop rod j; the distance the swell d is allowed to protrude in the shuttle-box g is regulated by the set screws h h. Thus when the shuttle enters the box the swell moves bodily back, giving by the form of its inclined surface an increased resistance to the shuttle on its completing its race; but when the shuttle is again expelled the resisting incline acting then upon the shuttle in its reverse direction at once relieves and assists by the pressure of its incline the expulsion of the shuttle into the opposite box.

SCIENTIFIC SOCIETIES.

THE IRON AND STEEL INSTITUTE.

THE second provincial meeting of the Iron and Steel Institute was this year held at Merthyr Tydvil, under the presidency of the Duke of Devonshire. There was a large attendance of members, including Lord Frederick Cavendish, Marquis of Bute, Sir John Alleyne, Bart., R. Fothergill, M.P., W. S. Roden, M.P., E. M. Richards, M.P., Joseph Dodds, M.P., B. Samuelson, M.P., and nearly two hundred gentlemen connected with the iron and steel trades of the kingdom.

The noble President opened the business proceedings by alluding to the pleasure with which the members must turn from the contemplation of the scenes that have recently taken place on the continent to the matters to be considered by the meeting. A report was submitted by the council in which they stated that arrangements had been made for publishing, in connection with the institute, a journal, in which, besides the usual proceedings of the institute, all matters connected with the manufacture of iron and steel at home and abroad, will be fully reported. The council recommended that Mr. Henry Bessemer should be nominated president elect for the year 1871. This proposal was very warmly received by the meeting, and a resolution approving of the suggestion of the council was moved by the Duke of Devonshire.

Mr. Bessemer acknowledged the compliment, and said his best endeavours should be given to furthering the objects of the institution, and he hoped to fulfil his duties, if not with entire satisfaction to himself, at least without injury to the institution.

The names of fifty gentlemen were then announced as having been duly elected members.

The first paper was read by Mr. Wm. Adams, Cardiff. The author estimates the extent of the South Wales coalfield at 937 square miles, or 600,000 acres, and the quantity of workable coal at 36,000 millions of tons. Towards the eastern end of the field the coal is chiefly bituminous, in the central part it becomes more free burning, whilst at the western portion of the field it is anthracitic.

he argillaceous iron ores are abundant and good. hey form an aggregate thickness of 60in. to 70in., ut are not so extensively worked as they were few years ago, chiefly in consequence of the ntroduction of cheaper ores from Northampton and elsewhere. Besides the argillaceous iron ores, here are deposits of hematite in various localities bordering upon the field. The annual production of coal is about 13¼ million tons, and of ironstone 6¼ million tons. The intersection of the coalfield by deep valleys places the lowest seam within 1,000 yards of the surface, so that the whole of the minerals can be won by pits of less than that depth for over two-thirds of the field, that is, between the eastern outcrop and the Vale of Neath. The dip along the north outcrop ranges from 3in. to 6in., and in some cases to 9in. per yard, while on the south it varies from 9in. to 12in., 15in. and 18in. per yard. This gradual flattening northwards leaves a large area in the centre of the field comparatively flat. The most numerous faults run from N.W. to S.E., and vary in amount of vertical displacement from 250 to 300 yards. Others running in an east and west direction have a displacement of from 400 to 500 yards. The greatest fault is one in Pembrokeshire, estimated as giving a displacement of 2,000ft. The deepest pits now sunk range from 304 to 435 yards.

The second paper was on improved pumping and winding machinery at the Castle Pit, Merthyr Tydvil, belonging to Mr. R. T. Crawshay. Mr. G. J. Snelus read a paper on "The Condition of Carbon and Silicon in Iron and Steel." With respect to carbon the author detailed the nature of the experiments by which he demonstrated that carbon is only mechanically combined in cast-iron. The author expressed his belief that there is no definite chemical compound of iron and carbon, but that the absorption of carbon by iron is a case of chemical solution, and he supported this statement by reference to the phenomenon of solution in general. The effect of silicon upon iron and steel is to render it hard and brittle, and in all probability the reason why Fairbairn and others have found pig-iron to increase in strength by several successive meltings is that by these fusions more or less of the silicon is removed. While melting, however, the iron gradually takes up sulphur and phosphorus from the fuel, and in the end the deterioration due to these substances more than counterbalances the increased strength caused by reduction of the silicon. Steel which contains more than one-tenth per cent. of silicon is brittle, and though it is a rare thing for Bessemer steel to be faulty from this cause, it may sometimes occur, thus proving, along with the analysis of Bessemer metal taken during the blow, that in the Bessemer process the silicon is not removed before the carbon as in the puddling and refinery processes, but along with it. A rather long discussion followed the reading of this paper, and afterwards a discussion took place upon a paper read at the last meeting of the Institute on "A New Method of Designing Rails."

The members afterwards visited the extensive works of which Mr. R. Fothergill, M.P. for Merthyr, is the principal proprietor, and the Cyfarthfa Iron Works, belonging to Mr. Crawshay.

Mr. C. W. Siemens read, on reassembling, a paper on pyrometers, a report of which we give elsewhere.

A paper was read by Mr. Jeremiah Head, on certain questions which affect the durability of boilers. The author alluded to the usual mode of supporting cylindrical boilers, and detailed his plan by which they are suspended and the usually destructive effects of repeated coolings and contractions are obviated. The system has been in operation at Middlesbrough for some time, and is reported to be working successfully.

Mr. Ferdinand Kohn read a paper on "Alloys of Iron and Manganese," showing that for the important compound of iron and manganese, called spiegeleisen, which is extensively used in the manufacture of Bessemer steel, can be substituted a compound of iron and manganese about to be manufactured in Scotland.

The remaining days of the meeting were spent in visiting the various iron works, &c., of the Principality.

EXETER NATURALISTS' CLUB.

The Exeter naturalists recently visited the Cheddar Pass, in the county of Somerset, where Mr. W. W. Stoddart, F.C.S., F.G.S., delivered an address on "The Geology of Cheddar." After a brief summary of the geological history of the British Isles, he called attention to the peculiar character of the cliffs, observing that it was entirely owing to their being carboniferous limestone. At the commencement of the Liassic period ;that part of England was uplifted and disturbed by volcanic agency, The underlying Devonian strata were elevated to 1,079ft. above the mean sea-level, the highest part being near Beacon Batch. While this elevation was proceeding, the limestone beds were broken in every direction, giving rise to innumerable cracks and fissures. When these were situated deeply in the rocks, they were simply closed cavities, penetrated only by water. In many parts of the Mendips these fissures communicate with each other, forming what are called "swallet holes." When, however, these cavities were nearer the surface, they often became open to the atmosphere, serving as dens for animals and retreats for mankind. One remarkable feature in the Cheddar Pass is that on one side the road the cliffs are absolutely perpendicular, while the other is sloping, and covered by a considerable quantity of débris. Mr. Stoddart explained that this arose from atmospheric and water action, combined with the different positions of the limestone beds, one side of the Pass being more amenable to the force of wave-action than the other. A map was exhibited, showing the outline of land and water as it existed after the close of the Glacial period, and that the country south of Bristol must formerly have been an assembly of islands, between which must have been strong currents of water. Afterwards the land became elevated, and converted into swamps and morasses, around which lived the bear, rhinoceros, deer, and many animals now extinct in England. In a gravel-bed, 50ft. below the surface, a large number of teeth and bones have from time to time been collected. In another gravel-bed, above this, and separated by sand, mud, and peat, have been found pottery and other proofs of man's presence. The evidence seems to prove the correctness of other observations in other places, that traces of man were more recent than traces of many of the extinct animals. Barometrical observations showed that the highest point of the Cheddar Cliffs was about 955ft. above the present mean sea-level. The volcanic product which burst through the crust of the earth, and formed the Clifton and Cheddar Gorges, may be observed in many parts of the country. In conclusion, Mr. Stoddart alluded to the old Roman lead-mines on the Mendips, which once were considerable. Even now, large quantities of lead, zinc, and iron ores are found in the Mendip range. On the conclusion of the address the company returned to the foot of the Cliffs for the purpose of exploring the more recently discovered of the two large caverns. This cavern is easy of access, with the exception of ascending a few steps and stooping slightly at two parts. At the head of it is a fine open space, lofty and imposing; but there is nothing very wonderful about the marvellous oddities it is advertised to possess. Mr. Pengelly, F.R.S., F.G.S., gave a short geological dissertation on the cave, and humorously remarked that some writers could review a book best before they had read it, and as he had never been in that cave before, he could probably lecture about it best without examining it, for if he began to investigate he should probably meet with difficulties he could not explain. He considered that it was clearly not a fissure, but the rock had been hollowed out by the action of water. Mr. Vivian was of opinion that at one time the cave had been filled with water—a view which was borne out by the fact that when first discovered there was a pool of water in the place which has been drained off. The cavern was illuminated with magnesium wire.

MAIDSTONE AND MID-KENT NATURAL HISTORY SOCIETY.

At a recent meeting of this society, the Rev. Walter Mitchell, vice-president of the Philosophical Society of Great Britain, gave an address upon "The Geometrical Structure of the Hive Bees' Cell." He said he had adopted the above title as there were 250 different species of bees in this country, not one of which possessed the geometrical accomplishment, and very peculiar construction adopted by the hive bee. This we called the domesticated bee, because it always followed in the steps of civilization, or rather preceded them, for in North America the red Indian knew immediately the hive bee was established in the forest that it would be shortly followed by civilized man. The bee's cell was the most marvellous thing in creation, as far as our wisdom was concerned, in interpreting the works of the Creator, for those marvellous cells were made of a substance which it was extremely difficult for the bee to procure, and out of this substance it manufactured its houses, its streets, and its city. This city had three different classes of inhabitants—the Queen bee, a few hundred males or drones, and several thousand neuters or working bees. He then pointed out that a bee on a given excursion fixed on a particular flower when it was collecting pollen dust, such as a wild rose or a lily, and visited those flowers only. The other bees collected honey for mixing with the pollen, and for the winter supply, which is put in the cells and sealed up. There was no creature whose habits the ancients were so fond of investigating as that of the bee. Virgil had written a great deal about bees, but none of them could tell from whence the bees obtained their wax. Some supposed that it was pollen, but on modern chemists burning it, they found that while pollen gave off an ash, wax gave none. This problem was, however, solved by John Hunter, the celebrated naturalist, who, on dissecting a bee, found that in the abdomen there were certain small bags containing a white substance, which, on burning it in a candle, proved to be wax, and it was, therefore, an animal secretion. The bee, therefore, had a chemical manufactory. He then described how the bees, during the summer months, gorged themselves with honey that this secretion might be produced. In the construction of its cells from this substance the bee showed marvellous geometrical skill. Not only had the bee, led by its divine instinct, to gather honey and store it for the winter, when it knew it could get no food out of doors, but it exercised great economy in the use of that precious substance out of which it constructed its cells. The cells consisted of a great number of hexagons, or six-sided figures. The wasp, which had been a paper maker since the creation of the world, made his paper out of wood, but he placed his comb, not vertically but horizontally. He made hexagonal cells, but he only made his houses on one side of the street—not back to back, as the bee did, and he simply covered in the bottom of his cell with a flat piece of paper. He displayed in this a certain amount of economy, but not the greatest amount of economy. The bees' cell on the contrary was terminated with lozenge-shaped bodies—like the diamond panes of a window—which, when they put their cells together, formed the bottom of a house, on the other side of the street. The lecturer then described how the great French naturalist, Réaumur, by the aid of an eminent mathematician, discovered that the measurement of these cells by the differential calculus was exactly 109° 28′, and that they gave the greatest possible internal space with the greatest economy of material. The lecturer said, therefore, he concluded that we had not yet discovered the marvellous mechanism by which the bee produced this wonderful arrangement; and, with regard to the theory of natural selection, suggested by Mr. Darwin, he pointed out that the bee could not derive its instinct from its parents for the working bees were neuters. The bees were wonderful architects. Among the wild ones there was the mason bee and the carpenter bee. Some were very fastidious, and would only line their cells with rose or poppy leaves. He then referred to the marvellous power of the bee in obtaining propolis to strengthen the structure of its cells, and in decreasing the size of the entrance of the hive in those seasons when the death's head moth was abundant, so that it could not get in, and by imitating the voice of the Queen bee be enabled, with impunity, to steal the honey. In conclusion, he said the more we studied the works of the Divine Geometer and the Divine Architect the more we should advance in philosophy and science. It would keep man's pride of intellect in check, and we should learn to study with child-like simplicity the works of Divine wisdom.

ENGLISH MECHANICS' SCIENTIFIC AND MECHANICAL SOCIETY.

The fifth monthly meeting took place on the 7th inst., in the society's room, Mechanics' Institute, Manchester.

The chair was taken by Mr. J. McEwen, the president, at 8 p.m., and the transactions of the evening announced were as follows:—1. A paper on Gas Meters, by Mr. James Bentley. 2. Discussion on the subjects which stood over from last meeting —viz., Action and Description of the Ejector Condensor; Clayton's Patent Scraper; The Practicability of the Birmingham Patent Safe and Sure Sectional Wrought-iron Boiler; how it is for Steam power, for comparative consumption of coal, &c.

Mr. Bentley, in introducing his essay to the society, said his reason in choosing the subject was owing to the general absence of knowledge with regard to the internal construction of gas-meters, although every house, office, and workshop in mechanical communities was supplied with the same.

After describing the use and work performed by gas meters, the history of the invention was traced from its origin, and the following instruments mentioned. 1. Sir William Congreve's, as one of the first instruments proposed for the indication of the quantity of gas passing from the main cock at the consumer's house. 2. Mr. Samuel Clegg, to whom the honour was conferred of having invented and constructed the first real gas meter. 3. Mr. John Malam's invention; and that although this was claimed to be a copy of the preceding one, a special committee who investigated the charge gave their verdict in favour of Mr. Malam, by awarding him their gold medal for his invention of a gas meter, new, ingenious, superior to all others, and likely to be of great benefit to the public. The construction of wet, dry, and compensating meters was then explained and illustrated by a collection of open meters, and others having glass fronts—the merits and defects of each being pointed out, with the various Acts of Parliament passed with regard to the same.

The thanks of the members was awarded to Mr. Bentley for his interesting essay. A discussion on the subject followed, in which the description of a recently invented hydro-carburetted gas lamp was given.

The remainder of the meeting was taken up in discussing the above-mentioned subjects, and in bringing forward questions relative to pistons, guidoscopes, and pedometers.

LETTERS TO THE EDITOR.

[We do not hold ourselves responsible for the opinions of our correspondents. The Editor respectfully requests that all communications should be drawn up as briefly as possible.]

⁂ All communications should be addressed to the Editor of the English Mechanic, 31, Tavistock-street, Covent Garden, W.C.

All Cheques and Post Office Orders to be made payable to J. Passmore Edwards.

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"I would have every one write what he knows, and as much as he knows, but no more; and that not in this only, but in all other subjects: For such a person may have some particular knowledge and experience of the nature of such a person or such a fountain, that as to other things, knows no more than what everybody does, and yet to keep a clutter with this little pittance of his, will undertake to write the whole body of physicks: a vice from whence great inconveniences derive their original."—*Montaigne's Essays.*

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⁂ In order to facilitate reference, correspondents when speaking of any Letter previously inserted will oblige by mentioning the number of the Letter, as well as the page on which it appears.

THEORETICAL.

[355] Sir,—If "T. A." "fancied there was more of the spirit of counsel defending a client right or wrong" in my letters, he was fully justified in writing bluntly. There is no graver offence a student of science can be guilty of than indulging so evil a spirit, unless it be, perhaps, purloining the work of others.

The fact is, "T. A.'s" reasoning never seemed to me to render a defence of accepted theories necessary at all. He seemed to be in the dark as respects light.

"T. A." will get hopelessly fogged, I fear, if he attacks the question whether "the powers and activities of material substances result from the action of properties they inherently possess" or not. There is a volume to be written on every noun, adjective, verb, and adverb of that portentous sentence; and I would not have him be too confident that he will find a prevailing belief to fight with.

Richd. A. Proctor.

P.S.—"Urban" will notice that I have not attempted to explain "T. A.'s" experiment. But I have no reason to doubt what "T. A." says, though I see two correspondents do so. It is a well-known fact that orange-yellow glasses commonly cut off nearly all actinic light, and it is equally well known that forces which are powerless to initiate chemical action are often capable of continuing and modifying such action when once commenced.

CURIOUS QUESTION.

[356] Sir,—I had not noticed Mr. Usborne's query at p. 450 (as addressed to me), and now referred to in letter 344, p. 598, or I should certainly not have "ignored it altogether." I have, therefore, so far as his question is concerned, no views to revise; my silence implying no opinion either way. But as in reply to a letter by "M. L." (236), p. 518, I had indirectly dealt with the question, and had (I find) made a mistake, I take the opportunity of now admitting as much. In my papers on "The Earth: her Figure, Motions, &c.," I had ennunciated the first principles on which the problem is to be dealt with; but in reply to "M. L." I applied these principles somewhat too hastily, and so came to an erroneous result. My mental reasoning was somewhat on this wise: a ball let fall from a great height has a slight easterly deflection, while a ball fired vertically upwards has a slight westerly deflection while rising; the westerly deflection during the rise of such a ball will be counteracted by the easterly deflection during the fall, and there will therefore be no deflection at all when the ball has reached the ground. The same reasoning applies when the ball is fired at an angle with the vertical—hence the easterly and westerly range of balls fired at equal angles to the horizon, and with equal velocities, will be equal. But the reasoning is wrong, and does not apply to either case. The ball will have westerly deflection from the moment it leaves the ground level to the moment it returns to that level; for in falling its condition is not that of a ball let fall from a fixed support, since at the moment it begins to fall it is actually travelling westwards.

I have not followed the correspondence on this matter so cannot tell what "F.R.A.S." may have said. If, answering Mr. Usborne's question directly, he has said that there is no deflection, it has doubtless been through the same inadvertence that led me wrong.

Here, by the way, is an old result of the "curious question," and the principles it depends on. If we conceive a perfectly elastic ball to be fired upwards from the earth's equator—the earth being conceived for the nonce to be a perfectly smooth sphere—the ball will rise and fall with a westerly deflection, rebound through a like path, and so hop westwards round the earth. On the other hand, if a ball be dropped from a fixed point above the earth's equator it will fall eastwards, rebound with eastwardly deflection, and so hop eastwards round the earth—to meet the other, belike. The case is, however, not unlike the cup in a pie-dish 32ft. high, or the problem of the elephant and the fly, where the weight of the elephant might be neglected, or (to conclude), Watson's famous problem of the man with a perfectly spherical head surmounted by an infinitely high conical cap.

Richd. A. Proctor.

THE SATELLITES OF URANUS.

[357] Sir,—In reply to "Etudiant" (335, p. 591), I should be very glad to look up the papers he refers to; but, as I mentioned to you some time since, I am quite overpressed with work of one sort and another just now. Let me remark, however, that as his notes show that the epoch 1851-2 really was in question, I have no doubt that the simple difficulty of determining the place of maximum elongation led to the seemingly contradictory result. I made the ellipse have axes as 7 to 10 by a geometrical construction; but taking 6 to 8 "Etudiant" will see that in such an ellipse, if lines be drawn from the centre, inclined 10 or 12 degrees to the major axis, their length will differ very little indeed from that of the half-major axis. Considering the difficulty of measuring the distance of a sasellite of Uranus from its primary with extreme accuracy (even when so powerful a telescope as Mr. Lassell's was used) it may safely be held that no attempt to determine the position of the apparent major axes of the satellites' orbits could be satisfactory.

Richard A. Proctor.

LUNAR COSMOLOGY.

[358] Sir,—Will "L. H. C." (248, August 26, p. 545), kindly favour your readers, including your humble servant, with the titles of those works which contain reliable information relative to the *chemical* constitution of objects on the moon's surface, as well as the basis of his own conclusions thereon? We shall all be much interested in learning the chemical, or at least mineralogical character of the central mountain of "Aristarchus," which Professor Phillips compares with white trachyte, also the nature of the dark floor of "Grimaldi." Assuming that "L. H. C." are the initials of "Littus Habet Conchas," and that the "continued series of critical observations . . . by the aid of superior telescopes and repeated examinations," are, as stated in the last letter, his own, not yet given to the public, would it not be desirable to forward copies to a selenographer able to compare them with others, and to examine them, not in connection with any given theory, but for the purpose of noting points of similarity and difference? I quite agree with "L. H. C." in the importance of "accumulating additional observations;" for assuredly our knowledge of the moon's surface is very limited, and the study of "Selenology," employing this term as the lunar analogue of "Geology," has as yet scarcely commenced. While, however, observations are scattered here and there, some published, others unpublished, each observer being prone te form and adhere to his own theory, but little progress can be made. Selenography, more than any other branch of astronomy, stands in need of co-operation. We may pick up many shells on the sea-shore, and replenish our little cabinets; but it is the experienced naturalist who alone is capable of so studying them as to advance biological science.

W. R. Birt.

ON FEED-WATER HEATERS, AND POPULAR DELUSIONS CONCERNING THEM.

[359] Sir,—The total heat of steam whose pressure is 40lb. per square inch above the atmosphere, or 55lb. total pressure, is 1,200 degrees, counting from zero. The average temperature of river water the year round in these countries is, I believe, 40°; therefore, if a steam boiler be supplied with water at 40°, and it is to be raised into steam of 55 lb. total pressure, it must receive 1,160° of heat from the fuel in the furnace; 25 per cent. or one fourth of 1,160° is 290°, and any feed water-heater which professes to save 25 per cent. of the fuel used in generating 55lb. of steam from water at 40°, *must send the water into the boiler at 290°, and no less.* But that is impossible, and to profess to do it is false and absurd.

Water cannot be made hotter in an open vessel (that is to say, one which is in free communication with the atmosphere, whether covered or open) than 212°, but 212° is only 18¼ per cent. of 1,160°. It appears, therefore, beyond the possibility of doubt or dispute, *that 18¼ per cent. is the greatest saving which it is possible to effect by warming the feed water by the waste steam,* and that is the greatest theoretical saving which we can show even upon paper; but that is not, never was, and never will be, effected in practice, for even if the water is got up to 212° in the "heater," it will lose several degrees on its way to the boiler through the pump and pipes, and from this cause alone the practical effect will always fall below the theoretical promise.

What then are we to say to those persons who persistently assert that their feed-water heaters save 25 per cent. of fuel? What can we say but that these statements originate either in utter ignorance of the natural laws which govern that operation, or else are put forth for the purpose of misleading the public and obtaining orders for their wares "by hook or by crook;" and what can we say to those persons (if there be such) who give testimonials that this utter [illegible] is effected by the patent apparatus of Mr. [illegible] such testimonials possess no more value, [illegible] no more of the element of truth than would [illegible] testified that perpetual motion had been [illegible] was to be seen at work every day at [illegible] what can we say to Mr. S. Crompton [illegible] in the number for July 8th assures me, [illegible] figures may say to the contrary, that the [illegible] per cent.' saved in fuel, is not a delusion [illegible] fact with feed-water heated to 212°." I [illegible] Crompton, "by careful and trustworth[illegible] proved the truth of these statements by [illegible] coal used, week for week doing, the [illegible] work with the engine in both experiments [illegible] say, one week with the cold water, the [illegible] the water heated to 212° with the 'econo[illegible] cases the statements have been fully confirm[illegible] I say to Mr. Crompton is simply this, [illegible] bungled the matter somehow, and has [illegible] ceiving himself. It is more charitable to [illegible] to say he is trying to deceive others, but [illegible] doubt he either has done the one, or is [illegible] the other.

To show the unreliable nature of Mr. [illegible] statements and experiments, I shall [illegible] count of another impossibility which he relates [illegible] stantially of his "economiser."

He says that with the waste steam from a [illegible] 14-horse engine he heats 6,000 gallons of water per [illegible] to 212°. Now what amount of heat is contained in [illegible] waste steam escaping from a 14-horse engine in a [illegible] and what amount of heat is required to raise the [illegible] gallons of water to 212° from 40°? If upon investigation we find the latter quantity to be a great deal more than the former, I suppose we shall be justified in saying that Mr. Crompton is a gentleman whose statements should be received with great caution.

A gallon of water at the average temperature of 40° is to be raised to 212°, it must therefore have 172° added to it.

A gallon of water in the state of *55lb. steam has* 1,200° of heat in it, and in warming *water to 212°* it parts with 988° before it falls to 212° itself. these 988° are sufficient to raise 5·74 gallons from 40° to 212° (for if we divide 988 by 172—the difference between 40 and 212—we get 5·74 for a quotient) that is to say, 5·74 *gallons of water at 40° can be raised to 212° by the condensation of the steam generated from one gallon of water under a pressure of 55lb. per square inch,* and the result will be 6·74 gallons of water at 212°. This is the theoretical maximum, which in practice is never reached by a "long chalk."

A nominal 14-horse non-condensing engine, working without expansion, requires 14 cubic feet of water per hour for steam, but Mr. Crompton says his engine cuts off at half stroke, therefore it should not require more than 8 cubic feet per hour—for steam when cut off at half stroke has its efficiency increased from 1 to 1[illegible] But in order to show my generosity to *Mr. Crompton* which my great advantage over *him enables* me to [illegible] without feeling it, I will say his engine uses 12 cubic feet of feed-water per hour or 75 gallons, or 750 gallons per day of ten hours, and that is the quantity of water in the state of steam which passes into the cylinder in that time; and as each gallon by its condensation is capable of raising 5·74 gallons from 40° to 212°, we arrive at a total of 4,305 gallons heated to 212° instead of 6,000, as Mr. Crompton asserts. But upon looking a little closer into the matter I find that a considerable deduction must be made from this 4,305 gallons, or else from the temperature it is presumed to be raised to, for all the heat which leaves the boiler on its way to the cylinder does not pass into the water-heater. [illegible] one-fifth of it at least is converted into work in the cylinder and disappears altogether, and not less than one-twentieth is dissipated by the exposed surfaces of the cylinder and pipes, &c., thus no more than three-fourths of the heat which leaves the boiler on its way to the cylinder ever reaches the water-heater, and the 4,305 gallons as found above must be reduced to three-fourths of itself, or 3,229 gallons, to which [illegible] must add the 750 gallons resulting from the condensed steam, making altogether 3,979 gallons, and that is the greatest quantity of water which it is possible to heat from 40° to 212° in ten hours by the waste steam of a 14-horse engine, and even that requires that every *particle of the steam should be condensed in the heater and that not a breath of it escape from the waste steam pipe* (pipe G in Mr. Crompton's drawing), but this condition is impossible of fulfilment, for as long as pipe G is there a considerable quantity of steam will always escape from it.

This is rather less than two-thirds only of what Mr. Crompton says the heater is doing. He must therefore be mistaken in either of three ways. Either the engine must be a great deal more powerful (30-h.p. at least), and use a great deal more steam than he supposes, or the quantity of water passing through the heater must be very much less, or at a much lower temperature than he asserts.

Suppose his assertion is true that 6,000 gallons do really pass through the heater per day, then the temperature of that water can be no higher than 170° (instead of 212°), and as Mr. Crompton feeds his boiler with this water, the saving of fuel by doing so is only 11¼ per cent., or not one-half of the "inevitable" 25, for which he so persistently sticks up, and this I am fully convinced, from my own observation and experience of feed-water heaters, is as much as nine out of every ten of them are doing in the ordinary way of work.

Every non-condensing engine should have a feed-water heater, it is wilful and prodigal waste to supply the boiler with cold water, when water at 160° or 170 e so easily obtained for the purpose, and a saving n 10 or 11 per cent. is not to be despised; but let an expect much more, for if he does, he will surely sappointed.

ave no hesitation in saying that Barton's heater good as any that can be adopted. I like the cut en paper very much, though I never had the sure of seeing it in operation, and I feel quite sure it is capable of doing as much as it is possible to n the direction of saving fuel by warming the l-water, and I also freely admit I consider the gn of it greatly superior to many others that I e seen and which bore a very good character as conomisers," but such wild, unfounded, and untene statements as Mr. Crompton has made respecting are only calculated to throw doubt and ridicule on it, and to bring a very excellent article into disoute, and Mr. Barton might well cry out, "Save me m my friends." JAMES BASKERVILLE,

Manager, City Foundry, Limerick.

SCREW POWER.

360] SIR,—In my letter on the above subject, on 592, your draughtsman has made my screws leftnded, instead of right-handed, which matters not in ig. 3, but has made a mess of Fig. 1. J. K. P.

SPECULUM WORKING.

[361] SIR,—Allow me to sincerely thank Mr. urkiss for so kindly coming to my assistance when I as in trouble with my 11¾in. speculum, and for his aluable series of articles on speculum working. Those rticles no doubt, thoroughly practical as they are, ave induced many to undertake the working of a peculum for themselves; they had the effect of stimuating me to renewed efforts after I had failed. It can carcely be expected that all operations will go smoothly in a first attempt of such a delicate matter as peculum working, however lucid the instructions may be; something or other will turn up unexpectedly for which instructions make no provision; then it is that we find our MECHANIC so invaluable. It is surprising as well as pleasant, even to those not immediately interested, to see how readily and disinterestedly information is given in "our" pages.

Having failed in polishing my speculum I began again, as Mr. Purkiss advised me to do, but not before I had laid the glass aside for some months, partly to attend to other matters, and partly to allow breathing time to brace up for the renewed effort and the trouble consequent thereon. I rough-ground the glass for a few hours, then commenced testing the iron tool to make it coincide with the curvature of the glass, which curve I took for granted was spherical. This testing is really a tedious process. I was about sixty hours in accomplishing this to my satisfaction. I renewed the oil and lampblack on the speculum several times, and spoiled several files; indeed, it was with great difficulty I could get the files to bite at all after a few minutes work. I verily believe they supplied me with a disc of steel at the foundry instead of iron. If Mr. Purkiss will inform me if he finds a similar difficulty in filing the oiled iron, and if the time I have stated would be considered by him much too long for the operation, I should be obliged.

When I had tested the iron tool so far that every square on it was marked by the oiled glass, I commenced the fine grinding on the polishing machine described by "Arcturus" some time ago. (Mr. Purkiss, of course, recollects the construction of this machine. There is no side motion to it, and I should be glad to know if Mr. Purkiss considers the side motion to be indispensable.) Having completed the fine grinding, and this I considerably prolonged, I proceeded to construct the pitch polisher. I had a die made as recommended by Mr. Purkiss, which would impress eleven grooves each way on the pitch. But in impressing the grooves I obtained an impression of the air-holes in addition. This appeared to be unavoidable. However, I cut off the projections as neatly as I was able, and passed on to the moulding of the pitch to the mirror, which after some trouble I accomplished, warming the pitch by the heat from a fire. By the time this was done some of the grooves were almost invisible. I then widened the grooves with a chisel (and I will here whisper to Mr. Purkiss that I chopped off several of the facets). The next operation was polishing. This was now a moment of anxiety. I applied the rouge, and in one minute I obtained what I failed to obtain on a previous occasion in 120 hours—a polish. But the polish could only be observed round the edge. The speculum worked somewhat stiffly, but I continued until it began to revolve the reverse way to that of the tool. I thought there was something wrong then, and remoulded the pitch and cut the facets smaller, hoping thereby to rectify this defect. But I could not do it. The speculum persisted in revolving the reverse way to that desired. I continued polishing, and in 10 or 12 hours the glass was polished all over. I believe this would have been done in about three hours if I had obtained rouge of good quality. It was only by using the rouge over and over again that I could advance with the polishing, avoiding adding fresh.

I now come to the process of silvering, which I have been unable to do in a satisfactory manner, and should be grateful if Mr. Purkiss can assist me in this matter. As a preliminary experiment I silvered a 6in. speculum, and that was everything that could be desired; the silver adhered tenaciously to the glass, and would bear polishing perfectly well. With exactly the same solutions I could not obtain an adhesive deposit on my 11¾ speculum. Nor have I been able to produce a silver surface that will bear washing after the deposit is effected. I have manipulated principally with the tartrate of soda process, requiring heat and sunlight combined. I have tried this process, with and without sunlight, with and without heat, and with weak and strong solutions. Lastly, I tried Browning's formula, as given in his "Plea for Reflectors," and allowed the speculum to rest in the solution 8¼ hours. The result, to my surprise, was a bright deposit of silver, only a portion of the surface being slightly clouded with a bluish film, which I thought would instantly disappear on the application of a little rouge. I was extremely careful in washing the silvered surface, pouring the water on from a cup—yet a portion of the surface was torn. I used hard water in washing, as I did on the other occasions, and distilled water for the solutions. The water was of the same temperature as the speculum. After I had been pouring for a few minutes a portion of the silver surface began to assume a dull appearance. On close examination this proved to be clusters of small blisters. (I should be glad to hear the explanation of this phenomenon.) Though the blisters flattened as drying took place, they left their outlines: but, on the whole, there is a capital polish, though I have administered no rubbing whatever; indeed, to do so would be to rub the silver off altogether. I want a surface that will bear polishing when tarnished, and should be rejoiced to hear of a certain process, or of Mr. Purkiss's method of procedure. I cleaned the speculum before immersing in the silvering solution with whiting, then with strong nitric acid, washed well with common water, then with distilled water, and finally with alcohol, and immersed the speculum wet with the alcohol. I have frequently obtained a deposit that would adhere well in patches, and in one instance at least, towards the edge of the speculum, I obtained a ring about ⅛th of an inch wide, that I could not rub off with my fingers, even when wet. I am quite unable to account for this.

I should like to know what I ought to be able to accomplish with my speculum, supposing it to be a good one; it is 11¾in. in diameter, and 18ft. focus. Will Mr. Purkiss be kind enough to tell me? I wish to test with terrestrial objects, that method being most convenient to me at present. I can command space of about a mile, and at that distance the objects may be buildings, a turret clock, or human beings. I did not construct the testing rod described by Mr. Purkiss for ascertaining the figure of the speculum, or I might perhaps have known what figure I had obtained with little trouble. I have never had the pleasure of looking through a good telescope of large diameter, but as far as I can judge I have reason to be satisfied with mine. I by no means regret the trouble I have bestowed on it. I can use the whole diameter of the speculum, even with what I believe to be a high power, on terrestrial objects. I have temporarily mounted it in the Herschelian form (aërial). Mr. Purkiss questioned the advisability of my making a speculum of such a long focus; but I may mention that I can adopt an arrangement of my own, possibly akin to the pancratic eyepiece, whereby I can use the speculum at any length within the focus, and which is convenient for terrestrial purposes. May I not expect good results in viewing planets by using a cap next the eye with a very small hole in it?

As it is my intention to work another speculum of the same diameter and focus, I must plead this as my reason for detailing my experience, hoping that Mr. Purkiss will favour me by explaining my seeming misadventures, and giving a hint or two on those points he may think needful, as he seems so well able to do. Perhaps I am the only one of "our" speculum workers who has met with difficulties in his labours, as we hear little or nothing about them. Are there any who have begun and have given up in disgust—banished the subject from their minds for ever? Let us hope not; *something* is to be accomplished, even by inexperience, assisted by "our" kind contributors, and our own energy, as my 11¾in. mirror proves. J. P.

SPECTRUM ANALYSIS.

SIR ISAAC NEWTON, PROF. ROSCOE, MR. NORMAN LOCKYER.

[362] SIR,—It is very desirable that those who assume the duty of popularizing science should, in doing so, confine themselves to facts and avoid all misrepresentations and erroneous statements. I regret to find that this is not always the case. In a course of lectures on Spectrum Analysis, delivered in the year 1868, before the Society of Apothecaries, by Prof. Roscoe, and published by Macmillan & Co., it is stated at page 22, by way of apology for Sir Isaac Newton not having discovered the spectral lines, that "Newton did not observe them; and for the good reason that he allowed the light to fall on the prism from a *round hole* in the shutter. In this way he did not obtain what is termed a pure spectrum, but a series of spectra, one overlapping the other, owing to light coming through different parts of the round hole. If he had allowed the light to pass through a fine vertical *slit*; and if this slit of light—if we may use such a term—had then fallen on the prism, placed so that the edge of the refracting angle is parallel to the slit, he would have observed that the solar spectrum is not continuous but broken up by permanent dark lines. Dr. Wollaston, making use of a fine slit (1-20th of an inch wide) of light, discovered these fixed lines in the solar spectrum." Before proceeding to show the erroneousness of these statements of Prof. Roscoe, it may be well to point out similarly erroneous statements made by Mr. Norman Lockyer, in a course of lectures, delivered by him before the Society of Arts during the winter of 1869. In Mr. Lockyer's first lecture, delivered on the 6th of December, 1869, and published in the *Journal of the Society of Arts* of January 14th, 1870, page 158, it is stated, "Newton made a round hole in a shutter for his experiments; but we now know he ought not to have done that; *he ought to have made a slit.* But this did not come out till 1812 (1802?) when Dr. Wollaston, by merely using a slit instead of a round hole, made a tremendous step in advance." Other statements of the same import were frequently made by Mr. Lockyer in his course of lectures.

Are these statements of Prof. Roscoe and Mr. Lockyer conformable to facts? Did Newton in his experiments confine himself to a round hole as alleged by these *savants!* The statements not only are not conformable to facts, but are directly opposed to facts. We have the refutation of them in Newton's own words, by which it plainly appears that he used in his experiments not only a round hole, but "an oblong slit 1-20th of an inch wide," and also a triangular hole. In Newton's "Optics" (edition of 1704), page 49, it is stated "Yet instead of the circular hole, 'tis better to substitute an oblong hole, shaped like a parallelogram, with its length parallel to the prism. For if this hole be 1in. or 2in. long, and but a 1-10th or 1-20th of an inch *broad* or *narrower*, the length of the image (spectrum) will be as simple as before, or simpler, and the image will be much broader, and therefore more fit to have experiments tried in its light than before." Hence we find that Newton used the very width of slit which Prof. Roscoe and Mr. Lockyer assert he did not use. And, further, they allege that if he had used the narrow slit, he would have discovered the spectral lines. He did, however, use the narrow slit, but did not discover the spectral lines.

It is quite evident that if Prof. Roscoe and Mr. Lockyer had read Newton's "Optics," they would scarcely have ventured to make such palpably erroneous statements. Indeed, if they had even read more recent works on optics, such as "Priestley on Light, Vision, and Colour," and the "Treatise on Optics" published by the Society for the Diffusion of Useful Knowledge, they would have found that Newton, in his optical experiments, *used* the *narrow slit*, which they allege he did not use.

Throughout the whole of Mr. Lockyer's first lecture, several very erroneous and inaccurate statements are made. For instance, in the *Journal of the Society of Arts*, for January 14th, 1870, page 155, he states, "You see, therefore, that our spectroscope depends first of all on Newton's discovery of the prism in 1675." [Mr. Lockyer ought to know better. He might have known that the prism had been used in optical experiments by the Italian philosopher, Grimaldi, long before the time of Newton's optical experiments. This is evident from Newton's "Treatise on Optics" (edition 1704, page 28), where Grimaldi's experiments are specifically referred to by Newton himself. Hence the prism was not discovered by Newton as alleged by Mr. Lockyer. Dr. Priestley states in "Light, Vision, and Colour," that Grimaldi perceived that when a beam of the sun's light was transmitted through a prism, instead of coming out round as it entered, it made a very considerable oblong image (spectrum) of the sun on the opposite wall, by which he proved that colours are produced by the refraction of light without any reflection; and, further, that Grimaldi's "Treatise on Optics," giving a detailed account of his experiments, was published before Newton commenced his optical experiments. E. NUGENT.

MR. DAVIS'S ARTICLES ON CHEMISTRY.

[363] SIR,—Will you allow me in all kindness to offer a suggestion to Mr. Geo. E. Davis, the writer of the chapters on "Chemistry," in the MECHANIC? I am afraid he has mistaken the class of readers for whom he is writing. He promised at the outset that the chapters should be of a thoroughly practical nature, and at once he plunges into theory. Under the head of "Atomic Weights," why not have given the method of finding them from the specific heats of the metals referred to—lithium as unity,—and the real method of finding the exceptions, such as carbon. Instead of saying "It has been found by experiment," give the experiment in full and simple language, and in giving typical examples of the classes of compounds, take the simplest and not the more complex? The whole *résumé* on "Crystallography" might have been advantageously omitted. The question of isomerism might very easily have been explained without any reference to the elaborate memoirs of Roscoe, Berzelius, and Rammelsberg on vanadinite, apatite, and mimetite; this kind of discourse and reference to *Nature* and the *Chemical News*, will only tend to disgust and dishearten and not instruct. One of two things is obvious—if the articles are intended for such as read *Nature* and the *Chemical News*, then they are superfluous in the MECHANIC; if, for more elementary readers, then they are too loose and diffuse. I would not have Mr. Davis sacrifice anything of scientific language and accuracy to anything like a popular discourse—that would be going to the other extreme. With every good feeling let me advise Mr. Davis to take up definite points and explain them fully, but on strictly scientific principles, defining everything sharply and accurately, then his chapters will be of great value both to the lone plodding individual and to the classes reading "Chemistry" throughout the country during the winter. But if the teacher has to warn his pupils against such and such statement in the MECHANIC it becomes awkward. From what I know of Mr. Davis I think we may expect good things from him, as his experience increases. In conclusion, let me remind him and your chemical readers,

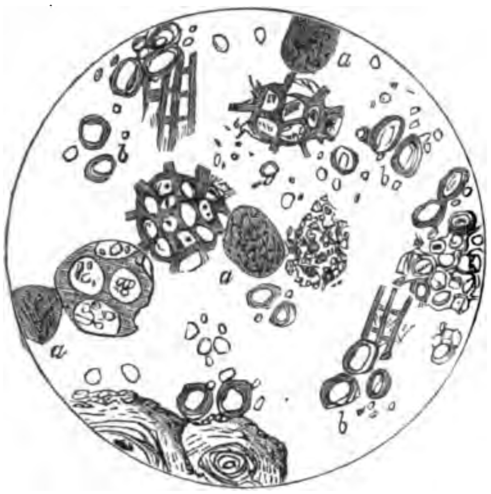
of one serious oversight—the word *radical*, throughout both chapters is spelled *radicle*; the latter would be correct enough in botany, but not in chemistry.

ROBERT E. H. GOFFIN.

MARANTA ARROWROOT, ETC.

[364] SIR,—The representation of Maranta arrowroot which appeared in the ENGLISH MECHANIC, p. 493, was drawn from a sample, given me by a microscopist as *genuine* maranta, and as the plate was drawn by camera lucida there is no error I am convinced. On turning to Brande's "Dictionary of Chemistry" I find a representation of West Indian arrowroot, and that differs only from mine in having the rings much more strongly marked; the shape is the same. Hassall in his "Adulterations Detected," gives a similar plate. The Maranta arrowroot, plate, p. 493, is magnified 200 diameters, that power being ample to delineate most starches.

I enclose a drawing also magnified 200 diameters of a sample of *pure* mustard, showing wheat starch (*b*) and turmeric (*a*).



Will "J. C." kindly mention the works, the plates of which I might possess or procure, from which he states he drew his information?

I am afraid if "Young Photo" tries to precipitate an ordinary old cyanide plating solution with common salt (T. W. Boord's process) he will not meet with much success, sodium chloride will not precipitate silver in solution as the double cyanide.

HYDROGEN LAMP.—"F.R.M.S." can purchase for 1s. the platinum at Griffin's, to fit in the thimble-shaped socket. If nothing else is wanting, when the hydrogen is turned on to the *dry* platinum it ought to ignite.

NITRATE OF SILVER (4676).—"Paddy" must mix the precipitate with carbonate of soda, and strongly heat either in a crucible or in a deep cavity on charcoal; the resulting silver must be dissolved in nitric acid and crystallized.

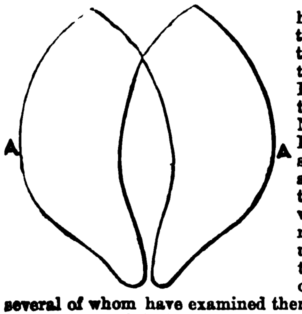
SCIENCE AND ART EXAMINATIONS (4699).—"Crow Trees" must be thoroughly acquainted with the organic portion of Fownes and Miller, and the contents of Bunsen's "Gasometry," Liebig's "Organic Analysis," and Ganot's "Physics." The Government examiner recommends that the candidate should digest the contents of Watts's "Dictionary" in addition.

(4706).—Has "In a Fix" got any cyanide in the water? Salt will not precipitate silver in the presence of an excess of cyanide.

GEORGE E. DAVIS.

AN UNKNOWN COAL-MEASURE FOSSIL.

[365] SIR,—The pages of Vols. I., II., and III. of *Scientific Opinion* contain many letters and papers from my pen on the subject of Coal-measure Palæontology, and especially on that department of palæontology which refers to fish and reptile remains found in the collieries of Northumberland.



You will perhaps permit me to direct the attention of your readers to two bones which I have recently obtained from the Northumberland Low Main Coal stratum. They are, I believe, new to science, and whether new or not, they are as yet uninterpreted by the best palæontologists in England, several of whom have examined them.

The forms of the bones and the positions in relation to each other in which they lie upon the slab of shale to which they are attached will be best understood by reference to the annexed outline sketch, which is one-half the natural size of the specimens.

The length of each bone is 5¾in., and the width of each at the broadest part is 2¼in.: the surface presented to the eye is tolerably level, but at the points marked A A, there are considerable elevations, as if for the attachment of muscles; and the external borders of the bones, extending from A to the extremities, are strong, the maximum thickness being about ⅜in. The bones somewhat resemble in form the supposed *operculæ* of the supposititious fish *Archichthys*. They are not much unlike the *maxillæ* of *Megalichthys* (the *Parabatrachus* of Owen), but they differ from both these in the curve of the inner edge, in the greater thickness of the bone, in the solid protuberances near A A, and in the longitudinal striations which cover the surfaces of the bones in a manner resembling the striations on the carpal bones of *Gyracanthus*. Upon the slab bearing the two unknown bones there are scales of *Megalichthys* and *Rhizodopsis*, but to neither of these fish can the remains be ascribed.

I forward this communication in order that any coal measure palæontologist who peruses your periodical may be enabled to compare the specimen with the fossils in his possession.

T. P. BARKAS, F.G.S.

SQUARING THE CIRCLE.

[366] SIR,—In the correspondence on the "Rectification of the Circle," allusion is made to the ratio 22·7, which, like 3·1416, I suppose is the result of a process of approximation, and I would, therefore, wish to ask:—

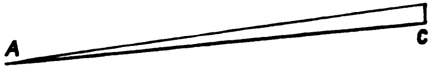
1. Would the result of any geometrical demonstration be objected to simply because it did not exactly agree with the latter, so universally recognized as true viz., 3·1416?

2. Has any one ever attempted to subject the excess of the square over the circle to a similar process of approximation, and if so, with what results?

My reason for putting such questions is, because I have a method of solving the problem geometrically, but the result is in excess of 3·1416 and less than 22·7, and if the answer was favourable I might be induced to publish it, as I feel convinced it is the true geometrical ratio. It would, though, put me to a little trouble to reduce to a system, &c.

G. H.

[367] SIR,—In one of your June Nos. a method is propounded of squaring a circle, which has been sufficiently anatomized and is clearly wanting in exactness. Had the writer, however, made the basis of his triangular sections *infinitely small* it would have been correct theoretically, as the following calculation may tend to prove:—For, let A B C be one of these sections, with base B C infinitely small. The circle will then be



made up of △ A B C + A B C′ + &c., *ad infinitum*. And B C when infinitely small will there and then only coincide with a straight line, also ∠ A B C (the ∠ B A C being infinitely small also) will = a right ∠.

Hence $\frac{AB}{2} \times BC$ = area of △ A B C, and area of circle $= \frac{AB}{2} \times BC + \frac{AB'}{2} \times B'C +$ &c. *ad infinitum*.

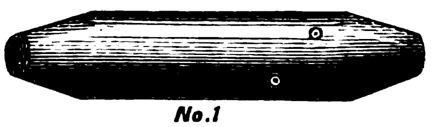
Now $\frac{AB}{2} = \frac{\text{radius}}{2}$ and $BC + BC' +$ &c., *ad infinitum* = circumference.

∴ Area of circle $= \frac{\text{Rad.}}{2} \times$ circumference and we have the usual formula for area $a = c\,\frac{r}{2}$.

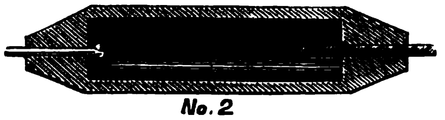
SUFFOLK AMATEUR.

THE "SMITH" TURN BUCKLE.

[368] SIR.—The diagrams annexed illustrate a handy and simple turn buckle easily made by any smith. It is the invention of Mr. J. B. Smith, the foreman of the smith department of the Harlem Railway Works (U.S.).



No. 1



No. 2

It is made from gas-pipe, and of size according to the work required. The process is as follows:—One end of the pipe is made solid for the thread, while the other is prepared for the bottom end of the rod, and several holes are made in the side of the pipe in which to insert the lever for turning the buckle. Fig. 1 represents the outside view and the holes for lever; Fig. 2 gives a sectional view. Compared with the usual buckles, which are expensive, and require the hand of an excellent workman, it is very cheap, its cost being at least 62½ per cent. less than the ordinary method.

KAPPA.

IRIS DIAPHRAGM.

[369] SIR,—Three weeks since I [illegible] to query No. 4493, but as the letter has [illegible] serted I repeat in reply to "Unit," that [illegible] "Iris Diaphragm" described in the [illegible] chester *Literary and Philosophical* [illegible] in Mr. Darby's *Astronomical Observer*; [illegible] drawings are given of the details of [illegible] noticed that "F.R.A.S." (317) [illegible] of the diaphragm, but I may tell "[illegible] figure is *almost* perfect, and that in [illegible] rays are caused when bright stars [illegible]

The instrument described by Mr. [illegible] ingenious, but I fear would be quite [illegible] nomical work, as the image of the [illegible] would probably take the form of the [illegible] pentagonal. The principle involved [illegible] has been long known; but I am not [illegible] description of the adaptation for [illegible] than those I refer to. Messrs. [illegible] adopted it to their microscope, but I [illegible] have superseded its use by another [illegible] ciple to that shown in (259), and [illegible] The blades are numerous, and the [illegible] but not so regular as that formed by [illegible] and would, most likely, cause rays from [illegible] instead of clear discs.

The only disadvantage of india-rubber is [illegible] cays in course of time, but can of course be [illegible] required. The diaphragm should never be [illegible] become frozen, and the more it is used the [illegible] will last. The full aperture may be used or [illegible] closed entirely, and by the simple machinery I [illegible] scribed may be worked from the eye end of the [illegible] and this is the chief advantage of the apparatus.

A. BROTHERS, F.R.

Fulshaw, Wilmslow.

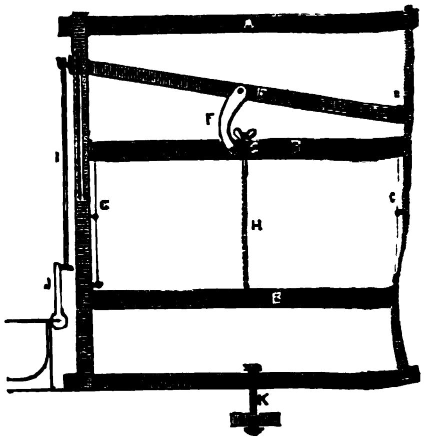
SCREW PROPELLING.

[370] SIR,—I hope the Rev. E. Kernan will not feel vexed if I add to the names of those connected with the history of the propeller, one not less deserving than the rest to be mentioned amongst the "*certain facts*." I mean that of Josef Ressel, then *Imperial Woodward* at Trieste. In his treatise on the *Archimedean screw*, as annexed to his petition on 28th November, 18[illegible], for the grant of a patent, showing, I believe, an earlier date than that of Captain J. Ericsson, and declaring a new invention consisting in propelling vessels at sea, and even in rivers, by means of a wheel resembling an endless screw, he says "the troublesome noise caused by the paddle-wheels of steam-boats, and the unpleasant oscillation inherent thereto, and also the waste of power and time in working the same, induced me to contrive an apparatus free from such defects. I adopted the theory of the screw and gave the water of the vessel the form of a screw, . . . and I think it advisable to fix the wheel at the stern, since the back water of the ship might promote its action." May the above suffice to explain the claim?

A MEMBER OF THE ENGLISH MECHANICS' SCIENTIFIC AND MECHANICAL SOCIETY.

GREENWOOD'S FRET-SAW MACHINE.

[371] SIR,—I send you a drawing, made on the scale of 1in. to the foot, of my fret-saw machine, which I trust may prove useful:—A A A is a frame made of beech wood, with a bead run all round the inside front edge. There is a slot in one of the uprights A for the bar D to work in. B B inside frame, with two iron rods C C working through guides to keep the frame true; D is a bar of beech hinged at E; F is a piece of iron to lift the frame up and down; G is a thumb-screw to tighten saw; H, saw; I is a connecting rod from the bar D in the crank J. On the mandrel there is a table to lay the wood on, not shown. The whole is well put together, and stained over the same as a new plane. K is a bolt to bolt it to the lathe-bed.



W. GREENWOOD.

DIVISION PLATE.

[372] SIR,—Your correspondent "Wahsrof" has been kind enough to send me one of Mr. Baker's

ACCESSORIES TO THE MICROSCOPE.

Fig. 8.

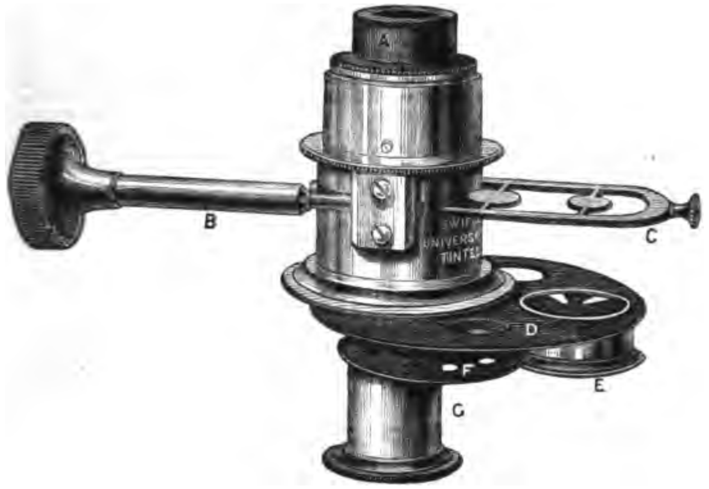
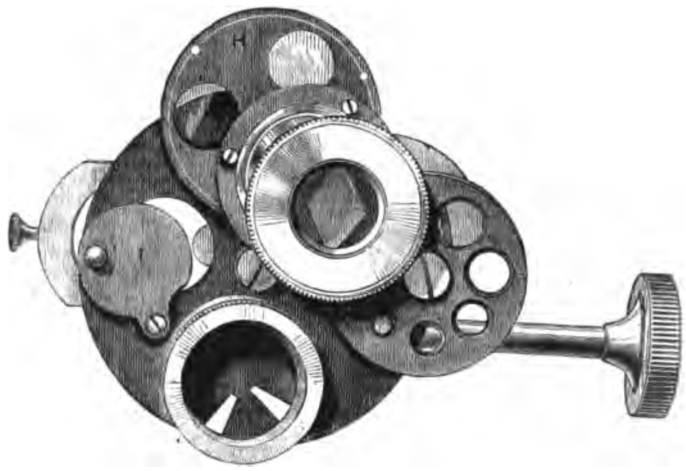
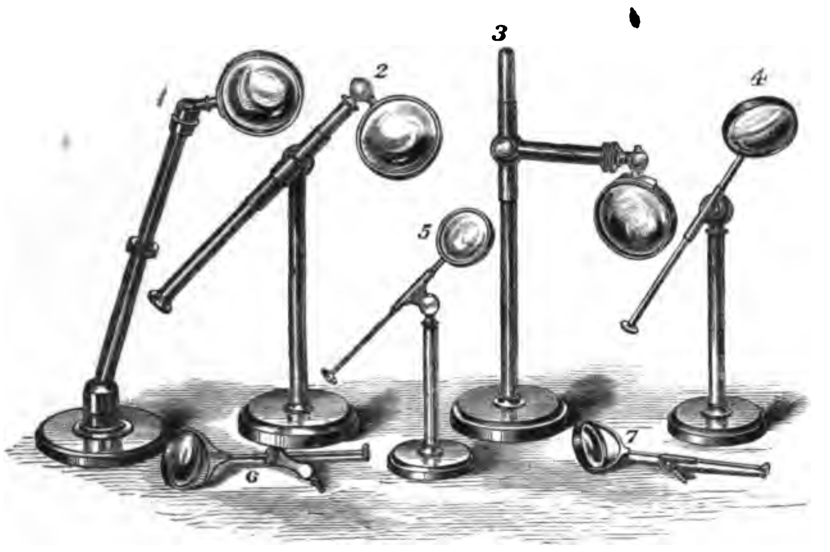


Fig. 9.





"Ready Reckoners" for the above. In return I will enclose in an envelope for him, on application to the Editor of the ENGLISH MECHANIC, the numbers of a few of my plates. People do not always see that very different numbers may be desirable according to peculiar requirement, or to the diameter of plate to be dealt with, or to the breadth of the flat portion thereof (as iron pulleys are commonly hollowed towards the centre in front), and that it requires some judgment to select from a really large variety of good working numbers those that are not too crowded, or those that may contain the greater number of prime factors, or those that contain decimal numbers or multiples of 5, and so on, according to the individual requirements of the person using them.

An amateur using an excentric chuck, for instance, may consider a pattern containing 12 circles to be rather coarse, and one of 14 as much too fine, and for his use it is requisite to supply a circle containing a multiple of 13, and in the same way one of 11, 17. and 19, and thus it occurs that on Holtzapffel's lathe you sometimes find 209 and 221, upon which two unhappy numbers I let off a stream of abuse in my answer to query on p. 572.

J. K. P.

ACCESSORIES TO THE MICROSCOPE.—No. II.

LIGHT AND CONDENSERS.

[378] SIR,—Light. Gentle reader, do not think that I am going to attempt a learned dissertation upon the wonderful properties of light, all I intend doing is to treat, as briefly as possible, light in connection with the microscope. We may possess a very beautiful instrument, have the best object glasses, and splendid specimens, but unless we have the required light all is in vain.

LIGHT.—Daylight and artificial light are both requisite in studying the microscope. We presume most of our readers will have to work at this pleasant subject when the labours of the day are done; so we will describe the use of artificial light first, as what we say under this head, with some little modification, will apply to daylight.

The first thing necessary will be a lamp. Most opticians supply a very useful lamp upon a sliding rod, so that it may be raised or lowered as desired, the price of which is from half a guinea upwards. Another handy and inexpensive arrangement is to have an ordinary lamp, and a solid block of wood, longer one way than the other, so that for transmitted light the lamp may be placed upon the side of the block, and for reflected light upon its end.

Many kinds of lamps are recommended according to the fancy of the microscopist; but for ordinary work, a paraffine lamp with a good base, costing from 1s. to 1s. 6d., will answer every purpose. In trimming the wick it will save much trouble and vexation of spirit if the corners be cut round; and when it is lit it should not be turned up as high as it may be required, until the chimney is quite warm; by so doing many glasses will be saved, and expense spared.

The first accessory necessary when proceeding with this delightful study, will be a condenser, upon the successful use of which will depend the beauty of the object shown.

A simple condenser consists of a plano-convex lens fitted into a framework of brass, which is attached to a steel rod, and so arranged that it can be turned in any direction. The cheapest is the stage condenser, as shown at Fig. 7; perhaps the next least expensive and most useful are those shown at Figs. 4 and 5. Figs. 1, 2, and 3 are large stand condensers, and suitable for the more expensive microscopes.

The parabolic or silver side reflector has a very useful illuminator; by its aid some very beautiful effects are produced. Professor Smith, of America, has invented an illuminator for high powers. It is so arranged that it has to be placed immediately above the object-glass, through which the light is thrown on to the object.

It will be observed that the condensers already described are for opaque objects; for transparent objects many beautiful contrivances have been adapted, and known as achromatic condensers. Most of the best microscope makers supply different arrangements with their microscopes to effect the same object, and it is only just to those gentlemen that their condensers should be made known to every scientific man who wishes to make the microscope his companion. Messrs. Powell & Lealand, Mr. Thomas Ross, Messrs. R. & J. Beck, &c., have each done much to bring, not only the optical, but also the mechanical part of the microscope, to its present high state of perfection.

A short time since Mr. James Swift, of the City-road, presented to the Royal Microscopical Society an achromatic condenser he had just completed, which has the advantage of containing more accessories than any other piece of apparatus, as Figs. 8 and 9 will show:—

A, optical combination.
B, rack adjustment for focussing.
C, sliding frame, with spots for dark ground illumination.
D, large diaphragm.
E, rotating cap to carry test stops.
F, small diaphragm of apertures.
G, polarizing prism.
H, selenite diaphragm.
I, oblique light shutter.

A description of this "accessory," taken from the "Transactions of the Royal Microscopical Society," was given in "H. P.'s" article last week. F. B.

SUMMARY OF OBSERVATIONS.—SPOTS ON PLATO, AUGUST, 1870.

[374] SIR,—The observations of the floor of *Plato* during the lunation of August, 1870, were much more numerous than those of the two lunations June and July of the same year, the number in June and July being 89 and in August 125. These numbers not only indicate that an improvement in the state of our atmosphere occurred in August, but they afford the means of a very fair comparison of the degrees of visibility of the spots observed (19)—viz., Nos. 1, 3, 4, 5, 6, 7, 9, 11, 13, 14, 16, 17, 18, 19, 22, 23, 25, 30, and 31. So far as the number may be regarded as a measure of the state of our own atmosphere it would be rather better than in April when observations of 17 spots were recorded. We, however, meet with the same irregularity which has characterized these observations throughout, for the two sets do not consist of the same spots. Those common to the two series are Nos. 1, 3, 4, 5, 6, 9, 11, 14, 16, 17, 22, 25 and 30; those seen in August, but unseen in April, were Nos. 7, 13, 18, 19, 23, and 31; while those seen in April, but unseen in August, were Nos. 24, 32, 33 and 35. The two last mentioned series consist of spots of low visibility.

In the summary for June and July, 1870 (ENGLISH MECHANIC, No. 282, August 19, p. 518), allusion is made to the decline of visibility of spots Nos. 4, 14, 16, and 5, to which may be added No. 9. Of these Nos. 4 and 9 have exhibited pretty nearly the same degrees of visibility as they did in April and May, No. 4 rising to 1·000 and No. 9 falling to ·200, the values in April and May of No. 9 being ·216, and of No. 4 ·978. No. 5 has risen from ·514 to ·650. No. 14 has not exhibited similar phenomena, although its visibility has increased it still falls short of that which it exhibited in April and May—viz., ·432, being in August ·250, and the visibility of No. 16 has continued to decrease. Fixing our attention on these five spots we find on examining the spot ledger that the decline of visibility of No. 4 is most probably due to "personality" for although the spot was recorded in June by Messrs. Elger and Gledhill, it was on Mr. Gledhill's returns for July that it was absent, being recorded that month by every other observer. The observations of Nos. 5 and 9 do not appear to be affected in the same manner, being distributed as usual. Nos. 14 and 16 have certainly decreased, especially the last, during the lunations April to August, and although No. 14 has increased during August it has not regained the degree of visibility it exhibited in April and May. On the 6th of August Mr. Elger remarked that the western part of the floor of *Plato* from a point just east of No. 14 and west of No. 16 was of an even light colour, and it is just on this region that the spots the visibility of which has of late been decreasing are situated. Of these we have No. 22, seen twice only in the four lunations April to July, on April 12 and May 18. During the August lunation it was seen on four occasions by Mr. Pratt, who thus records hif observations:—"Spot No. 22 according to my own observations has manifested a remarkable increase of brightness, and those parts of the shaded portions of the floor of *Plato* which are nearest the rim have come out more conspicuously darker than the rest than I remember to have previously noted. The tint of floor, too, has progressively paled. These three phenomena may possibly be connected by a common cause, for certainly in this lunation there is somewhat of a coincidence amongst them for instance, spot No. 22 is intensely bright at the time the marginal portions of the shaded parts are more conspicuously dark and these too again coincide with the time when the general tint of floor was at its very darkest. Again, after August 12 and 13, spot No. 22 decreased in *relative* intensity although I am not ready to hazard the assertion that it had on August 16 positively declined to its usual intensity as it was not seen. Two similar instances, I believe, I have noted before when spot No. 22 manifested a singular brightness *at sunrise.* But the connection between the visibility of the deeper tinted margins and the general deepening of colour is perhaps closer still, as both certainly paled after August 13. The perplexity seems to be that the variations in intensity of the margins are *relative* in respect of the general colour, and if differences of angles of illumination and vision do affect the general tint it might be supposed that they would in the same measure affect the margins and so produce no *relative* variation of intensity." On this point we may remark that the passage of a *thin cloud* before the moon greatly intensifies the darker tints. Returning to the spots which are situated on the western part of the floor we have No. 2, seen once only in the five lunations April to August, on May 18; No. 18, twice only, on May 18 and August 12; No. 19, the same; No. 16, which was seen on fourteen occasions in April and May has been declining since; while No. 18, which is also on the western part of the floor, has been increasing the spots which have been most frequently observed are situated upon and near the central part of *Plato*, and it is worth inquiry as to whether the localities of those which are most intermittent are situated in *low* portions of the floor. There is great reason to believe that while the sites of the markings are permanent, the manifestations of the markings themselves are variable. There is another feature connected with the spots which must not be overlooked. The observations of the second year have now proceeded sufficiently far to allow of the projection of the earlier portions of the curves; those of No. 17 and 8 form a group possessing high but decreasing visibility; those of Nos. 5, 14, 25 and 9 another, the first member manifesting a visibility above its ordinary value of about ·500, the degrees of the remaining members are lower. The curve of No. 16 is descending throughout, and the spot being in the neighbourhood of Nos. 13 and 19, it appears as if it were undergoing a similar change to that which has impaired their visibility, and which may be temporary or permanent. The spots Nos. 30 and 31, which have been seen as minute craterlets, have been increasing in visibility, not so much perhaps from an improved state of the earth's atmosphere, which has been of the opposite character during the period of their increase as from a probable action in the group to which they belong, the principal member, No. 3, having also increased in visibility at the same time. Taking into consideration the whole of the phenomena presented between April, 1869, and August, 1870, inclusive, it would appear that the visibility of the craterlets is not so intermittent as that of the spots, and both seem to be affected by agencies that occasionally obscure them, and in some instances render them invisible for considerable periods.

W. R. Birt.

BICYCLE RIDING.

[375] Sir,—We are sorry to differ with Mr. Reveley in his opinion of bicycle riding. Mr. Reveley states that no man can make more than sixty strokes per minute; this we can prove to be incorrect. A mile has often been done in less than five minutes, but we will take five minutes for example, so that there may be no doubt about it. This was done on a circular course of nine laps to the mile, so that it could not have been all down hill. This, supposing the wheel to be 3ft. in diameter (which is about the average) would be 117 strokes per minute, or about double what Mr. Reveley states to be possble. We do not pretend to say that this could be kept up for any great length of time; but still it is sufficient to prove that at least two strokes per second can be attained. We are sorry to observe that Mr. Reveley thinks fit to disbelieve all statements made to the effect that more than seven miles has been done in one hour. We ourselves have done forty miles in five hours. If Mr. Reveley can find an inclined plane forty miles in length, where a bicycle will run at that rate without any motion of the rider, we will believe that the journey we performed was at that very place.

Two Bicycle Riders.

[376] Sir,—I have been very much surprised lately on reading letters written against the bicycle, and I rejoice to see the sensible answer of "Senex." I also may call myself an elder: I am now too delicate and nervous to attempt horse riding, though accustomed to it all my life. I require exercise, and with my doctor's advice I tried the bicycle. I cannot walk more than four miles, and yet I have several times enjoyed rides of from 14 to 18 miles on my delightful machine. It is a shame for persons, without any object that I can see, to try and prejudice young men against the most delightful and health-giving exercise that has ever been invented. I can only hope that the writers of such letters have either had bad roads or bad machines to warp their better judgment.

An Invalid Clergyman.

[377] Sir,—I wish to say a few words in favour of bicycle riding. I am in my 60th year of age, 5ft. 6in. in height, and weigh more than 12 stone. I learned to ride a little last autumn, but could not go more than half a mile before I must stop to take breath, this I thought at the time would prevent me ever going any great distance. But now to show the advantage of bicycle riding, I left Leeds last Saturday (along with my two sons, one 17 years and the other 14 years, all upon ordinary bicycles) for Southowran, near Halifax, upon the worst road imaginable for bicycle riding—there is not 20 yards of level road in the whole distance of 16 miles; this we travelled against a strong wind, and returned to Leeds again in the evening less fatigued than I should have been with walking six miles. Although I am a year older since I learnt to ride, I feel 10 years younger in health and strength.

James Smith.

[The above letters are specimens of many others we have received on the same subject. We are sorry we cannot afford space for those written by G. Nash, "Motive Power," "Ajax" and "W. T." All the writers are unanimous in favour of bicycle riding.—Ed.]

BICYCLE RIDING AND WALKING.

[378] Sir,—The remarks of Mr. R. G. Bennett in your August 12th number, do not fairly represent what can be done by ordinary bicycle riders, and are, therefore, calculated to mislead. Mr. Bennett's "twelve months' continual practice" has had a most disheartening result, if it only enables him to go four miles an hour for five hours. The writer, who has never run in a race, and whose walking powers are certainly not more than at the rate of four miles an hour, considers himself an "ordinary amateur bicycle rider," and does not make the following statement boastfully, but simply as an instance of what can be done *without training and without over-exertion.* On 6th August I started from Leeds on the bicycle at 2 a.m., and arrived in Stoke-on-Trent at 1 p.m., thus riding a distance of seventy-five miles in eleven hours. As to the use of bicycles for practical purposes, I may say that myself and a friend have travelled on them upwards of a dozen times during the present summer distances varying from twenty to fifty miles, without any signs of exhaustion. I need scarcely remind your correspondent that a light well-made bicycle and the knowledge how to use it are as necessary to ensure success as moderately strong limbs.

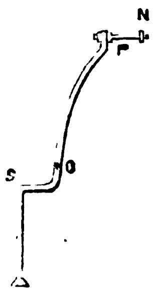
W. B.

[The above letter is a sample of a dozen letters on the same subject which have come to hand in answer to Mr. R. G. Bennett.—Ed.]

A BICYCLE STEP.

[379] Sir,—I send you a sketch of a simple contrivance of mine—a step for the bicycle—which will be found very useful to riders thereon. I have been using one for about two months, and can therefore recommend it with every confidence, believing it to be superior to any *patent* device for the same purpose. It only weighs, when complete, 1½lb., and being in one piece, it makes no noise in travelling along the road. Any blacksmith can make one, and fit it to the bicycle for about two shillings.

The sketch requires little explanation. A ½in. round bar of iron is bent into the shape shown; the step, S, is about one foot from the ground: through the top of the bar a ⅜in. pin, P, is passed, on which it should swing, pendulum fashion. To fasten it to the bicycle, remove the pin which carries the brake, enlarge the hole to ⅜in., then insert the pin, P, and fasten securely with the nut, N. This pin, P, will then carry the brake as well as the step. When travelling, the step is held up parallel with the hind fork by means of a spring made of a piece of ¼in. india-rubber tubing, one end of which is fastened to the hole, O, in the bar, and the other to the top of one of the upright springs which carry the saddle spring. To use the step, move the bicycle till the off treadle or crank points upwards, then press the step down to the ground, place the foot thereon, and quietly throw the other over the saddle on to the off treadle, press upon it, and when the bicycle moves forward (not before) remove the foot off the step, which will then spring back and upwards to its place, parallel with the hind fork and quite out of the way of any obstacle.



John C. Frank.

CARBONIC ACID GAS AS A MOTIVE POWER.

[380] Sir,—The use of carbonic acid in one shape or another has often been suggested as a motive power, and for some years I have been working on its application in the liquid state as a motive power for submarine vessels. Illness now prevents me continuing them, and I fear I shall not again be able to go on with them. May some reader of the English Mechanic carry out what I am unable to do; but for a nobler purpose than that of warfare—viz., the lifeboat. Anybody will understand the advantage of placing in a lifeboat a means of propulsion of 20 to 30 horse-power, and this is quite practicable by using carbonic acid. This gas under a pressure of about 800lb. per square inch becomes a liquid. This liquid, the same as water, requires a certain amount of caloric to reconvert it into gas. If it gets this heat from the atmosphere its evaporation will soon become comparatively slow, and the tensile force of its vapours low and useless. We want, therefore, a source of heat, and that we may find at sea.

Let the liquid acid be confined in a suitable or boiler, and thence made to pass (by a force through a coil of copper piping casing the nally. After passing through these pipes it to the boiler. It is evident that circulating these pipes it will absorb heat from the and maintain itself at the same temperature all that is requisite to furnish a gas with force of some 800lb. per square inch. carbonic acid be used for this purpose, other gas which liquefies under pressure. above though, for several reasons.

1. Its cheapness, as it can be made by the ordinary gas by a series of pumps, into another, suitable means being taken the heat so developed.

2. Its absence of action on metals.

3. Some will call the high pressure to be an objection; but I say that a pressure of 1 quite under control with modern appliances, the plant is conscientiously and well put together would be much safer than many iron-works Black country.

Feu Foll

FREE-REED ORGANS v. HARMONIUMS

[381] Sir,—Mr. Nash in his letter (No. 311, 2), hopes I shall not be angry with him for his defence of the harmonium against the objections raised in my note (239). He writes so temperately that in my turn have to bespeak his courteous attention to the fact that he merely replies to my objections without answering them.

He admits the first, viz.:—the reediness of tone of the harmonium, only urging that in this respect some harmoniums are not quite so bad as others, which I readily admit. He says himself, "this doubtless is the chief objection to the harmonium." I thought so too, and hence placed it first. But since he so entirely agrees with me on this subject it seems strange he did not concede the point without hesitation.

Mr. Nash thinks my second objection, about the bass overpowering the treble, unfair, yet does not scruple to reply to it in a much more unfair manner. He says "on the large harmonium the division of the stops into treble and bass renders it entirely the player's own fault if he suffers his right hand to be overpowered by his left." From which it is to be presumed he means that by using two or three treble stops against one bass the treble may be made predominant. Does not Mr. Nash see that his defence is based upon admitting the very indictment I make against the harmonium? Why is it that two or three sets of reeds in the treble require to be used against one set of reeds in the bass? Is not this the best possible proof that the bass *does* overpower the treble? But no stratagem of the kind really overcomes the radical defect of the inequality existing in any single set of harmonium reeds all through the register. It is easy to make up a *quantity* of tone in the treble by employing more stops than in the bass, but in that case the *quality of the treble and bass* are different. Yet more, as regards *the treble* itself, the objection is not removed but only carried an octave or two octaves higher; the alto overpowers the treble and the tenor overpowers the alto, for the simple reason that every note down the scale is relatively more powerful than the one above it. Mr. Nash concedes that the objection is just against any harmonium with a single set of reeds. It must therefore necessarily exist against any larger instrument combining a number of such sets of reeds. That a good player on a large harmonium with a number of stops at his command will do his best to hide the radical defects of his instrument and sometimes almost succeed, is not to be denied, but in such a case the credit is entirely the player's. In the Mason & Hamlin organ there is no such defect, and consequently no such need for strategic skill in manœuvring, every note in the register being of equal power and volume, and of a tone so pure and round that comparison is terribly odious. Mr, Herman Smith, in his admirable series of articles on the harmonium, does not attempt to palliate the defect. In the very number of your journal which contains Mr Nash's reply, Mr. Smith says (p. 556): "No doubt a smoother bass would be gained and better balance of tone" (that is, were reeds employed of such a size would necessitate a case almost as large an organ "for at present *the tenor and bass are shorn of their proportions*, in order to economize space, and the *roughness and readiness preponderates, drowning the treble*, unless great skill is exercised to restrain it within due bounds."

Mr. Nash's answer to my third objection respecting the sluggishness of articulation of the harmonium rendering it only *adapted* for the slowest of music, I may dismiss very briefly. He retorts that he has both heard brilliant operatic music performed and played such music himself upon the harmonium, and that (speaking modestly of the first case only) it was a very creditable performance. For my own part I have heard the "Dead March in Saul" played upon a jew's harp, and *I* thought it a "very creditable performance," without believing any the more that the music was *adapted* to the instrument. Mr. Nash does not go so far as to say that brilliant music is adapted to the harmonium. He is, I feel sure, too good a musician to assert anything of the kind, and too honest to deny that the harmonium is not sluggish of speech. I do not wish in anywise to exaggerate the defects of harmoniums, but I think most musical people will agree with me that the three objections I have urged against them are both well-founded and weighty, and that an instrument like the Mason & Hamlin organ, which is not reedy in tone, not unequable in register, and is instantaneous in articulation, is a great musical boon. That any one, once accustomed to a Mason & Hamlin, would of his own free will go back to the harmonium, I cannot believe. Mr. Nash thinks that "for certain purposes" a person might even be beguiled back to the harmonium. I confess I can only imagine one such purpose, and that is, by contrast, to endear him still more to the beauty of the American organ. It is the old story of the part discords play in music; they make the harmony sweeter and more precious.

EUSTACE HINTON JONES.

[382] SIR,—I do not know on what footing Mr. E. H. Jones can undertake to decide *ex cathedra* where so many *doctors* disagree upon the respective merits of an harmonium *proper* and the harmonium *improper*—yclept American organ. It was an old discussion in these columns, Mr. Editor, in the time of your predecessor, and in them the opinions of Dr. Ussher and of Dr. Leslie used to bear testimony to the super-excellence of the new instrument; but the flood of light let in upon the subject, and the experience resulting from many months' trial, have vastly modified at least one of these learned doctors' opinions. The other is capable of speaking for himself. In my humble opinion, it is rather unfair to your space thus to resuscitate the ghosts of hosts once slain; but at the risk of being tedious, I must join the ranks of your last correspondent, Mr. Nash, in temperate and faithful defence of the cause of harmoniums *versus* American organs. Now, I think that though Mr. E. H. Jones's attack upon the harmonium is his strong point, that his defence of the American organ is his weak side, and this latter I will examine first. As you are aware, I am not insensible to, and I have before given expression to my appreciation of, what are the merits of the American organ, and it is needless that I should repeat here what I have before written on the subject, and which I find no cause to alter. But what is it that Mr. E. H. Jones can say in its favour? I have read and re-read his letter for the sake of being impartial, and if he finds my analysis correct, I fear that if he has paid 90 guineas for a No. 46 8-stop Breavington he will be obliged to reconsider the meritorious points of his instrument in order to write of it in a more eulogistic strain than pervades his first composition. The total of what Mr. Jones can say in its favour I will reproduce from his letter in a few words. First, he says, "the tone is round and pure;" "it is resonant;" "it is pure;" "it is pure and true;" the intonation is perfect;" "it approaches the organ tone in quality." In addition, he claims that "the touch is as rapid and as delicate as a pianoforte," but has no more eulogy for the quality of tone, nor for the variety of *timbre* which can be attained by means either of the reeds or their separate chambers, or their resonant sounding-box, or the exhaust bellows by which air is drawn through them; so that his communication sins more from faults of omission than commission, except his ungracious attack on the harmonium, the defence of which instrument is foreign to the purpose of my letter. Now, my opinion is very well made up on one point—that is, that you can neither expect nor produce from the reeds adopted in the American organ more than one *timbre* or quality of tone, and I gather from my own experience and from your correspondence columns that the great desideratum in reed instruments is variety of *timbre*, or, in other words, variety of voice.

Seeing that every reed in an American organ is voiced in precisely the same manner, *i.e.*, by having a little corner of its tongue curled up, it is forced to speak in a manner a little less free than the ordinary reed of an harmonium. This little disposition of tongue-*tiedness*, combined with due arrangement of chamber and case, gives rise to that quality which is its speciality; beyond it you cannot go, and every fresh rank only being permitted to speak, in this identical manner limits the capabilities of the instrument as to variety of voicing, and gives rise to that sameness from which you easily escape in a well-voiced harmonium. The little mechanical appliances of foot swell and the little fan working as a tremblant constitute the only escape which the instrument offers from monotonous voicing, which, in course of time, will fall on the ear of the best-constituted musician. A little word as to the exhaust bellows. Will Mr. Jones say that he ever saw them in operation—that is, a pair of bellows which, instead of sending the air through the chambers containing the reeds, actually creates a vacuum presumably below them through which air rushes from above? If he ever did, will he please describe the process? I am sceptical, and my reason for doubting is that positively there is no necessity for the process; the reed of the American organ being as easily blown forward in the ordinary plan of any harmonium as the common concertina or harmonium reed. On this point I would beg the testimony of those English makers who are making American organs, notably Messrs. Cramer & Co., or any of your talented correspondents who are *au fait* to the mysteries of the trade. Excuse me enlarging, I was led into these remarks through the surprise expressed by Mr. Jones himself, that seeing the difference between the one instrument and the other is so simple that no English maker should have originated it. In conclusion I do not want to expatiate on the merits of the harmonium *per se* except I have occasion, but I resent Mr. Jones's attack on it unless he had more to say in favour of the American organ. Are we not all agreed that the American organ is simply an harmonium, in style, in reed, in bellows, in case? I do not despair of seeing added to any harmonium of sufficient size and value a rank of reeds of the quality of tone of the "pure and true" description vaunted by Mr. Jones; but they would not occupy a leading position in the instrument, but be merely secondary, giving a little more variety of voicing at the command of the performer, who seeks all sorts. Not a few dislike the quality, considering them as emasculated and squealing in the treble, although sweet enough in the bass, as I have before borne my testimony.

MARK ELLOR.

THE HARMONIUM.

[383] SIR,—Will Mr. Hermann Smith, "Eleve," the "H. B.," or any other fellow reader of the ENGLISH MECHANIC, help a poor man whose aspirations are larger than his means, by telling him what is the proper size for the bellows of an harmonium which is to have eight sets of reeds? Also, how much larger they must be if required to supply ten sets? It is intended to build the instrument with two manuals and pedals, so any information concerning matters of detail will be very acceptable.

The inquirer would be glad to be advised if it would be preferable to have two bellows, one for the reeds connected with the lower row of keys, and the other (with expression) for the reeds connected with the upper keys. Also, if it would be preferable to make the pans thicker at the bass end, so as to make the wind channels longer. Mr. H. Smith says that a reed for 16ft. tone having a wind channel about half a yard long, yields the best tone, and possessing plenty of that cheap article, wood (not in my head, I hope), and as I can use joiner's tools tolerably, I am quite willing to make the pans of any dimensions which will produce the most pleasing quality of sound. I do not, in the least, mind the labour of making the case of the instrument tall, wide, and deep enough to admit as large pans and bellows, or even two or three of the latter, if preferable, as may be considered best, so in any advice my fellow readers may be kind enough to give me they need not be restricted by consideration of the space which can be afforded for the instrument to stand in. I am well aware that I propose to construct what would be considered a large instrument, although not "Alexandre's" monster harmonium of the future, but then I have been accustomed to play on a large organ.

A POOR ORGANIST.

HARMONIUM.—REPLIES TO QUERIES.

[384] SIR,—New subscribers who are interested in the harmonium would find their advantage in purchasing the back numbers which contain my treatise. Questions they have asked, and many others which no doubt will arise to puzzle them, have already been answered in the progressive course of chapters explaining the construction and theory of the instrument. I made this reference to the past for the sake of those who do not seem to be aware of what has been done in the direction in which they are seeking information.*

"W. A. S." (4538, page 527) will find particulars of sound-board construction in No. 116: also details of sizes and scales of channels in my last chapter, in No. 284, and of pallet and reed apertures in the forthcoming chapter.

"A Young Amateur" (3998, page 287) is referred to No. 109 for information concerning the "Full Organ Movement," and its adjustment.

J. T. Hill (4487, page 550) renews a question often asked before, and which I have more than once replied to, and also commented upon incidentally in the course of the treatise in No. 158 and others; likewise in letters. For his benefit I repeat the explanation of the defect he mentions as belonging to his own instrument. The slowness of speech in the lowest octave of the bass may be caused by the reeds not being properly set or voiced; they may very probably be set too high, and it is only when the force of the current of air becomes strong that they are drawn into movement or vibration; they should, therefore, be pressed lower down that they will be set almost level with the block, the tip of the tongue rising perhaps 1-16in., but the exact distance must be determined by experiment, as the character of the reed decides the treatment it should receive. If it is set too low, the reed is equally liable to sluggishness of speech, from an opposite cause, there not being sufficient strength of current passing under or at sides of the tongue to draw the tongue with it, and the tongue acts as a door shutting its own channel. For this reason the large bass reeds are often reduced in width near their tips to secure a constant space at the sides for the passage of a current sufficient to throw the reed into action.

There is another cause for the slowness of speech in bass reeds of quite a different character—the shallowness of the body of air immediately under the reeds. The sound-board being thickest at the bass end there remains but very little space between it and the valve-board, in fact, very often under strong wind and energetic playing the reeds will strike the valve-board. As heavy swimmers require deep water to swim in, as large birds find difficulty in rising until they get a good depth of air under their wings, so in an analogous mode these bass reeds need a bulk of buoyant matter under them before they can gain their full swing, they require the co-operating elasticity of a mass of air to sustain and return the impulses of vibratory activity. It is as hard for bass reeds to get up speed in the open as it is for our legs to make progress over loose shingle—we want resistance to enable us to utilize our muscular force. Treble reeds may be easily sounded without being enclosed, but bass reeds require a body of air to strike upon in order to render their slow stroke effective, else the air gets out of their way too soon. On the other hand it is of the utmost importance that the air should not suffer great compression, the reed cannot swing freely when the air particles crowd thickly upon it. The slow speech of the bass is chiefly owing to this, that the air is packed in a narrow wedge-like space trying to get through the reeds, yet pressed upon by the greater volume rushing from the wider end of the chamber, which exercises a dead lock pressure disabling the reed from striking. To remedy this, to gain a play of elasticity to aid the reed to vibration, we make an artificial outlet causing the air to yield, yet not allowing it to escape. Drill two holes through the side or end of the frame of the pan or sound-board, from 2in. to 4in. apart, and about ¼in. diameter or less, if need be, but near the end where the bass reeds lie. Over these holes on the outside of the pan or sound-board glue a strip of soft sound leather from 6in. to 8in. long, and 2in. or 3in. wide, so adjusted that it shall form a pouch or cheek. In this pouch the overstress of wind expands itself, and the additional bulk of air stored in this reservoir affords its aid of elasticity to return and sustain the impetus of the reed.

In suggesting to the reader a reference to back numbers, I trust it will not be supposed that I am disinclined to the trouble of replying to new comers. It is a pleasure to me to give freely of whatever knowledge I possess in the field in which I dig and delve.

HERMANN SMITH.

CARBONIC ACID GAS AND OXYGEN.—TO "URBAN."

[385] SIR,—I am rather surprised to find the statement I made regarding the effects of carbonic acid so severely criticised by your learned correspondent "Urban" (343) p. 592. In the first place I would inform "Urban" that I am not an "Exhibitioner at the Royal College of Chemistry," as he has pleased to term me, and if he looks more carefully at the number he quotes from he will see his mistake. The contempt with which "Urban" speaks of little books, shows beyond doubt that he never stooped to read anything so elementary as to be contained in such diminutive nothings. I did not profess to quote the exact words of Professor Huxley, but for the edification of your correspondent take the following from page 113 of Huxley's "little book" on Elementary Physiology:—"The directly poisonous effect of carbonic acid, on the other hand, has been very much exaggerated. A very large quantity (10 to 15 or 20 per cent.) may be contained in air, without producing any very serious immediate effect, if the quantity of oxygen be simultaneously increased." My use of the word proportion may be called in question as being indefinite, or at least to convey an idea different to the quotation made.

"Urban" seems to have a wholesome dislike for indefinite statements, and this speaks well for his mathematical training; this being the case, I will endeavour to place before him in plain figures what I mean by increasing the oxygen in a like proportion. Take for example 100 litres of common air at 50° C. and 760 mean pressure; this air consists, in round numbers, of 21 parts by volume of oxygen to 79 parts of nitrogen. Now, suppose 20 litres of this air to be replaced by 20 litres of carbonic acid gas at the same temperature and pressure, then $\frac{21}{100} \times 20 = 4\ 1\text{-}5$ is the amount of oxygen replaced by carbonic acid. To make good this loss of oxygen, we must remove 4 1-5 litres of nitrogen from the 100 litres of mixed gases, and introduce 4 1-5 litres of oxygen. In this way we have made carbonic acid take the place of an equal volume of nitrogen in the air, and assuming the non-poisonous nature of carbonic acid when in small quantities, there does not seem to be any reason to doubt the statement made by Huxley. For the sake of simplicity I have supposed the nitrogen removed, although it may not be practicable. I cannot imagine where "Urban" finds his thousands per cent. certainly I have not introduced anything of the kind in the foregoing calculation; perhaps while "Urban" enforces definite statements, it will be well for him to make his own a little less ambiguous. Would "Urban" be kind enough to inform your readers, myself included, whether the experiment has been made of breathing air in which the whole of the nitrogen was replaced by carbonic acid? I would expect the result to be the same as Dr. Taylor's case.

Since the function of breathing is in great part the removal of carbonic acid and water, to take in at each inspiration a quantity of the gas of which it is necessary to rid ourselves must necessitate an enormous amount of labour to be thrown on the organs connected with this function, and should these organs prove unequal to the task death must ensue.

The statement that 4 per cent. of the gas did not produce any apparent effects on Dr. Smith is no doubt true, but he may be a strong, healthy man, and less susceptible than the majority of people. The condition of the lungs would very materially affect the question, and to establish a rule on one individual example would not, I think, be altogther advisable.

With the ambiguity of certain of Professor Huxley's statements I have not to deal, but I may say that few men have done so much to advance the cause of true science as he has. His election as president of the British Association shows that he has the esteem of many of our greatest scientific men.

EXHIBITIONER AT ROYAL COLLEGE OF SCIENCE.

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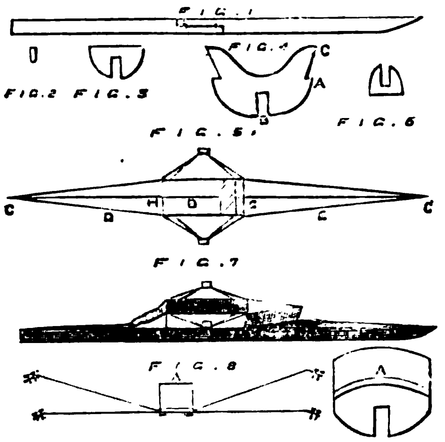
* The papers were commenced in 94, and continued in Nos. 96, 98, 100, 105, 109, 116, 118, 124, 126, 132, 133, 136, 141, 151, 158, 166, 172, 180, 190, all of which are to be had except No. 98.

BOAT BUILDING.

[386] SIR,—I send you a description, with illustrations, of a boat I made for myself, which is both swift and light. It weighs scarcely 50lb., and is easily carried from the water to its house. Procure two pieces of pine, ¼in. thick by 8in. wide, which, when joined in the middle, make a keel 30ft. in length, Fig. 1. Set this upon its edge, and for about 5ft. at each end round it on the bottom, Fig. 2, to fit the skin, or outside of the boat. Make the braces, Fig. 3, ⅜in. thick and of a width about 14in. in the widest part, tapering both ways, until no brace is required. Two braces are made different from these, of 1in. thick, and of pine, see Fig. 4. The one nearest the bow, placed 18in. from the middle of the boat, the other about 30in. The depth of the boat and of these braces was about 5in., except at the ends of the boat, where they can taper to 3in. The two braces, Fig. 4, measured from A to B, 5in., but from A up to C, 6in. Next procure some cedar plank, planed very thin; this cut into lengths to make the planking of the boat. It is sometimes bent on "whole," except at the ends, but not being an extraordinarily expert carpenter I did not attempt this, which is the method of the Thames and Tyne boat-builders. Break joints, from D to E, Fig. 5, two full lengths on both sides, the ends being pierced. Soak the cedar for about an hour, and in the mean time secure the keel firmly to some flat surface, keeping it down by a piece of wood, Fig. 6, nailed to the floor or bed. Place the braces in the positions they are to occupy, and get two pieces of yellow pine about 20ft. long, ⅜in. thick, 2in. wide, and tapering to both ends. These must be rounded for about half the breadth on the outside, and be let into the braces and firmly secured to them and the keel, forming an even rounded bottom. Now put on the previously soaked cedar, bending it carefully to the shape, and fastening with brass screws or copper tacks. Cover the seams with thin sheet zinc or brass, fastening it with copper tacks; and clamp a piece of the same metal over each end to prevent breaking at the point.



The boat is now complete except the top, the cockpit B, Fig. 5, seat, rowlocks or outriggers, and sculls. On the top of the braces, all around the boat, fasten a thin strip of wood, and on the braces, Fig. 4, let this strip fit into the shoulder, A. Then put on like strips edgewise, from G to C, and from H to C, gradually thinning to the ends, Fig. 5. Cover the whole of the top with waterproof cloth or linen, tacking it to those strips and to those round the edges of the boat. Cover the tackheads with a small bead. Now the boat is entirely closed in, except where the rower is to be seated. Let the seat be fastened to the keel, and to the sides by brass screws.

The cockpit is made by fitting the clapboards (or siding) around the braces, Fig. 4. At the end towards the bow fit two pieces to run out about 2ft. before meeting, like a V, and at the stern the pieces may be formed in a graceful scroll; but a piece about 2in. high should be fitted to the after brace of the cockpit to prevent the water coming in when "backing." The V piece at the bow should be so fitted as to form an acute angle with the forepart of the boat, as seen in Fig. 7. The irons, or outriggers, are 4ft. 6in. apart across the boat; and at their outsides, at bottom, about 14in. from the water. The irons are made as shown in Fig. 8, A being the rowlock with catgut fastened at the top to prevent the scull coming out.

Another piece of wood, shaped like Fig. 9, about 1in. thick, must be cut so as to fit over the keel, and is secured by movable screws through the clapboards at the side, and by a little block of wood fastened to the bottom plank and the side of the keel. This is the footboard, and is made to shift to suit the length of the rower's legs. It is as well to fit strips of sheet zinc where the heels come, to prevent the wearing of the plank. The boat must now be varnished, the inside of the cockpit as well. In fact, it is better to varnish the whole interior before putting on the waterproof cloth. A pair of light sculls, well leathered at the button, and a small cushion stuffed with horsehair will complete the equipment. I may as well mention that there is no necessity for the stem to be cut to the shape represented in the engraving, and the extreme ends of the keel should of course be bevelled off to a thin edge. When going out for the first row, get some one to hold the boat steady till you are seated, and with sculls in position. There is little danger of tipping over when in motion, but when resting don't let go of the sculls, as by keeping them under the water or on the surface you can balance your boat. Be careful in "turning," as you are liable to strain the boat, to prevent which the planks were put in the bottom, as well as to rest the feet on. It is as well to wear loose boots or shoes, so that in the event of going over you slip your feet out of your boots, which are apt to stick fast when placed under the strap on the foot board, A, Fig. 9. The V piece above mentioned should be well secured down to the waterproof cloth. In fact, it is as well to have pieces of wood underneath the cloth and fastened through. A boat of this description will cost about £4. AQUATICUS.

WHAT WE OWE TO THE ALCHEMISTS.

[387] SIR,—The labours of the alchemists were popularly supposed to be diabolical, and the popular legend of the D—— (something) and Dr. Faustus, is a not much exaggerated exposition of the light in which popular prejudice viewed their often useful works; but in this case, as in many others, good came out of *supposed* evil, and while trying to find the philosopher's stone (his wooden block would often be much easier to find, it being *patent)* the alchemists did find many useful things. I may especially mention antimony, which (however injurious to monks Paracelsus may have found it to be during his experiments on their *corpore vili*) has been of great utility to us secular individuals, especially those of us who have the privilege of dining at the Mansion House with the Lord Mayor, for this indulgence creates a great demand for antimonial wine to counteract the evil effects of certain other bad wines then and there taken into the human stomach.

Another of the alchemists' discoveries, phosphorus, has (although we make light of it) come into extensive use during the writer's time. Those who, like him, can remember the flint and steel of old, which, although an admitted improvement on his ancestors' two firesticks rubbed together, was what with knocked knuckles, blunt-edged flints and damp tinder—one of the torments of this life in the cold dark winter mornings, —I say they will bless the discoverer of the fact that much more *light* is to be got out of our bones than some of our brains are able to yield. Phosphorus has an evil reputation for poisoning those who work it, but here Alchemy's legitimate daughter, Chemistry, steps in and produces the perfect cure, or rather preventative, in the form of amorphous phosphorus, which surpasses poor human intelligence, inasmuch as it affords "instantaneous light" (more than human intelligence often can do) without injury to health or danger to property by accidental fire, for do not all its matches "light only on the box"?

Much as I am opposed to excessive governmental interference with what is termed the liberty of the subject—a thing which often subjects other subjects to great liberties—when I consider how detrimental to health, and how incendiarily dangerous ordinary phosphorus matches are, I really think any government deserving the name of paternal would be justified in restricting the liberty of mischief in its subjects, so far as to prohibit their production. This would, by the mere saving of the present loss of property by fire, be a pecuniary gain to us, not to mention the saving of life which would result. Perhaps it is quite useless to advert to saving life, for it is quite obvious that so long as *Christian* peoples go to war with each other, any argument in favour of saving life would be quite lost on them, unless it took the form of saving the lives of their own military men to kill others; it might, however, have some influence on a neutral Briton like the writer, who don't want to kill anybody, and who also, having an eye to the main chance, might appreciate that reduction of the premiums on his fire insurance which would result. This argument comes home to his feelings—I mean his breeches' pocket—but it's all the same.

An exceedingly interesting and instructive history of the various useful things discovered by those much-abused and misunderstood philosophers, the alchemists, might be written to advantage, and I do hope, even if you, Mr. Editor, cannot at present afford space for this history, that when the ENGLISH MECHANIC is enlarged eight pages (the doing of which is now a matter entirely in the hands of its readers), some one of my fellow correspondents, more fit than myself, will be found both able and willing to write it for the edification of his fellow readers,—may I add, also, for the edification of the readers of some other journals, which have occasionally been known to borrow the matter of the ENGLISH MECHANIC, sometimes with, oftener *without*, acknowledgment. Perhaps, like the American *re*-publishers of English literature, they forgot, or considered quite obsolete, that old-fashioned commandment, "Thou shalt not steal."

THE HARMONIOUS BLACKSMITH.

SUSPENSION WHEELS: THE PHANTOM AND OTHERS.

[388] SIR,—When adverting to a defect—for some purposes—common to all suspension wheels, viz., that their naves must to some (varying) extent be moved before their rims can be moved, which, by the way, is not a defect of much importance in bicycles and other carriages for light loads, I little thought what a nest of hornets (who have attempted to sting me) I should disturb; but as yet my rather pachydermatous cuticle is unconscious of their penetration,—like most of my fellow Britons, I don't know when I am whopped. Let me add that in writing about suspension wheels generally, and the Phantom wheel in particular, I was actuated by no hostile feeling towards its makers. It may, for anything to the contrary I know, be by far the best wheel out, but it seems to me to have steel rods, whose weight is far greater than is [illegible] genuine suspension wheel, to carry a single [illegible] perhaps I may be mistaken in classing it [illegible] sion wheels proper, for Mr. Tydeman says [illegible] "quite slack."

On referring to my former communication [illegible] seen that I expressed no doubt of the [illegible] Phantom as a *driving* wheel for a lightly-[illegible] Sooth to say, there can be no doubt of [illegible] when we are told that it is of small [illegible] with the Spider, and that it has thirty-[illegible] 3-16in. diameter. They must indeed be [illegible] —unless extremely slack—to transmit [illegible] force required to propel a bicycle even [illegible] hill. When it is considered that Smith and [illegible] No. 24 steel wire (pianoforte gauge) has [illegible] pitch for more than two years, with a [illegible] of 36in.—which fact I state on the [illegible] Chew; that the said wire is only 1-20in. [illegible] is equivalent to loading the said wire with a [illegible] about 800lb.); that the rods of the [illegible] are about 2-10in., *i.e.*, four times the [illegible] 24 wire; consequently, if made of equally [illegible] capable of supporting sixteen times the [illegible] wire can sustain; that there are thirty-two [illegible] that at least ten of them, from their nearly [illegible] position, are constantly helping to support the [illegible] of the rider,—I again say, when all these [illegible] taken into consideration, that I believe any [illegible] judge will admit that the thirty-two rods in the [illegible] wheel have a tensile strength pretty [illegible] excess of that required to *suspend* (I mean his [illegible] not himself) the very broadest of broad [illegible] fact, assuming the average weight of the [illegible] Christians who ride on bicycles to be [illegible] which is probably an excessive [illegible] rods at least, always in action, would [illegible] a score of such heavy-sterned Christians, [illegible] find it rather difficult to ride together [illegible] for the same reason John Chinaman [illegible] evacuated his fortifications, viz., "no [illegible] *one* place can be same time."

The number and weight of the [illegible] Phantom wheel being so enormously [illegible] requirement of any weight which [illegible] bicycle, we have a perfect right [illegible] said wheel is made so much heavier [illegible] support that weight. I have a very [illegible] that I could indicate the reason its [illegible] it; but of this anon.

In reply to Mr. Dawson, I never did [illegible] wheels were not rigid enough for driving [illegible] whether they be made sufficiently so or [illegible] a question of the proportion of the lengths, [illegible] nesses, and let me add, the degree of [illegible] their steel rods are subjected. The rigidity [illegible] rods increases, with increase of tension, [illegible] the more tension you subject them to the smaller [illegible] proportion of their tensile strength which remains [illegible] is available for supporting the weight carried; [illegible] however, is of little importance when, as in the Phantom, the material employed is so greatly in excess of that required to sustain the load.

Mr. Tydeman says his Spider and the Phantom [illegible] not to be considered "one and the same." Quite true. Sharks and sprats are not exactly "one and the same," but—I trust the reader will not deem my illustration *fishy* in the evil sense—they most decidedly have a common (piscatorial) nature, so also have these two varieties of the *suspension* wheel a common nature, however different the *proportions* of the parts of each. As in the instance of that monotonous *musical* (?) instrument which is said to be employed in the religious ceremonies of that little-known South African tribe, the Kanoodledums, the difference between the Spider and the Phantom and the difference between the *long* tom-tom and the *short* tom-tom are only differences of proportion, both *toms* are essentially tom-toms, both wheels are essentially suspension wheels, unless, indeed, the excessively thick (and *slack*) rods of the Phantom act as veritable rigid spokes or levers, and to some extent remove it from the class of wheels which support their loads on that principle.

May I just remind Mr. Tydeman I never [illegible] that the employment of elastic spokes prevented [illegible] the driving force from being transmitted to the [illegible] the wheel? As well might I have said that [illegible] weight is lifted by an elastic cord the hand [illegible] lift the whole of that weight. What I did say [illegible] if the spokes be elastic levers you must *bend* [illegible] fore they can transmit the driving force, which [illegible] as true as that, in the case of the elastic cord, [illegible] *stretch* it before it can lift the weight. I with [illegible] add that I believe Mr. Tydeman's theory of the [illegible] rubber tire to be perfectly correct, indeed it necessarily follows from the law that action and re-action are = each other. THE HARMONIOUS BLACKSMITH.

GERM DISEASES.

[389] SIR,—I am much pleased with Professor Tyndall's paper on filtered air and germ diseases in Nos. 265, 266. To destroy these germs and cause of disease:—In all places of closeness, bad smells, or contagion, secure an inlet of fresh air, and then generate pure nitric fumes from dry nitre and clean sulphuric acid aided by warmth. These fumes are diffused all over the room, and seizing all the moisture and germs, become visible as a slight fog. Fan or blow the fumes into every crevice and recess, and shake all clothing and bedding well in the fumes; every fresh article to be fumed before giving it to the patient, and every thing taken from him is to be fumed.

In a hopeless case of putrid fever, where one patient a just died, I recommended this process, and the othecary carried it through most admirably, and other patient began to mend the very day he introced it and gradually became well.

This occurred soon after its promulgation by Dr. rmichael Smith, to whom the government gave .000 for so doing. The doctor, though zealous for e public good, was not chemist enough to see the erruling superiority of nitric acid fumes, for all the ners are hurtful to our lungs. The nitric acid and r atmosphere are of the same gases; nitrogen 4 to xygen; the acid 4 oxygen to 1 nitrogen; so when uch diluted they are not hurtful but are rather easant, and yet strong enough to destroy all congious matter, and so render it safe for nurses and sitors.

Cornelius Varley.

P.S.—If these materials were kept at all hospitals small parcels, quite ready for use when any patient rrived, he might be fumigated, and also the conyance well fumed; this would remove all objections the use of cabs.

HINTS TO CORRESPONDENTS.

[390] Sir,—In No. 281, you inserted a letter (190) rom me on "Several Matters." Not having seen any of ne "Harmonious Blacksmith's" lucubrations since, has struck me that I might have offended him. I hope ot. I wanted to see him purify his style and not to cease riting altogether. I beg now to offer one or two more ints to correspondents. Every one, I should think, must admire the orderly manner in which the contents f the English Mechanic are now arranged. I wish hough that correspondents would attend to the simple instructions you have given under "Letters to the Editor." You say "in order to facilitate reference correspondents, when speaking of any letter previously inserted, will oblige by mentioning the *number* of the letter." If this rule were strictly adhered to time would frequently be saved by those who wish to refer to previously inserted correspondence. It would entail little or no additional labour on the writer, and confer a favour on the reader.

There is another matter well worth attending to. As a rule the letters are answered by letters, and answers to queries appear in regular order in their proper department. But some correspondents answer a batch of queries in a letter. Take, for instance, Geo. E. Davis. In the number just received, l. 381, p. 590, Mr. Davis answers no less than eleven queries. Now possibly some who asked the queries may look for the answers in their proper place and may not think or choose to look through the whole of the correspondence for answers. It is the same with several other correspondents. See "W. E. D.," "Psi," and "Urban." In Mr. Davis's letter the names of the query with the numbers are given. It is not so with our able correspondent "Urban," or even with "F.R.A.S." These gentlemen answer queries in connection with their pet sciences in letters; but how, let me ask, can their valuable answers be recorded in an index? And this is the point I am particularly driving at. A new subscriber turns over the pages of some back numbers and he sees just such a question as he should have sent himself. He refers to the corresponding number under "Answers to Queries" and it is not there, and he refers to the index and there is no record. If the answer had gone in according to the subscribed form no difficulty would have arisen. I am not finding fault —far from it. Doing the thing orderly would not entail more labour, and it would materially expedite reference. Let us all endeavour not only to extend the circulation of our English Mechanic, but to make it as useful as possible.

Suburban.

SHORTHAND.

[391] Sir,—After reading the correspondence on shorthand in your valuable journal, most of your readers must be convinced that there is very little, if any, difference in *actual practice* between phonography and what Mr. Pitman calls the A B C systems of shorthand. The chief object of shorthand is brevity, and brevity is opposed to the *correct* representations of sounds. The word phonography, as applied to shorthand, is a misnomer. By shorthand I mean the power to write as fast as we speak. Mr. Pitman says (page 521), "In the use of the consonants we are tolerably consistent." It is on the consonants that all shorthand writers depend. The vowels are always omitted. No one more strenuously insists on their omission than Mr. Pitman. If they are omitted, what is the difference between phonography and the A B C systems? If they are introduced and the systems are "correctly written," why is one not as readable as the other? It is the omission of the vowels that gives rise to the difficulty experienced in reading shorthand. In most of the shorthand works published during the last 20 years, the authors have tried to remedy this defect by introducing the vowels in the line of writing—either written or implied. This is evident in "Sound Hand," by G. P. Renshaw; "Vowel Shorthand," by J. Rodam Carr; Thompson's "Phonography;" "Stenography," by A. Geiger; "Shorthand for Everybody," by W. M. Williams; "Readable Shorthand," by Murdo Young; and "Universal Line Writing," by A. M. Bell. Some of these authors have been phonographers, and given it up on account of its complexity, and the extreme nicety and precision required in its notation. The care necessary in writing phonography may be imagined when you are told the alphabet contains forty letters, the straight lines having three sizes, thick and thin; the curves four sizes, thick and thin. Hooks of two sizes to signify the addition of *l*, *r*, *f*, and the termination *tion* with loops and circles of two sizes for *s str*, &c. The system is written on a line, real or supposed, in three positions—on, above, and below. There are three styles of writing; the learner's, corresponding, and the reporter's; each one differing from the other. In addition to this there are a vast number of signs, termed grammalogues, arbitrarily chosen to represent words of frequent occurrence. I use the word arbitrary because they follow no rule, and it is here that I take exception to the title "Phonography." It does not write by sound, because part of a word cannot be the whole of it. It depends for success on extreme abbreviation, taking care never to let one sign stand for more than one word. What is not simple is not possible. On this ground alone, Mr. Grierson, who so ably defends Lewis, has the advantage. It should be borne in mind that the acquisition of shorthand depends more on the individual than on the system. The late Charles Dickens was a facile and rapid writer of Mason's, better known as Gurney's, system, published in the 17th century, and having little merit to recommend it. The task of learning the simplest shorthand is one of immense difficulty, and can only be mastered by constant and unvarying practice. For all general purposes a system of abreviated writing, based on the common letters, combined with judicious abbreviation, would be found far easier of attainment, quite as effective, and more readable, because more familiar to the hand and to the eye.

W. Cannabe.

[Want of space compels us to omit letters by "Pegasus," Geo. Stedhan, and "J. H. R.," on this subject. Each of these writers answers Mr. Grierson, and vindicates Mr. Pitman's system.—Ed.]

TEA FOR THE MILLION.

[392] Sir,—Many of your subscribers may be glad to know that the raspberry-leaf—I mean the *second* leaf (that now on the branches) makes the finest tea I ever tasted. The spring leaves are too strong. I have used this tea myself for twelve months at a time without any fault being found with it. The leaves, when dry, should be infused just in the same manner as ordinary leaves. The garden raspberry will do, but I prefer the wild variety, which is very plentiful in the woods and dingles of England.

Nab.

METEORIC STONES.

[393] Sir,—The question of one of your correspondents ("D. W.") as to the composition and origin of meteorites is the more interesting from the knowledge we now possess, through the spectroscope, of the surface of the sun.

I have not had an opportunity of examining any of those meteoric *stony* masses, containing, as said, 6 per cent. of organic matter, of a kind of black mould of carbon, oxygen and hydrogen, somewhat like peat; but in my neighbourhood, on one of the Southdown chalk hills, the summit of which is capped with a patch of plastic clay, the *metallic* meteorites are found almost on the surface; the points and edges of the crystals being quite perfect. One of these masses, weighing about ¾lb., encloses a portion of an echinus. Near this locality is a gravel bed full of small fragments of meteoric iron much rolled. Quantities of this substance mixed with nickel are found in almost every strata down to the lias, if not lower. None of the portions found in the plastic clay influence the magnetic needle.

As to their origin, a friend suggested some months ago that these metallic substances were the ashes or residuum of the gas seen in combustion around the sun; he was the first who propounded this theory. It would account for the presence of these peculiar masses in so many strata of the earth; the same process going on at the earliest geological period as at present, the solid mass of metal falling, according to weight, the shallower or the deeper, into the semi-fluid strata.

Can that black kind of mould referred to above, be, after all, the black oxide of iron?

Laplace's opinion was that meteoric stones were projected from the moon into the confines of the earth's attraction, and consequently fell to the earth and became a part of it.

J. W. A.

THE SCREW PROPELLER AND ITS ACTION.

[394] Sir,—The Rev. E. Kernan writing in your columns on "Elementary Science," has given a description of the screw propeller and its action, all of which is somewhat loose, but the paragraph referring to "Negative Slip" is especially incorrect.

He says "*Negative Slip* (the italics are his own) is when the vessel is going quicker than the 'pitch' of the propeller requires, *i.e.*, when the ship advances at each turn over a space *greater than the pitch*. Suppose the *Great Eastern* to advance 40ft. at each revolution of the screw (its pitch being previously stated at 37ft.) this state of things is called the 'Negative Slip.'" Now this explanation is literally very misleading and the meaning intended to be conveyed is quite erroneous.

He continues—"And so far from being useful, the propeller is only retarding the progress. When, therefore, 'Negative Slip' is discovered it is time to stop engines, their action is sure waste." This is worse than incorrect, it is utter rubbish.

Then he adds—"It is evident that some external force, wind, current, &c., is able to do more just now for the ship than the propeller."

This also is quite wrong but it enables one to see that Mr. Kernan, writing on the subject not easy even to the professional mind, has at the outset quite misconceived the nature of the phenomenon he has endeavoured to describe.

The somewhat singular result known as the Negative slip of the screw propeller, is said to occur only when the excess of the vessel's speed over the speed theoretically due to it from the screw *cannot be accounted for* by "winds, currents, &c."

The effect of stopping the engines as recommended by Mr. Kernan would be to *stop the ship also*, and this plainly enough indicates that although the ship is advancing faster than the screw yet this advance is caused by the engine, although not directly, in the usual manner by the rotation of the screw.

The effect of a strong favourable wind on a screw-ship would be to assist the engines; and no doubt, if the wind were strong enough to force the ship ahead faster than the advance due to the rotation of her screw, the screw would exert a retarding influence. But it is not conceivable how a *current* could have any such effect. Nor would this advance be *negative slip*.

Mr. Kernan also mentions a peculiar arrangement of several boats driven by one steamboat. A system somewhat similar to this was I know tried on the Mersey some years since, but in this case the propelling barge was placed in front and drew the train of barges after it like a locomotive. In the arrangement Mr. Kernan illustrates the propelling barge is placed behind and pushes.

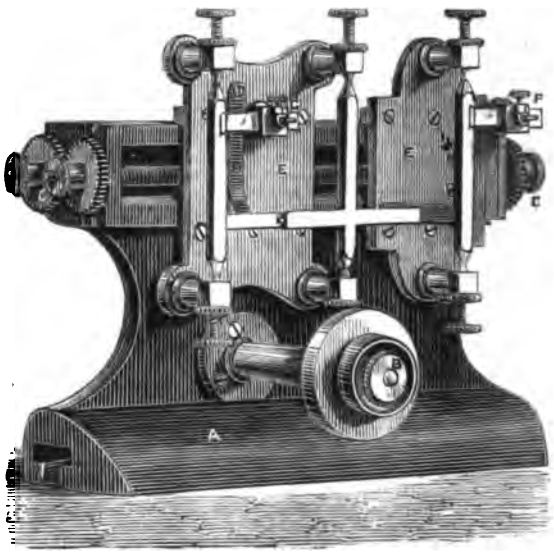
There can be no question as to which is the better arrangement, and I fancy Mr. Kernan alludes probably to the system I here mention.

W. H. N.

MEDALLION TURNING.

[395] Sir,—As there was no mention in "The Lathe and its Uses" of medallion turning, and I see there have been many inquiries of late in your paper on the subject, I herewith send you a photo. of my little machine for turning them. It will turn one in 20 minutes which any other machine will take 4 or 5 hours to do. If you think it would be a benefit to your readers, and particularly the amateur turners, you might insert it and the following, so that any amateur mechanic may make one for himself, as they can be applied to any lathe with two mandrels. A is a cast-iron stand on which all the slides, screws, wheels, pulleys, &c., are fixed; B is a small pulley which drives the wheels C from the back, D are screws driven by wheels C, E are two slides moved by screws D on slides, E are three levers that turn in conical centres and connected as shown to give motion from tracer to cutter, F and G are two tool boxes for holding cutting tool and tracing tool, H is a light spring to keep traces to medal. Both mandrels of lathe are made to revolve in same direction and same speed. An electrotype of medal is used for tracer to act on.

J. L.



AN AMATEUR MICROSCOPICAL SOCIETY.

[396] Sir,—With all due deference to "A. A. F." (342, p. 592) I cannot see the desirability of establishing another society when one already exists which is well able to meet the wants of those of our readers who are interested in microscopical science. Within the last few months frequent mention has been made in our journal of the "Quekett Microscopical Club," a society that now numbers 500 members, and which, for the small subscription of 10s., offers every advantage that one can desire. If "A. A. F." will refer to Vol. X., p. 241, he will get some insight into the practical working of the "Amateur's Friend;" or by applying to the secretary, 192, Piccadilly, he will soon learn that by enrolling himself as a member he will meet with *every* facility for prosecuting his favourite pursuit.

With reference to the inquiry of "E. L. G." (4615) as to the presence of fluorine in the human body, absence from home has prevented me sending a reply; the matter has, however, been so well gone into by three correspondents in this week's issue that it is unnecessary to say anything further upon the subject.

Beta.

[397] Sir,—In reply to letter 342, in last issue of English Mechanic, I should like to remark that the society lately formed in Manchester, under the name of "English Mechanics' Scientific and Mechanical Society," entertains the features mentioned in that letter, so that it would not require a new society to be formed. The object of this, our society, being the instruction and mental recreation of its members by the reading and discussion of papers on Scientific, Mechanical, and Literary subjects, as well as for promoting exchange of opinions on interesting subjects. We are not restricted to make mechanical investigations, as I believe is thought by many of your subscribers, but have, as will be seen from the above objects of the society, not excluded any scientific or interesting topic from our attention; therefore, I think "A. A. F.'s" suggestion for a separate society for microscopical studies needless.

A. Tolhausen, Sec.

REPLIES TO QUERIES.

*** In their answers, Correspondents are respectfully requested to mention in each instance the title and number of the query asked.

[3908.]—GRADUATION OF A CIRCLE.—On a strip of copper (tinned iron might answer) punch with a double-ended punch a number of holes, one in excess of division wanted; these must be punched by inserting one end of the punch, which should be rather larger than the other, into the previously-punched hole, and be in same straight line. The strip being thus prepared, turn down a circle of board to the size round which the strip will go tight with the two end holes covering, through which a pin may secure the strip round the board, or the two end holes may be riveted, and the strip forced on tight and secured. This will form a division-plate for required circle.—Suffolk Amateur.

[3919.]—GALVANIC BAND (Unnoticed Query).—I can see no cause of failure in your correspondent's appliance or manufacture of the above. He must, however, only expect weak effect. I did not notice this query, or should not have allowed it to pass so long unanswered, and have been from home.—Suffolk Amateur.

[3949.]—GUAYANA.—Without admitting that Stieler, or any non-Iberian, is authority for Columbian names, I was certainly surprised at learning from "J. G." that his atlas anywhere reproduced our *Guy* in this name. I find it does so in the small-world maps and the small South America, while the general map of both Americas has the full syllable *Guay*, and the detailed South America repeats it four times, always *Guay*. Moreover, his other authority (and that an Englishman), "J. G." himself quotes as beginning the natives' name with *Guay* and *Wai!* The fact is, that had men of our race discovered them, the spelling would unquestionably have been *Wyanna*. The doubled *n* would have insured the word against being made dactylic—if that is what "J. G." means by "short"—and the two letters *Wy* would, in English eyes, but no others in the world, have served for all that the Latin races mean by *Guai*, the *G* beginning this and scores of Spanish-American names by no stricter right than in the Latin forms of Walter and William. The native tongues throughout both Americas abounded in the syllables we (or cousin Jonathan) express by *Wa*, *Wha*, *Wy*, and *Why*. These the Spaniards wrote *Gua*, *Hua*, *Guai*, and *Huai*, the *G* and *H* being regarded as a kind of opposites in matter of aspiration, like the Greek ' and ʻ; but one or the other being always required, in their eyes, to nail up the *u* to the following letters as one syllable, and give it that strong *consonantal* quality that our Gothic ancestors better indicated by enlarging it into *W*. It was for a like reason that they enlarged *i*, when it begins a syllable, into *j*; and between two other vowels doubled it, as *ij*, to express that the former *i* merges into the previous syllable, while the latter becomes a semi-consonant beginning the next; and this *ij*, by losing its dots became *y*, as in this very name; so that, though neither is wrong the spelling with *y* (or *ij*) is more proper than with a single *i*. But the fact of our using single letters to express diphthongs, as in *by*, *bite*, *Bute*, a thing undreamt of in any other language; and that we might have expressed this syllable by *Wy*, can be no excuse for corrupting *Guai* into *Gui* or *Guy*, which not only every foreigner, but nine-tenths of Englishmen would be led to sound like the first syllable of Guido, Guyon, or even of Guienne or Guinea. With regard to climate, nobody fancies any country within 10° of the line, or even 30°, is "healthy for Europeans," and the *Colonial* Guayanas are known to be signally the reverse. It was worth noting, therefore, that, on the other hand, Venezuela has less ill name on this score, and contains, perhaps, more European blood than any other intertropical country—certainly any under the 10° parallel. A friend, moreover, lately went on foot, alone, and without a tent, across the 400 miles of Calabozo plains, from Caracas to the capital of Guayana; fording or swimming the minor streams. I do not suppose any such journey possible in the latter province itself, but should like to know in what other tropical continent the like has been done?—E. L. G.

[4115.]—TROPICAL FIBRES.—I have just received the work about which "J. C. P." inquired several weeks ago—"Tropical Fibres, &c.," by J. G. Squier. I was quite astonished in seeing that this book, advertized among "new ones" in a paper, was printed in 1863; it contains only 64 pages of print and 16 plates. These particulars may perhaps serve the querist.—Bernardin.

[4210.]—SIGN WRITING (Unnoticed Query).—If "Brush Hand" will buy a long sable-haired writing pencil and a book of ornamental alphabets and practise from them, noting well the form and manner of shading the letters, I cannot see but what he may soon be master of the art of sign writing.—Blackburn.

[4294.]—BREWING (Unnoticed Query).—Ales and beers left alone require a considerable time to become bright. If early maturity be required, I know no reason why such finings as isinglass or white of egg should produce acidity. In my native village amid the Chiltern Hills we never tapped our best ales until they had been brewed eighteen months. Those of my friends about Burton-on-Trent arrive at maturity in as many weeks. It is attributed to the water. "Only fancy it Burgundy, and 'tis worth ten guineas a quart."—Boniface.

[4299.]—SILVERING CLOCK DIALS (Unnoticed Query).—Dissolve a piece of silver in dilute nitric acid (two parts acid, one part water). When dissolved the liquid will be a blue colour if manufactured silver is used, as it contains copper; now place in the solution a piece of clean copper, when after a short time the silver will be thrown down as a grey powder. When there is no more deposit allow to settle, then carefully pour off the blue solution, and fill up with water so as to wash the powder from the acid, allow the powder to settle, then pour off as before. Repeat this two or three times, so as to wash away every trace of acid, when the powder may be left to dry. Now mix together equal parts of cream of tartar and common salt. Thoroughly clean the article to be silvered with fine emery cloth or paper. dip a piece of clean rag (previously moistened with water) first in the cream of tartar mixture, then in the silver powder, and apply to the surface, rubbing until silvered. Be careful not to let the fingers touch the article, wash in water, dry, when the dial may be varnished. Mastic varnish diluted with about half its bulk of spirit answers very well. I have just silvered some articles by this means.—S. Moody.

P.S.—The following taken from p. 19, Vol. I., of the English Mechanic would no doubt answer equally well but I have not tried it:—Nitrate of silver, 30grs.; common salt, 30grs.; cream of tartar, 3½ drs.; mix, moisten with water and apply.

[4300.]—SAUSAGES (Unnoticed Query).—For pork sausages, chop up fat and lean meat together, season with sage, pepper, salt, and allspice; 6oz. of bread crumbs to be chopped with 2lb. of meat. Fill skins that have been well cleansed.

Polonies are made of fat and lean pork, seasoned with salt, saltpetre, black pepper, and allspice. After standing several days with the above well rubbed in, cut small and mix with chopped shalot or garlic; fill ox-guts that have been thoroughly cleansed by scouring, salting, and soaking; hang up to smoke; the gut should be tied at intervals of six or eight inches, or less, as thought desirable.

Oxford Sausages.—To a pound and a half of pork add the same quantity of veal, free from skin, &c.; three quarters of a pound of beef suet; then mix, and chop fine; add bread crumbs, season with dried sage, pepper, and salt.

Beef Sausages are made in the same manner, but more highly seasoned with marjoram, thyme, and parsley.

Saveloys are prepared of salt pork and beef, with one-fourth part of bread crumbs, and a liberal allowance of spice, &c. Boil for half an hour.

Mutton Sausages.—Two-thirds of mutton to one-third of pork; the seasoning should be more delicate than used for beef sausages.

French Sausages.—Take pork, which must have more fat than lean, chop fine; also parsley and chives, pepper salt, and spices; either put in skins, or make up into cakes and grill. Vary the flavour by adding truffles or mushrooms, instead of chives. From MSS. recipes in an old family collection.

For trade purposes these recipes are often modified, by using oatmeal in large proportion, instead of bread crumbs, as pork sausages are now selling at from 6d. to 1s. 2d. per lb.—Paterfamilias.

[4317.]—COLOURING SIZE.—Use patent white size, about 2d. per lb.; and common ultramarine, about 6d. per lb. The yellow tint of common size will affect blue, or any delicate colour.—Derfla.

[4337.]—HOLLOW CANDLES.—I presume there is a glazed metal rod passed from top to bottom of each candle mould, with a hollow wick similar to that used for lamps, passed over it. When cold, the candle will draw out of the mould, and the rod out of the wick. The object is to brighten and spread the flame of the candle.—Derfla.

[4339.]—LA CROSSE (Unnoticed Query).—A short illustrated article, giving directions as to the method of playing the above game, appeared in the first weekly part of Cassell's "Popular Educator" (new edition, No. 1, Vol. I.), pp. 15, 16. Your correspondent may obtain a copy of the above specified number through any bookseller.—S. . . . r.

[4351.]—CASE FOR FERNS AND MOSS (Unnoticed Query).—From 8in. to 12in. are good depths, according to the description of plants for which the case is intended. It is better to have an aperture at bottom, which after the case has been planted and well watered should be plugged up. The case should be stout, of the best yellow deal, charring it inside would be beneficial, but avoid metallic linings. The "Fern Garden," by Shirley Hibberd, contains many valuable suggestions and plans of cases.—H. B. M.

[4361.]—METHYLATED SPIRIT.—If "T. L. H." will forward the address of "the chemical factory where tinctures of all kinds are manufactured from methylated spirit," to the Commissioners of Inland Revenue, he will probably hear of something to his advantage. By the act 29 and 30 Victoria, chapter 64, section 8, it is enacted, that "No person shall use methylated spirit or any derivative thereof in the manufacture, composition, or preparation of any article whatsoever capable of being used either wholly or partially as a beverage or internally as a medicine," under a penalty of £100 and forfeiture. The ninth section also prohibits any alteration being made in "finish," except by the addition of gum, resin, or colouring matter, under a penalty of £200 and forfeiture. A copy of the above sections was furnished to every chemist and druggist in the United Kingdom upon the passing of the Act in August, 1866. I leave "T. L. H." to draw his own conclusion.—A Revenue Officer.

[4367.]—RE-ENAMELLING CLOCK DIAL.—"Sheffield Flood," p. 454, can re-enamel his clock dial by grinding white lead with carriage varnish, apply it with a brush, dry it in an oven with a gentle heat, and polish with fine pumice. The figures are painted with mastic varnish and lamp-black made thin with either turpentine or oil of spike lavender.—J. M.

[4372.]—OBOE (Unnoticed Query).—In [illegible] reply to "Anon's" inquiry, I beg to say [illegible] That a first-class reed for the oboe [illegible] 2s. 6d.. but as for the blowing the instru[illegible] help him, as I am nearly fast with my [illegible] add that I think there are a good man[illegible] country, but that very few are proper[illegible] I should much like one of our friends [illegible] Mechanic to give us a few practical [illegible] they would be much appreciated.—J[illegible]

[4485.]—TO "GASHOLDER."—The [illegible] by S. Highley, is dear I think for £[illegible] a gasholder made much cheaper. I [illegible] size if required; the advantage is great[illegible] your oxygen for days without spoiling [illegible] than can be said for the bag plan; [illegible] travel from place to place, you would [illegible] holder too bulky.—Operator.

[4504.]—ELLIPSES.—"J. K. P." [illegible] if the curve is "ever egg-shaped, it must [illegible] symmetrical," but does not go so far as [illegible] "E. L. G." (p. 595), that it is a "mere [illegible] than the ellipse, however long his connecting[illegible] is not an "oval of the fourth order" at all, as [illegible] seen from its equation:

$$s = 2R + a - 2\sqrt{R^2 - [illegible]} - \sqrt{a^2 - [illegible]}$$

where 2 *a* is length of connecting rod, and [illegible] of crank, and is no more complex than a [illegible] section. "E. L. G." is a great deal too [illegible] T. W. Boord's mere sketch of a trammel, [illegible] gentleman is quite equal to self-defence. [illegible] ellipsograph is priced £3 to £4 in Holtzapffel's [illegible] and as mine, which is shown on p. [illegible] (destitute [illegible] the charm of novelty for "E. L. G."?) [illegible] double those amounts, according to size and [illegible] a draughtsman, requiring to strike ovals [illegible] something cheaper is a desideratum. If "E. L. G." will take the trouble to read my letter on p. [illegible], he [illegible] perceive that I was at least then aware of the [illegible] symmetrical nature of the curve produced, as I take the trouble of pointing out why one of the two [illegible] there proposed has an advantage over the other in certain purposes; but I repeat that when the length of connecting rod is five or six times that of crank, the departure from the true figure is so slight as to be hardly perceptible, even when one oval is laid over the other, and, I suppose, amply accurate enough for striking the semi-ovals in isometrical drawing. [illegible] made on the connecting-rod principle, a pen might be made to work accurately with scarcely anything additional in the way of mechanical complication. And now, taking the first part of "E. L. G.'s" [illegible] the fault of the subject being recurred to [illegible] with those who set down to answer a query [illegible] forward, but rather with the person who [illegible] referring to the back numbers. Also, the plan of [illegible] ellipses with a cord, even if accurate, would be perfectly inadmissible on a drawing, though it [illegible] purpose of the gardener for staking out a [illegible] in which also so much accuracy is not looked for.—J. K. P.

[4517.]—FISHING GUT may be stained with [illegible] coffee, or ink-and-water.—Suffolk Amateur.

[4541.]—EMBROIDERING MACHINE.—The machine referred to by "A Braider," is one sold by the Wil[illegible] & Gibbs Company. It makes a stitch like the Wil[illegible] & Gibbs sewing machine, but the embroidery is [illegible] the upper side of the work, and the feed is controlled [illegible] a small handle which enables the embroidery to be [illegible] in all directions without stopping or turning the work. The reel is on the under side, and the needle is similar to a crochet hook.—Thos. Fletcher.

[4546.]—DIVISION PLATE.—In reply to remarks [illegible] "J. K. P." I might, with great truthfulness, begin my reply in the same words as those used in your impression of 2nd inst. by your worthy and very clever correspondent referred to, but as I recommended no particular numbers, and only gave such as my own experience [illegible] useful, and also as I referred to a printed list [illegible] dividers by Baker, I will only explain, as briefly as I can, what to your aforesaid correspondent must appear very mysterious. My meaning of *divides into different* [illegible] is, that No. 720 has 15 divisors, viz., 2, 3, 4, 5, 6, 8, [illegible] 12, 15, 16, 18, 20, 24, 36; 360 has only 14: so that [illegible] appears to be the greatest divider, and consequently the most useful number of all the others. As [illegible] the Nos. 360, 144, 120, they will be found [illegible] equally useful and necessary when "J. K. P." [illegible] do fine work with poor eyes. I fear that the experience of "J. K. P." in fine fluting, drilling, &c., is not equal to *the attention* I have at times to give, as I have found every No. on my division plate come in. I [illegible] for "J. K. P.," a copy of Baker's "Ready [illegible]" which I request him to keep for reference; [illegible] probably Mr. Baker may answer his interrog[illegible] "who ever had a circle of 720 on his dividing [illegible] I have not, but all the other Nos. in the [illegible] Reckoner are on my Holtzapffel Rose Engine.—Wahsrof.

[4546.]—DIVISION PLATE OF LATHE.—In ordinary ornamental turning, if the division plate only admits of three circles of holes, I should say that 1[illegible] [illegible] and 112 would be found the best divisions; 180 divides by 2, 3, 4, 5, 6, 9, 10, and 12; 144 by 2, 3, 4, 6, 8, 9, and [illegible] and 112 by 2, 4, 7, and 8. A fourth circle of 96, if room could be found for it, will often be useful. I have a lathe of Holtzapffel's containing the divisions recommended by "Wahsrof," viz., 221 and 209, and during the twenty-eight years I have been working with it, I have never once had occasion to use either of those divisions.—G. C. C.

[4555.]—PHOTOGRAPHY.—"Lex" must say to what size he wants to make his enlargements, and if by solar or artificial light, then if the editor will spare me room I will give him full instructions drawn from my own practice. To the second question I must say that it would take a column of the Mechanic to properly answer it, but the formulæ I use is this, whites of eggs [illegible] beaten by a machine for a sufficient time to convert them to froth, this is allowed to settle to a clear liquid, and to each gallon is added 800 grains of chloride of ammonium, 800 grains of chloride of barium, dissolved in 20 ounces of water, the two well mixed, poured in flat dishes, and the plain paper floated on it, for from 15 seconds to three minutes, then dried in a room heated to 70°. To free the bath from acetic acid, pour into an evaporati[illegible] evaporate to dryness, fuse the residue, dissolve in or to 35 grains per ounce, filter and make just tral or slightly acid, with nitric acid. The autotype ting process is a method of printing in carbon by processes of Swan and Johnson, the patents are l by a company who grant licenses to work the pro- s on payment of a small sum per year.—OPERATOR.

556.]—TELEGRAPHY.—I am obliged to "Termi- " for his reply to my query under the above heading, I must confess my error (through hasty drawing) in ting *two* wires on one insulator. I also thank "John g," but "Terminal's" reply is undoubtedly right, as ctricity in any shape would be as likely to strike the e as the "guard."—MUS.

4567.] MATHEMATICAL INSTRUMENTS.—S. vens asks a question which week after week it has on my intention to ask, and although it is, so to ak, a wrinkle of trade, yet among the numerous d-hearted contributors to the highly-valued ENGLISH CHANIC, there are surely more than "J. K. P." who n find pleasure in offering advice and giving instruc- ns on this subject, clear, explicit, and practical, thout doubt there are many besides, who will be very ateful to any skilled brother who will, in such a irit, reply to the following questions; or, in their ual way, describe how the work is put in hand and one. The sort of "geer gathering" spirit, causes many our young folk to prize the heirloom instruments, hich have a value in their estimation above even the ne finished foreign cases, but a bad or broken joint ren- ers them of no use; the will to mend it is consequently ften strong if the way to do it were known. First, hen, the joint-plates of drawing instruments, if steel, re so soft that they can be sawn out, or the brazing re- elted and pulled out, or if worth while, a new joint an be made, and screwed or soldered lower down the g. Second, after the plates are prepared is there a method of fixing them with cold solder or brazing, or is t always by heat? If it is please describe the kind of furnace, fire, or blowpipe used, for there is such a risk of running down the solid metal, which is often only a stout wire of brass or white metal; and what solder is used? And last, while the file must shape, is the finishing done with it? I have heard that it is done on the "lead lap," but how is that made, is it used dry or with oil? The finishing is clearly seen to be across the work and very plane and even, and the small projections or lists are all sharp cut, so much so that the sharpest edge or angle of a lead wheel, would seem unable to make them. How then is it done? A kind, practical, painstaking reply will be gratefully received by many amateur youths, who in the darkening evenings will rejoice in rying their hands at this interesting work under good nstructions, instead of being by failures and ignorance liscouraged from attempting to revive the appearance and usefulness of their old instruments.—S. H.

[4568.]—WEIGHT OF RAILS.—"Ferrum" seems to be able to easily ascertain the weight per yard of round, square, or flat bars of steel and iron, I suppose, by means of the usual tables. He asks a rule to find the weight per yard of rails of various sections (iron and steel); but how can he expect that can be furnished him unless the sectional area of each individual specified rail shown on the tracings is given? If such were the case, he could of course by the same tables, as easily as in the former instance, learn their weights per yard. A simple way to find the weight of any section of rail he may receive is to get a carpenter to make from the tracing a full-sized model of the rail 6in. long; sink it in a quart of water, measure the displaced water, and check the same by measurement of the emptied space in the quart after the model has been taken out. Ascertaining thus the number of cubic inches in a length of 6in., he has only to multiply by six for a yard, and by the weight of a cubic inch of steel or iron to gain the desired weight per yard.—S. H.

[4572.]—GEOLOGICAL.—The limestone beds which are quarried on the west side of the Malvern Hills belong to the upper Silurian system, chiefly the Wenlock rocks of that formation. Should "Philosopher" require any further information I shall be glad to give it.—A. D. MELVIN.

[4589.]—TENDER FEET.—My plan is to wear shoes sufficiently roomy to admit an inner sole of cork or felt; thick soles are preferable to thin ones on country roads. On arriving at night soak the feet in warm salt and water. Next morning bathe them in cold water and rub well with a hard brush. Forty years' experience have proved this practice to suit.—AN OLD MAN.

[4590.]—TOWN GARDENING.—In the centre of London, amongst smoke and dirt, occupying the upper part of a house, with a broad staircase lighted from above, I have, at about 10ft. from the skylight, arranged around the walls the undermentioned plants, which live and flourish luxuriantly:—Scarlet runner bean, *Heliotropium Peruvianum*, *Scolopendrium vulgare* (hart's tongue fern), *Blechnum spicant* (hard fern), *Athyrium filix fœmina* (female fern), *Osmunda regalis* (flowering fern), *Eccremocarpus scaber*, Nasturtium (varieties), *Mimulus moschatus*, *Cobœa scandens*, Geraniums selected for foliage rather than flower, Fuchsias various, *Isolepis gracilis*, Convolvulus major, *Lysimachia nummularia* (moneywort), *Saxifraga Sarmentosa* (mother of thousands), *Vinca major* (periwinkle), *Tradescantia zebrina*; *Lycopodium formosum*, *L. apodum*, and *L. denticulatum*, under bell-glasses. These plants cost in the streets and markets from 1d. to 1s. each. The compost I use is vegetable mould mixed with one-fourth part of fine white sand; pots, well drained by potsherds, and bits of *charcoal*. They are well supplied with water, in which every fourth day is dissolved ½oz. of sulphate of ammonia to each gallon. The pots stand in porous red stands, from which the surplus water is drawn off by a siphon. When any dirt appears on the leaves the plants are carefully sponged. Such a utilization of a staircase might perhaps afford to others the same pleasure it gives to—AN ATTIC WORKER.

[4595.]—HOUSES FROM STRAW, ETC.—In the *Working Man*, a paper published by Cassell, some two years ago, there was made mention of workmen's cottages being built of bundles of straw and some other material. I believe they were building near Twickenham, about ten miles from London.—BLACKBURN.

[4605.]—PROPELLING VESSEL BY WINDMILL.—As I have misled Mr. Burton in the matter of the nautical windmill, I am only too glad to see that he is this week put on the right tack by various correspondents. I am sure we should all be very glad if John James (4605, replies to queries) would kindly give us some information as to the construction of his model, if he does not wish to keep his ideas private. If Mr. James could meet me at any decent piece of water with his model, I think I could convince him that it would not go at *double* the speed of a sailing boat. W. HARROGATE.

[4616.]—PROBLEM.—In my last, I gave "Amicus" the algebraical method of solving the statical problem. The printer or myself made two immaterial blunders—at least immaterial so far that the veriest tyro could tell what was meant. Thus: in line 18, read A C D = 135° not A C B; and in 4th line from the bottom read,

$$\sqrt{x^2 + x^2} = B\ D,$$

or,

$$x^2 + x^2 = B\ D^2.$$

I now give the trigonometrical method of solution. Formula:—

$$R^2 = P^2 + Q^2 + 2\ P\ Q\ \cos.\ \theta$$

(see Newth's large book), by data given,

$$P = Q \text{ and } \theta = 135^\circ;$$

thus,

$$100^2 = x^2 + x^2 + 2x^2 \cos.\ \theta\ (\cos.\ 135^\circ = -\frac{1}{\sqrt{2}}$$

$$= 2\,x^2 + 2x^2\left(-\frac{1}{\sqrt{2}}\right)$$

$$= 2\,x^2 - \frac{2\,x^2}{\sqrt{2}}\left(\text{multiply } \frac{2\,x^2}{\sqrt{2}} \text{ by } \frac{\sqrt{2}}{\sqrt{2}}\right)$$

$$= 2\,x^2 - x^2\sqrt{2}\ (\sqrt{2} = 1{\cdot}414, \text{ \&c.})$$

$$= 2\,x^2 - 1{\cdot}414\,x^2$$

$$10{,}000 = {\cdot}586\,x^2 \text{ (multiplied both sides by 1000)}$$

$$10{,}000{,}0000 = 586\,x^2$$

$$x^2 = \frac{10{,}000{,}000}{586} = \frac{5{,}000{,}000}{293} = 17064{\cdot}84, \text{ \&c,}$$

$$x^2 = \sqrt{17064{\cdot}84, \text{ \&c.}} = 130{\cdot}6, \text{ \&c., \&c.}$$

If the decimal places are carried further it will make a slight difference in the answer. P.S.—I shall be glad to solve a specimen example of such questions as can be worked arithmetically, in order to benefit those students prepaing for the Matriculation, London University, if the editor will spare space.—C. H. W. B.

[4616.]—PROBLEMS.—If I understand well, the problem is:—One angle of a rhombus is 135°, corresponding diagonal 100, to find the side. I observe that the supplementary angle is 45°, hence the side is the radius of a circle circumscribed to an *octagon*, the *side of which* is 100; seveval tables give for that radius 130·7.—BERNARDIN.

[4624.]—PENDULUM SPRING.—TO "YOUNG JOBBER." Pallets and lever depths. The proper depth for escape-wheel teeth on the pallets is, that they fall just safely on the locking face of each pallet stone, on no account must the depth be left shallower, because if the teeth when escaping from either pallet fall on the *slope* the guard pins will be driven upon the edge of roller, by which the motion of the balance will be very much impeded, and thereby prevent the watch keeping any regular time; sometimes when the watch has a strong mainspring it may stop through such shallow locking, the guard-pin being forced against the edge of roller, thereby stopping the balance. Of course when set to the proper depth just named, the depth must be transferred from the depth-tool to the *upper* plate for marking off, and when uprighted in the frame the following is a sure method for trying these depths. The wheel and pallets being in the frame, screw in the balance with the roller on, having previously caused the pallets to be end-bound, by placing upon the upper pivot of the pallets' staff a thin piece of cork. Next lead the balance round to allow the tooth of the escape-wheel to fall on the pallet stone. The pallets' staff being end bound ensures a good view as to the amount of depth the tooth has upon the stone. If the wheel be deeper on the pallets than I have named, the unlocking will be effected with loss of power. One thing must be always kept in view, namely, that the wheel teeth lock just over the rounded edge of the pallets' stones. Thus far the wheel depth on the pallets. The *lever* depth upon the roller and pin next follows. The roller-pin should have just visible freedom in the lever notch, and at the moment of the wheel-teeth falling on the pallets—they being kept stationary by the piece of cork just referred to—the corner of the lever-notch should be presented to roller-pin, and then when holding the balance firmly, at that point of its motion, with a piece of peg move the lever from side to side and observe what amount of motion it has; if the same—or a trifle more than appeared when trying the size of the roller-pin in the notch—that is a good depth. If there be no shake till the balance is moved onward, then the depth is too deep and the length of the notch must be shortened. Always observing when setting the roller-pin and notch-depths that just half the pin is embraced by the lever-notch. I have omitted to state that the frame should be held in the left hand with the fore-finger upon the balance for leading it, and that with a nicely cut piece of peg force the escape-wheel onward. The remaining portion of "Young Jobber's" query respecting "the adjustment," that will be found in my article in the *British and Foreign Mechanic*, Vol. II., p. 84; subject—"The Watch: Its History, and How to Repair it."—SECONDS' PRACTICAL WATCHMAKER.

[4630.]—COACH-PAINTING.—If an "Old Subscriber" will say what coach, carriage, or other conveyance it is that he has to paint, I will do my best to give him all the information requisite, as there are almost as many ways of painting a coach, &c., as there are days in the year.—BLACKBURN.

[4633.]—WEIGHT OF METALS.—I am sorry I had not time to reply to Ralph Williams before. To his first question I can only say that good works on mensuration generally contain a chapter on specific gravity, which is what he wants. Hutton's "Mensuration" is published by Longmans, London, and others; its price I don't know; I bought it second-hand. In reply to the other question, solid geometry proves that its sphere is ⅔ of its circumscribed cylinder. Of this cylinder the diameter and height are equal, in this case 7in. Therefore, $7^2 \times {\cdot}7854$ will give the area of the base, which multiplied by the height 7, will give the solidity, *i.e.*, $7^2 \times {\cdot}7854 \times 7 = 7^3 \times {\cdot}7854$ = the solidity of the cylinder, ⅔ of which will be the solidity of the sphere. Therefore, $7^3 \times {\cdot}7854 \times \frac{2}{3} = 7^3 \times {\cdot}5236$ = the solidity of the ball.—J. NASH.

[4647.]—PHOTOGRAPHIC.—If "Mendicus" was making a bath for negatives the rain-water will not do, he must add a few drops of a solution of carbonate of soda to the bath, just sufficent to cause a *slight* precipitate, shake well and put it in a clear white glass bottle, and expose to full sunshine for two or three days, then filter carefully, and add a drop or two of pure *nitric* acid sufficient to slightly redden blue litmus paper; if made of proper strength, 35 grains per ounce, it will work *first-rate*. The fact that the objects on the ground glass are reversed, will make no difference if he is taking negatives, the prints will be perfectly true to nature, it is owing to well-known optical laws, and not to any fault in the apparatus, as he seems to imagine. The third question is a rather difficult one to answer, as he gives me no data to guide me. Does the plate reremain quite clear after the developer has been on it a short time? if so it is owing most likely to too short an exposure, or a too acid bath; keep the bath so that it just turns the colour of litmus. If the plate turns black or brown as soon as the developer is applied it is owing to fog, perhaps from white light in the dark room. Prepare a plate and keep it in the dark room for about five minutes about 12in. from the window, then develop it: if it remains quite clear, and after fixing is as transparent as the glass itself, the fog is owing to light in the camera or dark slide. The remedy is obvious. If it fogs prepare a plate at night, using a candle about a yard from the plate to light the room, and develop as before; if *it* fogs, turn the bath out and proceed as directed for the bath made of rain-water. If that does not cure it he must ask again and send all particulars.—OPERATOR.

[4647.]—PHOTOGRAPHIC.—TO "MENDICUS."—First, your mixing the bath with soft filtered water will not in all probability affect the working of it; try it, and if it should there is no remedy but to crystallize the nitrate of silver contained in the solution and redissolve it in distilled water. Second, if you had given your second query a thought, it would never have appeared in the MECHANIC; of course the objects are upside down, and right side to the left. Third, are you sure the plate is exposed properly by pulling up the door of the dark slide, and then taking the cap off the lens? or is the developer make according to formulæ.—TOMETER.

[4647.]—PHOTOGRAPHIC.—The effect of "Mendicus" having dissolved his nitrate of silver in *soft water* would be that it would fog plates if in a negative bath, and in a positive would render the paper mealy. Notwithstanding, if he treats the bath in the same way as I suggested a dirty bath should be in two or three numbers ago, it will be equal to one made with distilled water. Second, the image that he sees on his screen is of course inverted on account of its being a "reflection" from the lens, and being inverted it is of course reversed. The only remedy for it is to carry out the suggestion of a humourous photographer, *i.e.* turn your landscape upside down, and make your sitters stand on their heads. Third, the causes of no image appearing on the application of the developer are many: insensitiveness, weak developer, under-exposure, too much acid and not enough patience. If "Mendicus" can get the back numbers from December last, he will find all my formulæ. He will not find it a waste of money,—on the contrary. But if he does not feel disposed to do so I will look back and let him know in what Nos. the formulæ appeared. "Mendicus" cannot help getting an image with it. If he fail he had better look to his lens and camera to see that the "old gentleman" is not in them.—MUS.

[4648.]—COINS.—The first coin engraved is a silver penny of William I. Inscription on the obverse, "Pillelm Rex," signifying William King; reverse, "Osmund on Sude," signifying it was struck by Osmund of Southwark; worth about 5s. The second coin is a sixpence of Philip and Mary. Inscription, "Philip et Maria, A.D.G.R. Ang. Fr. Neap. Pr. Hisp.," signifying Philip and Mary, by the Grace of God Queen of England, France, Naples, and Princess of Spain; reverse, shield of arms, with the inscription "Posvimus Deum Adivtorum Nostrum." The numerals VI at the top of the shield mean the value (sixpence); worth about 8s.—W. J. EGGLESTON.

[4648.]—TWO COINS.—No. 1, Penny of William I.; No. 2, sixpence of Philip and Mary.—BERNARDIN.

[4648.]—TWO COINS.—The first is a silver penny of William I. or II. Obverse: full-face bust of the Conqueror, holding a sceptre in his right hand. Legend, PILLELM REX (William, King). Reverse: a cross, with the letters P. A. X. S. in the angles: Legend, OSMVND ON SUDE (Osmund at Southwark). The name of the moneyer and place of mintage. Common value, 2s. to 5s. The second coin is a sixpence of the second issue of Philip and Mary, coined in 1554. It is rather scarce; value about 10s. For full accounts of these two coins see my "Guide to English Coins," Part II., pp. 15 and 67.—HENRY W. HENFREY, M.N.S., &c., &c.

[4650.]—FRENCH LANGUAGE.—The best work I know is Havet's "Complete Class Book," Parts I. and II., published by Simpkin & Co. Cassell's "Lessons in French, Parts I. and II., are very good, and will well repay careful study. Much more, however, depends upon continuous perseverance than upon the text-book. "Don't try to learn French in six months."—A. POCKLINGTON.

[4650.]—FRENCH LANGUAGE.—I have learnt very successfully from the two following:—"The Beginner's Own French Book," 2s.; key to the same, 2s.; by Delille. Should "Patty" wish to acquire a superior knowledge of the language he cannot do better than obtain the following in rotation:—"Easy French Poetry for Beginners," 2s.; "French Grammar," 5s. 6d.; key to same 2s.; "Modeles de Poësie," 6s.; "Répertoire des Prosateurs Français," 6s. 6d.; "Manuel Etymologique," 2s. 6d.; the whole comprising Delille's series, which is pronounced by the leading professors as the best.—PIRO.

[4651.]—POWER OF WATER-WHEEL.—The rule for this is as follows:—Raise the radius of the wheel to the third power, and extract the square root of this power; multiply this root by the area of the transverse section of the stream which supplies the buckets; divide the product by 6·5, and the quotient will be the mechanical effect in horse powers:—

Rad. = 8

$8^3 = 8 \times 8 \times 8 = 512 \qquad = (a)$

$\sqrt{a} = \sqrt{512} = 22{\cdot}627 \qquad = (b)$

Assume transverse section of stream = 4 × 1·5 = 6 sq. ft. = area of „ } = (c)

$(b \times c) = 22{\cdot}627 \times 6 = 137{\cdot}762 \qquad = (d)$

$(d \div 6{\cdot}5) = 137{\cdot}762 \div 6{\cdot}5 = 21{\cdot}194$ = power of wheel in horse-power. Say 21 horse power. As "Miller" has not given the area of the stream it is assumed as 4 × 1·5.—Studiosa.

[4652.]—TONING BATH.—The following I have constantly used, and found to give satisfaction, producing from black to bright sepia tones, according to length of immersion:—Take carbonate of soda sufficient to cover a threepenny-piece; dissolve it in a teaspoonful of cold water in a cup; add 2 grains chloride of gold; then add 8oz. of boiling water; use in 15 minutes. After toning, pour it into a stock bottle, adding a particle of acetate of soda to give it keeping qualities. The next batch to tone, commencing in same manner, but using half the above quantities. Add it to the stock and tone immediately, and so keep on, omitting to add the acetate of soda, which should be added but once in twenty times. As is well known, one formula will suit one paper but not another. I never knew this to fail with Hart's alb. paper. —Pero.

[4652.] — TONING BATH. — I must refer John Terras, as I have others, to my formula in a back number. It is certain in its working, which can properly be said of no other bath—that is, in every one's hands.—Mus.

[4652.]—TONING BATH.—If John Terras had stated what toning bath he uses, and the kind of tones he wishes to produce, it would have been easier to reply to his question; but he will find the old acetate of soda bath as trustworthy and uniform as any.—Dædalus.

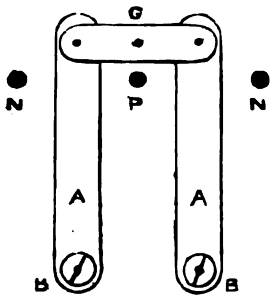
[4652.]—TONING BATH.—Dissolve 25 to 30 grains of crystallized phosphate of soda in 6oz. distilled water; then stir in 1 drachm of distilled water containing 1 grain of chloride of gold. Immerse the prints, which after removal from the printing frames have been well washed in common water and then dried. Five minutes in the toning bath is generally enough. Futher particulars and other formulæ on application.—T. Wyer.

[4652.]—TONING BATH.—For Rive paper try the following:—Acetate of soda, 6 drachms; dissolve in 6oz. of water. Borax, 2 drachms; dissolve in 6oz. of water. Mix the two together, and add chloride of gold, 15 grains, dissolved in 12oz. of water. Pour the solution of gold into the acetate and borax solution slowly, with constant stirring; use next day. It will keep in good order with the addition of a bath made in the same way, using only one-fourth of the water, so as to keep up the strength. For Saxe paper:—Chloride of gold, 15 grains; water, 2oz.; precipitated chalk, 1oz. Mix in a jug, and pour boiling water, 30oz., over; stir, and let it settle; pour the clear liquid off, and add saturated solution of chloride of lime, 3 drops, and use. It will keep, and may be strengthened by adding a strong solution made the same way. As these two baths are used by me, the latter one in an establishment turning out some thousands of carte pictures per week, they can be depended on as giving first-rate results.—Operator.

[4655.]—MANGANESE BATTERY.—I should recommend "E. H. B." to solder each element of his batteries to a piece of stout copper wire a foot or so long, and then on the ends of these wires he had better put the terminals, which will not then get corroded. I believe the cause of corrosion is the vapour from the fluid in the cells.—Tometer.

[4656.]—GOLD COIN.—It is an ancient British one, coined about 200 years B.C. I have a similar one in my collection, found at Brighton last year. The design on one side is meant for a horse. The value is about a guinea. Would Mr. Hoad kindly send me impressions in sealing-wax of both sides of the coin, with his address? —Henry W. Henfrey, M.N.S., &c., &c., Markham House, Brighton.

[4663.]—BRAKE PIECE.—In reply to "Tometer" the cheapest commutator to make is this: A A two strips of thin brass with connecting piece c, like a parallel ruler.



N, P, N, three studs connected as the letters indicate with the negative and positive poles, then as the parallel strips are moved from left to right, or *vice versa*, the screws and consequently the connections underneath them become positive or negative.—B. N.

[4664.]—PRESSURE OF WATER.—In reply to "Holbeck" it may be stated that the pressure at the bottom of the two pipes will be equal, since, by the well-known law of the pressure of liquids, the weight or pressure of a column of water is proportional to its height, and is exerted equally in every direction; therefore, although one pipe is, for two-thirds of its length, 8in. in diameter, yet the pressure at the bottom of the pipe, 4in. only in diameter, will be as if the pipe had been 4in. in diameter throughout its whole length. The pressure at the bottom of both pipes, due to a column of water 12ft. in height, may be stated (roughly) as 5lb. per square inch. —S . . . . R.

[4665.]—SOLUTION OF PROBLEM.—Let x = length of line in miles, y = miles per hour the train ought to travel. Then (α) we have the following equations:—

$$\frac{x}{y} + 1\frac{5}{6} = 1 + \frac{1}{2} + \frac{x - y}{\frac{2}{3}y}$$

(which becomes, when reduced to its simplest terms, $x = 5y$), [A]

and,

$$\frac{x}{y} + 1\frac{4}{6} = 1\frac{1}{2} + \frac{1}{2} + \frac{x - 1\frac{1}{3}y}{\frac{2}{3}y},$$

(which also becomes $x = 5y$.) These results, being identical, show that the problem is indeterminate. The reason of this is that the speed of the train is not given. The speed being assumed at pleasure the length of the line will bear a fixed ratio to it, which ratio (from equation A), is $\frac{x}{y} = 5$. Thus if the assumed speed be 40 miles per hour, the length of line will be 200 miles; if 20 miles per hour, 100 miles, &c. And (β) gives the following equation:—

$$\frac{x}{y} + 1\frac{1}{3} = \frac{\frac{1}{3}x}{y} + \frac{1}{2} + \frac{\frac{1}{2}x}{\frac{2}{3}y},$$

which leads to the same result as before, viz., $x = 5y$. The enunciation therefore of the facts, altered as supposed in the problem, would be true; but it would not suffice to determine the absolute length of the line. As in the former cases we could only discover from it the length of the line relatively to the speed of the train.—R. Bennett.

[4667.]—CLEANING GUN BARRELS.—In reply to "Needle Gun's" query I certainly don't recommend the use of fine emery paper for cleaning the inside of gun barrels every time they get dirty (there is nothing for that purpose so good as hot water and clean tow), but to clean off all rust, &c., that may have accumulated in barrels that have been put by for a time, and to make them look as clean and bright as on the day they left the gunsmith's shop.—Muzzle Loader.

[4673.]—INDIAN COIN.—It is a copper coin, struck in England for the use of the English settlements on the island of Sumatra. On the left hand side of the engraving (p. 574), is the following inscription in the Malayan language:—*Dua Kepeng*, 1247. This denotes the value to be two copper cash, 400 of which are equal to a Spanish dollar, formerly the general currency of the Eastern islands. 1247 is the Mohammedan date.—Henry W. Henfrey, M.N.S., &c., &c.

[4675.]—GOLD FISH.—You need not protect them, they will live through the winter.—C. B.

[4675.]—POND FOR GOLD FISH.—I have kept them alive and increasing in weight for several years, without protection, until they attracted the attention of poachers and found the road to London. No pond should be without shelter of some kind, old stumps of trees, hurdles, &c., and the banks planted with water plants. *Isolepis gracilis* is at present a great favourite in Covent-garden. —Engraver.

[4676.]—NITRATE OF SILVER.—I should decidedly recommend "Paddy" to send his precipitate to some respectable refiner and get nitrate of silver in return, for to do it himself would be more trouble than profit; but if he likes to try, here is the way to do it: Throw the precipitate in a filter in a funnel sufficiently large to hold twice as much, then wash with hot water until the precipitate is free from all soluble matter, then dry in an oven, powder well, and mix with twice its weight of a mixture of carbonate of soda and carbonate of potash in equal parts well dried; put it in a crucible and expose to the heat of a blacksmith's forge until the contents of the crucible are perfectly liquid; let the crucible cool, then break it and separate the button of silver from all traces of slag, dissolve the silver in an evaporating basin, by a mixture of equal parts of pure nitric acid and water, avoiding all excess of acid, heat will be required; then evaporate down to dryness and fuse the dry residue, taking care to use no more heat than is absolutely necessary. The fused silver, if the operation be properly done, will be purely neutral and fit for *any* photographic purpose.—Operator.

[4680.]—BLEACHING BROWN CALICO.—If "N2" will first boil the calico in lime water, wash, and without drying boil again, in a solution of soda or potash; wash, and without drying steep in a weak mixture of chloride of lime and water for six hours; wash and without drying steep for four hours in a weak solution or mixture of sulphuric acid and water; wash well and dry; he will find his calico white, sound, and beautiful.—Wahsrof.

[4682.]—TONING BATH.—I will look out the number that the formula appeared in and let "Photographer" know which it is.—Mus.

[4683.]—VALVE FACINGS OF CYLINDERS.—The cylinders always have the valve facings cast on them; they are finished by being turned, and the parts that will not run true are filed as best they can be. I think borax is the flux for brass. Will "Amateur Brass-Founder" kindly describe his furnace for the benefit of his brother readers who will gladly receive the description, at all events I shall be extremely obliged?—Tometer.

[4684.]—TYPE.—There is a decided and palpable difference between "genuine" and "pirated" type, as there is between an original woodblock and its *cliche*. Any typefounder would point out the distinction practically in a minute better than word painting would tell in an hour. Weight for weight, I should prefer the "genuine," but I never heard of any positive trial as to duration. In metal of equal quality much difference may be produced by the manner of casting.—Engraver.

[4689.]—PEDOMETERS, DESCRIPTION OF.—The following description of a pedometer, the invention of a Mr. Payne, is extracted from the *Magazine of Science*. "In this extremely ingenious and skilful contrivance motion is communicated *from* the traveller *to* the machinery of the pedometer, by means of a horizontal lever, which is furnished with a weight at one end and a pivot or axis at the other; under the lever is a spring which keeps the former when at rest close up to a regulating screw; the spring being so arranged as to be only just sufficiently strong to overcome the weight of the lever, and prevent its falling downwards. When the body of the traveller is raised in progression, the lever is impelled downwards by the jerk, and immediately returned to its place by the spring, and so long as the motion is continued, the lever is constantly in a state of vibration. A small ratchet wheel is fixed to the axis of the lever, and beneath it is another and larger ratchet wheel, which fits on the same axis, but is not attached to it. These two wheels are connected by a ratchet or pale in such a manner that when the lever falls both wheels are moved forward one or more teeth, but when the lever rises again from the force of the spring the larger ratchet wheel is held stationary by a ratchet. The larger wheel is connected with a series of toothed wheels and pinions, by means of a pinion fixed on its under-surface. The centre wheel carries an index or hand, which points to figures on the dial-plate."—S . . . R.

[4693.]—BICHROMATE BATTERY.—The distance between the plates should be as little as possible, say ¼in.; the copper wire can either be soldered direct into the carbon or a terminal soldered in first, and the wire clamped by means of the screw. The soldering must be done carefully to ensure a good connection; drill a good deep hole into the carbon and fill it with soft solder, using plenty of soldering fluid, put the clean wire or terminal into the hole hot.—Tometer.

[4694.]—HOROLOGICAL.—I cannot understand what B. E. Loddy means by the first portion of his query; is it a misprint? The sizes of foreign watches are reckoned by lines and English watches run by twos, thus:—8, 10, 12, up to 24, which is the largest size in general use; No. 8 size is the smallest.—Tometer.

[4701.]—CLEANING COINS.—To clean copper coins, scrub them, and then lay them in dissolved sulphate of copper (a super-saturated solution), for a few hours, then brighten with a brush or leather. Silver coins can be cleaned in the same manner, by using nitrate of silver.—C. B.

[4701]—CLEANING COINS.—Put them in a solution of one part of acid sulphuric and four of water for a few minutes, and then rub well with a piece of chamois leather; they may be kept bright by giving them a coat of collodion.—Geometros.

[4703.]—CHANGE WHEELS.—I don't think there is a rule that would answer his purpose, only what is called the rule of thumb. If you can tell how many laps of roving (of a certain hank) it will take to fill from one end of the bobbin to the other, and then calculate the speed required to run with the wheels you have on (fixed by the maker), and by the following general rule for speeds. Multiply the speed of driving wheel by the intermediate driving wheels for a division; then the required speed by the driven wheels for a dividend, the quotient will be the wheel required, for lifting or copy. For ratchet wheel the following will be the only means that I know of (I take it for granted that you know the general rules of cotton calculation): the two extremes of the cones give the speeds for full and empty bobbins. If you know how many laps of a certain hank will fill a bobbin, you may then find how many teeth there is in the ratchet by the following simple methods. We will suppose there are 60 laps on a bobbin and a fixed wheel on the shaft (that carries the ratchet wheel) which makes three revolutions; in moving the strap from one end of cones to the other, it will require 60 movements of ratchet wheel to fill the bobbin half a tooth each time; divided by three, the number of revolutions to move it to the end will give ten, the number of teeth required; and in answer to the other I don't fully understand which wheel he means.—B. H., Rochdale.

[4704.]—CHANGING SURNAME.—The usual plan now, I believe, is to advertise your intention in the leading newspapers. A few years since many letters appeared on the subject, when Mr. Jones took the name of Herbert, and Mr. Bugg that of Howard. Consult Palmer's index to the *Times* newspaper.—An Old Man.

[4705.]—NATURALIZATION.—There is a department called the Alien Office, either at Whitehall or at Downing-street, where application should be made, and the proper forms obtained.—An Old Man.

[4706.]—PHOTOGRAPHY.—"In a Fix" has most probably added too much salt. It is a fact frequently forgotten that chloride of silver is far from being insoluble in a strong solution of salt. Let him add some strong silver such as an old bath, and after stirring it will settle clear. For the future use as little water as you can for washing the prints, as the weaker the solution the longer time it takes to settle, and instead of salt use hydrochloric acid to throw down the silver, it will answer much better. About a dram or so to the gallon of washings will be sufficient.—Operator.

[4706.]—PHOTOGRAPHY.—Let "In a Fix" expose the water to sunshine for a day or two after putting in the salt, he will be sure to have a precipitate then; that is, if there is any silver at all in the water.—Mus.

[4706.]—PHOTOGRAPHY.—Allow me to suggest to "In a Fix" that perhaps his exciting bath has got very weak, so that his prints contain little or no free nitrate of silver, because if any is present in the washing water salt is certain to precipitate it.—Dædalus.

[4707.]—STEAM.—The best rules for treating this difficult question will probably be found in Rankine's works, as his "Useful Tables and Rules," page 302, &c.—E. L.G.

[4710.]—TO REFASTEN BRASS TAP IN KITCHEN BOILER.—Obtain a spanner to fit the nut inside the boiler first of all; turn the loose tap towards the left, then place spanner on nut inside; hold tight, then turn the tap back until it becomes firm.—Carfax.

[4710.]—THE BOILER TAP.—"Inquirer" will find *inside* his boiler a screw ferrule on the shank of the tap, which he must screw up tight with some red lead in the joint.—Geometros.

[4710.]—FASTENING TAP IN KITCHEN BOILER. —Hold the nut inside the boiler with a spanner, while you turn the tap round outside with another spanner until it is tight enough. Should the tap be not upright when thus tightened, unscrew and back tap and nut sufficiently and screw up again. Sheet-lead for washer is perhaps the best.—G. F. B.

[4713.]—BEES.—I should advise "J. G." not to remove his bees till the spring, as the combs will then be full of brood; the better plan would be to let them swarm and put the swarm where they are to remain. The hole in the wall should be 3in. or 4in. wide; the bees will be sure to find it if placed there the day they swarm. The best food is lump sugar and water in the proportion of three of the former to one of the latter, boiled till dissolved. A common pickle bottle filled with this, and a piece of cap net tied over the top and then inverted over a corresponding hole in the top of the hive is the best way of administering it. Bees should have all the food they require for the winter given to them during mild weather, as if it is too cold for them to take wing after taking food they are very subject to disease. If

. G." would get "Bee-keeping for the Many," pub-
ied at the office of the *Cottage Gardener*, he will find
the information necessary to an amateur. I forgot
mention that a piece of perforated zinc should be
iced over the hole in the hive to prevent the bees
m coming out when the bottle is taken off to be re-
led.—Oxford.

[4720.] — KALEIDOSCOPE.— In answer to "H.
. L." (page 575), I have to state that this pretty op-
cal toy is made thus:—Procure two oblong slips of
oking-glass, length and breadth at pleasure. Join
em together at an angle of 60°; the upper side of the
iangle is covered with stiff cardboard blackened; the
hole is then tied up neatly and put into a tube of tin
r brass of corresponding size; one end of this tube is
overed with a disc of glass and the other end with a
iaphragm, with a small hole in its centre, through
hich to look at the coloured objects contained in the
ell at the other end. This cell is fitted on the tube
ike the object-glass of a telescope, and made to turn
round; it has a disc of ground glass in front; this cell
contains the pieces of coloured glass and other objects which are required. Then keep the proper side up and the body of the instrument stationary, and turn round the cell on the end, when the effect will be very striking, in consequence of the endless variety which can be produced. An angle of 60° gives six reflections; one of 90° gives four ditto; one of 45° gives eight; but 60° gives the best results as to brilliancy.—Valve.

[4723.]—BAROMETER.—In reply to "Geemetros," question 1, The degrees on my barometer have nothing to do with the thermometer, and are merely divisions for the reading off of the liquid level; 2, the heat of course affects the height of the liquid, as I have fully explained in recent numbers which I hardly think "Geometros" has seen; 3, as the liquid never stands at the same place for any particular degree of temperature (the level being varied by barometric pressure) it would be quite useless to place the temperature graduations on the tube. Hence the necessity of the index which secures the proper corrections.—Cornubia.

[4725.]—SHORT SIGHT.—"Moses" does not state what his daily occupation is, therefore my reply is not so comprehensive as it might be, but I recommend him to wear concave spectacles when out of doors, he need not fear any injurious results, I have done so for many years without experiencing any detriment to my eyesight.—Ab Initio.

[4725.]—SHORT SIGHT.—In reply to "Moses," I should certainly advise him to use glasses, for instead of straining his eyes, they would relieve them; he need only wear them when out, because they would cause confusion in near objects that he could before see well. It is very strange that his eyes should get more convex as they appear to have done from his communication, but he may rest assured that his eyes will improve as he gets older.—B. T. N.

[4725.]—SHORT SIGHT.—The case of "Moses" is a very common one indeed. If there is no organic disease of the eye he is probably suffering from conical cornea, the cornea becoming too convex. This is caused by close application to minute things, as reading, writing, watchmaking, tailoring, the microscope, &c., when the eye is in a weak state. To prevent the eye getting worse (it will probably never get better), remove the cause. Take to a seafaring or farming life. At all events examine minute things as little as possible, and then not by candlelight, firelight, or twilight. Strengthen the eye by frequent washings of pure cold water. He may use spectacles with advantage, *only the spectacles should suit him*. They should be *opposite* the eyes, the distance between the pupils of his eyes being the same as that between the centres of the glasses. If there is no organic defect, he could easily find a pair of concave spectacles, with which he could see distant objects quite distinctly. *He should reject those* and take a lower power, one which leaves a certain amount of haziness about the letters on the opposite side of the street. The reason being because the eye tries to accommodate itself to circumstances, and if the spectacles be rather too weak the eye will never feel tired, but in trying to accommodate itself to the spectacles it is at the same time lessening the convexity of the cornea. If the spectacles be too strong the eye becomes more shortsighted in straining itself to suit them. Above all never use an eyeglass, or he will continually have to change it for others of a higher power. Through an illness my eyes became weak at fourteen. Reading caused me to become gradually shortsighted. I can now read distinctly at no more than 7in. I give "Moses" the benefit of 25 years' bought experience in this matter.—G. P.

[4725.]—ANSWER TO "MOSES."—My case was exactly like that of "Moses." About the age of 14, my sight got so short that I could see nothing at any distance. I was consequently debarred from every amusement or occupation requiring eyesight. About this time a friend made me a present of a pair of glasses, certainly the most valuable present I have ever received. It as it were opened a new world, or rather restored the old one to me again. I, who had been getting gradually blind, so to speak, for years was suddenly made to see again as well as ever. I am now 34, and have used *the same glasses* ever since without the slightest inconvenience of any sort. My eyes are certainly no worse, though I cannot say they are much better, than they were when I began to wear them. I cannot now (nor could I then) read print as large as the heading English Mechanic at more than 1½ft. distance without my spectacles, but with them I can read the smallest print in the above (such as the address, &c., of the publisher at the bottom of last page) at more than arm's length from the eye. Of course I have a pair of very strong lenses, but "Moses" need have no fear of the term "very strong" as it only refers to the diverging power of the lens, and as far as my experience goes has no injurious effect upon the eye whatever. My glasses were the best pebbles (this I believe is an important thing to notice), and cost originally half a guinea (steel frame) at an optician's in the Strand. Except a new pair of frames I have had no other expense with them, though I have worn them continually out of doors and ever since without an hour intermission, except at night time. If my experience is of any use to "Moses," he is heartily welcome to it.—Ivory.

[4728.]—ZINC AND SODIUM CHLORIDE.—Mr. Jarman overlooks the altered conditions in the two cases. Zinc cannot displace the sodium from common salt, for the reverse action takes place; in the old phrase the affinity of sodium for chlorine is greater than that of zinc; let us express this by figures, which are, it must be understood, purely arbitrary, and used simply to convey the idea. Expressing the attraction of zinc by 40 and that of sodium by 60, we see that the zinc cannot break up a molecule of the salt; but, formulating it, $Na_2\ Cl_2 \times Zn$, we readily conceive that the internal affinities of the salt are weakened, that the molecule is held together by a residuary force of 20 only, and is thus "polarized;" it only requires, therefore, some other force to complete the rupture. In the manganese battery this is supplied by the readiness of the extra atom of oxygen to enter into a new combination, and as a result of the several actions which take place on the line of polarized molecules, the sodium is transferred elsewhere and chloride of zinc formed. I think Mr. Jarman is mistaken as to the iron. I have seen cast-iron long buried pass into such a state as to become soft and have great excess of carbon, but ordinary cast-iron contains only from 3 to 6 per cent. of carbon, either as graphite or combined.—Sigma.

[4729.]—α ARIETIS.—I do not think α Arietis can be seen with a 3in., unless the observer possesses altogether exceptional powers of vision. If I remember rightly I describe it in my "Half Hours with the Telescope," as a very difficult object for such a telescope. A sharp-eyed friend had seen it with such an aperture, or told me so; and it is to be remembered that seeing minute points of light depends quite as much on eyesight as on the telescope. If I did not believe this I should have to regard some esteemed friends as untruthful, for they see objects which are not only wholly invisible to me with the same telescope, but commonly regarded as wholly beyond the power of such telescopes. The position angle of α Arietis is about 107°, B of about 10th magnitude and purple, distance is considerable, and B is triple.—Richard A. Proctor.

[4731.]—CARBONS.—The process given by me for protecting carbons and their connections does not at all affect the conductivities, I carefully tried that point before publishing the process; of course it will destroy conductivity at the surface, that is to say, the reception of the current; though if well rubbed so as to clear off any film of paraffine current will pass into it from metals to considerable degree, but of course not from liquids, because they do not come into real contact with the carbon.—Sigma.

[4732.]—GAS TAR.—I am not acquainted with the process, and should think a preparation of carbolic acid likely to be more useful and much pleasanter.—Sigma.

[4733.]—BRONCHITIS.—"Omega" is surely mistaken when he describes his symptoms as "bronchitis." Bronchitis is an *acute* inflammation of the membranes of the bronchiæ, or breathing-tubes, and if attacked with it he would not be able to walk about long. "Omega's" ailment is evidently *chronic*, and the fact of the mucus being streaked with blood is an extra reason why he should seek medical advice at once.—Saul Rymea.

[4738.]—GEOLOGICAL.—The question of "Veritas" is one I believe most unaccountably shelved by our present geologists. The only theory I have seen ever attempting it was by a Fellow of the Dublin Society; that in the frequent and tremendous dislocatory earthquakes attested by the "faults" or dykes of those early strata, each of those dislocations or cracks through the whole earth crust, down to the very lava level, acted as a mill, grinding and shooting forth upward clouds of its own pulverised rock, which, diffused through a vast extent of overlying sea, then settled on its bed, forming what has, under intense pressure, for thousands of ages, accompanied in many cases by baking heat, now become a thin bed of sandstone, shale, or clay. Phenomena feebly representing this are known even in some modern earthquakes, as the last great Peruvian one, a dark and stifling cloud of dust being suddenly puffed up from a new crack into the air. Now the extent of rub or "downthrow" in these dislocations is rarely perceptible or noticed. Say it is inches—what then must have been ground and shot forth by the ninety fathom fault, the Cleveland, or any of the innumerable great faults that dislocate our elder strata in all directions, when the miles of crust thickness were thus wrenched through in the throes of the earth's infancy. If coal beds be now preparing about the great tropical river mouths, that pour down a yearly tribute of forest spoils, there must be very thick uniform deposits, as much so as the Nile alluvium, the London clay or chalk. The old strata, with their countless distinct beds, rarely yielding a stone a yard thick, and continual changes of material—a foot of this, two of that, so many inches deep red sandstone, one inch pale buff, and then the deep red again—these indicate a widely different state of nature from any now known; and I agree with that Irish geologist that it is utterly inconceivable the bulk of those ever changing sediments were ever derived, like the tertiary or alluvium, from the rain and river wash on ancient lands, as it is now the English fashion to assume.—E. L. G.

[4740.]—CONTACT BREAKER.—I believe the contact breaker of the Polytechnic coil is a modification of Foucault's. A stout glass vessel is perforated at the bottom, and a large platinum wire inserted, a layer of an amalgam of platinum is placed in the vessel and covered for several inches deep with the strongest alcohol. On the top of the vessel is a fitting exactly like the rod of the bichromate cell (in fact, the apparatus is made from a bichromate battery), with a spiral spring added to sustain the rod, the extremity of which is armed with a large platinum knob. To make contact, the rod is depressed till the knob touches the amalgam; to break contact it is simply released and the spring withdraws the rod, which is, of course, prolonged with ebonite, &c. to prevent danger to the operator. I am not quite sure that this is the final form the contact breaker has assumed, as a good deal of trouble was experienced at first. —Sigma.

[4744.] — GUN-COTTON. — "Experimentalist" does not state whether it is the explosive or soluble guncotton he wishes to obtain, but I presume it is the former, from his adding no water to his acids; if so, the nitric acid used ought to be of the specific gravity 1·500, this is poured into a vessel and mixed with twice its volume of strong sulphuric acid; then the cotton is immersed in it, and the air bubbles well squeezed out with a glass rod; after it has remained in the acids for about five minutes it is removed and instantly plunged into water; after being washed until it loses all traces of acid, it is dried and the matted parts pulled out with the fingers or a pin.—P. B.

[4744.] — GUN COTTON. — Take of cotton 1oz., sulphuric acid, 5 fl. oz., nitric acid, 5 fl. oz.; mix the acids in a porcelain mortar, immerse the cotton in the mixture, and stir it for three minutes with a glass rod, until thoroughly wetted. Transfer the cotton to a vessel of water, stir well with a glass rod, decant the liquid, pour more water on the mass, and repeat the process until the washing ceases to give a precipitate with chloride of barium. Drain the product on filtering paper and dry in a water bath.— W. F. L.

[4744.]—GUN COTTON.—Mix 4½oz. of pure, dry, nitrate of potash with 30 fluid drachms of sulphuric acid (sp. gr. 1·845), and stir into this mixture carefully 120 grs. of best carded cotton. As soon as saturation is complete (in about one minute, if proper care has been used), throw the cotton into a large pan of clean rain water, and change the water repeatedly until litmus ceases to show the presence of acid, then squeeze it in a cloth and, after being well pulled out, dry it at a temperature of about 180°. (Ure.) I have not had occasion to make gun cotton for some years, but I am pretty certain that I have tried the above, among many others, and found it suitable for photographic purposes. Nitric acid is sometimes used in place of nitrate of potash, though I think the latter is preferable.—T. W. Boord.

[4744.]—GUN COTTON.—One part of finely carded cotton is immersed in 15 parts of a mixture of equal measures of nitric acid, of specific gravity 1·52, and sulphuric acid of specific gravity 1·845. The cotton must be completely immersed in the mixture, otherwise it becomes so hot as to undergo instant decomposition. After a few minutes immersion it must be plunged into a large volume of cold water, and then washed so long as the least trace of acid is perceived, when the moist mass is placed upon litmus paper. It is then to be carefully dried at a temperature below 212° Fahr. When prepared for military purposes it is found advisable to prolong the immersion in acid for forty-eight hours, and to continue the washing for several days. As thus prepared gun cotton scarcely differs from unchanged cotton in appearance; it is white and fibrous, and rather harsh to the touch.—Oxoniensis.

[4752.]—DIFFERENTIAL CALCULUS.— By formula

$$\text{If } u = \frac{\phi(x)}{\psi(x)}$$

$$\frac{du}{dx} = \frac{\phi'(x)\,\psi(x) - \psi'(x)\,\phi(x)}{\{\psi(x)\}^2}$$

$$\text{or } = \frac{\frac{d.\phi(x)}{dx}\,\psi(x) - \frac{d.\psi(x)}{dx}\,\phi(x)}{\{\psi(x)\}^2}$$

$$\text{In this case } \phi(x) = (a^2 + x^2)^{\frac{3}{2}}$$

$$\psi(x) = x^3$$

$$\therefore \frac{du}{dx} = \frac{\frac{3}{2}(a^2 + x^2)^{\frac{1}{2}}.\,2x\,.\,x^3 - 3x^2(a^2 + x^2)^{\frac{3}{2}}}{x^6}$$

$$= 3\frac{(a^2 + x^2)^{\frac{1}{2}}(a^2 - a^2 - x^2)}{x^4} = \frac{-3a^2\sqrt{a^2 + x^2}}{x^4}$$

Oxoniensis.

[4764.]—BRONZING COPPER URNS.—The surface, thoroughly clean and bright, is covered with a thick coat of rouge and water; when dry, the article is placed in a clear hollow fire (say a chamber of bricks, red hot) for a short time until the rouge has turned to the desired shade of colour. When the article is placed on a suitable stand, and polished with a soft brush and rouge powder and afterwards with soft leather. The tinning and soldering are subsequent operations.—G. F. B.

[4768.]—POLISHING PLASTER OF PARIS.—First make very smooth and free from grit with glass-paper or otherwise; when perfectly dry, oil with linseed oil, when hard, French polish in the usual way. If a bust; or anything similar, and required to be white, make smooth size with white size, and varnish with white hard varnish.—Derfla.

[4773.]—MOTION OF THE EARTH.—The "Querist" should read Lardner's "Mechanics," from which the following is extracted: "A body once put in motion would continue for ever to move in the same direction, and with the same speed, unless stopped by some external cause."—G. J. W.

[4776.]—LATHE.—The dimensions, in inches, asked for by "Amateur Turner," on the two lathes I mentioned, are as follows:—

	Holtzapffel.	Buck.
Diameter of mandrel screw	·8	·87
Number of threads per inch	9·434	10
Diameter of pulley	7	7¼

Both are 5in. centre lathes. As far as my experience goes I think Holtzapffel's mandrel screw is the best for amateur purposes, its length is barely 11-16in. I am afraid these particulars are but of little use alone, perhaps "J. K. P." would favour us with a word on the subject of mandrel screws.—T. W. Boord.

[4776.]—LATHE.—The thread of mandrel-nose that I have generally seen on Holtzapffel's 5" ornamental lathes is 9·45 to an inch; deep thread, angle of point of screw-tool 45°, and diameter $\frac{25}{32}$. For the same-sized lathe Evans uses the same thread or else 9½ to an inch. A 3in. lathe may have Whitworth's ⅝ thread 11 to an inch. My new double-geared 5" is Whitworth's, 1" diameter, 8 to an inch, and a 5½in. double-geared, made last year, was 1¼ diameter, 7 threads to 1in. Whitworth's threads are with a point-angle of screw-tool of 55° throughout. As to the pulleys, I always put in the biggest pulley the headstock will take in, which will, for small lathes, be about 1½in. less than the largest possible face-chuck, and for 5in. to 6in. lathes (say) 2in. less than the chuck, as you have to allow for the thickness of the base part of the headstock. The outside row of divisions need not be more than 3-16in. from the edge (the larger the better), and 5-32in. between the rows centre to centre, is sufficient for amateurs' lathes, and affords room for strong holes—*i. e.*, that will take a strong peg. And the holes should be drilled with a taper drill and have a peg that fits accurately. I have not yet schemed my model division peg or "alidade," but shall shortly, and communicate the same. Those in common use are abominable.—J. K. P.

[4779.]—HOLTZ' ELECTRICAL MACHINE.—"A Revenue Officer" (p. 599) will find the Holtz machine explained with detailed wood-cuts, in the English Mechanic, Vol. III., p. 170. In French, description with wood-cuts is to be found in *Les Mondes* (L'Abbé Moigno's), Vol. XV., p. 489, also in Ganot's "Physique," the last edition, the 13th. Poggendorf's improvement of using a "*full*" *fixed disc* with small holes, is mentioned in *Les Mondes*, Vol. XXII., p. 801. The latest change proposed by Fr. Provenzali, of the Roman College, was announced and explained in a Roman journal of last May.—E. Kernan.

[4779.]—HOLTZ'S ELECTRICAL MACHINE.—A description is given in No. 226, Vol. IX., p. 391. Several modifications have been made lately, and several essays and papers on the subject published in Germany, but I am not acquainted with the particulars.—Sigma.

[4779.]—HOLTZ'S ELECTRICAL MACHINE.—In reply to "A Revenue Officer," he will find a description of Holtz's electrical machine in Ganot's "Physics," page 616, edited by Atkinson, published by Longman. Also in Brooke's "Physics," page 390, published by Churchill. —B. T. N.

[4781.]—SUSTAINING BATTERY.—I do not know what is the special battery referred to; from the description it may be the sulphate of mercury, as in this mercury does collect; but an ordinary Daniell's or a sulphate of lead battery would do if considerable force of current is needed; or a manganese or mercury cell, if merely signal instruments are to be worked. The period of working would, in any case, depend on the amount of work to be done in any given time; it is quite impossible to name any time without knowing this.—Sigma.

[4785.]—BINDERS' TOOLS.—I cannot inform "L. J. W." where he can obtain a pattern book. Has he applied to Timbury, 104, Fetter-lane, E.C.? I have never given any recipes for staining leather in "our" Mechanic, but if he will state in the next number whether it is white calf he wishes to colour, and the particulars, I shall be most happy to give him the desired information.—Ab Initio.

[4786.]—IMPRESSION OF FERN LEAF.—Well oil a piece of paper (say note paper) with linseed oil, hold it over a smoky flame, such as that given by a tallow-candle with a long snuff, moving it about so as to evenly black it all over, place it on a smooth surface and lay the fern leaf on it; over that place a common piece of paper, rub the hand well over the part where the leaf is, remove the paper and place the leaf, the blacked side downwards, on the paper to receive the impression; place over this another piece of paper, rub the hand as before and on removing the paper and fern an accurate impression will be found upon the paper.—P. B.

[4786.]—IMPRESSION OF FERN LEAF.—I have found the following way answer very well. Take a sheet of note or other paper, grease it on one side and then hold it over a lighted candle, so that the smoke blackens the greased paper, when well blacked place the leaf on it, press it well and then transfer to a clean sheet of paper, after pressing it some time it will be found to leave a very good impression.—Francesa.

[4786.]—IMPRESSION OF FERN LEAF.—Roll the leaf carefully with a printers' ink roller, lay on a sheet of paper and apply pressure in a screw press.—T. W. Boord.

[4787.]—SPEAKING TUBES.—Gutta percha is the best of all materials for this purpose.—Sigma.

QUERIES.

[4788.]—DISSOLVED BONES.—Will some correspondent inform me how to manufacture dissolved bones, and other artificial manures, on a small scale for use in my garden?—J. H. B.

[4789.]—MAP.—How can I make my paper map adhere to the linen, as I find the linen absorbs the gum?—Beriro.

[4790.]—COPYRIGHT.—Can any reader kindly inform me how I am to proceed in the case of my wanting to enter anything at Stationers' Hall, or any other register of copyright? Whoever will do so will oblige.—Mus.

[4791.]—HORIZONTAL OSCILLATING CYLINDER.—Can any reader refer me to a number of the English Mechanic containing a description of a horizontal oscillating cylinder? If it has not hitherto been described, will some engineering friend kindly explain its mechanism, and assist an amateur trying to make one?—F. A. B. Salt.

[4792.]—PROBLEM.—Will "J. K. P.," or some brother reader kindly solve the following? (*a*) A force of 100lb. is resolved into two equal forces acting at an angle 60°; find magnitude of either component. Ans. 57·7. (*b*) A force of 100lb. is resolved into two equal forces acting at an angle of 30°, find magnitude of either component. Ans. 51·7. Please draw figures to illustrate both.—Onus.

[4793.]—IRON SHIP.—Would some of the correspondents of the Mechanic oblige me with the method of laying down an iron ship (of any size)?—T. H. Rogan, Sunderland.

[4794.]—ELECTRICAL.—TO "SIGMA."—"Sigma" (to whom many thanks), says (No. 281, p. 481), that in cases requiring a large current, as for magnets, &c., the peroxide of manganese battery is "absolutely useless." On the other hand, he states (p. 482) that the sulphate of lead battery "yields a large current," and would therefore, I infer, be very suitable for magnets. Will he kindly inform me whether a 1¼in. magnet with six convolutions of No. 18 B.W.G. covered wire would, with 8 pint cells of the last named battery, lift 8oz. 1-16in., the connections measuring about 10ft., or whether he can suggest any alteration in diameter of wire, number of cells, &c. Also if the battery should be coupled for quantity or intensity. An answer on these points would much oblige, and probably save me needless expense.—W. J.

[4795.]—ENAMELLING SLATES.—I shall feel truly obliged if one of your kind readers will be so good as to explain to me the process of enamelling (or japanning) on slates; or inform me of any book on the subject. —Do Me So.

[4796.]—UNIVERSAL SWIVEL GAS-JOINT.—Will D. Clark be so kind as to inform me what kind of a joint a universal swivel gas-joint is? Also, what kind a telescope joint is.—Anon.

[4797.]—TUB HOOPING.—I have a great deal of tub-hooping to do, and I want some one to tell me how to get the proper *level*, as I cannot get them to fit properly. —Anon.

[4798.]—STAINS ON WOOD.—Will some fellow-reader kindly answer me the following, by giving the reason why some joinery work with which I am connected has, on being stained and varnished, become covered with black stains, in the form of spots spread indiscriminately over the surface, but especially over the panels?—Geometros.

[4799.]—SCIENCE AND ART DEPARTMENT.—Can any of our technical friends give any information concerning the Queen's medals for subject L.; are students that have passed in honours eligible for medals?—L. M. N.

[4800.]—GEOMETRY.—Divide a septagon into nine equal parts by lines parallel to one edge.—T. Storey.

[4801.]—GREENHOUSE.—Will some brother subscriber kindly send me a sketch (if our editor will allow space for it) of a small greenhouse. I want some decorative work about it, such as gable boards and carved top; also, what would be best to heat the same, as I can have steam conducted to it with little trouble? I want the house span roof?—Black Country Joe.

[4802.]—WATER POWER WANTED.—Will some practical person advise a professional man with mechanical and farming tendencies? I have two small farms which could be much benefited by irrigation. Each has a stream running along the lower boundary. The stream, though never dried up, is in summer so diminished that it probably might be conveyed through a 6in. or 8in. pipe, and then velocity is also very small, the fall being perhaps 2ft. to 3ft. I want a self-acting power to convey water, by pipe or otherwise, to the higher level of 10ft. or 12ft., by means of a pump or other sufficient lifting arrangement. I have made a rude model on the principle of a screw within a tube, intended to be caused to revolve by the pressure of water passing through the tube. The model tube is 19in. long, 1in. bore; the screw has but one thread, making a coil of thirty-nine within the length. I am now aware that the pitch of the screw is not correct, and that a second or more threads would give more power. Under water pressure of 3ft. or 4ft. my model gives a rapid velocity, but incapable of resisting even very slight obstruction. —D. J.

[4803.]—FAURE'S BATTERY.—I have recently purchased one of Fauri's batteries, and shall be greatly obliged if some correspondent will inform me how it would answer to fill the carbon bottle with a saturated solution of bichromate of potash instead of nitric acid. —Dædalus.

[4804.]—THE LATE DROUGHT.—Being deeply interested in the progress of meteorplogical science, I should like to learn whether the late severe drought in the British Isles and in France has also prevailed in remote regions, as in Russia, North America, or elsewhere. As it may have extended more or less over the whole northern hemisphere, I should esteem it a great favour if any brother reader, who may possess notes on the weather or the amount of rainfall during one or more of the past three or four months, or any remarks on the season, from remote stations on the globe, would kindly and briefly inform me through the medium of your columns.—C. F.

[4805.]—HEATING APPARATUS.—Will one of your readers kindly inform me the best way of constructing and heating *coil pipes* for the warmth of a small office 6ft. long by 4ft. wide? I have in previous winters used the gas-jet, but find it affects my health, without comfort to the feet. I have an idea that a boiler outside the office in an enclosed passage, "now erected," might be heated by gas without being unhealthy, and cause the steam to pass through the pipes near the floor to warm the place. Advice upon this, or any other method, will be received with thanks by—A Poor Clerk.

[4806.]—DISCOLOURED IVORY STATUETTES.—Can any of your numerous correspondents inform me how to restore the whiteness to ivory statuettes that have become yellow and discoloured?—Wahsrof.

[4807.]—REFLECTOR STAND.—Would any of your readers, who has mounted silver or glass reflectors on stands, inform "a youth" how he could make a stand (equatorial preferred) for a speculum of about 6in. diameter? If any friend has got one near Wigan I should be very glad to see it.—Amateur Astronomer.

[4808.]—THE TELESCOPE.—I am a beginner in astronomy and want a telescope. As I cannot buy "a good" refractor cheap, I thought I might make a good reflector for a far less number of pounds than is asked for a good achromatic. Suppose I had "about" three pounds that I would lay out to make a good useful telescope myself, which kind would be the best for one like me to make if I bought the principal parts? In some books I find they are dead against the reflector. And what size of object glass would be equal to a 6in. speculum? If Mr. Purkiss, "F.R.A.S.," Mr. Proctor, or any other reader could help me I should be much obliged. P.S. I have a small achromatic with a 1¾ object-glass with a power of 15¼ only.—Amateur Astronomer.

[4809.]—CELESTIAL GLOBE.—I have a celestial globe, 16¼in. in diameter, made by Benjamin Martain, which getting rather old I had cleaned and varnished, but when I came to use it the varnish peeled off in some places; could any of your readers tell me whether I can get it re-covered, or can I do anything with it myself, as the paper has also come off in many places. What would be about the cost?—Amateur Astronomer.

[4810.]—LARD AND SAUSAGES.—I shall be obliged to any correspondent who will inform me of a simple apparatus for rendering lard, one that will not require much attention, and without risk of burning; also the best way of pressing the "scraps." I should also be obliged to any one for a good sausage recipe, and instructions how to make them.—Shopkeeper.

[4811.]—WEIGHT OF WIRE.—Will any [illegible] correspondent be kind enough to state how many [illegible] of No. 36 copper wire make a pound; [illegible] cotton and silk covered?—Tometer.

[4812.]—VERTICAL SLIDE REST.—Will [illegible] be so kind as to explain a vertical slide rest, as I [illegible] to fit one up in conjunction with a friend.—[illegible]

[4813.]—SMALL PLANING MACHINE.—[illegible] ago I asked through your valuable journal [illegible] a small planing machine, and several [illegible] kindly answered me, but none gave me [illegible] I desired—viz., how I could make the [illegible] the castings together myself? If one of [illegible] kind will greatly oblige—Tometer.

[4814.]—WATER SUPPLY.—Will some practical plumber explain to me through our invaluable [illegible] the following? I am about laying a pipe from a [illegible] to our house, a distance of nearly 700 yards [illegible] calculation. The rise will be 13ft. above the [illegible] in other words, a pole 13ft. long standing in the [illegible] the top of it would be on a level with the [illegible] Now I should like to know all that is required [illegible] the pipe. I have seen two taps in the side of a pipe [illegible] similar situation. I want to know what use they [illegible] or if it would do without them. I understand it is absolutely necessary to have a turn-off tap at the reservoir, and is it likewise necessary that there should be any air pipe; if so, in what part of the pipe should it [illegible] The neighbour's one that I have examined [illegible] slower and slower, until it stops altogether, and turning on one of these taps that I mentioned as being at the side of the fountain pipe, and allowing it to run [illegible] perhaps seven or eight minutes, when I shut it, it immediately runs faster into the cistern, and continues all right for a week or two, when the same has to be done again. Surely there is something wrong. I may mention there is no air pipe in it, and we are not satisfied altogether with the plumber's reasons. He says the pipe is holed somewhere, but it is so recently put in I cannot think that is the cause. Perhaps at the same time you will let me know what the best thing is to stuff a force-pump stuffing-box. Is leather, cut washer-shape, any good?—A.

[4815.]—GOOD REED ORGAN PIPE.—Will any fellow contributor inform me how to make a good reed organ pipe? Also the size of pipes required for an 8ft. stop, voiced on "Adept's" flute principle.—A Contributor.

[4816.]—CLEANING FURS.—Could any of your correspondents kindly inform me how [illegible] furs are cleaned? I am living in the country, and it would be a great accommodation to me if I could do them at home instead of sending them to London.—O. P. Q.

[4817.]—STEAM CARRIAGES.—Can any brother reader inform me whether there is any law respecting the use of steam carriages on the turnpike-road, and what it is?—R. J.

[4818.]—RUBBER VALVE.—How long will vulcanized india-rubber valves stand in the condensing part of a low pressure steam-engine, usual heat? And how many degrees of heat will they stand without being destroyed, supposing superheated steam were used, and having to blow through to obtain a vacuum before starting?—R. J.

[4819.]—SCIENCE QUESTION.—Will any kind reader inform me how to work the following question occurring in the Science Examination Paper for Honours of last May? Determine the locus of the curve whose equation is $(y-2)^2 + (x-\sqrt{2})^2 = \sqrt{2}$. unit = 1in.? And which is the best book for such study?—X. Y. Z.

[4820.]—EBONISING.—Will some one be kind enough to describe the above process for the benefit of—Carfax.

[4821.]—PENDULUM SPRING.—What is the usual method of determining and fixing the isochronism of a pendulum spring, in either English or foreign watches? I have a watch (verge) with the top pivot broken. Will some of our competent brethren kindly tell me the easiest way to put in a new pivot? I have also a watch with fusee arbor square completely off. Is it possible to put in a new square without taking the arbor completely out of the fusee? If so, how am I to do it? If not to be done in that way, can the arbor be taken out of the fusee and another fixed securely in its place? And how are they usually fastened in. I also wish to know if the pinions two and three of watches have their leaves turned down to a shoulder with the common graver, and how, in the turns, to form a seat for the fixing of the wheels before riveting on? Also what ought to be the relative size of the ferrule to the article turned? When you use the bow, how do the faces of wheels in watches receive the smooth surface they generally possess? Is it turned up with the graver in the turns after the wheel is riveted on the pinion, or is it smoothed on the polishing block? Are there no small lathes in use with a wheel and dead centres for turning up watch wheels and pinions? Would they be equal to the bow and [illegible] for light work?—Improver.

[4822.]—LEAD BURNING.—I wish to gather some information respecting the art of lead burning. A description of the apparatus required, and all necessary particulars. Or is there a work to be obtained that will give the necessary information?—W. C.

[4823.]—STAINS ON STEEL.—I have had some of my polished steel tools damaged by rust, after taking off the rust (by sandpaper and oil) a dark mark remains. I shall be glad if any of your readers will inform me how to efface the dark mark, and restore the original polish. —T. W. U. R.

[4824.]—BATTERIES.—I quite agree with the remarks of John Legg (l. 316, p. 570) in his description of the sulphate of lead battery as regards its constancy, as it is the best I have had to deal with, but is not the form in which he describes it a patent? Will John Legg describe the manganese battery and oblige?—Roanoke.

[4825.]—ELLIPTICAL CUTTING FRAME.—Can any of your correspondents tell me how to make an elliptical cutting frame for ornamental turning? I know there has not been anything of the kind described lately, as I have taken in the Mechanic for some time. Please give full and complete directions as I am totally unacquainted with this tool. It is for a 4in. lathe.—J. W. G.

[4826.]—SCREW CUTTING.—Having a great many screws to make I should be glad to hear your correspondents' dodges for getting them done quickly. The screws are brass and all the same size, with the heads milled so as to turn them with the fingers; about ¾in. long, ⅜in. diameter of head, ¼ screw. I get them cast in lengths of 12.—J. W. G.

[4827.]—MOTIVE POWER FOR LATHE.—I am in want of a motive power to drive my two lathes, grindstone, drilling machine, &c., &c. Can any one inform me of a cheap plan to drive them (one at a time) as I find treading them very hard work from morning till night? —J. W. G.

[4828.]—SPECULA GRINDING.—TO MR. PURKISS. —Will Mr. Purkiss kindly answer the following questions for me? What should be the diameter and thickness of the brass tools for grinding a perfect spherical curve on a glass disc 4in. diameter? What are the different finenesses of emery used, and how long ought I to work each kind? How can I tell when the glass is ground fine enough for polishing? Ought the pressure to be light or heavy when using the finest emery? When the tool is covered with a piece of linen rag, and putty-powder is used, how long ought it to take to polish the glass? Should I press very heavy in polishing? Is it necessary to *wash* the putty powder as purchased in the shops.—APLANATIC.

[4829.]—TO "INDUCTORIUM."—Will you be so kind as to inform me in what respect is cotton covered fine wire inferior to silk covered wire for induction coils, when both are varnished with shellac or paraffine?—FINE WIRE.

[4830.]—DIAMOND POINTS IN DRILLS.—Will some brother reader tell me how to fix the diamond points in drills? I am told they are soft-soldered in; I have tried it and failed. I could not make the solder take to the diamond.—R. N.

[4831.]—FORCING AIR CURRENT.—I want to force a continuous current of air into a chamber not less than 180° of heat. Any information on the above subject will greatly oblige.—AN ANXIOUS INQUIRER.

[4832.]—PAINTING METAL BATH, TIN, ETC.—Can you, or a brother reader, tell me the best way to paint a hip-bath, so that the paint will not come off very readily with the water? 2nd. What is the process of stoving tin goods? 3rd. What paint is best for the purpose?—X. Y. Z.

[4833.]—RENDERING CALICO AIR-TIGHT AND WATER-TIGHT.—Could any of your correspondents tell me the best way of rendering calico air-tight and water-tight?—YELOC CIREDERF.

[4834.]—LINK MOTION.—Would Mr. Baskerville or any other please give a simple rule, showing how to draw in the excentric pulleys for an indirect acting link? —P. B. Mc G.

[4835.]—INDIA-RUBBER.—I find that india-rubber after it has been exposed to the light two or three years loses its toughness. In fact it becomes brittle and useless. Can any one suggest a mode of preserving the material?—J. P.

[4836.]—ARTISTS' LAY-FIGURES.—Can you or any brother reader inform me how the joints of the patent papier-mâché mannikin or lay-figure used by artists are put together? Also the best and cheapest method of making a papier-mâché suitable for the purpose, and how are they moulded from life?—G. S. WALSDEN.

[4837.] — FOREIGN WOODS. — Being desirous of obtaining information concerning many foreign woods which are available for the uses of the ship-builder, carpenter, and cabinet-maker, I should be much obliged if my fellow readers could direct me where I can find printed descriptions of the properties of any or all the following woods—some of which were in the International Exhibition,—or any other woods especially suited for cabinet work, with which they may be acquainted, or by their assisting me in my endeavours to acquire knowledge by describing their properties in the pages of the ENGLISH MECHANIC, should you, Mr. Editor, think the subject, which is really an important one, worth the space. Blue mahogany of Jamaica, bay, beet, beef, bergamot pear, camphor, canary, cocus, lilac, iron woods (very various), purple wood, red sanders, sandal, sassafras, satin, sabicu, zebra. *American woods:* Elm, black oak, white wood, mangrove of Trinidad. *African woods:* Oak, mahogany, green ebony. *Australian woods:* Blue gum, cedars, mahogany, red wood, iron bark, stringy bark.—LIGNUM VITÆ.

[4838.]—PEDESTRIAN TOURS.—Will "Scholasticus" or any other of your readers give me some suggestions as to the best direction in which to walk under the following circumstances:—A friend and myself intend making a five days' tour at the close of the present month; my friend takes considerable interest in architecture, especially that of the cathedral type, while I on the other hand take more pleasure in the attractions of scenery. We wish to select a walk (of not more than 25 miles a day) which will give satisfaction to the tastes of both, without making more than a very limited use of the railway or other means of conveyance. London is to be our starting-point. "Scholasticus" has kindly offered information as to "good and cheap houses for sleeping, &c.," and I think any such hints would be of great service.—F. P. P.

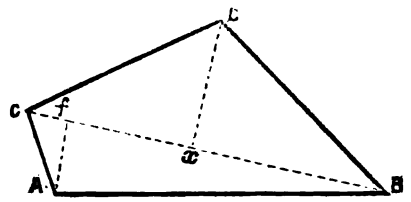
[4839.]—CANNON.—How can I alter a muzzle-loading cannon to a breech-loader? Will some kind reader oblige?—GUNNER.

[4840.]—GUNPOWDER.—In Mangnall's "Questions on History" it is stated that gunpowder was invented by one Schwartz, A.D. 1340. I have always understood that it was known and used in China and other eastern countries long before that date. As Mangnall (who is considered an authority) states this with any reservation or qualification, I shall be glad if any of your learned readers can throw any light on this subject.—STUDENT.

[4841.]—SPONGES.—Can any one tell me how to preserve sponges? I use one daily in a sponge bath, and find that in about a year's time it falls to pieces.—D. N. E.

[4842.]—LAND QUESTION.—I have a small parcel of land (which = 300288 square links) to be equally divided between four persons, but as the sides of the piece of land are very irregular I find it somewhat difficult to divide. Perhaps there are some readers of this journal who will be able to solve the problem for me. I give an illustration of the piece of land.

AB = 1088 links, A C = 241, C C = 680, and B D =



840 links. The diagonal line from B to C = 1128 links; the perpendiculars D x 482, A f 210.

N.B.—Each person's share of the land to fall perpendicularly upon the side A B, and also the number of links in length for each person upon the given line AB.—AN AMATEUR LAND SURVEYOR.

[4843.]—MUSICAL. — Would some correspondent kindly tell me where I can procure an old song on tobacco, each verse ending with the refrain "Think of this when you smoke tobacco"?—D. N. E.

[4844.]—NUMISMATICAL. — Will our good friends Mr. Henfrey or Mr. Batty give us some information as to the best practical method of displaying coins in a museum, taking into consideration safety, expense, and educational use, the best mode of affixing names, dates, &c.? If they, or any of our numismatical friends will do so they will much oblige—SAMUEL SMITH.

[4845.]—ELECTROLYSIS.—I have repeatedly tried to effect the decomposition of water by using six Bunsen's cells, quart size, and a common "shocking coil," but have failed. Will "Sigma" be good enough to put me right?—WORK.

[4846.]—LOGARITHMS. —Will any brother reader kindly solve the following in full?—Given log 7·5014 = ·8751428, log. 7·5015 = ·8751481, find the number corresponding to logarithm 3·8751462. Ans. ·007501467.—WORK.

[4847.]—NATURAL FORCES.—TO "SIGMA."—I desire to thank "Sigma" for his ready, kind, and complete answer to my letter, and if I do not trespass too much on his time I should feel obliged if he would indicate a book or books which show or treat of the relations of the forces of nature. I have only studied electricity for a couple of years, and of course am not quite so clear on the subject as I should like to be; however, I cannot help thinking that it is intimately connected with heat, and am very anxious to read a good authority on the subject. I have read a great number of smaller books; but none of them seem to generalize. I should also feel greatly obliged if "Sigma," or any other reader, could give me a tolerable description of the machine which Professor Jacobi (in 1834) constructed to propel a boat on the Neva.—THINKER.

[4848].—HYDRAULIC APPARATUS. — Can you or any of your correspondents inform me what the probable cost would be of furnishing and fixing, ready for use, a hydraulic apparatus of, say, *half a horse-power*; and secondly, what would be the approximate cost per diem for working this power, the water being supplied by meter. The above is required for working a small printing machine.—SUNDERLAND.

[4849.]—MEDICAL.—Would any brother reader give a simple test to find whether medicine in a liquid or other form contains mercury?—PATIENT.

[4850.]—THE TELESCOPE.—I wish to thank Mr. Purkiss for his very kind and complete reply to me with respect to the size of the flat. Mr. Purkiss has in his letter supplied valuable and plain information that will be useful to many of our readers, and which has never been so supplied before. I had before writing to him adopted a fifth, but I believe a sixth is generally used. I had a wish to know his own plan, but as he justly observes, a fifth or fourth gives a little play. I now wish to draw his kind attention to another matter. I have tested a 10in. mirror of my own make with his bar test. I used a power as high as 640, which the mirror stood perfectly well, both before silvering and after, and on the brightest stars, and yet I cannot get a good definition. I have tried the test over and over again, and with good air (for I had my refractor out the same time) and each night trying it on the stars and Saturn, and it will not give a star disc nor show the division of the planet's ring. I invite Mr. Purkiss' opinion as to whether a bad flat would not allow a good mirror to show the test-bar straight and parallel, and what effect imperfect centering would have? There was one thing I particularly noticed, the edges of the bar was not seen sharp and well defined like a sharp and distinct shadow, it looked like the shadow of an object (say a penholder) when held nearer to a lamp than to the white blind on which I projected its shadow. I expected to see the shadow of the test-bar sharp and distinct as when the penholder is held *near* to the white blind. When I looked at Jupiter, there seemed to be a round shadow of the planet on one side; this shadow was not seen only when the planet was a little out of focus (inside the focus). I have sometimes seen the same appearance with the stars. Now this would seem to prove that my mounting was not good, and that the mirror gave a *double image*, which from the pains I took in mounting the mirror I am not willing to admit. The flat I have used is only a piece of ordinary plate glass, *not select* pieces. How does Mr. Purkiss succeed in silvering after failing a few times? First, I was induced to depart a little from Browning's directions, and have always since succeeded in getting excellent films, but they are always slightly transparent. I think this should not be the case as there must be some loss of light. Would it not be advisable to strengthen the silver solution a little, and so get thicker films? Lastly, can Mr. Purkiss, or any other of our able correspondents, tell me whether a truly parabolical mirror will converge rays to one identical focal point from objects at *any* distance, as well from an object at 50 or 60 yards, as from the stars?—G. C.

[4851.]—AEROSTATICS.—To what space a quart or gallon of common air can be compressed, and what expanding power that would be? Also whether there is any gas (gases) or fluid more compressible, and with a greater expanding power?—J. R. L.

[4852.]—GOLD CRUSHING.—Copper plate being used in connection with our gold-crushing machines, the copper is coated with quicksilver to retain the gold as it flows over the same with the water and crushed material. After several months' use the plates become impregnated with the gold and silver. A certain experiment is used to clean the plates. The plates are painted with a solution which is black, and exposed to a certain heat, after which the gold comes off in a thin shale. What is the solution and proper mode of operation to effect the same?—J. RUSSELL.

[4853.] — GEARING FOR BUCKET.—I shall be thankful for a simple rule for striking a pattern or gearing for a bucket, such as used in a drawing lift (or pump), say for a 9in. or 6in. working barrel.—J. RUSSELL.

[4854.]—SWIMMING PADDLE.—Some time ago I constructed a swimming paddle, which for some reason or other does not answer the expectations I formed of it. My original intention was to work it entirely under water, and I thought to avoid the drag of reflex action by placing the blades at right angles to each other, and feathering at each stroke. I soon found this plan would not answer, since it necessitated a change in the position of the hands, which weakened the pull. On the next trial the blades were made to correspond in position, being lifted out of the water alternately, but even then candour compels me to admit that it is quite as much a hindrance as a help. Will any reader kindly tell me what they think to be the cause of failure, or whether in their opinion longer practice with the paddle might render it really serviceable as a means of progression in the water?—PERCY JOHNSTONE.

[4855.]—BATTERY CONNECTIONS.—I have twenty-four Grove's batteries, and am puzzled as to making the connections. I have tried slips of copper, bent tight on to the platinum, but this tears and wastes it. I do not wish to incur the expense of purchasing binding screws, and unfortunately I had the platinum cut too short to allow of its being bent over against the next zinc. If any brother reader could inform me of some simple method I should be greatly obliged.—R. T. BELL.

[4856.]—WENHAM'S PARABOLICAL REFLECTOR. —Would Mr. Pocklington say if Wenham's "paraboloid reflector" can be used with low as well as with high powers? The idea mentioned by your correspondent "A. A. F." of organizing an "English Mechanic Microscopical Society" is, I should think, a good one, and will, I do not doubt, be acceptable to many of your subscribers.—A. L. B.

[4857.]—MODEL WINDMILL.—"John James" (see 4605) will oblige if he will say where his model windmill can be seen, or give a sketch in your paper; also cost for a boat 25ft. long and 5ft. 5in. beam.—INQUIRER.

[4858.]—THAUMATROPE.—Will some one tell me how to make a thaumatrope?—J. M.

[4859.]—LOCOMOTIVE DRIVING.—What is the cause of a train progressing by a series of jerks? Is it due to bad driving or bad management of the firing?—STEAM RIDER.

[4860.]—REGULATION OF COMPASS.—Will any one tell me how the compass is tested and regulated in iron ships? Is it absolutely necessary to put the ship with her head to the north?—NAUTIS.

[4861.]—INCLINE.—What degree of inclination would stop a locomotive drawing four times its own weight?—S. B.

[4862.]—LEAD POISONING. — Can any of your readers furnish me with an antidote against white sugar of lead poisoning?—W. E.

[4863.]—GLASS ANALYSIS.—I shall feel obliged if Mr. G. E. Davis will give me plain directions for analyzing glass.—J. M.

[4864.]—MANGANESE BATTERY FOR IGNITION OF POWDER.—Will "Sigma" or Mr. Jarman kindly inform me whether they consider that six quart-cells of this battery would suffice for the purpose of igniting gunpowder? In that case would a piece of platinum wire passing through the powder effect the explosion, when the circuit was closed? I also wish to know whether constantly shifting batteries about, taking out of their boxes, &c., in any way effects their electrical condition?—C. H. B.

[4865.]—LACQUERING BRASS WORK.—Can you tel me how to lacquer small brass work so as to improve and brighten the metal? I find the lacquer dulls and spoils the work, rather than do it good. I made the metal warm and applied the solution with a camel-hair brush, but the surface comes out so dull that I must be wrong somewhere. I used what is called best gold lacquer; if this be the right stuff, please tell me how best to use it? —STICK-IN-THE-MUD.

[4866.]—WATERPROOFING TIMBER ROOFS.—I should feel obliged if any of your readers can inform me how to render a wood roof of shed 40ft. long waterproof. I have tried tar and sand, and after bags nailed on and tarred. I want something cheaper than felt.—H. SEYMOUR.

[4867.] — AUSTRALIAN NUGGET. — Being the possessor of a small nugget sent to me by a very dear friend in Australia, with the request that I would have a hoop made of it and wear it for his sake, and being anxious that the hoop should be made from that particular piece of gold (without the slightest doubt) I wish, if possible to make it myself. My object in troubling you is to inquire if any of the readers of your invaluable paper will oblige me with a description of the process required to accomplish the object I have in view.—A NEW SUBSCRIBER.

[4868.]—TRUMPET STOP.—Will any harmonium correspondent kindly inform me whether a trumpet stop (worthy of the name) has yet been introduced on the harmonium; and if so, by whom, or on what maker's instruments to be found?—RARA AVIS.

[4869.]—LENGTH OF PENDULUM.—I have the movements of a clock, the escape wheel of which has 45 teeth, and it revolves once per minute, making in that time 90 beats, each beat, therefore, according to my calculation, being two-thirds of a second; now I wish to know what length the pendulum should be? I purpose making the bob of a brass cylinder, about 2in. in diameter and 4in. long, filled with lead, and the rod of seasoned deal, well varnished. I understand that "the time of vibration of a pendulum varies as the square root of its length," but not being up in mathematics I cannot find the length for myself, and will thank any of my fellow readers for the information.—ELECTRO-MAGNET, No. 1.

UNNOTICED QUERIES.

In future, if any query remains unanswered for four weeks, we shall insert the number and subject of the query in this list, where it will remain for two weeks, if not previously replied to. We trust our readers will look over the list, and send what information they can for the benefit of their fellow-contributors.

Since our last "Blackburn" has answered 4210; "Suffolk Amateur," 3919; S. Moody, 4299; "Boniface," 4294; "Paterfamilias," 4300; "S . . . . r," 4339; "H.B.M." 4351; "Judas," 4372; "J. M.," 4367.

4354 Copper Medal, p. 454.
4357 Coil, 454.
4360 Galvanizing Nails, 454.
4362 Condensing Water, 454.
4366 Insects in Water, 454.
4367 Re-enamelling Zinc Clock Dial, 454.
4372 The Hautboy, 454.
4374 Printing, 454.
4405 Shell Gold, 455.
4406 Supposed Ancient Painting, 455.
4422 Reversing Engines, p. 478.
4426 Steaming Bones previous to Grinding, 478.
4428 Coil, 478.
4429 Tinning and Brazing, 478.
4430 Putting the Shot, 478.
4431 Mending Ebonite Bath, 478.
4435 Changing Red Coral to Pink, 478.
4436 Beekeeping, 478.
4438 Cotton Spinning, 478.
4440 Wheels and Pinions of Watches, 478.
4447 Bogie Engines, 479.
4454 Black Japan Coachwork, 479.
4455 Manufacture of Hard Soap, 479.
4463 Rotatory Motion, 479.

USEFUL AND SCIENTIFIC NOTES.

SOMNAMBULISM.—Two instances are recorded in *Les Mondes* of somnambulism being perfectly cured by the administration of bromide of potassium. In one case, a woman of the age of twenty-four who had been subject to attacks two or three times a week for ten years, was operated upon; the dose given was two grammes of the bromide in seventy-five of water per diem, gradually increased to six grammes; the attacks became at once less and less frequent, and entirely ceased at the end of two months. In the other case, a girl of eight was the subject; one gramme was given morning and evening, and the cure was complete and immediate.

A CAUTION.—R. Bennett says: "In the English Mechanic of the 26th August last, page 546, under the head "A Valuable Table," are given certain dimensions of boxes, which it is stated will contain the several measures or quantities there mentioned. These dimensions are in every case erroneous. The statement is not true, even on the principle that "you can put a pea into a bushel," since there are errors of defect as well as of excess in the table. Subscribers will do well, therefore, to put a note of warning against reliance upon it in the margin of their copies. I give an instance of error. A pint really contains 34·659 cubic inches, plus a very small quantity which may be disregarded. The table states that a box of 4 × 4 × 4¼ (= 68), cubic inches will contain a pint. So it will, and nearly another pint; but that is not, I presume, what the author of the table intended. In any view, the table is calculated to mislead, and hence I am induced thus to address you."

[We obtained the above mentioned paragraph from a journal called the *American Artisan*. As it appeared to contain what is simply a matter of calculation, it did not undergo the customary editorial criticism. In future we shall hesitate before we insert any "valuable" tables found in our Transatlantic contemporaries.—Ed.]

COMPOSITION OF CHINESE LACQUER-WORK.—According to Dr. Wiederhold, genuine Chinese lacquer-work is done over tin-foil, and consists of a mixture of two parts of copal and one of shellac, molten together. When fluid, there are added two parts of boiled linseed oil; and, after the vessel containing this mixture has been taken from the fire, there are gradually added ten parts of oil of turpentine. If colour is required, gummigutta, dissolved in oil of turpentine, yields yellow, and dragon's blood, dissolved in the same liquid, yields red.

IODINE FROM CHILI SALTPETRE.—Professor Wagner says that the manufacture of iodine from Chili saltpetre already amounts to 30,000lb. per annum. The method invented by Thiercelin for its reclamation from the crude material is as follows: The mother liquors resulting from the manufacture of saltpetre are treated with a mixture of sulphurous acid and sulphite of soda, in proper proportion, and the iodine will be precipitated as a black powder. The precipitated iodine is put into earthen jars on the bottom of which are layers of quartz sand, fine at the top, and coarse at the bottom: from this it is removed by earthen spoons into boxes lined with gypsum, and a greater part of the water thus removed. It is sometimes sold in this impure state, or further purified by sublimation.

A CHEAP BATTERY.—Dr. Golding Bird describes a cheap form of battery with which an energetic current can be evolved, sufficient to decompose water, ignite wire, charcoal points, &c. Procure the bowls of six tobacco pipes, and stop up with sealing-wax the holes left by breaking off the stems; next get six small toy tumblers about an inch in height; place in each a cylinder of amalgamated zinc, put a pipe-bowl in each cylinder, and in the pipe-bowl a thin slip of platinum foil half-an-inch wide, connected to the zinc of the next cell by a platinum wire; fill the pipe-bowls with nitric acid, the tumblers with dilute sulphuric acid, and the battery is complete. When platinum cannot be obtained copper will work.

ANSWERS TO CORRESPONDENTS.

*** All communications should be addressed to the Editor of the English Mechanic, 31, Tavistock-street, Covent Garden, W.C.

The following are the initials, &c., of letters to hand up to Tuesday morning, September 6, and unacknowledged, elsewhere:—

W. and T. P., R. F., R. R., J. H., P. C. V., J. O'Connell, Edward B. Fennessey, H. Pocklington, J. R. Allen, Ed. James, T. W. B., Rev. E. Kernan, James Williamson, T. C., W. Kimmis, J. B. Primas, H. P., A Young Man, George, Welby, R., Unit, Argent Sable, J. J. B., F. B. White, Zeta, Espérance, Alpha, Scraper, S. Dixon, G., A Student, Totnesian, Derf Errac, Cuthbert, T. B, A New Subscriber, A. S. C., G. W. A., F. J. Walker, R. N., Harry G. Newton, A. E., E. W. A., M. W. G., Paterfamilias, Ivory, Vulpecula, H. P., G. Valentine, Cabinet Maker, C. H. Wynn, Mechanician, T. L. H., J. A. M., Augustine, Thos. Fletcher, Argus, Farmer, A Mere Novice, A Runaway, Z., G. J. W., T. A., A. Childs, Scio, Idea Cather, W. Pocklinton, H. H., H. W. Henfrey, J. A. H., J. Andrews, Student, Rupert, John Hewitt, G. L., H, W. Reveley, R. D., A Morayshire Man, Mr. Batty, Epps, A. P., W. E. D., G. Prew, J. E. Y., E. Cooper, Atomic, Chemicus, Quill Pen, R. A. M., T. M. Simkiss, North Pole, Graham, F. S. H., Sigma, J. K. P.

Henry W. Henfrey, of Brighton, says:—"I think that with such improved printing, engraving, and paper, the English Mechanic ought soon to double its circulation."

The Phantom Wheel.—Additional letters confirming the views of preceding correspondents, from "Bicycleist," James Thompson, and "J. R." They all repeat the same story, that the "Harmonious Blacksmith" spoke from insufficient experience.

W. S. Owen.—Advertisements for *Sale Column must* be prepaid.

Mr. Browmidge.—We don't answer queries through the post.

T. H. Somerville.—Next week.

T. O'Connor.—All received from you has been inserted.

J. H. N.—Thanks. We have had too many *series* of articles of late, and cannot promise to insert yours at present.

T. W. Boord thanks "Urban" for pointing out the mistake in his answer to "Young Photo," qy. 4622. He "carelessly mistook the solution he mentioned for an old photograph bath" and gave details accordingly.

F. Darkin.—See Mr. Tydeman's letter, 301, p. 467, and the note thereto. All correspondents tell the same tale.

Canadian.—Such a letter should be stamped with some authority.

G. Firth.—With every disposition to give the widest latitude to correspondents, we really do not see the practical use of writing or inserting letters which are more as a pedantic criticism than affording solid information to our readers. Let "G. F." imitate "F. R. A. S." and Mr. Proctor, in sending us substantial contributions, and we will insert all he sends. He evidently possesses great ability, and his last letter is not inserted because we have no desire to encourage correspondence spiced with provocative innuendos.

Tau Tau.—Dr. Grindrod's "Hints to Dyspeptics" was published many years since and may now be out of print. The Doctor was uncourteous in not answering your letter, and particularly when you wanted to buy his book. Perhaps this hint may meet his eye.

R. Baldwin.—No stamps enclosed.

C. A.—Krankentrager means "bearer of the sick," as a porter attached to an ambulance.

E. Smith.—Copper melts at 1996° Fahr.; brass, at 3807° Fah.; tin melts at a lower heat than lead.

Egrec.—The value of a thaler, either in Prussia proper or Germany, is 3s. English money. It is divided into 30 silbergroschen.

A Suggestion.—"Beriro" suggests that the English Mechanic and Mirror of Science should be called "The Amateur Philosopher." The reasons given are that in inducing others to become subscribers it was supposed the English Mechanic was filled with descriptions of machinery and such like, and that "the highly intellectual class" will not take in a paper supposed to be produced for mechanics. There is no doubt much in what "Beriro" says. But it is not an easy thing to alter the name of a paper. Neither do we think we should improve matters much if we called it "The Amateur Philosopher." The English Mechanic is to all intents and purposes a scientific journal, and we have often regretted that a more generic name was not given to it at the commencement.

Aviarian.—The chough, or mountain crow, is seen in considerable numbers in Scotland, Wales, and in Cornwall. It is found in abundance on most of the mountains of Europe, and particularly in Spain. The scientific name is *Fregilus graculus*. It is known by its long arched beak, which, with its short-toed foot, is a brilliant scarlet colour. The eyes are dark brown, and the plumage glossy black. It is about 15in. long by 31in. across the expanded wings.

J. T. B.—The Marquis of Worcester's perpetual-motion wheel was exhibited in the Tower about 1638.

T. H. Rogan.—Any queries on the subject you mention. should appear.

A Young Beginner.—Simply limejuice and glycerine;

Pressure.—Write to Jabez Francis, Rochford, Essex, or Fairbairn & Co., East-passage, Long-lane, Smithfield, London.

Francis Nash.—No.

Un Jeune Belge.—Most of the numbers in Vols. VII. and XI. are to be had.

The "Sixpenny Sale Column" is the only place in which can appear queries by B. W. J. Williams.

C. B. T.—See back numbers.

Oliver Cromwell.—Much information on gilding is to be found in back volumes, especially numbers for September 24 and October 1 and 8, 1869.

Pompey.—Write the publisher.

J. W. Green.—A moment's consideration must convince you that we cannot be responsible for recipes and other directions given by our correspondents. If you want us to look further into the matter you must refer us to the number of the reply.

W. Whetter.—No stamps sent with exchange. Inquire at the Architectural Association, 9, Conduit-street, Regent-street.

J. Davids.—Such a discussion has taken place, and the majority appeared to think electricity beneficial.

Tometer.—We have not received them.

John T. Neelson (Windsor, N.S.W.).—The subscription, with extra postage, is 17s. 4d. per annum.

R. B. Scott.—See back numbers for information respecting construction of aquarium.

A. H.—A sheet of copper 1ft. square by 1-16in. *thick* weighs 2·9lb.; the same in zinc, 2·3lb.

T. Smith.—Patents are granted in the United States *for* seventeen years, and cost £21 10s.

J. B. D.—No. A Prussian mile contains 24,712·5 English feet. The Swedish is the longest, containing 35,073 English feet.

Inquirer.—No. According to the Chartered Gas Company, some specimens of Boghead Cannel coal produce 15,000 cubic feet of gas per ton, with an illuminating power of 37·75; while Dr. Fyfe, with other kinds of Boghead, has obtained 15,486 cubic feet, and an illuminating power of 52·0. Newcastle coal averages about 11,000 cubic feet, giving a light equal to thirteen candles.

W. R. Birt writes: "Will 'Foreigner' kindly communicate with me at Cynthia Villa, Walthamstow, in order that I may append his name to the lunar catalogue as the authority for the intersection of the fissures west of Fontenelle, discovered by him on the 20th of July, 1870?"

G. B. had better consult "Chats on the Constellations" in English Mechanic.

R. T.—Your query is incomplete, write again.

William Stevens.—There is no such book. The nearest approach to such a work is made by the "Replies and Queries" contained in the pages of this journal.

Sabas.—Write to any London toy-maker. For second query see back Nos.

A Very Old Subscriber.—Without more particulars it is impossible to identify the figures engraved on your seal.

T. Welsh.—Any polishing material with a little exertion will brighten tin dish-covers. Possibly the tin is worn off, in which case the covers will need re-tinning.

Bernardin has sent a similar reply to query 4511. Weight of balls, as W. Moor, jun., last week.

S. J. Northington.—Consult a *reliable* man who has capital, and who understands *such things*.

F. F. Henbest.—Too theoretical for the space *the letter* would occupy. Why not ask a query?

Rev. E. Kernan in a private letter says—"I must congratulate you on the unmistakable resolve you have so fearlessly announced of cutting off discourteous letters. I have every confidence that the effect will be just what you say in your note on the letter of 'Lex.'"

H. W. J.—Send your address.

A. L. T.—There are 225 sheets in a box of 1 C tinned plates, each sheet measuring 13¾ × 10in.; the weight is 1 cwt.

Brush.—No. Schweinfurth green is a more beautiful and velvety pigment than Scheele's green. Equal parts of a boiling concentrated solution of acetate of copper, and of arsenious acid are mixed, and when the resulting olive-green precipitate is boiled in the liquor from which it was precipitated, a new deposit takes place in the form of a dense granular green powder. It is also readily made by *adding to the boiling* solutions, their own weight *of cold water, when, in the* course of two or *three days, crystals of Schweinfurth* green are formed.

Foretelling Events.—"W. B." draws our attention to a prophecy of Zadkiel in relation to Louis Napoleon. The following is the paraded prophecy:—"But let him not dream of lasting honour, power, or prosperity. He shall found no dynasty, he shall wear no durable crown, but, in the midst of deeds of blood and slaughter, with affrighted Europe trembling beneath the weight of his daring martial hosts, he descends beneath the heavy hand of fate." To profess to tell a man's future by the light of the stars in such vague language as this, without fixing a time for the event of his life, is, to our minds, pure charlatanism. This prophecy, as it was called, appeared in 1853 or immediately after the *coup d'etat*. Nothing could be easier than to intimate in loose language that the man whose imperial career began in violence and blood would end some time or another in a similar fashion. This miserable prophecy is now being paraded as an advertisement. But the impostor does not state a word about the prediction relating to the Emperor which appeared in his Almanac this year. "The year 1870," he says, "opens favourably for the imperial native. In March he finds much to occupy him with the matters of State. In June he is troubled by the press, and he will be likely to meet with quarrels, and be rather suffering in the head and brain. In August he increases his armies and will be *full of* warlike dispositions, and if at war he will gain some battle. About the middle of October he will have many sudden changes favourable to his wishes; but about the 23rd day let him beware of hurts and accident. This year is prosperous to him generally." Zadkiel says that this year will be generally prosperous to the Emperor, when it has hitherto been the most disastrous year of his life. We have only pity for the deluded purchasers and readers of such a miserable publication.

E. Moorey.—1, Lansdowne-terrace, Wandsworth.

T. J. C.—We have nothing whatever to do with the prizes offered by the now absorbed journal. We expressed our opinion about them at the time. It is also, we think, useless to apply to any one else, as the proprietor of the *British and Foreign Mechanic* was obliged to pass through the bankruptcy court.

A Clergyman writes us a touching letter in reference to his reply to "F. F. C." He says, "My letter, 302, was no sooner beyond my reach than I wished it where it ought to have been—behind the fire. However, I still hoped the yawning waste-basket—the dreaded enemy of so many—might get to be once a friend." He therefore asks pardon of F. F. C. (see "Answers to Correspondents," p. 600), for any harsh or unkindly remarks he may have written. A Clergyman says: "If we cannot write something useful, encouraging, and kind, it were far better not to write at all."